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OR, A
DICTIONARY
OF
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IN WHICH
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By a Society of GENTLEMEN in Scotland.
IN THREE VOLUMES.
VOL. I.
EDINBURGH:
MDCCLXXI.
CONIC SECTIONS.
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Plate XXIII.

ENCYCLOPÆDIA BRITANNICA

THE UNIVERSITY OF CHICAGO

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"LET KNOWLEDGE GROW FROM MORE TO MORE
AND THUS BE HUMAN LIFE ENRICHED."

ENCYCLOPÆDIA BRITANNICA

VOLUME

2

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ENCYCLOPÆDIA BRITANNICA

Volume 2

ANT *TO* BALFE

ANT. The ants are one of several groups of social insects that belong to the order Hymenoptera.

General.—The more than 5,000 known species of ants, including the 600 species and subspecies in the U.S., are classified in seven subfamilies of the family Formicidae (*see* last section below). The ancestors of the ants are believed to have been solitary, fossorial wasps. Nothing is known about the initial evolution of ants, for no fossils antedating the Early Tertiary period (about 70,000,000 years ago) have yet been found. By that time the ants had reached the evolutionary level that they occupy today. Some of the beautifully preserved Baltic amber ants (Oligocene, about 35,000,000 years ago) are so nearly identical with present-day forms to suggest that the fossil and its living counterpart are of the same species.

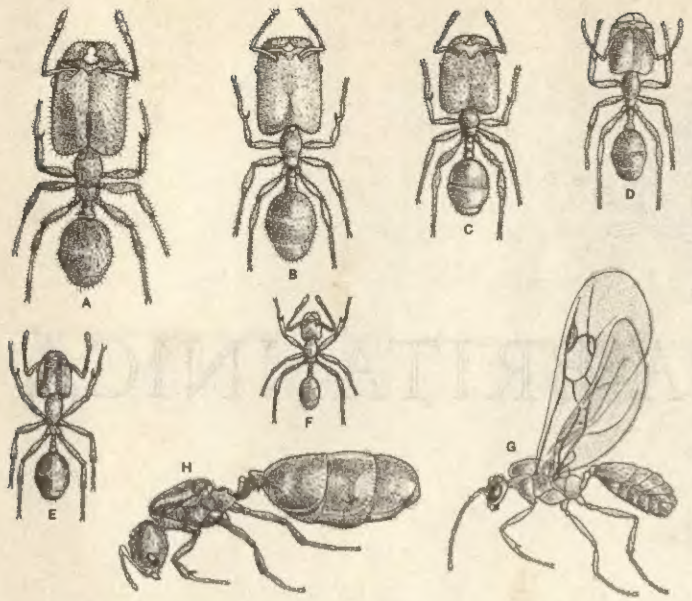
Ants are heat-loving insects and only a few of them can endure cold climates. It follows that the greatest diversity of genera and species is found in the tropics and that the representation steadily decreases with an increase in distance north or south from the tropics. The number of ants in arctic or alpine regions is extremely low, and the group appears to be absent over great areas north of the Arctic circle.

The habits of ants vary endlessly, and it has been suggested that this may be partly due to their method of handling their larvae. Unlike the bees and the social wasps, ants do not enclose their larvae in individual cells. This gives them a flexibility in dealing with both larvae and nest that the other two groups lack. In extreme cases there will be no fixed nest, as in the Dorylinae, who carry the larvae with them during the nomadic phase. Despite their ability to utilize all sorts of nest sites most ants nest in the ground. Thus the majority of them still follow the pattern of their fossorial ancestors, who dug a burrow in the soil, provisioned it and laid their eggs therein.

Similarities and Differences.—It is difficult to give criteria by which any ant can be recognized because of the marked caste differences they show. In most ant colonies three castes (male, female and worker) are present, but in many of them the worker caste is polymorphic and has produced subcastes (major, medium, minor) that can be strikingly dissimilar. This structural diversity is often so great that it is impossible to associate the several castes of a species unless they are taken together in the nest.

Stages of Development.—All castes pass through the same stages of development: the egg hatches into a grublike larva; the larva, after a period of growth, changes into a pupa, and the pupa transforms into an adult. The structural differences that distinguish the castes first appear in the pupal stage, but other significant differences exist from the time the egg is laid. The eggs that develop into males are unfertilized, hence they contain only half as many chromosomes as does a fertilized egg; the characteristics of the male are determined by the chromosomal condition of the egg from which it develops. All fertilized eggs contain a double set of chromosomes, and all such eggs develop into females. The females are of two sorts: some are capable of mating, others are not. The queen, who can mate, is ordinarily winged at maturity. The worker, who cannot mate, never has wings and its simplified thorax is very different from that of the winged queen. Flight plays a large part in the mating reactions of most queen ants, but the lack of it does not explain the inability of the worker to mate. There are a number of ants in which the queen is wingless and has a worker type of thorax. These flightless queens can mate because they have a sac, the seminal receptacle, in which sperm cells are stored during copulation. In the worker this sac is vestigial or absent, hence the worker cannot store sperm. Although the worker cannot produce fertilized eggs it is not a sterile female, for it has functional ovaries and can lay unfertilized eggs that develop into males. But it is unable to lay fertilized eggs, which is the principal function of the queen. Each colony produces males and potential queens at certain times each year, usually in warm weather.

Establishing a Colony.—If a potential queen is to lay fertilized eggs, she must be inseminated, and, since most queens are winged, this ordinarily leads to a complicated set of responses known as the marriage flight. The virgin queen mates with a single male, who also is winged, and the two take off coupled together. During their flight the male transfers to the seminal receptacle of the queen all the sperm cells she will have for the rest of her life. Observations on queens in artificial nests have shown that this supply of sperm cells can last for at least 15 years. Since the only function of the male is to inseminate the queen, he is discarded at the end of the marriage flight and promptly dies. This leaves nest-founding entirely to the queen. Each of the many potential queens that becomes fertilized is capable of setting up (or taking



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

FIG. 1.—EIGHT CASTES OF HARVESTER ANT (PHEIDOLE TEPICANA PERGANDE)

(A) soldier; (B-E) intermediate workers; (F) typical worker; (G) male; (H) queen after loss of wings

over) a nest of her own, provided she survives. The primary objective of the newly fertilized queen is to find a spot where she can safely raise her brood, although this is by no means all that is involved in nest-founding. Ants rarely move their nests after the colony has been established, hence a satisfactory nest site must not only provide immediate protection for the queen but also must later meet the requirements of the developing colony. When these requirements are exacting, the response of the female must be exact. Thus the queen of an arboreal species that can survive only in trees must seek out this environment at the time of nest-founding. It may, therefore, be said that the distribution and the environmental relationships of any species of ant represent the selective effect of the environment on the nest-founding responses of the female during the course of the species' evolution.

Soon after the marriage flight the queen's wings fall off or she pulls them off. The bulky wing muscles then begin to degenerate and are slowly converted into salivary secretions. At this time the queen's ovaries become functional and egg-laying begins. Later these eggs hatch into larvae, which must be fed. In primitive ants the queen will leave the nest at this time and forage for food to give to the larvae. In specialized ants the queen rarely behaves in this fashion. After she has selected a nest site she never leaves it. Thus her first larvae are fed on salivary secretions derived from the degenerating wing muscles. In this type of nest-founding the queen usually eats some of her own eggs. Those that survive transform into very small workers called minims. Once the minims have been produced the queen's greatest difficulty is over, for the minims leave the nest and forage for food and the colony is well on its way to successful establishment. The colony and its queen, who continues to lay eggs fertilized by the stored sperm of her dead mate, may survive for 10 or 15 years.

Trophallaxis.—It is important to understand why the queen tends the brood during nest-founding and why the workers do so after the nest has been established. Affection for the brood is not the reason, for the nest-founding queen normally eats some of her own eggs, and the workers, if prevented from foraging, will eat the brood rather than starve. The brood is tended because those who tend it wish to eat certain secretions that the larvae produce when fed. Food given the larvae is thus exchanged for edible secretions produced by the larvae. This food exchange is called trophallaxis, and it is the basis of ant society. Anything that affects trophallaxis is certain to produce drastic results in the life of the colony; many of the most remarkable habits of ants are measures that cover impaired trophallaxis.

When a great disparity exists between the size of the queen and that of the worker, the queen may be too large to tend her larvae. In the genus *Carebara* the queen may be more than 2,000 times as large as the minute larvae from which the tiny workers are produced. Just before the queen of *Carebara* begins her marriage flight a few workers lock their mandibles on her tarsal hairs. This response is often misdirected, for the workers will also seize the tarsal hairs of the male, and those who do are discarded with him when the marriage flight ends. But the queen's little passengers can tend her brood as soon as she starts to lay eggs. Without them there could be no nest-founding in *Carebara*, since trophallaxis between the queen and her larvae is mechanically impossible.

At the other extreme are the diminutive queens (*Formica*, *Bothriomyrmex*, etc.) whose limited wing musculature cannot furnish enough salivary secretion to bring through the first brood. These little queens may be smaller than their own workers and are not easily recognized as queens. This may help them gain entry into the host nest, for all such queens must have aid in raising their first brood and all depend upon the workers of some other species for this aid. To secure it the little queen must enter the host nest and remain in it until she has replaced her own nest odour with that of the host species. If she can avoid being killed during this period, which she often does by hiding, she will be accepted by the host workers, who will tend her brood. The intruding queen may then dispose of the rightful queen by violence (in *Bothriomyrmex* she climbs on the back of the rightful queen and slowly chews her victim's head off) or she may make herself so attractive to the host workers that they allow their own queen to die of neglect. As the intruder's offspring mature, a mixed colony results, but this is temporary since the host workers ultimately die. Here again this behaviour results from the inability of the diminutive queen to carry on trophallaxis with her larvae during nest-founding.

The most spectacular habits resulting from inability to perform trophallaxis are those of the so-called "slave-making" species in the genera *Polyergus*, *Harpagoxenus*, *Strongylognathus*, *Formica* and *Leptothorax*. These intruding queens are highly pugnacious and can force their way into the host nest. If the queen's entry is resisted she quickly kills any host workers who oppose her. Her ferocity at this time is astonishing, and the surviving host workers soon cease to combat her and try to save their brood. But the intruding queen appropriates all the brood that she can find and guards it so that the host workers cannot recover it. This brood contains pupae, some of which soon transform into host workers who accept the intruder as their queen. By this time the disorganization of the host nest is often so great that the host queen may die of neglect, but if she lives the intruding queen finally kills her and disposes of any hostile workers who still remain in the nest. These complex responses provide the intruding queen with host workers who will care for the brood that she is unable to tend. But the matter does not end here, for workers produced by such queens repeat in large part the nest-founding activities of their queen. At certain times they will force their way into a nest of the host species, kill any opponents that resist them and appropriate their brood. This brood is then carried back to the raider's own nest, where it transforms into workers of the host species. Such mixed colonies are often permanent, for new workers of the host continue to emerge from the brood brought back to the raider's nest. In *Polyergus* the mixed colony must be maintained, for the workers of *Polyergus* feed neither their larvae nor themselves, a deficiency that is rectified by the activities of the host workers. Here trophallaxis has totally broken down, for neither the queen nor the worker of *Polyergus* exchanges food with the larvae.

Liquid Food.—Much of the evolutionary advance that marks the higher groups of ants is attributable to one notable improvement in their trophallaxis—they have developed a method of feeding their larvae liquid food. If the larvae can only be given solid food, which is the primitive condition, many easily secured liquid foods (the nectar of flowers, the sugary honeydew secretions of aphids, the juices of fruits, etc.) cannot be used in trophallaxis. To feed the larvae liquid food the worker must make use of a

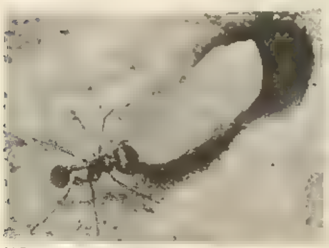
complex abdominal structure, the proventriculus. This combination valve and pump occurs at the posterior end of the crop. Liquid foods that enter the crop can be stored there indefinitely if the proventriculus is kept closed. Enough of this food to keep the worker alive can be admitted to the mid-gut if the proventriculus is briefly opened. Or, if the proventriculus performs its pumping function, part or all of the food in the crop can be forced back into the mouth. This is called regurgitation, and regurgitation is necessary for trophallaxis when liquid foods are employed. The regurgitated food can be fed not only to the larvae but also to any member of the colony. Experiments with liquid food containing tracers have shown that regurgitation may distribute such food to every adult member of the colony in three or four hours.

Food Storage in Repletes.—Certain ants that live in arid areas (*Myrmecocystus, Leptomyrmex* and a few species of *Camponotus*) take advantage of the storage function of the crop to produce a remarkable kind of worker called a replete. The prospective replete is fed large amounts of honeydew or other sugary liquids by the other workers. The storage of these liquids in the crop causes it to become so greatly distended that the abdominal sclerites are forced apart. The engorged replete finally has an abdomen about the size and shape of a large garden pea, made translucent and swollen to the bursting point by the distended crop full of honey. The repletes attach themselves to the ceilings of special chambers, for the enormous abdomen makes locomotion difficult, and supply liquid food by regurgitation as needed. Despite this remarkable adaptation many honey ants also store dead insects in their nests, for few ants are so stereotyped in their diet that they rely on a single kind of food.

ROSS E. HUTCHINS

FIG. 2.—HONEY ANT REPLETE (MYRMECOCYSTUS) HANGING FROM CEILING OF ANT CHAMBER

Ants as Nuisances.—A notable exception to the generalization that ants eat a varied diet is the fungus ant, of which the leaf cutters of the genus *Atta* are the most spectacular. These ants eat only a fungus that they raise in their nests. The workers cut pieces from leaves, bring them to the nest, chew them into a spongy compost and raise the fungus garden on it. Since the nests of *Atta* are usually populous, these ants may strip a small tree overnight, hence they are sometimes a pest to fruit growers. But in most cases they are no more than a nuisance, and this is true of most ants for these insects seldom cause extensive damage unless they are introduced into an area from a foreign source. If an ant is notably insectivorous, as are the army ants of the American tropics, it is usually regarded as beneficial despite the nuisance it causes. Instead of being a dreaded scourge these highly efficient insect exterminators are often welcomed by people who live where they occur. For the temporary inconvenience caused by the intrusion of a column of army ants into a house is outweighed by the fact that when the ants leave the house will be free from insects and other unwelcome arthropods.



AUTHENTICATED NEWS

FIG. 3.—AN ANT LIFTING A STONE, MANY TIMES ITS OWN WEIGHT, UP AND OUT OF ITS BURROW

Exterminating a Colony.—If an ant colony is to be exterminated the queen must be killed. Since she retires to the most obscure part of the nest when disturbed, the most lethal poisons (hydrocyanic acid gas, DDT and the nerve gas derivatives) may fail to reach her. A more certain method involves the use of poison bait, a method based on the fact that the queen receives more food than any individual worker. If the concentration of poison in the bait is correct (usually about 2% of some form of arsenic) it will not kill the foraging workers but will kill the queen when the workers feed it to her. The main difficulty with this method, aside from its slowness, is that no one bait will attract all ants equally well. But, since few ants that are nuisances refuse sugar baits, these generally prove effective if consistently used.

CLASSIFICATION

In the discussion of the subfamilies, the following definitions apply. The petiole is the slender, waistlike part that connects the thorax with the large, terminal gaster. Primary monomorphism is the primitive evolutionary condition of the worker caste in which all the workers are of the same size and not notably smaller than the queen. The next higher condition is polymorphism, in which the workers vary notably in size and often in structure as well. A fully developed polymorphic worker caste contains minors, medias and majors. If the medias drop out a dimorphic worker caste of minors and majors results. If both medias and majors drop out, the worker caste has reached a condition of secondary monomorphism, where all the workers are the same size but notably smaller than the queen. While it cannot be claimed that the worker caste invariably passes through these stages as evolution proceeds, enough species have done so to make the condition of the worker caste a reasonably good index of the degree of evolution.

The family Formicidae is made up of the following seven subfamilies:

Ponerinae.—Petiole of two segments, the second often not clearly set off from the gaster. Sting present and functional. Pupae usually enclosed in cocoons. Worker caste monomorphic (primary), rarely polymorphic. Uniformly carnivorous. Many of the larger ponerines have atrocious stings and use them freely. In areas where such ants occur the natives detest and fear them.

Cerapachyinae.—Petiole as in the ponerines. Sting present and functional. Pupae, where known, enclosed in cocoons. Worker caste monomorphic (primary). Carnivorous and living largely upon other ants whose nests they raid. A small and little-known subfamily that combines ponerine and doryline features.

Dorylinae.—Petiole of two segments, the second usually, but not always, clearly set off from the gaster. Sting present and functional. Pupae naked or enclosed in cocoons. Worker caste polymorphic or monomorphic (secondary?). Carnivorous and nomadic. The African "drivers" and the Neotropical "army ants" belong to this subfamily. The doryline queen always lacks wings and has a voluminous gaster capable of great distention during periods of active egg-laying.

Pseudomyrminae.—Petiole of two segments. Sting present and functional. Pupae never enclosed in cocoons. Worker caste monomorphic (primary). Omnivorous. Mainly arboreal although some species live in the hollow stems of sedges and grasses. Most members of this subfamily are slender, agile ants with large eyes. Some of the species are very pugnacious and sting severely.

Myrmicinae.—Petiole of two segments. Sting always present but not always functional. Pupae never enclosed in cocoons. Worker caste polymorphic, dimorphic or monomorphic (secondary). Widely diverse food preferences. In this subfamily there are harvesters, fungus growers, slave makers, thief ants, guest ants, arboreals and workerless parasites. One group of genera has become secondarily carnivorous and feeds entirely on collembola. This is the largest subfamily and most diverse one, both in structure and habits. It has produced a number of species that are regarded as pests. The "grease ants," "pavement ants" and "fire ants" belong to this subfamily.

Dolichoderinae.—Petiole of one segment. Sting vestigial, except in one genus. Pupae never enclosed in cocoons. Worker caste mainly monomorphic (secondary), occasionally polymorphic, rarely dimorphic. Omnivorous. These ants possess repugnatorial glands that produce a powerful odour that repels other ants. This subfamily is a highly successful one, although it lacks the great structural diversity of Myrmicinae. The habits of the Dolichoderinae are also rather uniform, but the group has produced

arboreal species, a genus that has repletes and one whose female is a temporary social parasite. The "Argentine ant" belongs to this subfamily.

Formicinae.—Petiole of one segment. Sting absent, the poison sac much modified. Pupae usually enclosed in cocoons. Worker caste polymorphic or monomorphic (secondary) or occasionally dimorphic. Omnivorous. This is the second largest subfamily. While it has produced a number of species whose structure is greatly modified, in the main the structure is rather uniform throughout the subfamily. Nevertheless this subfamily shows a considerable range of habits. There are species that produce repletes, slave makers, temporary social parasites and arboreal species with widely different habits. One group of arboreals makes a nest of leaves, which they "sew" together with silk produced by the larvae. An unusually large proportion of the species in this subfamily are able to tolerate cold climates. It follows that most people who live in north temperate areas derive their concept of ants from this subfamily. Often it is based on the "carpenter ant," which is a widespread and troublesome member of this group.

See INSECT: *Classification; Hymenoptera* (*Ants, Bees, Wasps, etc.*); SOCIAL INSECTS: *Ants; see* also Index references under "Ant" in the Index volume.

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(W. S. CR.)

ANTA, in architecture, the slightly projecting pilaster strip at the extremity of a wall that flanks a porch or part of a porch. It is a masonry development from early wooden structural posts used, as in the Heraeum at Olympia, to reinforce the brick walls. The term is also used in modern work to describe any pilaster

(LEFT) FROM BUHLMANN, "CLASSIC AND RENAISSANCE ARCHITECTURE" (NEFF & HELBURN); (RIGHT) BY COURTESY OF THE ORIENTAL INSTITUTE

(LEFT) ANTA AND COLUMN, TEMPLE OF NIKE APTEROS, ATHENS; (RIGHT) ANTAE AND COLUMNS IN ANTIS, TEMPLE OF RAMESES III AT MEDINET HABU, EGYPT

whose detail resembles that of a true anta. Columns set between antae are termed "in antis." *See* GREEK ARCHITECTURE.

ANTALYA (ADALIA), an ancient seaport and capital of an *il* (province) of the same name on the southern coast of Turkey. Pop. (1960) 50,908. The walled city occupies the summit of a low cliff overlooking the harbour, which is protected by extensions of the fortifications. The modern town spreads westward along the cliff, with municipal buildings and gardens, a market and hotels. There are considerable remains of the Roman occupation, including "Hadrian's gate" in the north wall and a fragmentary temple of Diana. There are also Seljuk buildings, in one of which, a medrese with a fine minaret, is a museum. Antalya is accessible from the interior only by road from the railhead at Burdur (75 mi.) or from Mersin by the new coastal road. The harbour is suitable only for small coastal steamers. There is an airport 4¼ mi. from the town.

Founded in the 2nd century B.C. by Attalus II, king of Pergamum, the town was bequeathed by his family to the Romans. As the biblical Attaleia it was the port from which SS. Paul and Barnabas sailed to Antioch. In A.D. 135 Hadrian made it the capital of a senatorial province, Pamphylia. A Byzantine stronghold in the 10th century, it was taken by Kilij Arslan in 1207 and became the first Seljuk port on the Mediterranean. After the fall of the Rum sultanate, it changed hands many times, being successively occupied by the Mongols, the Karamanoglu, the Venetians and the Genoese. It was incorporated in the Ottoman empire in the 15th century.

ANTALYA *il*, containing two *kaza* (districts), consists mostly of a crescent-shaped coastal plain hemmed in by the Taurus mountains. Pop. (1960) 418,355. It has become a tourist area because it is easily accessible by motor road, and because of such well-known historical sites as Aspendus (*q.v.*) with its finely preserved Roman theatre, Perga (*q.v.*), Sillium, Side near Manavgat, excavated by Turkish archaeologists, and the picturesque Seljuk fortress and harbour at Alanya (Ala'iyya). In ancient times part of the modern Antalya was the district of Lycia (*q.v.*).

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(S. H. LL.)

ANTANANARIVO (Fr. TANANARIVE), the capital of the Malagasy Republic (Madagascar) and the seat of the French high commissioner. It is centrally situated about 90 mi. from the island's eastern coast. The climate is tropical with a cool, dry season and a warm season that brings torrential rains. The average temperature is 65° F. The population increased rapidly during the 20th century. In 1901 there were 56,000 inhabitants and in 1960 the figure had grown to 247,917.

The town, formerly called Analamanga ("the blue forest"), stands on the highest of 12 hills in a mountainous region comprising Tananarive province (area 22,042 sq.mi.; pop. [1960 est.] 1,209,168), of which Antananarivo is the administrative seat. Avenues and flights of steps lead up the steeper hillslopes to a rocky ridge (4,694 ft.) which rises over 600 ft. above the fertile plains of the Ikopa to the west. High on this ridge is the rova or royal estate with its towered palaces built by the Imerina kings. Lower on the hillside, in the district off the Place Colbert, are the banks and administrative buildings, and lower still, at the level of the rice fields, is the commercial quarter. Public buildings include the French residency and the Anglican and Roman Catholic cathedrals. In addition to many missionary schools there are research institutes, an observatory and schools of law and medicine; the university has faculties of science and literature. Antananarivo is the distributing centre for an extensive rice-growing region. Its industries include tobacco and food processing, and factories produce leather goods, clothing and foodstuffs.

Air travel is of paramount importance. The airports at Ivato and Arivonimano are about 25 mi. and 38 mi. respectively from the town. Antananarivo is linked by rail with Tamatave (*q.v.*), the island's chief port, on the eastern coast and with Antsirabe to the south. Main roads from the north, south and east coasts converge at Antananarivo, the only road to the Mozambique channel being merely track for part of the way.

Founded in the 17th century, Antananarivo was for a long time the capital of the Hova chiefs, but it advanced in importance as those chiefs made themselves sovereigns of the greater part of Madagascar. In 1794, with the capture of the town by Andrianampoinimerina, prince of Ambohimanga, the town's precedence in Imerina (the central district) was established. The first Frenchmen penetrated to Antananarivo in 1777, and in 1832 arrived the French artisan Jean Laborde who introduced many industries. Both Protestant and Catholic missionaries began to settle there in the 1820s. Because of its politico-economic importance and its central position, Antananarivo was selected as its headquarters by the French command when it was set up in 1895. *See* also MALAGASY REPUBLIC. (J. AR.)

ANTARAH (ANTAR; Arab. 'ANTARAH IBN SHADDAD AL-'ABSI), Arab poet and warrior of the second half of the 6th century, famous both for his poetry and as a figure in Arabic legend, comparable with Hercules in Greek mythology or Samson in the Old

Testament. His father was of the tribe of 'Abs and his mother a Negro slave. He loved his cousin 'Abla, but his request for her hand was refused because, not being acknowledged by his father, he was regarded as a slave. He won his father's recognition when, as he relates in one of his poems, the 'Absites were attacked and a fierce engagement ensued in which Antarah refused to join, saying, "A slave does not know how to fight"; whereupon his father cried, "Charge, you are free!" Many of his exploits were performed in the war between the tribes of 'Abs and Dhobyan, which began over a contest of horses and was called after their names the war of Dahis and Ghabra. He died in extreme old age in a fight against the tribe of Tai. The most famous of his poems (which are chiefly concerned with fighting or with his love for 'Abla) is contained in the collection of pre-Islamic odes known as the *Mu'allaqat* (*q.v.*). The romance of his life, *Sirat 'Antar ibn Shaddad*, was long handed down by oral tradition and has grown to immense proportions. It recounts heroic deeds against great odds, the slaying of a lion by the tearing apart of its jaws and an adventurous excursion into Persia, where Khosrau II showed him favour.

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ANTARCTICA, the continent lying concentrically about the geographic south pole. Antarctica increases in importance as it becomes better known, and it is also significant as an area of large-scale international co-operation.

This article is divided into the following sections:

I. GENERAL SURVEY

1. Location and Description.—Antarctica lies in unique isolation in the triangle formed by the southernmost extension of South America, Africa and Australia. The nearest oceanic approach to a neighbouring continent is about 600 mi. (970 km.) across Drake strait from Tierra del Fuego to the tip of the Antarctic peninsula (a recently accepted name after long disputes over priority of discovery during which the British previously called this peninsula Graham Land and Americans called it Palmer peninsula; Argentina named it San Martin and Chile, Tierra de O'Higgins). Surrounding the continent is the Southern (or Antarctic) ocean, which is merely the confluent portions of the Pacific, Atlantic and Indian oceans; it is notoriously the stormiest in the world, for there is nothing to break the force of the persistent west winds. Warmer tropical waters meet with cold antarctic waters in a remarkably permanent girdling line ranging between latitude 45° and 65° S. known as the Antarctic convergence. This line, which varies considerably with longitude but generally within and not more than a degree or two of latitude per year, establishes a boundary between subtemperate and subantarctic zones. South of the convergence the waters are characteristically ice-laden and abound with subpolar aquatic life. It is a feeding region for myriads of pelagic sea birds and is the location of Antarctica's principal industry—whaling.

The continent itself is essentially circular in form except for the Antarctic peninsula and the inward bights of the Ross and Weddell seas. The great mile-thick (average) layer of continental ice thins toward the coasts and discharges flat-topped icebergs into the surrounding seas from piedmont glaciers, ice tongues and shelf-ice systems (*see* also Glacier). Along the periphery of the continent are rugged mountain peaks left bare by the skirting and receding ice. Farther inland the rugged landscape is generally drowned by ice cover, although gentle rolling surfaces and crevassed regions in places reflect its hidden character. Seismic exploration of the great expanses of deep ice cover indicate vast lowlands and areas in which the land surface is depressed below sea level by the weight of thousands of feet of ice cover.

The continent is asymmetrically divided into two parts by the high upthrust Transantarctic mountain range exceeding 15,000 ft. (450 m.) elevation. This cordillera runs from Victoria Land on the New Zealand side toward Coats Land on the Atlantic side. Its central relationship with the Andean-type ranges of the Antarctic peninsula is still uncertain for lack of adequate exploration. The geological formations of this central range seem to bear little resemblance to the Andean type, however, and its flat-lying, uplifted sedimentary rocks are in part carboniferous. Extensive low quality bituminous coal outcrops to within 200–300 mi. (320–480 km.) of the south pole yield fossils which portray an earlier age when the continent was forested. Whether this former warmer climate was due to climatic change, polar wandering or continental drift is still a matter of conjecture and investigation.

West Antarctica, the lesser of the two major subdivisions of the continent, lies almost entirely within the western hemisphere, facing toward the Pacific ocean. Ice soundings have shown this region to be largely an ice-covered archipelago. Ice thickness between the islands ranges to 14,000 ft. (4,270 m.) with elevations 4,000–6,000 ft. (1,200–1,800 m.) above sea level. West Antarctica is bordered by the bights formed by the Ross and Weddell seas. Its most thoroughly studied regions include Marie Byrd Land and the Antarctic peninsula.

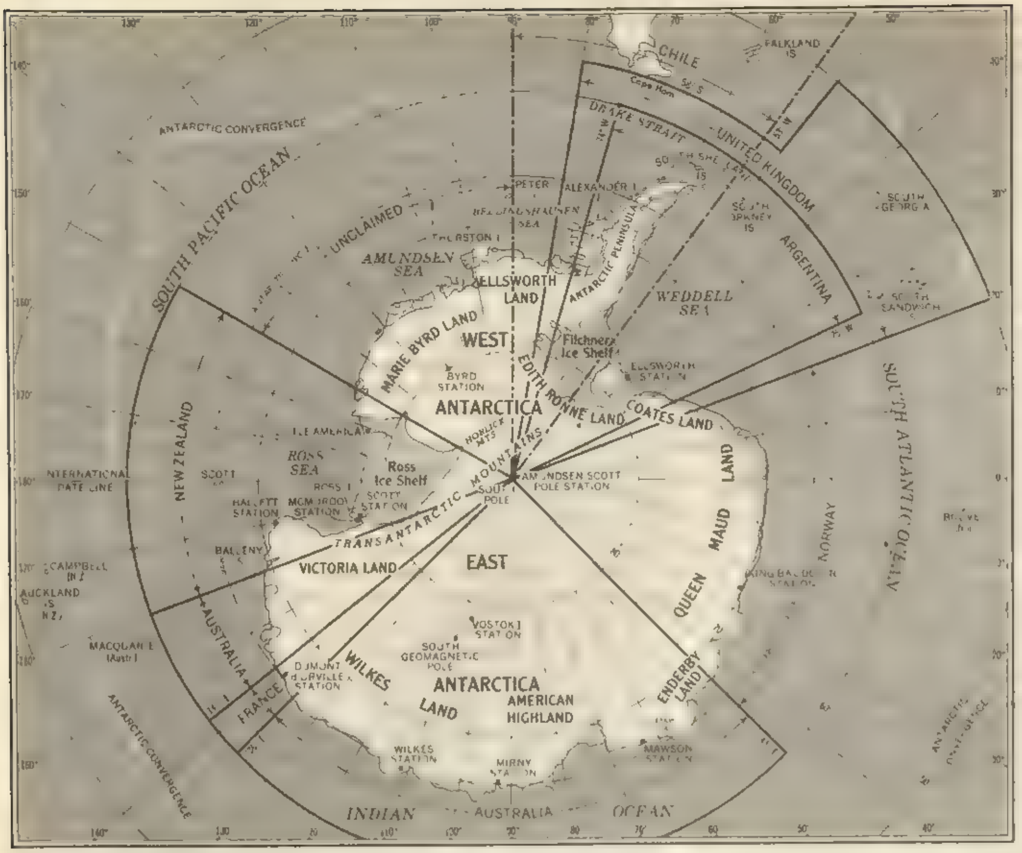
East Antarctica is nearly twice as large as west Antarctica and lies mostly within the eastern hemisphere. It appears to be more contiguously a continental mass. The subsurface beneath the ice is extremely rugged except west of Victoria Land, where it appears to be an extensive plain close to sea level; the internal ice cover forms nearly featureless domes rising to elevations above 1,200 ft. (370 m.).

Taken as a whole, with its lofty mountains and ice cover, Antarctica averages about 8,000 ft. (2,400 m.) in elevation, the highest of all the continents.

In sharp contrast to the lushness of sea life, the continent is virtually lifeless. Seals and birds that frequent the coasts and off-lying islands of Antarctica depend upon the sea for food and do not go farther inland than necessary to find breeding grounds. Aside from microscopic forms of life sparsely detectable in the snow and melt ponds, the only permanent life on the continent are lichens, mosses, fungi, a few grasses and two diminutive flowering plants. Tiny insectlike creatures find shelter and livelihood in the more luxuriant clumps of these hardy plants.

2. Knowledge of the Region.—Surrounding islands were discovered during the 18th century, but until 1820 sea ice prevented even the most daring navigators from seeing the continent itself. Positive recognition of a land mass of continental proportions was achieved in the mid-19th century, but, aside from relatively insignificant landings, the first fruitful efforts to explore the interior were initiated near the beginning of the 20th century.

Deep penetration by Ernest Shackleton, R. F. Scott and Roald Amundsen culminated in Amundsen's reaching the geographic south pole first in Dec. 1911, about 31 months after the north pole was reached by Robert E. Peary. It was not until the advent of new technical advances, such as aircraft, radios and aerial photog-



ANTARCTIC TERRITORIAL CLAIMS, TO REMAIN STATUS QUO UNDER THE TERMS OF A TREATY SIGNED BY 12 NATIONS ON DEC. 1, 1959. THE TREATY DEDICATES ANTARCTICA FOR PEACEFUL PURPOSES ONLY AND IN EFFECT INTERNATIONALIZES THE ENTIRE CONTINENT. (ICE SHELVES INDICATED BY LINED AREAS)

raphy, that the bulk of the coast lines and interior were first crudely mapped in the late pre-World War II period. Afterward much improved technical developments further stimulated interest in exploring the continent. Foremost was the appearance of powerful ice-breaking vessels which could shepherd cargo vessels through pack ice; the coast guard icebreaker "Northwind," leading vessel of the U.S. navy's Operation "Highjump" in 1947, was the first of its class to approach Antarctica. Advances in aircraft, aerial cameras, communications, weather forecasting and navigation systems and aids improved the ability to reach icebound coasts and inland areas denied to earlier expeditions.

A further significant change was in personnel. Early visitors to Antarctica, except for crews of sealing and whaling vessels, were unpaid volunteers who went exploring for adventure. In the post-World War II period there was an abundance of available military and civil service personnel, as well as excesses of usable military supplies, ships, aircraft, vehicles, foods and instruments, making logistics less difficult. All members of exploring parties became well-salaried employees; nominal leaders were administrators who themselves could not afford the time to remain in the antarctic during winter and in some cases not even in summer. Stations therefore became more like agencies receiving instructions from outside the continent. Nevertheless, the new approach provided longer continuity, and systematic long-range surveys and scientific programs became possible.

The continent can be said to be permanently inhabited since 1943, even though its personnel is usually exchanged annually. There was a marked increase of scientific exploration of Antarctica in the period 1955–60 associated with the International Geophysical year (*q.v.*) of 1957–58, and after IGY an intensive co-operative scientific program continued.

3. Ownership.—At the present time, by international agreement, the questions of antarctic ownership have been set aside in favour of unrestricted, co-operative, scientific exploration. However, previously the declared ownership of parts of Antarctica was confused and controversial among seven claimant nations. The United Kingdom, New Zealand, Australia, Norway and France agreed basically among themselves in laying claim to the bulk of the continent, with the notable small central portion of west Antarctica conceded to the United States. Norway's claims were the most modest, extending only to their coastal discoveries facing the Atlantic between longitude 45° E. through the Greenwich meridian westward to longitude 20° W.

France's claim of Terre Adélie, which is the smallest segment of any claimant, is bounded by longitudes 136° E. and 142° E. and flanked on either side by Australian claims. France also claims the Crozet and the Kerguelen islands in the southern Indian ocean.

The United Kingdom formerly made extensive claims but later bequeathed large portions of them to New Zealand and Australia. The New Zealand claim included the wedge-shaped segment extending from longitude 150° W. westward past the international date line to 160° E., bordering the Australian claims in Victoria Land. The French-split Australian claim was the largest national claim, extending from 160° E. westward to 45° E., adjoining the Norwegian claim. This region lying south of Australia and the Indian ocean included Wilkes Land, an important American discovery in 1847. Australia also claimed the Macquarie, Heard and other islands.

The British claim retained for itself the Falkland Islands dependencies (*see* FALKLAND ISLANDS AND BRITISH ANTARCTIC TERRITORY). It incorporated the best-known portion of Antarctica, the Antarctic peninsula and the numerous islands of the South Shetland and South Orkney archipelagos. South Georgia, whaling centre, was also included in the claim area, which extended in a segment to the pole lying between longitudes 20° and 80° W.

Argentina and Chile made conflicting claims of most of this same area, originally and primarily on the basis of the extension of their national longitudinal boundaries south to the pole, although after World War II both nations maintained many small military bases. The Argentine claims of 1943 extended between longitudes 25° and 74° W., including the Falkland Islands and South Georgia. The Chilean claims extended southward of latitude 60° S. between longitudes 53° and 90° W. British efforts to take the conflicting claims case to the International Court of Justice in 1947 and 1955 were ignored by Argentina and Chile.

Although U.S. citizens have laid claim to portions of Antarctica, the United States government has never made any formal claims nor recognized the assertion of other claimants. Other nations that have taken part in the exploration of Antarctica without laying claims include the U.S.S.R., Belgium, Japan, Germany, Sweden, Poland and South Africa.

In 1959 an Antarctic treaty extending for 30 years was signed by the 12 nations then actively exploring Antarctica and was later acceded to by other nations. Provisions of this treaty opened Antarctica to unrestricted scientific exploration in a spirit of international co-operation. Claimants agreed to place questions of sovereignty into abeyance during the period of the treaty without prejudice to their prior rights. They further agreed that no exploration during the treaty period would be used as a basis for future claims. If the treaty is extended indefinitely, Antarctica

may become the first international land in recent world history.

The bases of the various claims and the related question of the future status of Antarctica are discussed at greater length in following sections of this article. (PL. A. S.)

I. PHYSICAL CHARACTERISTICS

1. Meteorology.—The weather and climate of Antarctica are the result of several factors: (1) its location near the south pole of the earth, with the implied astronomical influences; (2) its great elevation, which intensifies the polar climate; (3) its perpetual snow cover with strong reflective and radiative characteristics that also intensify the polar climate; (4) its complete isolation from all other continents by a completely surrounding ocean of relatively warmer water.

The antarctic atmosphere has the same composition as that of the rest of the world, except that the principal variable gaseous component, water vapour, has only about one-tenth the concentration, on the average, that it has in middle latitudes. Excluding the Antarctic peninsula, the monthly mean temperature during the warmest month is around 32° F. (0° C.) in the coastal region and from −30° to −4° F. (−35° to −20° C.) in the interior; the water-vapour concentration can be no higher than about 5.5 and 0.5 gr. per cubic foot, respectively. In winter the coldest monthly mean temperature is from about −22° to −4° F. in the coastal region and from −94° to −40° F. in the interior; the water-vapour content is less than 0.9 and 0.002 gr. per cubic foot, respectively. The carbon dioxide content is between 310 and 315 parts per million, about the same as other parts of the world. Total atmospheric ozone is at a maximum in spring, usually November; limited dark-season data indicate minimum during the winter. Dust and other pollutants are practically unknown. Nuclear radiation, also, is at the very lowest levels observed on earth.

The total of the incoming direct and diffuse solar radiation reaches values of 75%–85% of the solar constant, depending upon the altitude of the station. The high values are partly due to the earth's being at perihelion—that point of its orbit nearest the sun—during the southern hemisphere summer, but the clear, dry atmosphere and high elevation of Antarctica are important factors. However, as much as 80%–90% of the incoming shortwave radiation is reflected by the snow surface. Only the upper three to five feet of the snow cover absorb appreciable amounts of the solar energy, and it is quickly lost again in the dark season because the dry atmosphere has little blanketing effect. Small amounts of cloud do not appreciably reduce the total amount of solar radiation reaching the surface, since there is a high multiple reflection caused by the snow surface and the underside of the clouds. In some cases this can even raise the total of the direct and diffuse radiation reaching the surface to a value higher than that of the solar constant; *i.e.,* the amount of radiation from the sun reaching the top of the atmosphere. The albedo, or reflectivity of the snow surface, varies from about 75% to 90%; values tend to be lowest after periods of ablation (*e.g.,* sublimation, melting, evaporation) and wind erosion and highest after fresh snowfall. The albedo has a seasonal as well as shorter period variation.

The isotherms of mean annual temperature over Antarctica generally approximate the terrain contours; the warmer temperatures are found near the low-lying coast and the coldest temperatures are found on the high plateau in the interior of east Antarctica, which averages between 2,600 and 3,600 ft. higher than the pole elevation of 9,200 ft. The annual mean on the plateau is about −68° F. and temperatures below −125° F. have been reported.

Although it is the world's coldest continent, Antarctica is not uniformly cold. Variations in the atmospheric circulation bring about considerable differences in temperature, both in time and in space. The minimum temperatures at one place do not always occur during the same month from one year to another, and places several hundred miles apart may be under completely different temperature regimes at the same time. A rise and fall of as much as 15° F. in the monthly mean temperature can take place in successive months during the winter. Under conditions of large-scale flow of air from the oceans to the continent, increased cloudiness will inhibit the loss of heat by radiation from the snow surface as well as increase the amount of heat radiated downward to the snow surface; a rise of as much as 25° F. in one day can occur.

In winter the main supply of heat to Antarctica is the warm air carried by the atmospheric currents. The first strong radiational cooling in winter causes an early winter temperature minimum, but the atmosphere reacts to this by changing its circulation so as to bring in the warmer air; finally, at the end of the winter, radiational cooling again becomes dominant and late winter minimum temperatures are noted, usually just before the return of the sun.

The cyclonic storms that move around Antarctica often pass across the west Antarctica highland, and even across the south pole, but only rarely over the higher plateau of east Antarctica. The exchange of air horizontally in the levels from about 8,000 to 15,000 ft. is such that a temperature fall of only about 15° F. is noted in the monthly mean values from summer to winter. The very lowest layers of the atmosphere lose heat by radiation and by contact with the snow surface. The result in these cases is inversion—that is, the temperature increases with height, and a gradient of 50° F. in 1,000 ft. is not uncommon.

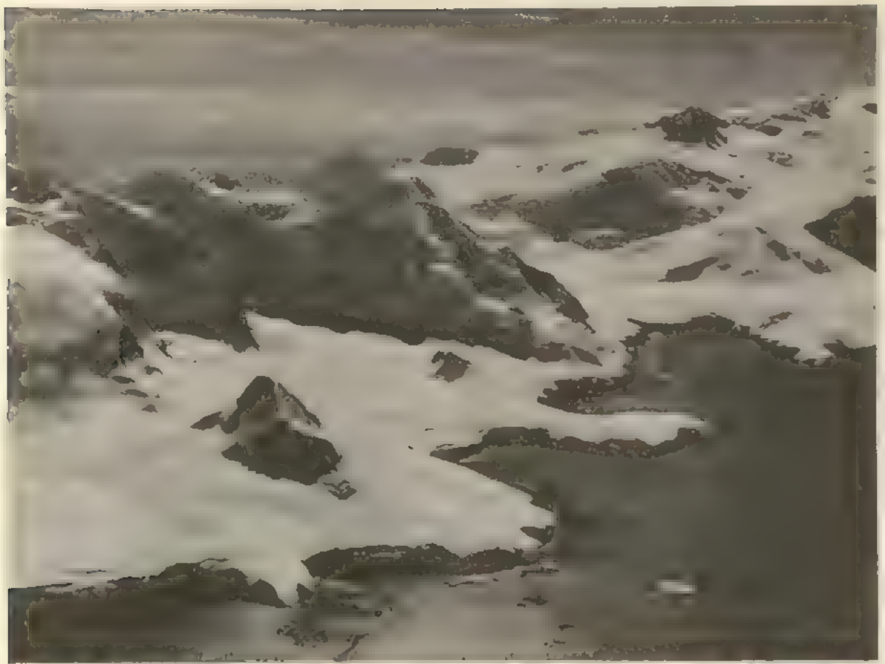
Cyclones on the polar front attain great intensity and size; the air trajectory and the contrast between ocean and continental underlying surface are the principal factors in the development of weather at a given spot. The great storms and blizzards of long duration are related to deep disturbances extending in many cases from sea level to the tropopause (the boundary between the troposphere and the stratosphere), a height of about five miles in summer and six in winter. Storms of blowing snow accompany the disturbances and even persist for some hours after the passage of the initial storm. The shallow storms tend to move quickly around the periphery of the continent and are not related to the large-scale planetary waves in the atmosphere. The large storms move in arclike, clockwise trajectories, generally from the northwest to the southeast, and remain north of the coast line in most cases.

The high level of the continent, the strong gravitational outflow of the cold air in contact with the surface and the procession of storms act against the formation of large polar anticyclones, although the surface pressure in some localities has gone above 1,035 millibars. Some of the cold anticyclones have provided sufficient cold air, both from west Antarctica and from east Antarctica, to reach other southern hemisphere continents, although much modified by overwater trajectories of several thousand miles.

The jet stream, the core of winds of maximum velocity, found usually just below the tropopause and in regions of maximum horizontal temperature gradient, tends to broaden its latitudinal extent and strength in winter and tends to narrow and weaken in summer. Surface winds frequently attain speeds of 100 m.p.h. or more during the passage of storms along the coast of east Antarctica. The steep slope of the continent accentuates the geostrophic component of the wind in these cases; along low-lying coast lines, the maximum force of the wind is usually less.

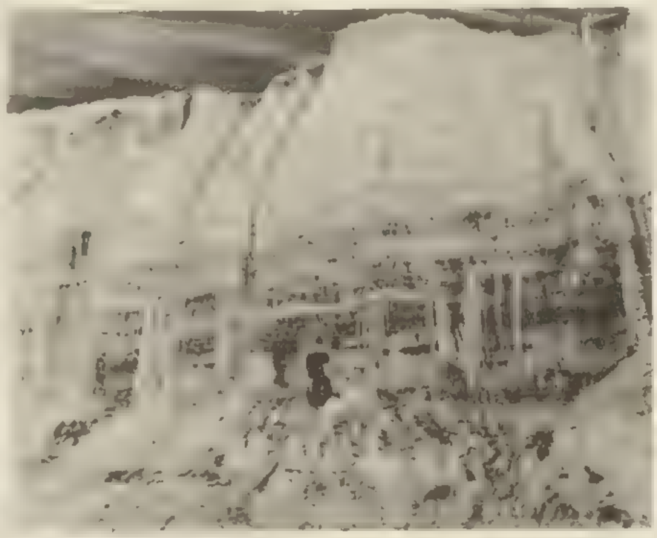
The extension of the "effective" continent as much as six degrees of latitude farther north of its summer coast line comes about through the freezing of the surface layers of the ocean in winter. This inhibits the vertical exchange of heat between ocean and atmosphere and also provides a longer continental trajectory for the air of oceanic origin that reaches the continent. This is one reason for lower average cloudiness in winter than in summer.

In the spring and early summer great changes take place in the stratosphere. The circulation that was strongly cyclonic, with westerly winds averaging as much as 100 m.p.h., changes abruptly. In the free atmosphere at altitudes of about 12 mi. and higher, warming of as much as 70° F. takes place between early October and November, and easterly winds generally prevail. Much of this warming appears to be due to the transport of warm air from lower latitudes and to adiabatic heating—that is, an increase in air temperature as a consequence of internal processes of contraction caused by sinking motions over the continent; it is only partly caused by absorption of solar radiation in the atmosphere. During this period there is a sharp rise in surface pressure from the late wintertime minima that are noted almost everywhere over Antarctica to the summertime maxima. Great masses of air are transported and as much as 150,000,000 tons of air are lost or gained



(TOP LEFT) AEROFILMS AND AERO PICTORIAL LTD., (TOP RIGHT) PAUL POPPER, (BOTTOM LEFT) NATIONAL GEOGRAPHIC SOCIETY, (BOTTOM RIGHT) NATIONAL SCIENCE FOUNDATION

(Top left) Snow-covered peaks of volcanic rock, Brabant Island; (top right) the Matterhorn berg; (bottom left) mines in the snow, which provide source of water supply and samples for glaciology studies; (bottom right) Wilson piedmont glacier at Marble Point across McMurdo Sound



over Antarctica from one month to another. Water-vapour condensation not only adds to the snow cover but also contributes about 14% of the net heat energy transported by the atmosphere. It is estimated that between five and eight inches of water equivalent is deposited in the form of snow over Antarctica in one year, on the average. The coastal regions have up to ten or more times the two inches snowfall deposited on the interior. If there were no outflow of this snow, or no loss in any other way, it would have taken from 9,000 to 15,000 years to deposit the 5,750,000 cubic miles of ice that is currently thought to cover the continent.

(M. J. Ru.)

2. Geology.—The geology of Antarctica is imperfectly known, as would be expected in a continent not fully explored and whose exposed bedrock amounts to less than 1% of the continent's surface. However, in a general way Antarctica can be divided into east Antarctica, which lies south of Australia and Africa, and west Antarctica, which lies south of South America. The dividing line between these two areas, the Transantarctic mountains, lies along the west side of the Ross sea and Ross ice shelf and extends north of the Horlick mountains to the Weddell sea.

East Antarctica was considered a shield area of igneous and metamorphic basement rocks of Precambrian (?) Age partly overlain by sedimentary rocks of Paleozoic to Mesozoic Age. This shield is bounded on the west side of the Ross sea and Ross ice shelf by the block faulted and folded Transantarctic mountains. In the interior, ice about 9,000 ft. (2,740 m.) thick rises to altitudes of 7,000 to 12,000 ft. and caps the bedrock. The bedrock is below sea level in many places.

Basement rocks in Victoria Land consist of granitic gneiss, mica schist, granulite and crystalline limestone which is intruded by granite containing veins of aplite and pegmatite. Overlying these rocks and extending at least to the Horlick mountains are flat-lying sedimentary rocks that consist of limestone of Cambrian (?) Age, and the Beacon group, consisting of quartz sandstone, arkose, conglomerate, shale, limestone and coal of Devonian (?) to Triassic (?) Age. These sedimentary rocks are intruded by diabase sills and dikes and cut by faults. Volcanic rocks at Mt. Discovery and at Mt. Erebus on Ross Island (the only continuously active volcano in Antarctica) are the youngest rocks in the area. Volcanic rocks also are found on offshore islands and in the northern part of Victoria Land in the vicinity of Cape Adare, where occur slates and graywackes of the Robertson bay group, of possible Early Paleozoic Age. Basement rocks similar to those in Victoria Land are exposed in some places along the coast of Wilkes Land.

From Wilkes Land to Enderby Land the basement is composed of quartzite, hornfels, gneiss, aplite, pegmatite, gabbro, norite, pyroxenite and hypersthenite of Precambrian (?) Age. Hypersthene granite, and diabase and basalt intrude part of these rocks. Southeast of Mawson, flat-lying arkosic sandstones and grits with

pebble beds and coal of Permian (?) Age are tentatively correlated with the Beacon group of Victoria Land. Slates, graywackes and volcanic rocks are exposed along the coast farther west.

West Antarctica has mountains jutting through an icecap that is thicker in places (over 14,000 ft. [4,270 m.]) but also generally lower in elevation than the plateau of east Antarctica.

Andean folding and volcanism can be traced southward from Cape Horn to the Scotia arc and Antarctic peninsula, where plutonic rocks are flanked on the west and north by a volcanic belt along the Scotia arc and on the east by sedimentary rocks. Conglomerates, sandstones and slates containing fossils of Jurassic Age occur on the east side of the Antarctic peninsula, and similar rocks and limestone are along the east side of Alexander I Island. Volcanic rocks have invaded the sedimentary sequence. Islands at the northeastern end of the Antarctic peninsula contain conglomerates and sandstones of the Snow Hill group of Cretaceous Age, which are overlain unconformably by conglomerates and sandstones of the Seymour Island group of Eocene to Miocene Age.

In Marie Byrd Land quartzites and slates about 15,000 ft. thick in the Edsel Ford ranges and the Rockefeller mountains are intruded by granite, granodiorite, quartz monzonite and recent volcanic rocks. Samples collected in the Executive Committee range and south of the Kohler range indicate that those mountains are of volcanic origin, whereas low-grade metamorphic rocks have been found in the foothills of the Sentinel mountains. Diorite is exposed in a part of Thurston Island but most of the island has been inadequately explored.

Geologists have thought that a broad ice-filled channel exists between the Ross and Weddell seas. However, new data indicate that a ridge of bedrock from the Sentinel mountains to the Transantarctic mountains crosses the supposed channel, and, instead, a deep trough may exist between the Bellingshausen and the Ross seas.

No minerals have been found in economic concentrations, but those of potential value include atacamite, azurite, beryl, bornite, cassiterite, chalcopyrite, chromite, fluorite, galena, gold, graphite, hematite, magnetite, malachite, manganese minerals, molybdenite, monazite, sphalerite, stibnite and uranium minerals.

Coal has been found near Mawson and in many places in the Beacon group from Coats Land, the Horlick mountains, Queen Maud range, Beardmore glacier region and northward into Victoria Land. The coal ranges from lignite to anthracite in grade and is generally in seams only a few inches thick, but one seam eight-feet thick was found near the top of Beardmore glacier by Shackleton's party in 1908. No petroleum has been discovered but it is conceivable that some may be in sedimentary rocks. (A. R. TA.)

3. Southern Ocean.—The Southern, or Antarctic, ocean forms the principal connecting link between the other major subdivisions of the world ocean (*see* OCEAN AND OCEANOGRAPHY). Although its northern limit has to be set quite arbitrarily and therefore has been characterized in various ways, it is convenient to follow the practice of the British admiralty and to define the Southern ocean as all the waters south of latitude 55° S. It thus has a total area, up to ice shelf edges, of 12,451,000 sq.mi. (32,248,000 sq.km.), with an average depth of 12,240 ft. (3,701 m.). Of this total area 5,643,000 sq.mi. is part of the Pacific ocean, 3,180,000 sq.mi. is part of the Atlantic ocean and 3,628,000 sq.mi. is part of the Indian ocean.

An appreciable additional portion of the Southern ocean is overlain by floating ice shelves and hence is commonly included in the area assigned to antarctic land. The Ross ice shelf covers about 160,000 sq.mi. of ocean, and the Filchner ice shelf and the extensive ice shelves off Marie Byrd Land, Queen Maud Land and elsewhere bring the total to about 360,000 sq.mi. Even inland from the ice shelves, Antarctica cannot be considered wholly as dry land, since measurements made during the International Geophysical year of 1957–58 showed that a large portion of the interior (possibly as much as a quarter) consists of ice of a thickness greater than its height above sea level. Thus, much of the "continent" is an island archipelago with glacier ice extending to the bottom of a former shallow ocean area.

The great circle routes between Cape Town and Melbourne, and from Australia or New Zealand to the North Atlantic via Cape Horn, penetrate deep into the Southern ocean. The use of the Suez and Panama canals has greatly reduced the shipping in southern waters, and many parts of the Antarctic are regularly visited now only by whalers, research ships and expedition vessels.

Seas and Islands.—The narrowest part of the Southern ocean, the strait between South America and the Antarctic peninsula, is known as Drake strait or Drake passage. The sea to the east, bounded by South Georgia and the Falkland, South Sandwich, South Orkney and South Shetland islands, is the Scotia sea. The Weddell sea is the area south of the Scotia sea from the Antarctic peninsula east to Cape Norvegia in 12° W. Cape Adare in 170° 15′ E. and Cape Colbeck in 158° 10′ W. mark the extremities of the Ross sea. The Amundsen sea is the bight between Cape Dart in 123° W. and Cape Flying Fish in 101° W. The Bellingshausen sea extends from Cape Flying Fish to the Antarctic peninsula.

There are few oceanic islands in the antarctic. The Scotia ridge trends east from Tierra del Fuego and then loops south and west to join the Antarctic peninsula. Its elevated portions form South Georgia (which lies just north of 55° S.), the Clerke rocks (about 40 mi. to the southeast), the South Sandwich Islands (a chain of volcanoes, some still active) and the South Orkneys. Bishop and Clark islands are a group of rocks in 158° E., outliers of Macquarie Island in 54° 45′ S. The Balleny Islands are an ice-covered volcanic chain in 67° S., 164 ° E. Scott Island, in 67° 24′ S., 179° 55′ E., is less than 100 mi. from the intersection of the Antarctic circle with the international date line. Peter I Island is a glacier-covered extinct volcano rising nearly 4,000 ft. above sea level in 68° 50′ S., 90° 35′ W.

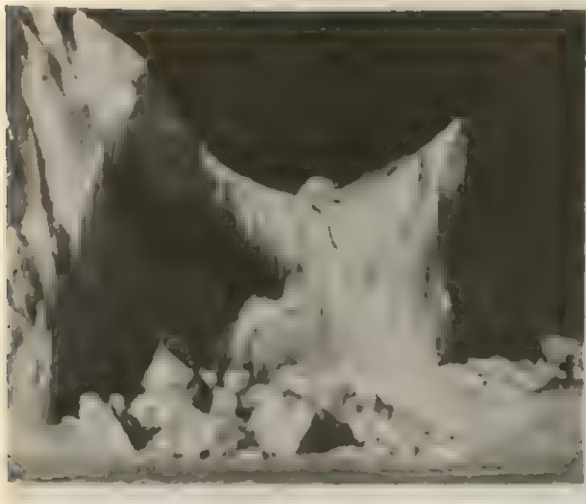
The principal islands of the continental shelf areas of the Southern ocean are Cape Horn and the neighbouring islands off Tierra del Fuego, and the South Shetlands and numerous other islands off the Antarctic peninsula. Alexander I Island (16,700 sq.mi.), in the eastern Bellingshausen sea, is the largest island south of 55° S. discovered by 1960. It is joined to the mainland by an ice shelf. Several islands have been identified beneath the Ross sea ice shelf.

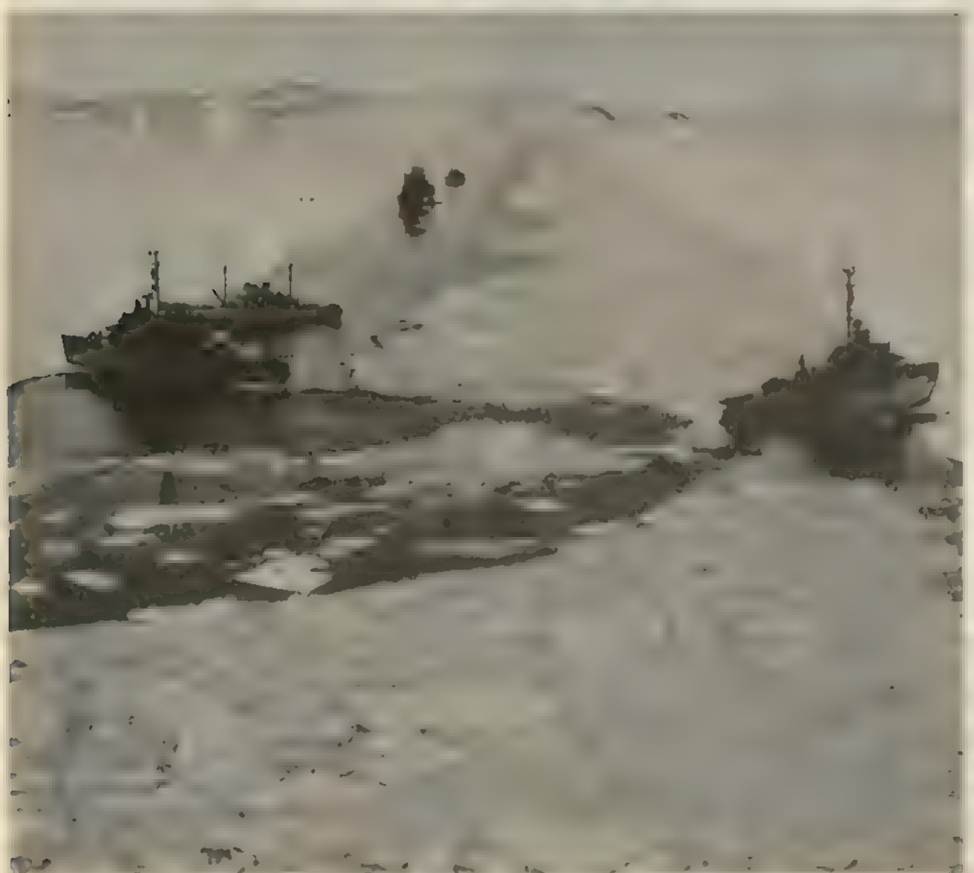
Ocean Floor.—The continental shelves surrounding Antarctica are to a large extent covered with ice shelves. Seaward of the ice shelf edges the continental shelves are mostly at a depth of 1,200 to 1,800 ft. They are widest in the western portion of the Weddell sea and in the southern Ross, Amundsen and Bellingshausen seas, with a maximum width of more than 300 mi. Elsewhere, as off Queen Maud Land, the continental shelf is virtually lacking. The sediments of the continental shelves are a random mixture of fine to coarse fragments of the continental rocks.

The deeper waters of the Southern ocean are characterized by four deep basins with soundings mainly from 15,000 to 18,000 ft., separated by ridges with depths of less than 12,000 ft. The largest of these basins lies between the Scotia ridge and a ridge running north and south through the middle of the Indian ocean (the mid-Atlantic ridge ends at the northern limit of the Antarctic ocean). It includes the Meteor Deep, a trench with a maximum sounding of 27,108 ft., just east of the South Sandwich chain; elsewhere its greatest depth does not exceed 19,500 ft. Between the mid-Indian ridge and a ridge running south from Tasmania is a smaller basin with a greatest depth of about 16,000 ft.; farther east a basin having a greatest depth of about 19,000 ft. about midway between New Zealand and Victoria Land is separated from the fourth basin by a ridge that runs northeast across the Pacific from Victoria Land. North of the Amundsen and Bellingshausen seas, this basin has a maximum depth of about 18,000 ft.

The pelagic sediments of the Antarctic ocean are composed chiefly of diatomaceous oozes, with an admixture of glacial clays, particularly north of the Weddell sea. These grade into the globigerina ooze of the central Pacific and into red clay closer to South America.

Tides and Currents.—There is a fairly uniform progression of the tidal wave from east to west around Antarctica. The tides are mainly diurnal, but mixed tides exist south of the Indian ocean along the western part of Wilkes Land and on the other side of the continent on the northern part of the Antarctic peninsula and the off-lying islands. Tidal ranges are moderate, mostly less





THE CHURCH BERG AND GROTTO (TOP LEFT) AND THE CASTLE BERG (TOP RIGHT): IMMENSE ICEBERGS CREATED FROM FLOATING CONTINENTAL SHELF ICE. (BOTTOM) ICEBREAKERS CLEARING A PATH THROUGH FLOATING SEA ICE NEAR LITTLE AMERICA

than five feet except at the northeastern tip of the Antarctic peninsula, where they may reach eight feet

The principal surface circulation of the Antarctic is part of the west wind drift, with a current of generally less than a knot setting easterly around the continent South of the Antarctic divergence which, except in the Weddell and Ross seas, is about 250 mi from the continent, there is a surface flow to the west. This current is best developed in the Weddell sea where it sweeps clockwise against the Antarctic peninsula

Water Masses and Deep Circulation.—The Antarctic divergence which exists around most of Antarctica, marks roughly the boundary between the prevailing westerly winds and the easterly and northeasterly winds that blow off the continent. About 600 mi northward is the Antarctic convergence, the position of which varies greatly with longitude, depending on the configuration of the coastal boundaries and the bottom topography. The surface waters south of the Antarctic convergence are colder than [illegible] F. in winter, except where the convergence reaches its farthest northerly limits. North of the Antarctic divergence there is a summer increase of about 5° F. in water surface temperature but farther south most of the summer heat is used to melt pack ice, and water of 30° F. or colder still surrounds the continent. This belt of cold water undergoes an increase in salinity and hence in density during the winter as the pack ice freezes, and it sinks to great depths all around the continent, especially off the Weddell sea. Deep water is forced to the surface by this process. At the Antarctic convergence cold surface water sinks beneath the subantarctic waters to the north This Antarctic intermediate water can be traced as far north in the Atlantic as 20° N. The surface salinities in the Antarctic are close to $34^0/_{00}$, except in the vicinity of melting ice, where they may be as low as $32^0/_{00}$. The deep convection of the Antarctic ocean is the main mechanism preventing stagnation in the deeper waters of the oceans to the north

The Barrier.—A unique phenomenon of Antarctica is the floating shelf ice, which is a derivative of the inland ice sheet When Capt. J. Clark Ross in 1841 first penetrated the pack ice into the Ross sea, he sailed due south until he was brought up in about 77° S. by the ice front of the greatest of these shelves, from 50 to 200 ft. high, barring his way to the south. The Ross ice shelf, as it is called, is the largest of these floating ice shelves but is typical of many others in the Antarctic. It is roughly the size of France and consists of a sheet of ice varying from [illegible] to [illegible] ft. or more in thickness, the outer end being open to the ocean and the inner end held fast to the continent by the glaciers, which act as feeders and by being anchored on shoals close to the actual coast. Its surface is smooth and it forms the easiest approach to the pole itself, since it reaches to within 300 mi of it. The tabular icebergs of the southern hemisphere, with their flat tops, stratified appearance and immense size (up to 90 mi in length of side) are derived from this shelf ice

The Sea Ice.—The sea ice itself is comparatively temporary It begins to form in sheltered bays as early as the end of January and by the beginning of March any ship is liable to be frozen in unless its harbour is a windy one. There are large variations from

year to year in the area of sea solidly frozen over, since strong winds, and such are very frequent, will prevent sea ice from forming or will blow out any that is not of considerable thickness. In sheltered bays the ice will continue to increase in thickness until October or November, by which time it will be any thickness up to seven feet. This will begin to break up and float northward from the beginning of December onward, but the innermost bays may not lose their ice until late in February, or occasionally not at all for two years or more in succession. The belt of pack ice which rings the continent is made up of the ice from this summer breakup. (J. L.)

4. Animal Life.—*Birds.*—Bird life of Antarctica is essentially marine, and, in keeping with general characteristics of the plant and animal life of cold oceans, it is poor in number of species but relatively rich in number of individuals. The birds of the region may be generally divided into those species inhabiting the islands within the subantarctic, some of which are within the Antarctic convergence, and those found on islands within the Antarctic circle and along the continent.

Within the Antarctic circle the emperor penguin (*Aptenodytes forsteri*), the Adélie penguin (*Pygoscelis adeliae*), the snow petrel (*Pagodroma nivea*) and the south polar skua (*Catharacta maccormicki*) are circumpolar in distribution and might be considered truly indigenous to the area. The emperor penguin, following the end of its winter breeding season, spends the summer no farther north than the edge of the pack ice. Conversely, the Adélie penguin nests on the islands and on the mainland of the continent during the summer and spends the winter within the pack ice. The south polar skua has the distinction of being the world's most southerly bird in its distribution. It has been observed within 80 mi. of the geographic south pole.

The emperor penguin is the most truly antarctic of all birds and is distinctive from other polar species in that it begins nesting in the winter. Unlike the Adélie penguin which has a fixed nest site that it returns to annually, the emperor penguin has no nest and merely carries the egg on top of its feet. It has no territorialism, and most of the rookeries are located on sea ice adjacent to the continent.

Prior to the IGY six emperor penguin rookeries had been located in Antarctica. These known rookeries included Cape Crozier in the McMurdo sound area at longitude 169° E., the first ever discovered; the Dion Islet rookery off the west coast of the Antarctic peninsula, south of Adelaide Island, where the British conducted the first detailed studies of the species; a rookery near Gaussberg in Kaiser Wilhelm II Land at longitude 89° E., reported by the Germans; the Point Géologie rookery in Adélie Land at longitude 140° E., which was studied by the French; the Haswell Islet rookery at longitude 92° E., discovered by Mawson in 1915; and a rookery at Taylor glacier on Mac-Robertson Coast at longitude 61° E., reported by the Australians in 1955. Known population figures for all these rookeries totaled less than 40,000 birds.

The Cape Crozier rookery, found in 1902 by members of the British National Antarctic expedition, was revisited by New Zealand scientists in Sept. 1957. It had shifted position somewhat from its original location on the sea ice and had about 1,000 adult birds, approximately five times the estimated population 50 years earlier.

During the IGY five new emperor penguin rookeries were discovered by the Australians, bringing to six the known number between longitudes 55° E. and 80° E. Two other rookeries were found in the Weddell sea area at Halley bay and Gould bay, numbering 21,000 and 8,000 birds respectively. These discoveries confirmed earlier reports of the presence of breeding birds.

Another large emperor penguin nesting area was discovered from a helicopter by United States personnel in Dec. 1958. Located approximately 250 mi. N. of McMurdo sound at latitude 73° S., longitude 169° E., between Coulman Island and Lady Newnes ice shelf, the rookery contained an estimated 33,000 breeding pairs. By 1960 known emperor penguin rookeries numbered 14 with an estimated population of more than 150,000. (*See* also PENGUIN.)

Additional bird species either nest on the islands and coasts of Antarctica or spend much of their time within this zone, and can be considered circumpolar in distribution. These include the giant petrel (*Macronectes giganteus*); silver-gray fulmar (*Priocella antarctica*), which except for the snow petrel is the commonest bird in the pack ice throughout the whole circumpolar belt; Cape pigeon (*Daption capensis*); antarctic petrel (*Thalassoica antarctica*); Wilson's petrel (*Oceanites oceanicus*); antarctic whalebird (*Pachyptila desolata*); antarctic tern (*Sterna vittata*); antarctic blue-eyed shag (*Phalacrocorax atriceps bransfieldensis*); and the kelp gull (*Larus dominicanus*). Other species will come within the zone at times but only about 32 species of birds penetrate beyond latitude 60° S. and most of these are subantarctic rather than polar wanderers. One of these, the arctic tern (*Sterna paradisea*), migrates from its nesting grounds in the arctic to the antarctic.

Mammals.—The antarctic seas are rich in marine mammals, particularly seals and whales, and whaling constitutes the only industry in the whole antarctic region. This industry is controlled, in part, through action of the International Whaling commission, organized in 1946. About 70% of the annual world catch of whales is taken in the antarctic. The species of most importance belong to two suborders, the Odontoceti (toothed whales) and the Mysticeti (whalebone whales). The whalebone, or baleen, whales, instead of having teeth, have a straining mechanism which enables them to feed on small marine organisms. The antarctic baleen whales of greatest industrial importance include the fin, sei, humpback and blue, the last mentioned being the largest of all whales. The sperm whale is the most important of the toothed whales. Fin

BIRDLIFE IN ANTARCTICA

(Above) Skua in flight, one of the world's most southerly birds; (left) emperor penguin, the only Antarctic bird that breeds in winter; (below) Adélie penguin, one of the few species native to Antarctica

whales, which form about 50% of the world catch, constitute about 70% of the total antarctic catch of all species. The more common smaller whales in antarctic waters, which are not usually taken commercially, include the killer whales. (*See* also WHALE; WHALING.)

Whereas mammal life in the arctic is closely related to forms found within the adjacent temperate belt, much of the similar life in the antarctic is largely endemic. This distinctive character is exemplified in the four well-marked genera of truly antarctic seals, which are unusual in that they show remarkably diverse structure correlated with no less distinct habits.

The crabeater seal (*Lobodon carcinophagus*) lives in the pack ice during winter and summer and is circumpolar in the antarctic but occasionally reaches subantarctic latitudes. It appears to be semimigratory, is gregarious and is the commonest seal in those waters. It lives almost exclusively on the pelagic shrimp *Euphausia superba*.

The Weddell seal (*Leptonychotes weddelli*) is more southern in distribution than the crabeater seal, and its range is confined more to the fast ice along the coasts throughout the year. It is gregarious, occurs in considerable numbers in parts of its range, is circumpolar, and occasionally reaches subantarctic latitudes. It feeds on large fish up to 50 in. in length, which are obtained by diving to depths of 1,400 ft.

The circumpolar Ross seal (*Ommatophoca rossi*) is the rarest of the four polar species. It inhabits the pack-ice belt, is solitary in its habits although a group of 10 were seen in the Ross sea, and appears to feed on fish and cephalopods.

The leopard seal (*Hydrurga leptonyx*) has a rather broad latitudinal range and is found from the shores of the antarctic continent northward to parts of the temperate zone. It is semimigratory, solitary in its habits and relatively widespread, but scarce. This aggressive seal preys on other seals and penguins as well as on fish and cephalopods.

The elephant seal (*Mirounga leonina*) normally breeds on the subantarctic islands but is occasionally found in antarctic waters. Several rookeries of immature seals have been found on the edge of the continent in Indian ocean waters. These largest of all seals were formerly hunted for their oil. Although once nearly extinct, their numbers are increasing. Fur seals, for nearly a century reported extinct, have been reported in small colonies on several subantarctic islands. Bird Island off South Georgia has a rookery estimated at 15,000 fur seals. (*See* also SEAL.)

Marine Zoology.—As a result of upwelling of replacement water, bringing up plant nutrients such as phosphates and nitrates, antarctic waters are perhaps the most productive in the world for marine animals. The enriched waters produce heavy plant plankton growths, which in turn result in rich growths of animal plankton. These are fed upon by various vertebrates and invertebrates, which results in extremely large populations of zooplankton. Representatives of most invertebrate groups are found there, one of the more important being the small shrimp *Euphausia superba*, whose food consists of plankton. This shrimp is a most important food for great numbers of vertebrates, particularly whales.

Fishes native to the antarctic are primarily of the order Nototheniiformes, a perchlike group confined to waters of the far south and somewhat analogous to the cod in the northern hemisphere. The order is remarkable for including several species that lack pigment in their blood. It is believed that the high solubility of oxygen at the temperature of the cold antarctic waters and the low metabolic rates required at these same near-freezing temperatures make it possible for these fishes to transfer sufficient oxygen to their tissues from their gills by simple physical solution in the blood plasma, without the necessity for the chemical linkage with hemoglobin that is required in nearly all other vertebrates. Other fishes include eelpouts (Zoarcidae), many species of which are circumpolar. Of the antarctic fish about 90% are of endemic species and 65% of endemic genera.

Terrestrial and Fresh-Water Animal Life.—The land and fresh-water animal life within the Antarctic convergence is comprised primarily of primitive forms of arthropods (insects, crustaceans, etc.), which are usually found among mosses, algae and lichens, or in moist soils or fresh-water pools. The more widely distributed species of insects in the antarctic appear to be parasites of birds and seals. About 44 terrestrial species are presently known and include biting and sucking lice, mites, springtails, ticks and wingless flies. Other animals include the tardigrades, or water bears, and various species of fresh-water rotifers. (C. R. E.)

5. Plant Life.—The land vegetation of Antarctica consists almost entirely of the lower cryptogams, of which the lichens and mosses are the largest plant forms. Terrestrial and fresh-water algae are equally abundant and probably more widely distributed; cryophilous (cold-tolerant) algae appear to have a restrictive range notwithstanding the fact that more than 90% of the continent is covered with ice and snow. Large showy fungi are absent from Antarctica, but the basidiomycetes, *Omphalina* and *Galerina* (Agaricales), have been reported respectively from the Antarctic peninsula, and South Georgia and other subantarctic islands. Yeasts, lower fungi and bacteria have been cultured from the primitive antarctic soils, from mosses and algae and from snow. It is quite likely that the antarctic microscopic flora is widespread, and evidence to date suggests that many species are of cosmopolitan distribution. Observations in 1965 reported the southern limits of lichens at 86° 09′ S., 176° 50′ W. at an altitude of 5,200 ft. in the Shackleton glacier area. Mosses were collected at 84° 35′ S., 174° 52′ W., at an altitude of 2,310–2,515 ft. and also at 84° 42′ S., 170° W. Bacteria were cultured from soils obtained near the Shackleton glacier.

Lichens are the most conspicuous part of the land vegetation. The fruticose *Neuropogon* occasionally grows over the ground in large dark-green patches, but it is the yellow splotches of the crustaceous *Caloplaca* on rocks about penguin rookeries that provide a modicum of colour to the coastal landscape. Lichens are much less in evidence in the interior and are generally less abundant, smaller and less conspicuous. Lichen vegetation is best developed in the Antarctic peninsula; it is relatively profuse at Wilkes and Hallett stations in comparison to that at McMurdo station or other ice-free areas south of the Antarctic circle. *Verrucaria serpuloides* in the Antarctic peninsula is unique in that it is a marine lichen, growing in the infralittoral zone to a depth of 33 ft. The actual number of lichen species is open to question, although estimates have ranged to 400 different types. In general, the antarctic lichen flora is not as well developed as that in the arctic regions.

Mosses have almost as wide a distribution as the lichens, but they are less frequent away from the coast. The moss vegetation is a striking feature in some parts of the Antarctic peninsula, where it forms dense mats to about three feet in depth and may extend in areas up to an acre. The few *Hepatica* species were believed restricted to the peninsular region, but collections of these were made at Wilkes station (1957) and Cape Hallett (1964). The Antarctic bryophytes are estimated to number about 80 species.

The Cyanophyceae, or blue-green algae, are the dominant terrestrial and fresh-water algae of Antarctica. During the austral summer small ponds quickly develop blooms of algae. The yellow, green and red snows reported from some coastal areas and subantarctic islands are an ephemeral phenomenon brought about by the sudden bloom of cryophilous algae in association with microscopic fungi and bacteria. These growths have not been reported from the interior ice cap. The larger cryptogams exhibit the same world-wide distribution of species earlier attributed to the microscopic flora.

Only two species of vascular plants, the grass, *Deschampsia antarctica*, and the pink, *Colobanthus crassifolius*, have been collected within the Antarctic circle. These plants occur only on the west coast of the Antarctic peninsula and the adjoining subantarctic islands; both are reported to produce seed. In 1953 a single specimen of the grass, *Poa annua*, was found on Deception Island; another grass, *Poa fratensis*, and the chickweed, *Stellaria media*, were later found on the Antarctic peninsula and Signy Island. There is no evidence that these weeds have established themselves. The distribution of the land vegetation, both cryophilous and ter-

restrial, is concentrated largely on the periphery of Antarctica. This serves to point up the favourable influence of maritime climatic factors and the fertilizing value of bird guano from coastal rookeries; this peripheral region also represents the greatest area of ice-free land in Antarctica. However, oases, dry valleys and other ice-free land along the coast are frequently lacking in any vegetation, primarily because of excessively dry conditions. The lower cryptogams are highly dependent on free (melt) water and this, more than low temperature, restricts their distribution. The vascular flora is thought to be limited by the consistently low temperatures, and the short growing season of the summer.

An important factor in the development of antarctic plant life is the complete isolation of Antarctica from other continents in the southern hemisphere. Botanists are divided on the natural plant provinces of the south polar regions; these have been most recently distinguished as the high antarctic, low antarctic and subantarctic. There are two theories on the origin of the present-day antarctic flora. One is that it represents a remnant of the pre-Pleistocene vegetation that managed to survive as periglacial or refugium species; others believe that the present vegetation reinvaded the continent along the Scotia Arc Islands or that plant spores and seeds were distributed south with the help of winds and birds from adjacent continents. (G. A. LL.)

III. EXPLORATION AND DISCOVERY

1. Conjecture About Antarctica.—The great bulk of knowledge about Antarctica has been accumulated since the mid-1950s because of the remoteness of the antarctic regions. However, the existence of climate zones similar to those in the northern hemisphere had been predicted by Greek philosophers; the name of the region is from the Greek *antarktikos*, "opposite the Bear," the northern constellation. The first humans to approach the far southern frozen seas may have been Polynesians. According to Rarotongan legends, Ui-te-Rangiora and his Polynesian companions made such a voyage about A.D. 650 in the canoe Te-Ivi-o-Atea. For western civilization, however, it was not until the 15th century that exploration of the southern hemisphere began, when Prince Henry the Navigator in 1418 encouraged the penetration of the torrid zone in the effort to reach India by circumnavigating Africa, which led to Vasco da Gama's rounding of the Cape of Good Hope in 1497. Successive explorations set a southern limit to the great known continents without approaching the true antarctic regions, but geographers still believed in the existence of a vast southern continent.

The search for it was a leading motive of explorers in the 16th and early 17th centuries. Men lost the fear of open oceans after the Columbian period, but they were inhibited from going far south by choice after Amerigo Vespucci, Ferdinand Magellan and Sir Francis Drake pioneered the shortest route around the tip of South America. Voyagers rounding Cape Horn frequently met with contrary winds and were driven southward, but no navigator is known to have crossed the Antarctic circle before James Cook. Almost all of those who encountered the southern ice before 1750 did so by being driven off their course and not of set purpose. An exception is the French naval officer J. B. C. Bouvet de Lozier, who during Jan. 1739 traveled through ice-encumbered sea for 48° of longitude in 55° S., a voyage that resulted in the discovery of Bouvet Island in 54° 10′ S. On Feb. 12, 1772, another Frenchman, Y. J. de Kerguelen-Trémarec, discovered land in 50° S. which he believed to be part of the southern continent. Sent out again to complete the exploration of the new land, he found it to be only the inhospitable archipelago now called Kerguelen Islands. Meanwhile, between Jan. 13–24, 1772, yet another French navigator, Marion Dufresne, had discovered the Crozet and Prince Edward islands.

2. Crossing the Antarctic Circle.—On his voyage of 1772–75 Capt. James Cook, one of the most famous British seamen of his day, boldly approached the antarctic pack ice with the sailing ships "Resolution" and "Adventure," circumnavigating Antarctica without sighting land. In the course of his voyage he crossed the Antarctic circle several times, reaching 71° 10′ S. at 106° 54′ W. on Jan. 30, 1774, a record not to be surpassed in the 18th century. He disproved connection of islands, such as New Zealand, to any southern continent, and reduced the conjectured size of Antarctica to lie within the 60th parallel. After he discovered the South Sandwich Islands in the South Atlantic he concluded that if land lay farther south it was inaccessible and valueless; and his voyage suggested that there might be no antarctic land mass at all.

Sealers.—Cook's voyage ushered in a new era of antarctic history. Mariners now dared to enter the cold seas up to the forbidding ice pack, and soon sealers began to visit southern waters, in the exploration of which they played an important part. Between 1790 and 1820 there entered antarctic waters about 19 voyages, one Australian and the rest half U.S. and half British. In 1790–92 Capt. Daniel F. Greene from New Haven, Conn., visited South Georgia and took the first fur sealskins to China. This U.S. sealing expedition was the first American approach to the antarctic and culminated in a circumnavigation of the globe. In 1810 Frederick Hasselborough, an Australian, discovered Macquarie Island.

Then suddenly the antarctic experienced an economic boom. In the period between 1819 and 1822 about 110 U.S. and British voyages were made by sealers into the area south of South America, but, because there was considerable rivalry and secrecy, discoveries became confused and lost. In Feb. 1819 William Smith of the British brig "Williams" saw land in 62° 42′ S.; repeating the voyage in October, he landed on the South Shetland Islands. Within a year these islands were the haunts of many U.S. and British sealing ships.

3. Discovery of the Mainland (1820–99).—The "Williams" with Smith aboard was chartered by the British naval commander Edward Bransfield, who on Jan. 30, 1820, surveyed the South Shetlands and went as far as 64° 30′ S. Bransfield and Smith may have been the first to discover and chart a portion of the antarctic mainland, which they named Trinity Land. Later in the same year, on Nov. 16, the young U.S. sealer Nathaniel B. Palmer discovered an archipelago and more of the mainland coast. In early 1821 Capt. John Davis, another U.S. sealer, made what appears to be the first landing on the mainland. Thus began the complex history of the discovery of the Antarctic peninsula. A party of British sealers made the first antarctic wintering on King George Island in the South Shetlands in 1821. In 1821–22 George Powell, accompanied by Palmer, discovered and surveyed the South Orkney Islands.

Bellingshausen.—In 1819 a Russian expedition was sent out under the command of Fabian von Bellingshausen in the "Vostok," with M. P. Lazarev in the "Mirny" in company, each sloop of about 500 tons. The object was to circumnavigate the antarctic area, keeping as far south as possible in those longitudes where Cook had made his northward detours. On Jan. 22, 1821, as he was completing his journey, Bellingshausen sighted the first land ever seen within the circle, the little island named for Peter I. A week later another and larger island, named for Alexander I, was seen. Bellingshausen then made for the South Shetlands and thence returned to Russia.

Exploring Whalers.—The furious slaughter of seals in the South Shetlands and South Orkneys during two seasons from 1820 through 1822 depleted the supply and came suddenly to an end. In the next 15 years an average of less than two ships per year approached the antarctic, and in some years there were none. During this period, however, as the commercial emphasis turned toward whaling, ships ranged more widely and began to push their way into the ice pack. The Enderby whaling firm of London in particular encouraged their whaling captains to explore. In 1823 James Weddell in command of the "Jane," a brig of 160 tons, with the cutter "Beaufoy" (65 tons), sailed into the sea which now bears his name and on Feb. 20 reached a new southing record of 74° 15′ S., 34° 17′ W. In 1830 John Biscoe, in command of another Enderby brig, sailed eastward from the South Sandwich Islands and crossed the circle in 1° E. He saw Enderby Land in 49° 18′ E. but was unable to reach it. Biscoe later crossed the whole of the southern Pacific in a high latitude in Feb. 1832 and discovered the Biscoe Islands and Graham Land (now Graham Coast), a south-

ward extension of Bransfield's Trinity Land and the Antarctic peninsula; the coast was named for Sir James R. G. Graham, first lord of the admiralty at that time.

In 1833 another Enderby captain, Peter Kemp, discovered Heard Island and Kemp Coast, about 10° E. of Enderby Land. Heard Island was named after the U.S. whaling captain John J. Heard, the third of the many independent discoverers of this small, out-of-the-way island in the far south Indian ocean. In 1839 John Balleny, sailing from New Zealand, crossed the circle in 178° E. and discovered the Balleny Islands.

Dumont d'Urville.—About 1835 the importance of obtaining magnetic observations in the far south, and scientific interest in the antarctic, led to plans for expeditions being put forward in the U.S., France and Great Britain. The French were first in the field; J. S. C. Dumont d'Urville with the frigates "Astrolabe" and "Zelée" was instructed to surpass Weddell's latitude in the South Atlantic. This attempt failed but on Jan. 21, 1840, he discovered the area now called Adélie Coast for Mme d'Urville. Ten days later in 64° 30′ S. he cruised westward along a high shelf of ice from longitude 131° E. and then returned northward.

Wilkes.—Charles Wilkes was appointed to command the first U.S. exploring expedition of six vessels in Aug. 1838. His instructions required him to follow Weddell's route as far as possible, to visit the most southerly point reached by Cook and to try to penetrate the southern ocean "as far west as longitude 45° E., or to Enderby Land." In following Weddell's route Wilkes in March 1839 fared no better than d'Urville in the previous year, but the "Flying Fish" (96 tons), under W. M. Walker, reached 70° S., 105° W. and reported having seen land about 100 mi. offshore from Thurston Island, discovered by Richard E. Byrd a century later. Wilkes sailed from Sydney in the "Vincennes" on Dec. 26, 1839, accompanied by the "Peacock," the "Porpoise" and the "Flying Fish." The expedition went south to the west of the Balleny Islands and cruised west toward Enderby Land. The weather was bad, and although land was reported by each vessel at several points, it was rarely seen distinctly. Some doubt was cast upon Wilkes' discoveries and his positions were occasionally inaccurate, but explorations in the 20th century revealed the coast of Wilkes Land essentially as he described it. He was first to see a major segment of Antarctica and the first to recognize the probability of a continental land mass. His locating of the south magnetic pole was also creditable.

Ross.—The British government outfitted its 1839 expedition more adequately for antarctic exploration and magnetic surveys. There were two ships, both strengthened for navigation in sea ice—the "Erebus" (370 tons), commanded by James Clark Ross, and the "Terror" (340 tons), commanded by F. R. M. Crozier. Ross had intended to make straight for the meridian of the magnetic pole but, finding that d'Urville and Wilkes had already made similar plans, determined to try to make a high latitude farther east. Leaving Hobart on Nov. 12, 1840, he crossed the circle on Jan. 1, 1841, and entered the pack ice on Jan. 5 in 174° E. Five days later both vessels reached open water of the Ross sea, which in later years proved the gateway to the continent for Scott, Shackleton, Amundsen and Byrd. A chain of mountains was sighted rising from a coast which ran due south in 71° S. This land was claimed and named for Queen Victoria. The ships continued southward in sight of land until twin volcanoes, named Erebus and Terror, were sighted in 78° S. on Jan. 28. From Cape Crozier, at the base of the mountains, a lofty ice front ran eastward, rising perpendicularly from the water to the height of 200 or 300 ft. After attaining 78° 4′ S., 167° W., Ross returned to Hobart.

In Nov. 1841 Ross returned to the same area but did not greatly extend his discoveries. However, he did break his own southing record by six miles in the neighbourhood of the Bay of Whales region along the Ross ice shelf. This record of 78° 10′ S. at 161° 27′ W., set on Feb. 22, 1842, was to stand for another 58 years, until men grew bold enough to tramp inland across the surface of Antarctica.

Return of U.S. Whalers and Sealers.—Following the briefly awakened interest in Antarctica by the French, American and British government expeditions, antarctic waters became the almost exclusive haunt of U.S. whalers and sealers from 1839 until the mid-1880s, when mineral oils began to supplant the high demand for animal oils. U.S. activities centred around Kerguelen, Crozet and Heard islands. In spite of the fact that the American Civil War brought great losses to the whaling fleets, some 200 American voyages were made to antarctic waters from the period of d'Urville, Wilkes and Ross until the end of the 19th century. During the same interval there were only about 18 British voyages, some of which were merchant vessels taking great circle routes to shorten the course around Africa to Australia and New Zealand; ships of other nations approaching the continent did not exceed a total of about 25. Aside from occupation and rediscovery of some of the off-lying islands, the U.S. sealing and whaling fleets did not add appreciably to the knowledge of the region.

During the transit of Venus in 1874, which was best observable at Kerguelen Island, American, British, German and French expeditions converged on that isolated outpost.

The first steamer to cross the circle, on Feb. 16, 1874, was the "Challenger" commanded by Capt. George S. Nares of the Royal Navy. Although the "Challenger" penetrated only to 66° 40′ S., 78° 30′ E., its dredgings and soundings showed a general shoaling of the ocean toward the antarctic ice and indicated the approach to a continent. (*See* also "CHALLENGER" EXPEDITION.)

Between 1872 and 1888 there was a revival of the sealing industry, especially at the South Shetland Islands. In 1873 Eduard Dallmann in the German sealer "Grönland" made several discoveries on the northwest coast of the Antarctic peninsula. In 1882–83 three German vessels wintered at Royal bay, South Georgia Island, making scientific observations as their contribution to the first International Polar year.

Further 19th-Century Developments.—In 1894 the Norwegian whaler Svend Foyn sent the "Antarctic," under Capt. Leonard Kristensen, to visit the coast of Victoria Land, having on board C. E. Borchgrevink, who was to return to Antarctica four years later. A small party landed on the mainland on Jan. 23, 1895.

From time to time efforts had been made by Georg von Neumayer in Germany and by Sir John Murray and others in Great Britain to inaugurate a new era of antarctic research. In 1895 Sir Clements Markham, as president of the Royal Geographical society and of the International Geographical congress, also took the matter up, and interest in the antarctic regions became general. In 1897 Adrien de Gerlache organized and led a Belgian expedition in the "Belgica," which crossed to the west of the Antarctic peninsula and made surveys of the archipelago there. The ship finally penetrated the pack as far south as 71° 30′, where it was beset for more than a year, making scientific collections of unique value. This was the first truly international antarctic expedition, with scientists and crew from many nations; Roald Amundsen, a Norwegian, was first mate and Frederick Cook, an American, was the medical officer.

The attention given to the arctic in the last half of the 19th century, especially stimulated by the search for the lost expedition of Sir John Franklin (*q.v.*), had deflected interest from the antarctic. As the century ended, however, man had lost his fear of the ice pack and was ready to begin the first serious exploration of the continent of Antarctica—a task undertaken largely by the nations of northwestern Europe.

4. Quest for the South Pole.—*Borchgrevink.*—The first expedition to winter on the continent was that of C. E. Borchgrevink, which left England in 1898 and landed at Cape Adare, the northeast point of Victoria Land. No sledge journeys to the south were possible, but valuable scientific work was done. Before returning, Borchgrevink sailed south to the Ross ice shelf and discovered that the ice front was considerably farther south than it had been in 1842. His short journey inland on skis at the Bay of Whales on Feb. 16, 1900, gave a new southing record of approximately 78° 50′ S., 165° W. It was from there that Amundsen 12 years later was to journey onward to the south pole; about 30 years later Byrd chose the site for the Little America bases.

Scott.—The British national antarctic expedition of 1901–04 was organized by a joint committee of the Royal society and the Royal Geographical society and was equipped under the superin-

tendence of Sir Clements Markham. The "Discovery," a ship of 700 tons register, was specially built for the work. The expedition sailed under the command of Comdr. R. F. Scott of the Royal Navy. McMurdo sound at the southwest corner of the Ross sea was selected as the expedition's headquarters. This area was to become not only a major centre of Scott's and Shackleton's expeditions but a half century later the major port for U.S. and New Zealand scientific activities. Before laying up for the winter, Scott cruised eastward of the farthest point reached by Ross and discovered land of continental character which he named King Edward VII Land (later known as Edward VII peninsula). Like that of Borchgrevink, this expedition initiated a new phase of exploration by working from a settled base. The main journey was that of Scott, Ernest Shackleton and E. A. Wilson, who sledged southward to a new southing record of 82° 17′ S., which they reached on Dec. 30, 1902. The second year's work was distinguished by Scott's man-hauling sledge journey to a point 300 mi. W. of the ship and more than 250 mi. inland.

Drygalski.—Simultaneously with Scott's British expedition and in full scientific co-operation with it, the German government equipped an expedition in the "Gauss," led by Erich von Drygalski. A supplementary expedition set up a station in the Kerguelen Islands. The "Gauss" crossed the parallel of 60° S., 92° E. early in Feb. 1902, but was beset soon afterward and spent the winter in the ice. Land of considerable extent was seen to the south and was named Kaiser Wilhelm II Land (later called Wilhelm II Coast); the most conspicuous feature on it was a volcanic hill called Gaussberg (Mt. Gauss), in 67° S., 90° E.

Nordenskjöld and Bruce.—Two private expeditions were in the antarctic simultaneously with the British and German national expeditions, making synchronous meteorological and magnetic observations. Otto Nordenskjöld led a Swedish party in the "Antarctic," with C. A. Larsen in command of the ship, and penetrated the Weddell sea almost to the circle in 50° W. Two winters were spent at the base on Snow Hill Island. The "Antarctic" was crushed in the ice on her way to take the shore party off, but they were rescued by the Argentine gunboat "Uruguay," under Capt. Julian Irizar.

Meanwhile W. S. Bruce equipped a Scottish expedition in the "Scotia," which made valuable oceanographical investigations in the Weddell sea in 1903 and, returning again the next summer, sighted Coats Land, named for supporters of the expedition. A meteorological station, Orcadas, established by the expedition on Laurie Island in the South Orkneys, was handed over to the Argentine government and has been occupied ever since.

Charcot.—Jean B. Charcot, a scientist and yachtsman, reached the antarctic in Jan. 1904 in the "Français," cruising along the western side of the Antarctic peninsula to 67° S., and again in 1908 in the "Pourquoi Pas?," wintering in 1909 on Petermann Island, 65° S. In the next summer he pushed farther south and west after discovering a coast later identified as Charcot Island.

Shackleton.—In 1908 Ernest Shackleton established an expedition at Cape Royd on Ross Island, his ship the "Nimrod" returning to New Zealand for the winter. A new departure in antarctic sledging was initiated by the use of Manchurian ponies. Before the winter set in, a party under T. W. E. David reached the summit of Mt. Erebus. In the succeeding summer David, accompanied by the geologist Douglas Mawson, sledged to the magnetic pole, situated in latitude 72° 25′ S., 155° 16′ E. at an altitude of more than 7,000 ft.

The greatest achievement of the expedition, however, was the journey made by Shackleton, J. B. Adams, E. Marshall and F. Wild to the latitude of 88° 23′ S., in the course of which they discovered a route on to the plateau by way of the Beardmore glacier and pioneered the way to the pole itself. As a member of this group and as a former member of Scott's southern party in 1903, Shackleton thus took part in the most extensive southward advance since Cook, and fell short of reaching the very pole itself by a mere 97 mi. Alarm over the change in appearance of the Bay of Whales deterred him from basing at this closer point, from which Amundsen met success three years later.

Scott and Amundsen.—Captain Scott again left England in 1910 with an expedition in the "Terra Nova," his objectives being a journey to the south pole and scientific investigation of the Ross sea area. The main party established itself on the west side of Ross Island. The "Fram," with a Norwegian party under Roald Amundsen, was encountered shortly afterward by the "Terra Nova" in the Bay of Whales on the Ross ice shelf. With the news of Peary and Cook's discovery of the north pole this expedition, intended for the north polar regions, had changed its plans and decided to attempt to reach the south pole instead.

After some very successful depot-laying journeys Amundsen set out on Oct. 20, 1911, for the pole, accompanied by four companions on ski with 52 dogs. They reached the polar plateau by way of the Axel Heiberg glacier in 85° S. and arrived at the pole on Dec. 14. The return journey took 38 days, and they returned to their winter quarters with 12 dogs and ample food—a model of technical performance. Another sledge party visited Edward VII peninsula to the east.

Meanwhile Scott sent a subsidiary party to Cape Adare, where they wintered in Borchgrevink's hut. This party later made a hazardous land journey of 300 mi. back to Cape Evans along the coast of Victoria Land, wintering on the way with improvised equipment. A winter journey to the emperor penguin rookery at Cape Crozier was made by E. A. Wilson, H. R. Bowers and A. Cherry-Garrard in severe conditions. The pole party started from Cape Evans on Oct. 24, 1911, with motor sledges, ponies and dogs. The motors soon broke down, the ponies were shot before reaching 83° 30′ S., and from there also the dog teams were sent back to the base.

On Dec. 10 Scott with 11 others began the ascent of the Beardmore glacier with three man-hauled sledges. On Dec. 21 four men with one sledge were sent back from 85° 7′ S., and on Dec. 31 the last supporting party of three under Lieut. E. R. G. R. Evans returned from 86° 56′ S.

The polar party—Scott, Wilson, Bowers, L. E. G. Oates and Edgar Evans—reached the pole on Jan. 17, 1912. All were tired out from their 69 days' march and bitterly disappointed to find that they had been forestalled by Amundsen. The weather on the return journey was exceptionally bad. Evans died on the Beardmore glacier on Feb. 17. Oates, at the end of his strength, sacrificed himself on March 17 in 79° 50′ S. by crawling out into the blizzard. The supply of fuel oil at the last depot had been deficient and 20 mi. remained before they reached the next. The three survivors struggled on for 10 mi. but they were bound to their camp by a blizzard that lasted for nine days, and they awaited death with quiet fortitude. The tent with the frozen bodies was found by search parties on Nov. 12, 1912.

Mawson.—The Australian antarctic expedition which set out in the "Aurora" in Dec. 1911 was organized by Douglas Mawson. The main base was established at Cape Denison at Commonwealth bay on George V Coast, where Mawson wintered with 17 companions. The ship, under the command of J. K. Davis, proceeded 1,500 mi. to the west where Queen Mary Coast was discovered, and Frank Wild landed with a party of seven men and a hut to form the western base. Sledge parties started from the main base in Nov. 1912, diverging to explore inland toward the magnetic pole and eastward and westward near the coast. Mawson's two companions, B. B. S. Ninnis and X. Mertz, perished, leaving him with scant stores 100 mi. from Commonwealth bay. He reached the hut on Feb. 10, 1913, by an effort of almost superhuman endurance and found that the "Aurora" had just sailed to relieve Wild, leaving a volunteer rescue party with whom he awaited the return of the ship in Dec. 1913.

Filchner and Shirase.—A German expedition led by Wilhelm Filchner in the "Deutschland," under Capt. R. Vahsel, penetrated the Weddell sea to 77° 50′ S. early in 1912 and delimited part of its southern boundary. The Luitpold Coast between 29° and 37° W., named for the prince regent of Bavaria, was discovered and charted. The vessel was beset in March 1912 and drifted for nearly nine months with the pack ice, finally escaping on Nov. 26 in 63° 37′ S., 36° 34′ W.

Choku Shirase led a Japanese party in the "Kainan Maru," which cruised in the Ross sea during the summers of 1910–12. A short

sledge journey was made on the Ross ice shelf, followed by a landing on Edward VII peninsula.

Shackleton.—Sir Ernest Shackleton planned the Imperial Trans-Antarctic expedition in 1914, intending to cross the continent from the Weddell sea to the Ross sea by way of the south pole. The "Endurance" entered the Weddell sea early in Dec. 1914 and worked southward between 15° and 20° W. Caird Coast was discovered between Coats Land and Luitpold Coast on Jan. 11, 1915, but no landing place was found. The ship, beset in the ice on Jan. 18, drifted northward and was crushed and abandoned on Oct. 27 in 69° 5′ S. The 28 men camped on an ice floe, which continued to move northward until April 9, 1916, when it broke up in 62° S., 54° W. after a drift of 457 days. The party took to their three small boats and landed six days later on Elephant Island. Shackleton with five men reached South Georgia, 750 mi. distant, in a 22-ft. boat and finally succeeded with the Chilean trawler "Yelcho" in rescuing the others on Aug. 30, 1916. The expedition had a companion group in the McMurdo area led by A. E. Mackintosh for the purpose of laying depots for the transcontinental party. Their ship "Aurora" was also beset in the pack ice and drifted for 315 days. The leader and two others perished.

Among a series of minor activities during the pre-World War I period was the fourth cruise of the U.S. scientific ship "Carnegie" under W. J. Peters in 1915–16, which made magnetic observations on a subantarctic circumnavigation of the continent. During 1918 and 1919 Antarctica was abandoned.

5. Exploration, 1920–40.—The first party to winter in Antarctica after World War I was the smallest expedition in Antarctic history. In 1920–22 T. W. Bagshaw and M. C. Lester, two young British explorers, landed from a whaling ship and lived for a year at Waterboat point on the west coast of the Antarctic peninsula. Despite their primitive shelter made of an upturned lifeboat and packing boxes, they carried out creditable observations of meteorology, tides and zoology.

Shackleton sailed in the "Quest" in Sept. 1921 to explore the Enderby Land area (0° to 90° E.). He died at South Georgia on Jan. 5, 1922. Frank Wild, second in command, carried on the voyage to 69° 17′ S., 17° E.

During the period from 1922 to 1928 no wintering bases were established in Antarctica and activities were confined to minor scientific investigations of off-lying islands. Whaling activities in the southern Atlantic and Pacific oceans were largely carried on by the Norwegians and in the southern Indian ocean by the French.

"Discovery" Investigations.—The Discovery committee was appointed by the British government in 1923 to undertake comprehensive oceanographical research in antarctic waters, with a view to regulating and perpetuating the whaling industry there. The first southern cruise was made by the old "Discovery" in 1925–27. In 1926 the research vessel "William Scoresby" (324 gross tons) was commissioned and during the following 12 years made eight cruises in the waters of the southern ocean. In 1929 a new research vessel, the "Discovery II" (1,036 gross tons), replaced the "Discovery" and up to the outbreak of World War II in 1939 had undertaken five southern commissions.

Christensen.—Between 1927 and 1937 a series of eight exploratory voyages in the southern ocean were promoted by the Norwegian whaling magnate Lars Christensen. During these years a large number of important geographical discoveries were made along the coasts of the antarctic mainland by expeditions led by H. Mosby, Ola Olstad, Hjalmar Riiser-Larsen, Klarius Mikkelsen and others. In the four summer seasons between 1927 and 1931 the "Norvegia" cruised in antarctic waters. Bouvet Island and Peter I Island were claimed for Norway at this time. The former island was photographed from the air during the season of 1929–30, and an air reconnaissance was made of western Enderby Land and parts of the coast of Queen Maud Land between 40° and 50° E. and 0° and 10° W. Further flights were made in 1930–31 and the coast of Queen Maud Land between 20° and 30° E. was discovered and roughly charted. In the summer of 1933–34 a number of flights were made from the "Thorshavn," during which parts of Princess Elizabeth Land were discovered. During the following season the "Thorshavn" landed a party on the Ingrid Christensen Coast, part of Princess Elizabeth Land, in about 80° E., and topographical surveys were made in that area. During one of these cruises four women guests aboard the whaler were the first of their sex to visit Antarctica. In 1936–37 part of Queen Maud Land between 30° and 40° E. was photographed from the air. Queen Maud Land was claimed for Norway in 1939.

Wilkins.—In 1928–29 Australian-born Sir George Hubert Wilkins led a U.S.-financed expedition to the Antarctic peninsula region and made an air reconnaissance of the east coast. Local flights were made again the following year. These appeared to confirm the erroneous impression, gained in 1928–29, that the Antarctic peninsula was an archipelago rather than part of the continent. Wilkins discovered the insularity of Charcot Island.

Byrd.—After his successful flight over the north pole (1926) and across the Atlantic (1927), U.S. naval aviation commander Richard E. Byrd turned his energies toward antarctic exploration, believing that airplanes and aerial cameras were the answers to exploring Antarctica. He organized a private expedition in 1928 and constructed a 42-man station, Little America, on shelf ice about four miles north of the site of Amundsen's Framheim on the east side of the Bay of Whales. On fall flights to the east he discovered the Rockefeller mountains, named for John D. Rockefeller, Jr., a patron of the expedition, and the peninsular structure of Scott's Edward VII peninsula. Farther to the east, beyond 150° W., he discovered Marie Byrd Land, named in honour of his wife, and the Edsel Ford ranges, named for another of the sponsors. During the winter night a meteorological, magnetic and auroral program was carried out. The following summer (1929) Lawrence M. Gould and a party of five sledged by dog team to the Queen Maud mountains due southward for geological reconnaissance. On Nov. 29, 1929, Byrd as navigator, accompanied by Bernt Balchen and Harold June as pilots and Ashley McKinley as aerial photographer, flew successfully to the vicinity of the geographic south pole in a tri-motored Ford airplane "Floyd Bennett." Several new glaciers were aerially mapped and the escarpment to the east of the Queen Maud mountains could be seen for another 100 to 200 mi.

Byrd returned to Little America II in Jan. 1934 after making seaplane flights from the ice-laden seas north of Marie Byrd Land. Additional buildings were erected at Little America to house the 56 members of the expedition. Cows were taken along for fresh milk. Using a Curtis Condor biplane for his major exploratory work, Byrd discovered the trend of Ruppert Coast, the Horlick mountains extending eastward of the Queen Maud mountains to at least 115° W. and peaks as far eastward as longitude 130° W. in Marie Byrd Land. (The names are for Jacob Ruppert and William Horlick, who helped support the expedition.) Byrd alone occupied Bolling Advanced Weather station about 123 mi. S. of Little America on the Ross ice shelf, the first inland station in Antarctica. During his five months' winter isolation there Byrd recorded temperatures to nearly −80° F.

The following summer four major field parties operated out of Little America. A tractor party under E. J. Demas began sounding ice thickness by seismic methods; deflected eastward on a southern journey by crevasses near 81° S., the party returned over the high plateau of western Marie Byrd Land east of the 150th meridian. This expedition made the first successful use of tractors for freighting and exploring in the antarctic. Quinn Blackburn with two companions and three dog teams retraced Amundsen's and Gould's route to the Queen Maud range and made a geological cross section up Robert Scott glacier to Mt. Weaver on the plateau 230 mi. from the south pole. Coal and fossil specimens were collected. Meanwhile, a four man dog-sledging party led by Paul A. Siple traveled eastward from Little America II to make the first mapping, geological and biological surveys of the newly discovered Marie Byrd Land. They visited the Rockefeller mountains and traveled through the central Edsel Ford ranges to the Fosdick mountains, 77° 30′ S., 144° W., named for Raymond B. Fosdick, president of the Rockefeller foundation. They collected 89 new species of mosses and lichens. The fourth important field party, led by Thomas C. Poulter, second in command of the expedition, made seismic soundings of the Ross ice shelf from the Bay of Whales to

Discovery inlet, charting ice thicknesses and ocean depths below the shelf. An extensive scientific program was carried on at Little America II, including meteorology, cosmic radiation and magnetic studies, vertebrate and invertebrate zoology, bacteriology, auroral and meteor studies, glaciology and oceanography.

Mawson.—The British-Australian-New Zealand Antarctic Research expedition led by Sir Douglas Mawson made two extensive cruises in the "Discovery" in 1929–30 and again in 1930–31. Important work was done between 45° and 75° E. and between 120° and 130° E., the coast line of these parts of Antarctica being roughly charted. A number of landings on the continent were made and Princess Elizabeth Land, Mac-Robertson Coast and the Banzare coast were discovered. The sector known as the Australian Antarctic territory was formally annexed by Australia at this time.

Ellsworth.—In 1933–34 the U.S. explorer Lincoln Ellsworth visited the Bay of Whales in the "Wyatt Earp," but his aircraft was damaged beyond use for that season. In the following summer he visited the east coast of the Antarctic peninsula with the intention of making the 2,200-mi. transantarctic flight to the Ross sea. This did not prove possible until his third trip at the end of 1935. With H. Hollick-Kenyon as pilot, Ellsworth set out on Nov. 23, 1935, from Dundee Island off Louis Philippe peninsula, for the Bay of Whales. He discovered the Sentinel mountains between 77° and 79° S. and 86° and 89° W., so named because of their prominent position as a landmark; the corridor over which he flew is now called the Ellsworth Highland. Three landings were made during the crossing of the continent and the aircraft finally arrived near the Bay of Whales on Dec. 5. These landings on unprepared terrains, made in bad weather, were a new departure in polar aviation. The two fliers were rescued by the "Discovery II" in mid-Jan. 1936. Ellsworth made one more antarctic voyage in the "Wyatt Earp" in the summer of 1938–39. A flight was made inland to 72° S., 79° E. in Princess Elizabeth Land. He named the plateau he discovered there the American Highland and claimed it for the United States.

Rymill.—The British Graham Land expedition of 1934–37, led by John Rymill, went south in the "Penola" and in successive seasons wintered at the Argentine Islands and the Debenham Islands, off the west coast of the Antarctic peninsula. In addition to comprehensive scientific investigations, flights and sledge journeys were made and the coast and off-lying islands of the western Antarctic peninsula were surveyed from the Palmer archipelago to Alexander I Island. Two major discoveries were made: first, that the Antarctic peninsula is part of the antarctic mainland and not an archipelago; second, that Alexander I Island is separated from the peninsula by George VI sound.

Ritscher.—A German expedition in the "Schwabenland," commanded by Alfred Ritscher, spent three weeks off the coast of Queen Maud Land during the summer of 1938–39. Two aircraft made extensive flights between 14° W. and 20° E., penetrating inland to about 74° 25′ S. and photographing about 135,000 sq.mi. The area was renamed New Schwabenland and claimed for Germany.

U.S. Antarctic Service.—In 1939 the U.S. government inaugurated the U.S. Antarctic service to commence permanent occupation and scientific exploration of sections of Antarctica, but the advent of World War II brought an untimely end to field operations in 1941. Admiral Byrd was assigned command, logistics were assigned to P. A. Siple and the science program to F. Alton Wade. Two major bases were established: West base, 33 men, at Little America III at the Bay of Whales, led by Siple; and East base, 29 men, at Marguerite bay, Stonington Island on the Antarctic peninsula coast, led by Richard B. Black. The U.S.S. "Bear" and the U.S.S. "North Star" serviced the bases. Using a Barkley Grow seaplane from the "Bear," Byrd discovered the Thurston Island region along the icebound coast facing the Pacific ocean near 72° S., 100° W. Byrd did not winter in Antarctica; instead he initiated the system of absentee management of the affairs of an expedition from the home country used in most subsequent expeditions. Wade was in charge of a specially built overland snow cruiser designed by T. C. Poulter for inland exploration. The 35-ton machine was underpowered and remained at Little America III as a scientific laboratory. At West base major exploratory flights included gross observation of the Ross ice shelf, aerial photography of the region between Beardmore and Robert Scott glaciers of the Queen Maud mountains, delineation of the eastern limits of the Ross ice shelf and extension of Ruppert Coast 76° S., 146° W. to Mt. Siple, 73° 15′ S., 123° W. Inland, the Hal Flood and Executive Committee ranges were more completely investigated. Aerial photography of the Edsel Ford ranges taken in February and March 1940 were reduced to maps for several dog sledge field teams working in the area the following December. The geology party of four men to the central Edsel Ford ranges was led by Lawrence A. Warner; the biological party of three to the Fosdick mountains was led by Jack E. Perkins; the Pacific coast survey party of three to the Hal Flood range was led by Leonard M. Berlin. Two additional field parties explored Edward VII peninsula, one led by Wade for geological investigations, the other for surveys by Roy G. Fitzsimmons. Extensive science programs at the main base featured the first antarctic upper air meteorological soundings, obtaining minimum temperatures of −130° F.; glaciology of the Ross ice shelf, found to move a third of a mile per year; magnetism; aurora; biology; and radio wave propagation studies. A similar scientific program was carried on at East base. Geographic discoveries included an extension of the Antarctic peninsula southward to 77° S. and reconnaissance of the peninsula northward and of Alexander I Island. A Weddell coast dog team party led by Paul Knowles did geology and surveys to 72° S., 61° W., and a second major sledge journey was made by Finn Ronne and Carl Eklund along the eastern and southern sides of Alexander I to within sight of open water along Robert English Coast. Important biological, geological and meteorological observations were made on shorter excursions near the base.

East base was evacuated by air because the ice in Marguerite bay did not break up in 1941 to permit the relief ships to enter. While awaiting relief operations, scientists of the already relieved West base made surveys and collections of botanical and geological specimens at the Melchior archipelago.

World War II Antarctic Activity.—During World War II antarctic waters became involved in military activities. Kerguelen became the "Alstertor" resupply point for German raiders Hilfskreuger 33, 16 and 45, "Pinguin," "Atlantis" and "Komet" raiding the South Pacific. The German raider "Pinguin" captured an entire Norwegian whaling fleet, including the whale factory ships "Ole Wegger" and "Pelagos," the supply ship "Solglimt" and 11 catchers. British and Australian naval vessels searched for the enemy. H.M.S. "Cornwall" sank the "Pinguin" in May 1941 after she had captured 136,550 tons of Allied shipping. After 1941 pelagic whaling ceased for the duration of the war.

In 1941 the British established a meteorological forecasting station in the Falkland Islands and destroyed fuel stocks at Deception Island. On a 1943 visit to the same island they obliterated signs of sovereignty claims left there the year before by Argentina H.M.S. "Carnavon Castle" also visited Signy bay and Laurie Island in the South Orkneys. The Argentine vessel "Primera de Mayo" made voyages to Antarctica in 1942 and 1943 to take formal possession of the sector between 25° and 68° 34′ W. south of 60° S. and to remove British emblems of sovereignty. On the latter voyage the ship visited Stonington Island in Marguerite bay and removed some instruments and materials from the U.S. East base, which were later returned to the U.S.

The winter of 1943 was the last time Antarctica was without at least a transient population.

Partly for reasons of sovereignty and partly for wartime surveillance, the British naval Operation "Tabarin I" in 1943 began permanent occupation of meteorological stations along the west Antarctic peninsula. Base A was established at Port Lockroy under the leadership of J. W. S. Marr, commander of the shore staffs, and Base B at Deception Island under the leadership of W. R. Flett. Scientific programs including geology, biology and surveys were carried on during the winter. The following year, 1944–45, the bases were relieved, and a new one, Base D, was established at Hope bay. After the war the administration of British

bases became the Falkland Island Dependencies surveys.

See also biographies of the explorers.

IV. NATIONAL EFFORTS AT OCCUPATION (1943–55)

1. Conflicting Claims.—During the decade following World War II. attitudes toward Antarctica became singularly nationalistic. Claims of territory had been announced by seven countries—the United Kingdom, Australia, New Zealand, Norway, France, Argentina and Chile. The only remaining segments of the continent not specifically claimed lay between 90° and 150° W. in west Antarctica and between 45° E. and 20° W. in east Antarctica, southward toward the pole from the explored coast claimed by Norway. The basis of claims varied with individual countries, although, with the exception of Norway, the claimants adhered to the "sector" principle, propounded by Pascal Poirier in the Canadian senate on Feb. 20, 1907. His concept would recognize the extended claims of any nation bordering the polar regions by extending the meridians of its extreme boundaries to the north or south pole. The concept has never been tested in a world court, and the United States has been notably among those nations which have never accepted the principle in either the arctic or antarctic. The majority of claimants in Antarctica have used this sort of convenient pie-shaped wedge claim system, but their reasons for the chosen boundaries have been devious and varied. The French claim of Terre Adélie, for example, extends d'Urville's coastal discovery of 1840 to the pole, although he did not set foot on the land and the first French return to the area was not until Dec. 1949; but the more intensive and extensive explorations of Charcot in 1903–05 were not used as a basis of claim. Norway made no attempt to exploit the discoveries of Amundsen but claimed the Russian-discovered (1821) Peter I Island and the French-discovered (1739) Bouvet Island; the coast claimed by Norway was largely explored by Norwegian whalers, although it lies in the sector which South Africa might conceivably claim if it extended its boundaries according to Poririer's principle, as Argentina, Chile and Australia have done.

The vigorous British claim to the Falkland Island dependencies is based upon some priority rights of discovery, but the region includes land and islands first explored and, in some cases, occupied by the U.S., the U.S.S.R., France, Sweden, Germany, Norway, Belgium, Argentina and Chile. Although other nations might assert justifiable formal claims in this region, only Argentina and Chile, who previously had explored it less than some of the others, have formally made such assertion. Argentina, in addition, voices claim to the Falkland Islands and South Georgia. Argentina's nearly 60 years' occupation of the Laurie Island weather station gives it the longest record of possession of any single spot in Antarctica south of 60° S.

U.S. policy as stated by Charles E. Hughes, secretary of state in 1924, that occupation was the strongest basis for claims of a territory, had an impact on antarctic exploration. The U.S. Antarctic service, 1939–41, was intended as the first step toward occupying Antarctica on a permanent basis, but the effort had to be temporarily abandoned because of World War II. Even before the war had ended British naval forces established three bases in the Falkland Island dependencies and announced them as permanent meteorological stations. These stations opened post offices, issued postage stamps and had appointed barristers. Britain added progressively to the number of permanent stations during the next decade, as did Argentina and Chile, sometimes at the same sites and manned by military personnel. High officials, governors of provinces, and even the president of Chile and Prince Philip of Great Britain visited their countries' respective stations. The competition for possession grew serious enough that whenever foreign stores, national emblems or unoccupied refuge huts were discovered, they were destroyed. Arrests and deportations occurred and there was one instance of armed resistance without casualties by Argentina against a British landing party at Hope bay in 1952. British naval war vessels put in an annual appearance in the Falkland Island dependencies and during 1948 Argentina had about 15 naval vessels in the area on maneuvers, in addition to a 13-vessel flotilla to establish bases. Tension caused by this show of naval force was eased somewhat after 1949 by annual declarations between Argentina, Chile and Britain aimed at restricting the use of warships.

By the outset of IGY in the 1956–57 season the British were occupying 11 permanent stations, Argentina 8 and Chile 6. Although these stations were primarily political, valuable work resulted during the nationalistic decade. The Chileans did some hydrographic and survey work. The Argentines did comparatively more scientific work and produced superior hydrographic charts of the regions surrounding the South Shetlands, South Orkneys and the Antarctic peninsula. The British were still better equipped for biological, geological and electromagnetic reconnaissance and in addition did superior ground surveys and mapping of the land. Vertical aerial-strip surveys of the entire northern half of the Antarctic peninsula were accomplished, resulting in the most detailed maps of any portion of Antarctica.

At the close of the nationalistic period, the continent's periphery was mapped for the first time and U.S. personnel, with the aid of aircraft, had seen more of Antarctica than all other explorers combined. However, the U.S. continued its policy of making no official territorial claims, recognizing no one else's claims but reserving its rights to make claims at a future time. In 1950 the U.S.S.R. announced a similar policy, and although it had done no active exploration since 1822, it had been carrying on whaling since 1946 and was preparing to take a highly active part in IGY antarctic activity. Germany and Japan were forced to surrender their rights to antarctic claims at the close of World War II.

The accompanying station location table will help to clarify the sequence of activities from 1943 to 1955, which were especially complicated in the British, Argentine and Chilean area around the South Shetland and South Orkney islands and the Antarctic peninsula. The station list includes, for the most part, only bases that were occupied through one or more winter seasons. It does not include temporary summer stations or many refuge huts built by these nations.

Beginning during the IGY in 1957–58 an attitude of international co-operation began and in most cases national claims were not pressed. After the signing of the Antarctic treaty in 1959 virtually all territorial claims were placed in abeyance.

2. Operation "Highjump" and Other U.S. Expeditions.—In 1946–47 the U.S. naval task force 68 undertook Operation "Highjump," the largest expedition attempted in the antarctic up to that time. The enterprise was under the general direction of Rear Admiral Byrd and the 13 ships taking part were commanded by Rear Admiral Richard H. Cruzen. The objectives were to test equipment, to give polar experience to 4,000 men, to extend the basis for United States claims and to photograph as much of Antarctica as possible from the air. The task force was divided into three groups and worked around most of the periphery of the continent during the summer. More than 100 men were based at Little America IV from January to March. Operation "Highjump" utilized six R4D aircraft, the largest planes to take off successfully from a carrier and subsequently from the improvised snow surface airstrip. In the first of these, Admiral Byrd flew to the base from the aircraft carrier "Philippine Sea" near Scott Island. Twenty-nine photographic flights extending into previously unexplored territory radiated into Marie Byrd Land, the Horlick mountains, the polar plateau and Victoria Land. Byrd made his second flight over the geographic south pole on Feb. 15, 1947. Some meteorology, glaciology and geophysical work was accomplished. P. A. Siple led an attached war department, army and air force observation team. The eastern group under command of Capt. George J. Dufek explored and photographed by seaplane the Pacific coast area of west Antarctica between Mt. Siple and Charcot and Alexander I islands. One aircraft crashed on Thurston Island with loss of part of its crew. This group later circumnavigated the Antarctic peninsula and Weddell sea to explore part of Princess Martha Coast. The Western group under Capt. Charles A. Bond explored and photographed by seaplane the coasts of east Antarctica from Oates Coast to the Princess Astrid Coast. Near longitude 100° E. this group discovered Bunger Hills, an extensive area of ice-free land, misleadingly called an oasis.

A smaller naval expedition, designated Operation "Windmill," consisting of two icebreakers under Comdr. G. L. Ketchum, visited Antarctica during the following season. The object was to fix geographical points so that the air surveys of the previous expedition could be properly located.

A private antarctic research expedition, heavily supported by government sources, was undertaken by Finn Ronne in 1946–48. The expedition reoccupied East base of the U.S. Antarctic service (1939–41) at Stonington Island in southwest Antarctic peninsula. Noteworthy scientific and topographical survey work was accomplished, some of which was in co-operation with the staff of the Falkland Island Dependencies survey's southernmost station, also at Stonington Island. An important summer journey of 1,180 mi. was made, using British sledging equipment and U.S. air support.

Stations in Antarctica Established by Various Countries

Country	Station*	Place	Founding leader†	Latitude	Longitude	Year established	‡Years occupied
			WEDDELL SEA REGION (sector 0° to 45° W.)				
Argentina	General Belgrano; P-I	Filchner ice shelf	Pujato (Ogara)	77° 56′ S.	38° 29′ E.	1955	6
Norway (U.K. and Sweden)	Maudheim	Queen Maud Land	Giaever	71° 03′ S.	10° 53′ W.	1950	2
Norway	Norway base, I	Queen Maud Land	Helle	70° 30′ S	02° 32′ W	1957	3
South Africa	Norway Base; I	Queen Maud Land	La Grange	70° 30′ S.	02° 52′ W.	1960	1
United Kingdom	Halley Bay; P-I	Halley bay, Coats Land	Dalgliesh (Smart)§	75° 31′ S.	26° 36′ W.	1956	5
United Kingdom	Shackleton	Filchner ice shelf	Fuchs	77° 57′ S.	37° 16′ W.	1956	2
United Kingdom	South Ice	inland	Lester (Fuchs)	81° 56′ S.	29° 30′ W.	1957	1
United States	Ellsworth; P-I	Filchner ice shelf	Ronne	77° 43′ S.	41° 07′ W.	1957	2
Argentina	Ellsworth	Filchner ice shelf	Suarez Johnson	77° 43′ S.	41° 07′ W.	1959	2
			SOUTH SHETLAND and SOUTH ORKNEY ISLANDS				
Argentina	Orcadas, P I	Laurie Island	Bruce (Galindez)	60° 45′ S.	44° 43′ W	1903	58
	Primero de Mayo; P-I	Deception Island	Cabrera (Hemelo)	62° 59′ S.	60° 43′ W.	1948	13
	Teniente Camara; P-I	Half Moon Island	?(Panzarini)	62° 36′ S	59° 57′ W.	1952	8
Chile	Arturo Prat; P-I	Greenwich Island	O'Neil (Toro)	62° 29′ S.	59° 38′ W.	1947	14
	Pedro Aguirre Cerda; P-I	Deception Island	del Rio (Bofil)	62° 56′ S.	60° 36′ W.	1955	6
United Kingdom	First Antarctic wintering	King George Island	(Clark)	62° 00′ S.	58° 15′ W.	1821	1
	Base B; P-I	Deception Island	Flett (Marr)	62° 59′ S.	60° 34′ W.	1944	17
	Base C	Cape Geddes, Laurie Island	Choyce (Bingham)	60° 42′ S.	44° 34′ W.	1946	1
	Base H; P-I	Signy Island	Robin (Butler)	60° 43′ S.	45° 36′ W.	1947	14
	Base G; P-I	Admiralty bay	Platt (Fuchs)	62° 05′ S.	58° 25′ W.	1948	13
			ANTARCTIC PENINSULA (sector 45° W. to 90° W.)				
Argentina	Melchior; P-I	Gamma Island, Melchior archipelago	Nadau (Garcia)	64° 20′ S.	62° 59′ W.	1947	14
	San Martin; P-I	Barry Island	?(Panzarini)	68° 08′ S.	67° 07′ W.	1951	10
	Admirante Brown; P-I	Paradise harbour	?(Panzarini)	64° 53′ S.	62° 53′ W.	1951	10
	Esperanza; P-I (Army)	Hope bay	Casanova (Diaz)	63° 16′ S.	56° 49′ W.	1952	9
Chile	Bernardo O'Higgins; P-I	Cape Legoupil, Trinity peninsula	Prado (Navarrete)	63° 19′ S.	57° 54′ W.	1948	13
	Gonzalez Videla; P-I	Waterboat point, Paradise harbour	Tapia	64° 49′ S.	62° 52′ W.	1951	10
Norway	Shipwrecked Antarctic crew	Paulette Island	Larsen	63° 35′ S	55° 47′ W.	1903	1
Sweden	Snow Hill Island	Snow Hill Island	Nordenskjöld	64° 28′ S.	57° 12′ W.	1902	2
	(3 men)	Hope bay	Andersson	63° 24′ S.	57° 00′ W.	1903	1
United Kingdom	British Graham land expedition	Argentine Islands	Rymill	65° 15′ S.	64° 15′ W.	1935	1
		Debenham Island	Rymill	68° 08′ S.	67° 07′ W.	1936	1
	Base A; P-I	Port Lockroy	Marr	64° 50′ S.	63° 30′ W.	1944	14
	Base D; P-I	Hope bay	Taylor	63° 24′ S.	56° 59′ W.	1945	13
	Base F, P I	Argentine Islands	Burd (Butler)	65° 15′ S.	64° 16′ W.	1947	14
	Base J; I	Prospect point, Ferin Head	Miller (Rice)	66° 00′ S.	65° 24′ W.	1957	4
	Base Y; P I	Horseshoe Island	Gaul (Anderson)	67° 49′ S.	67° 17′ W.	1955	6
	Base O	Danco Is.	Foster (Worswick)	64° 44′ S.	62° 37′ W.	1956	
	Base N	Arthur harbour, Anvers Island	Hooper (Anderson)	64° 46′ S.	64° 04′ W.	1955	
	Base W; I (Shackleton)	Detaille Island, Loubert Coast	Murphy (Anderson)	66° 52′ S.	66° 48′ W.	1956	2?
	Base E	Stonington Island	Bingham	67° 11′ S.	67° 00′ W.	1946	4
	Waterboat point	Paradise harbour	Bagshawe Lester	64° 49′ S.	62° 52′ W.	1921	1
United States	East base (USA)	Stonington Island	Black (Byrd)	68° 11′ S.	67° 00′ W.	1940	1
	East base	Stonington Island	Ronne	68° 11′ S.	67° 00′ W.	1948	1
France	Pour Quoi Pas	Booth Island	Charcot	65° 05′ S.	64° 00′ W.	1904	1
			ROSS SEA (sector 90° W. to 180° to 160° E.				
New Zealand	Scott, P-I	Ross Island, McMurdo sound	Hatherton Hillary	70° 50′ S.	166° 44′ E.	1957	4
New Zealand-U.S.	Hallett; P-I	Cape Hallett	Shear Tur	72° 18′ S.	170° 18′ E	1957	4
Norway	Framheim	Bay of Whales, Ross ice shelf	Amundsen	78° 38′ S.	163° 37′ W.	1911	1
United Kingdom	Cape Adare	Cape Adare, Victoria Land	Borchgrevink	71° 18′ S.	170° 09′ W.	1889	1
	Hut Point	Ross Island, McMurdo sound	Scott	77° 51′ S	166° 45′ W.	1902	2
	Cape Royds	Ross Island, McMurdo sound	Shackleton	77° 34′ S.	166° 09′ W.	1908	1
	Cape Evans	Ross Island, McMurdo sound	Scott	77° 38′ S	166° 24′ W.	1911	2
United States	Little America I	Bay of Whales, Ross ice shelf	Byrd	78° 34′ S.	163° 56′ W.	1929	1
	Little America II	Bay of Whales, Ross ice shelf	Byrd	78° 34′ S.	163° 56′ W.	1934	1
	Bolling Advanced weather station	Ross ice shelf	Byrd	80° 10′ S.	164° 00′ W.	1934	3/5
	Little America III, West base	Bay of Whales, Ross ice shelf	Siple (Byrd)	78° 29′ S.	163° 50′ W.	1940	1
	Little America IV, Operation "Highjump," USN	Bay of Whales, Ross ice shelf	(Byrd Cruzen)	78° 29′ S.	163° 50′ W.	1947	0.2
	Little America V, I	Kainan bay, Ross ice shelf	Graham-Crary	78° 11′ S.	162° 10′ W.	1956	3
	Williams naval air facility; P-I	Ross Island, McMurdo sound	Canaham	77° 51′ S.	166° 37′ E.	1956	5
	Amundsen-Scott; P-I	south pole	Siple-Tuck	90° 00′ S.		1956	4
	Byrd, P-I	Marie Byrd Land	Toney Dalton	80° 00′ S.	120° 00′ W.	1957	4
			EAST ANTARCTICA (sector 0° to 160° E.)				
Australia	Main base, Cape Denison	George V Coast	Mawson	67° 00′ S.	142° 40′ E.	1912	2
	West base	Shackleton ice shelf	Wild (Mawson)	66° 18′ S.	95° 05′ E.	1912	1
	Mawson; P-I	Mac-Robertson Land	Dovers (Law)	67° 36′ S.	62° 53′ E.	1954	7
Belgium	King Baudouin; P-I	Princess Ragnhild Coast	Gerlache de Gomery	70° 26′ S.	24° 19′ E.	1958	3
France	Port Martin	Terre Adélie	Liotard (Victor)	66° 49′ S.	141° 24′ E.	1950	2
	Ile de Petrels	Point Géologie	Marret (Victor)	66° 40′ S.	140° 00′ E.	1952	1
	D'urville; P-I	Point Géologie	Imbert (Victor)	66° 40′ S.	140° 01′ E.	1956	5
	Charcot; P-I	south magnetic pole	Guillard (Imbert)	69° 22′ S.	139° 02′ E.	1956	2
Japan	Showa; P-I	Prince Harald Coast	Nishibori (Nagata)	69° 00′ S.	39° 35′ E.	1957	3
United States	Wilkes; P-I	Budd Coast, Wilkes Land	Eklund-Burnett	66° 15′ S.	110° 31′ E.	1957	2
	Wilkes (satellite); I	inland	Cameron (Eklund)	66° 28′ S.	112° 17′ E.	1957	1?
Australia	Wilkes; P-I	Wilkes Land	Dingle-Hansen	66° 15′ S.	110° 31′ E.	1959	2
U.S.S.R.	Mirny; P-I	Queen Mary Coast	Sømov	66° 33′ S.	93° 00′ E.	1956	5
	Oazis; I	Wilkes Land	Tselishchev	66° 16′ S.	100° 44′ E.	1956	3
	Pionerskaya; I	inland	Gusev	69° 44′ S.	95° 30′ E.	1956	2
	Komsomolskaya; I	inland	Pelevin	75° 00′ S.	93° 00′ E.	1957	1
	Vostok I; I	geomagnetic pole	Aver'yanov	78° 27′ S.	106° 52′ E.	1958	3
	Sovietskaya; I	inland	Babarykin	78° 24′ S.	87° 35′ E.	1958	1
	Lazarev; P-I	Astrid Coast	Kruchinin	69° 56′ S.	12° 58′ E.	1959	2

*"P" after station names indicates permanency; "I" after station names indicates that it carried on IGY, S.C.A.R. and IQSY programs. †Names in parentheses denote responsible senior leader not in residence at the station. ‡Years occupied prior to 1961. §Leader first year of IGY. ||Intermediate station.

The combined party reached 74° 45′ on the east coast of the Antarctic peninsula and returned after 105 days in the field. Mrs. Ronne and Mrs. Harry Darlington, who accompanied their husbands, were the first women to winter on the antarctic mainland.

3. A.N.A.R.E.—The Australian National Antarctic Research expedition (A.N.A.R.E.) was established by the Australian government in 1947 under the direction of Stuart Campbell and later of P. G. Law. Scientific stations were set up on Heard Island in Dec. 1947 and on Macquarie Island in March 1948. The Heard Island station was closed in 1955; the Macquarie Island station was operated continuously, annual relief parties being sent to the island each summer. In Feb. 1954 Mawson station, led the first year by R. G. Dovers, was established on the antarctic mainland and has been maintained permanently. Subsequent explorations along the coast and inland have added much to the knowledge of this region. The Prince Charles mountains were found to extend inland to about 74° 30′ S.

4. Other Events.—In Dec. 1947 the South African government annexed the Prince Edward Islands, which lie halfway between South Africa and Antarctica, and in Feb. 1948 a weather station was erected on Marion Island. This station has been manned by successive relief parties since that time.

An antarctic expedition organized by the private body known as Expéditions Polaires Françaises, under the direction of Paul-Émile Victor, established a station at Port Martin in Jan. 1950. A. F. Liotard was in command during the first year. He was succeeded by M. Barré early in 1951. During 1950 and 1951 a number of important journeys were made in mechanical tracked vehicles along the Adélie coast line and inland toward the magnetic pole. The station at Port Martin was destroyed by fire in Jan. 1952, but a small party led by M. Marret wintered at Pointe Géologie, about 40 mi. E. of Port Martin.

In Dec. 1949 the French government established a large scientific station at Port-aux-Français on the Kerguelen Islands. The station was manned continuously after Jan. 1951 by members of an official organization known as Missions aux Terres Australes et Antarctiques Françaises, under the direction of Pierre Sicaud. An airfield was established on the islands, which lie midway between South Africa and Australia.

An international expedition, sponsored by the Norwegian, British and Swedish governments—the first of its kind—worked in Queen Maud Land in 1949–52. The primary objective was to try to determine whether the antarctic icecap is waning, as is true of most northern glaciers, in response to a warming climate trend which has been in progress since 1900. The expedition, which was led by the Norwegian John Giaever and comprised members of all three nationalities, established a station called Maudheim on a floating ice shelf. During the field seasons of 1950–51 and 1951–52 a number of journeys were made, using mechanical tracked vehicles and dog sledges, and an advanced base was established in 72°. 17′ S., 3° 48′ W. An important seismic sounding journey was made inland to a point 370 mi. from Maudheim on the inland ice plateau. A number of flights were made over Queen Maud Land and air photographs were taken.

V. INTERNATIONAL CO-OPERATION

1. International Geophysical Year.—When the committee in charge began organizing the International Geophysical year, to extend from July 1, 1957, to Dec. 31, 1958, it became apparent that nearly a fifth of the world-wide data to be collected would be missing if Antarctica was not included in the effort. Of the 66 nations that eventually joined the IGY effort, 12 volunteered to use existing stations in the antarctic regions or to establish new ones. The south pole was to become the tie point of north-south lines of stations extending through the other continents. It became further obvious that inland stations would be required as well as ones on the coast. These would be both costly to build and difficult to achieve. Only the United States and the U.S.S.R. volunteered to use their resources to attain far inland goals, although France and the United Kingdom later placed small stations short distances inland.

The seven claimant nations all played an active role but restricted their station efforts to localities within their claimed areas. The nonclaimant nations taking part, in addition to the U.S. and U.S.S.R., were Japan, Belgium and South Africa. Correlation was achieved by means of an International Antarctic committee organized in Paris in 1955. The nonclaimant nations established their stations in gap areas to improve spacing. In some cases, however, there were more stations than were essential to the program; for example, the United Kingdom, Chile and Argentina had stations at Deception Island and Hope bay and the U.S., the United Kingdom and Argentina established new stations not far apart on the Filchner ice shelf. On the other hand, areas such as the Pacific-facing coast of west Antarctica were neglected because of the difficulty in approaching them; its protecting pack ice was first breached in 1960, well after IGY.

Along the coast of Norwegian-claimed Queen Maud Land, nearly 2,000 mi. long, Norway's single station on the Princess Martha Coast was joined by a Japanese station, Showa at Prince Harald Coast on Lützow-Holm bay, and by a Belgian station, King Baudouin station on Princess Ragnhild Coast. Australia added Davis station at Princess Elizabeth Land on Ingrid Christensen Coast to its existing Mawson station. To help fill in gaps along this coast the U.S. located Wilkes station on Budd Coast and the U.S.S.R. located two stations, Mirny on Queen Mary Coast and Oazis at Bunger Hills in Wilkes Land. The French station Dumont d'Urville at Point Géologie on the Adélie Coast further filled in the observing points in this region. The French also established a small, temporary inland station, Charcot, near the south magnetic pole. In its claimed Ross dependency sector New Zealand established Scott station on Ross Island, McMurdo sound, close to the Williams naval air facility, a U.S. installation. The U.S. and New Zealand jointly established Hallett station at Cape Hallett near Cape Adare of Victoria Land. The U.S. main IGY station, Little America V, was established in this same sector at Kainan bay, about 20 mi. N.E. of the former Little America sites.

In the Weddell sea sector claimed in part by both Britain and Argentina the latter built General Belgrano station just prior to IGY. Later, and nearby on the Filchner ice shelf, the U.S. built its Ellsworth station and Vivian E. Fuchs his Shackleton station for the British Trans-Antarctic expedition, only coincidentally a part of IGY. This group also built a support station, South Ice, inland. The only strictly new British IGY station, Halley Bay, was established about 250 mi. to the northwest on Coats Land. In the area of the Antarctic peninsula and the South Shetland and South Orkney islands claimed by the United Kingdom, Argentina and Chile, 24 of the nationalistically motivated stations took creditable part in the IGY program. Seven of these were Argentine, six were Chilean and the remainder British.

The United States built two major inland stations in support of the IGY effort. Byrd station at 80° S., 120° W. was established by tractor and air support; the geographic south pole station Amundsen-Scott was established entirely by air. The U.S.S.R. originally planned two inland stations, Vostok, to be established at the south geomagnetic pole (where the earth's magnetic field focuses downward from outer space), and Sovietskaya, to be in the geographic centre of the continent. Because of high elevations and soft snow the mobile stations failed to reach the sites on schedule, and in consequence the intermediate stations Pionerskaya, Komsomolskaya and Vostok I were established as overwintering sites en route and Sovietskaya was established about 400 mi. short of its goal.

In the wide expanse of antarctic waters and far southern oceans there are few islands suitable for stations. A number, however, served as useful IGY station bridges to the surrounding continents: Kerguelen (France); Campbell (New Zealand); Macquarie (Australia); Marion, Tristan and Gough islands (South Africa); and Falkland and South Georgia islands (United Kingdom).

Logistic support for the stations followed various patterns. Danish iceworking ships built for Greenland commercial travel were chartered by several nations. The U.S.S.R. used its icebreaking oceanographic vessels "Ob" and "Lena" as well as other vessels out of their Northern Sea Route administration. The U.S. logistics support was assigned to the department of defense

BY COURTESY OF (ABOVE AND TOP RIGHT) U.S. NAVY, (RIGHT) TRANS-ANTARCTIC EXPEDITION

20TH-CENTURY EXPEDITIONS AND SCIENTIFIC RESEARCH

(Above) Launching a helium-inflated balloon into the upper atmosphere; (top right) Installing a 40-ft. steel arch across the garage tunnel at Byrd Station; (right) Sno-cat tractor transporting supplies across a crevasse in the icecap during British Trans-Antarctic expedition, 1957

and on to the U.S. navy, which in turn called upon the air force and the army for specialized assistance. Rear Adm. George Dufek of the United States navy was assigned command of the logistics task forces, called Operation "Deepfreeze." Naval personnel were assigned with their own command lines to furnish medical, communication, construction and station maintenance, whereas the scientific program was under a separate civilian command line responsible to the National Academy of Sciences. Until his death on March 11, 1957, Admiral Byrd was responsible for the over-all administration of the U.S. Antarctic programs.

The scientific programs of the IGY concentrated upon synoptic subjects which required simultaneous readings from the many scattered stations. The principal subjects included surface and upper atmosphere meteorology, geomagnetism, ionospheric physics, aurora, seismology, cosmic radiation, oceanography and glaciology. The latter study was intended to determine the history of past climate variations and trends as revealed by snow accumulation rates. Although mapping and geology were not part of the program, they were encouraged, as were biological studies. Glaciology traverses by cross-country tractor and aircraft included seismic ice depth determinations and earth gravity determinations. Although traverses were run out of many of the stations, those by the U.S. in west Antarctica and by the U.S.S.R. in east Antarctica were the most extensive. More spectacular was the transantarctic crossing by a British tractor party led by Vivian E. Fuchs—the first overland crossing of the continent. The trip began from Shackleton station on the Weddell seacoast and ended at Scott station on the Ross seacoast. Support for the journey past its midpoint visit at the U.S. south pole station was given by a tractor party led by Sir Edmund Hillary from the New Zealand Scott station. The traverses of all stations revealed that the land mass beneath Antarctica's ice cover is extremely rugged. The cap averages a mile in thickness and in many places goes far below sea level, indicating in general that west Antarctica is mostly an island grouping and that east Antarctica is more truly continental.

Coastal stations were similarly equipped but varied in size depending upon the scope of problems they were handling. Little America, McMurdo and Mirny had more than 100 inhabitants during the winter and many more during the summer season. Little America V served as the main U.S. scientific administration and communications centre under A. P. Crary. This station also served as the Weather Central for the continent. There was some exchange of foreign observers among the bases, including a U.S.S.R. observer at Little America V and a U.S. observer at Mirny, a practice continued after the end of IGY.

Of the inland stations Byrd station was the largest, serving as support for traverse operations. It was established by an army-pioneered tractor train party from Little America V. The Russian and French inland stations were modified mobile units dragged inland. The most unusual of the stations was the U.S. Amundsen-Scott south pole station, established by air force parachute drops and navy ski airplane landings. The station of 18 men, led by IGY leader P. A. Siple and naval leader J. Tuck, was the first base at either of the earth's poles to be inhabited for a year. During the six sunless winter months a world record low temperature of $-102.1°$ F. was recorded. Average winter wind speeds were about 17 m.p.h. and the average temperature $-73°$ F. at this 9,200 ft. elevation. A year later, Aug. 25, 1958, at the 11,220-ft. Russian Vostok station, where winds were less, a minimum temperature of $-125.3°$ F. was recorded. (Subsequently, on Aug. 24, 1960, a temperature of $-126.9°$ F. was reported there.)

The IGY program amassed great volumes of information which may require years to fully analyze and co-ordinate. The IGY nations formed three major data centres in which the raw data and final reports were sent for processing and exchange with the other centres. Data Centre A is assigned to the United States, serving generally North and South American countries; Data Centre B is assigned to the U.S.S.R., serving Asia and especially the communistic nations; and Data Centre C is in western Europe, serving also Africa and Australasia. Each data centre is in turn divided into subcentres by various subjects and scientific disciplines. In the U.S. these centres are variously located in universities, research institutes or government departments, such as the weather bureau and the national bureau of standards, dealing nationally with meteorology and ionospheric physics.

By the 1960s masses of publications were already appearing in all three centres and being widely exchanged according to agreement. The antarctic data are incorporated with data from all

parts of the world except in cases unique to the region.

The IGY was the largest international scientific undertaking of all time, and the intense study of Antarctica was one of its greatest achievements. IGY may stand as a prototype of international undertakings in the pursuit of knowledge for the common good of the world; but whatever its full assessed value may be, its initial stimulus to the large-scale study of Antarctica cannot be overestimated.

2. Special Committee for Antarctic Research.—Stimulated by the success of the IGY and the recognition that the high investments in stations justified their further utilization, the international effort in Antarctica was extended beyond the closing date of IGY, Dec. 31, 1958. A Special Committee for Antarctic Research (S.C.A.R.), under the International Council of Scientific Unions, replaced the IGY Antarctic committee for international scientific co-operation of the 12 nations which had carried on the antarctic IGY activity. The organizing meeting was held at The Hague in Feb. 1958; the second meeting was in Moscow in Aug. 1958 and the third in Melbourne in 1959; meetings took place almost annually thereafter. Although most of the stations were still active during 1959 and 1960 some began to change sponsors. The U.S. Ellsworth station on the Weddell coast was transferred on co-operative loan to Argentina with continued U.S. support to the science program; the Wilkes station was transferred to Australia; the U.S.S.R. Oazis station was offered to Poland, which, however, found difficulty in gaining support; and the single Norwegian station was transferred to South Africa. The U.S.S.R. opened a new station, Lazerev, on Astrid Coast of east Antarctica facing Africa. By the mid-1960s it had become the U.S.S.R.'s main station, and Mirny began to be reduced in size and importance.

Traverse activity, frequently of international composition, was continued at an increasing pace, and mapping and geology neglected during IGY was encouraged. U.S. traverses extended widely over west Antarctica, reaching Pacific coastal mountains in the north and the Horlick mountains in the south. In 1960 the powerful icebreaker U.S.S. "Glacier" broke through the previously impenetrable pack ice of the southern Pacific area and reached the Thurston Island region of Marie Byrd Land, opening a way for stations along this coast, and en route repositioned mountain peaks in the Executive Committee range. Vinson Massif (16,863 ft.), at 78° 35′ S., 85° 25′ W., appeared to be Antarctica's highest known peak. A United States–New Zealand traverse party crossed Victoria Land into Terre Adélie.

A U.S.S.R. traverse visited the U.S. south pole station in Jan. 1960, traveling en route from Mirny via Vostok. Resupply of Byrd and the U.S. south pole stations was accomplished in part by C-130 cargo aircraft landing for the first time on ski.

3. Antarctic Treaty.—Stimulated by the success of international co-operation in Antarctica during the IGY, the 12 nations that had taken part in the endeavour signed a treaty in Washington, D.C., on Dec. 1, 1959; later other nations acceded to it. Formal ratification of the treaty was announced two years later when the contracting nations convened in Canberra, Austr., to further the purposes and objectives of the treaty. The treaty dedicated Antarctica for peaceful purposes only and restricted its use for military purposes. It promoted international co-operation in scientific research, exchange of personnel, information and results.

No member nation was required to renounce its claims or previously asserted rights to claims. However, there was to be freedom of operation anywhere about the continent, although no such operations were to form a basis for new or extended claims during the time the treaty was in force.

Nuclear explosions and disposal of radioactive wastes in Antarctica were prohibited, although peaceful and scientific use of atomic devices was permitted. The treaty applied to the regions lying south of latitude 60° S. but did not restrict normal freedom of the high seas included in this area. There were elaborate provisions for exchange of plans, observation, inspection and settlement of possible disputes. The treaty had provision for new member nations wishing to take an active part in antarctic activities and bound its members for a period of 30 years.

As a result of the treaty a majority of the nations continued most of their IGY programs unabated. Considerable attention was given to surveying, mapping and geological reconnaissance until the advent of the International Years of the Quiet Sun.

4. International Years of the Quiet Sun (IQSY) 1964–65.—Because of the work begun and facilities established during the IGY, which was held during a period of high sunspot activity, antarctic research stations required little more bolstering of scientific programs to be prepared for the IQSY when solar sunspot activity fell to a minimum in its normal cycles. Studies of meteorology, upper atmosphere, ionospheric sounding, cosmic radiation, aurora, and radio wave propagation were emphasized. Although the intensiveness of some antarctic research will decrease and increase with new programs of this nature, the international co-operation enthusiastically pursued under the treaty is expected to keep permanent activities going on indefinitely. Most stations maintained strong summer programs with an influx of temporary staff, while the winter personnel were fairly well stabilized in numbers. These latter groups were replaced annually, though many of the workers returned for another tour of duty. Thus individuals are carrying on what may become a lifetime career in antarctic scientific activities and becoming in a sense Antarctica's first inhabitants.

5. Future Prospects for Antarctica.—Despite the facts that Antarctica had its first temporary year-round inhabitants at the turn of the 20th century, that it is still incompletely explored and that its periphery outlines were mapped only after World War II, it is being so intensively studied that it will soon be as well known as most of the rest of the world's continents. Technological advances after 1940 provided a means of safe access, and the fearful shrouds of the unknown and the intense cold lost their inhibiting power. This once bleak, lifeless continent teems with hundreds of men each year, wresting out the challenging problems and answers to its hidden secrets. Man will not rest until he knows the relationships of Antarctica's physical character, history, life and phenomena to those of the rest of the world. The Antarctic treaty has proven to be a further stimulus and it is reasonable to expect that well before the close of the 20th century the continent will be fully explored and well mapped both as to surface and subglacial features; the geology of most exposed mountain areas will have been studied and the mineral resources assayed; weather forecasting will become a permanent part of a world meteorological forecasting system; electromagnetic phenomena of the region will be correlated with global phenomena as well as solar and extraterrestrial space events; the flora and fauna will have been intensively studied and their distribution well mapped; the surrounding oceans will have been systematically studied as to physical character and biological distributions; in short, the continent will be as well, if not better, understood as regions of the world enclosed by firm national boundaries, for the exchange of new knowledge will be expedited through international channels. It is also reasonable to expect that technology of travel and living will soon permit during any month of the year access to any part of the continent from any of the surrounding continents; nuclear reactors are already furnishing heat, power and water to comfortable houses and facilities of sizable communities; space satellites are already supplementing surface studies and atmospheric sounding rockets have been launched in Antarctica; commercial air travel in the southern hemisphere will likely be using great circle routes across Antarctica; colonization of a unique sort will be initiated by families under contract manning permanent meteorological, communication and scientific data recording centres and outposts; and some food may even be produced locally.

On a somewhat longer time scale, but probably within the 20th century, industrial centres may develop for those industries requiring extensive space, safety of operation, freedom of contamination, large quantities of fresh water reserves or natural refrigeration. Extensive mining operations will depend upon discovery of minerals which can compete with lower cost sources in other parts of the world; however, some development of commercially extracted by-products of antarctic coal reserves appears possible.

The most significant aspect of Antarctica's future, however, may lie in its becoming the first free region of the world, a step to

internationalizing the world of the future. National claims of the present are so confused and basically indefensible by protective forces that they will likely weaken until they give way to a continent whose inhabitants and visitors are free from normal national restrictions of movement or commerce, and are subject only to a form of yet-to-be-defined international laws. This international experimentation and co-operation may be of greater value to mankind than Antarctica's future material potential.

See also references under "Antarctica" in the Index, and, for current developments, the annual summary in the *Britannica Book of the Year.*

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ANTEATER, a term applied to several mammals that feed mainly upon ants or termites. The giant anteater or antbear (*Myrmecophaga tridactyla*) is the largest representative of the tropical American family Myrmecophagidae (*see* Edentata: *Hairy Edentates: Sloths and Anteaters*). It measures four feet in length, exclusive of the long bushy tail, the hair of which may be 16 in. long, and reaches a height of two feet at the shoulder. Its usual colour is gray-black. It inhabits the swampy savannas and humid forests of South and Central America, but is nowhere common. Characteristic features are the long tapering snout, small mouth, absence of teeth and the strong curved claws on the forefeet. With the latter it not only defends itself effectively but also tears holes in the dwellings of ants and termites, capturing the inhabitants by means of its long sticky tongue, which it extends for about nine inches and lashes from side to side. The female produces a single young at a birth. The young ride on the backs of the mothers the first few months after they are born. The tamandua anteater (*Tamandua tetradactyla*) is smaller and arboreal, inhabiting the forests of South and Central America. Also arboreal is the little or two-toed anteater (*Cyclopes didactylus*) of the same region, about the size of a rat and yellowish in colour.

For the Cape anteater, *see* Aardvark; for the scaly anteater, *see* Pangolin; for the banded anteater, *see* Marsupial; and for the spiny anteater, *see* Monotreme and Echidna.

ANTELAMI, BENEDETTO (active after 1178), the preeminent Italian architect and sculptor of his time, is named for the first time in an inscription on a relief of the "Deposition" dated 1178 in the right transept of Parma cathedral. Of Lombard origin, he appears to have worked initially in Provence, and the influence of the Romanesque sculptures of St. Gilles is reflected both in the "Deposition" and in his masterpiece, the sculptures of the baptistery at Parma. Antelami's principal achievement as an architect, the baptistery, was begun in 1196 and appears to have been largely completed by 1216.

In the later sculptures of the baptistery and the figures of David and Ezekiel on the façade of the cathedral of Borgo San Donnino (Fidenza), there is evidence of contacts with the early Gothic sculptures of the Ile-de-France. These contacts assume preponderant importance in Antelami's last work, the church of S. Andrea at Vercelli (founded 1219, consecrated 1225), where the architectural scheme derives from that of St. Ived de Braisne and the lunette of the "Martyrdom of St. Andrew" over the portal also contains recollections of French Gothic sculpture. Despite his indebtedness to France, Antelami developed a style of great individuality and occupies an unchallenged place as the greatest Italian Romanesque sculptor.

See G. de Francovich, *Benedetto Antelami, architetto e scultore* (1952). (J. W. P.-H.)

ANTELOPE, the name of numerous ruminant ungulates of the superfamily Bovoidea. Antelopes range in size from that of a rabbit to that of a large ox and nearly all bear horns, at least in the males.

The antelopes, sheep, goats and oxen are all fairly closely related to each other and, together with the pronghorn, form the very large superfamily Bovoidea, which is divided into two families, the Antilocapridae, made up of a single species, the American pronghorn; and the Bovidae (*q.v.*), consisting of more than 50 living genera. The name antelope, however, cannot be defined exactly in zoological terms because it is applied to animals that, although superficially similar, do not form a homogeneous group. Popularly, the animals classified as the Bovoidea consist of three groups, the antelopes, containing all the animals that cannot be included in the other two, the oxen and the sheep and goats, a classification that is not in agreement with the zoological classification based on their relationships to each other.

THE ANTILOCAPRIDAE

The pronghorn *Antilocapra*, the only living representative of the Antilocapridae, is confined to North America, but the name "American antelope" commonly applied to it in the United States is regarded as a misnomer in view of its distant zoological relationship to the true antelopes (*see* PRONGHORN).

JOE VAN WORMER FROM NATIONAL AUDUBON SOCIETY

FIG. 1.—MALE PRONGHORN ANTELOPE (ANTILOCAPRA AMERICANA)

THE BOVIDAE

Subfamily Bovinae.—The first groups of antelopes among the Bovidae are the tribes Strepsicerotini and Boselaphini of the subfamily Bovinae, both closely related to the Bovini (oxen, buffaloes and bison).

Strepsicerotini.—The Strepsicerotini contain the bushbucks and their allies and include some of the largest antelopes, such as the kudu and eland. They are large- or medium-sized antelopes with spirally twisted horns present only in the males. The bushbucks, including the harnessed antelope (*Tragelaphus scriptus*), are frequently brilliantly coloured, the body being rich chestnut or orange-brown with a white nasal chevron and longitudinal and transverse stripes on the body. They are widely distributed over forested Africa south of the Sahara and extend to the Cape. The nyala (*T. angasi*) is a much larger species, the male with larger horns and a mantle of long hair on the sides. The male is blackish in colour, the female a dark chestnut, and both are marked with stripes like those of the bushbuck. Nyala are restricted to a small area in southeastern Africa. The mountain nyala (*T. buxtoni*) is the largest member of the genus, standing nearly as high as the kudu. It is grayish-brown in colour. This fine species lives on the high mountains near Lake Zwai in Ethiopia. The sitatunga (*T. spekei*) is a little larger than the bushbuck, with longer limbs and elongated hoofs, an adaptation to the mud and soft marsh ground. Sitatungas are found from west Africa to the Sudan and south-central Africa. The greater kudu (*T. strepsiceros*) stands nearly five feet at the shoulder; males possess large spirally twisted horns. This species is distributed throughout much of the plains country of Africa south of the Sahara. The lesser kudu (*T. imberbis*) is only about 40 in. tall at the shoulder and has much smaller horns. It is restricted to the drier parts of east Africa, from southern Ethiopia to Tanganyika. The eland (*Taurotragus*) is the largest of the antelopes, adult bulls standing nearly five feet at the shoulder. The common eland (*T. oryx*) of south and east Africa, differs from the Derby eland (*T. derbianus*) by having smaller, less massive horns and narrower ears. The larger form is found south of the Sahara from Senegal to the Sudan and the northern section of the Republic of the Congo. The bongo (*Boocercus eurycerus*) is a close relative of the eland, found in west Africa, the Congo and certain mountain forests. It is bright chestnut in colour with 10 to 13 white vertical stripes on the body. Both male and female bongos bear horns, much more loosely spiraled than those of the eland.

Boselaphini.—The Boselaphini contain only the nilgai, or blue bull (*Boselaphus tragocamelus*), and the four-horned antelope (*Tetracerus quadricornis*), both found in peninsular India. The adult bulls of the nilgai are bluish-gray, with short, slightly spiraling horns, but the females are pale yellow and hornless. The four-horned antelope is a small forest-living species and differs from other antelopes in that the males, at least in one race, have two pairs of horns, the first pair being smaller.

Subfamily Cephalophinae.—This subfamily comprises one tribe, the Cephalophini, containing the duikers or duikerboks, is the most primitive subfamily of the Bovidae. Duikers are small or medium in size and are characterized by their spikelike horns which are commonly present in both sexes, their naked muzzles and large face glands represented externally by a long narrow streak below the eye. The female has four teats. *Cephalophus*, including the forest duikers, is distinguished by horns sloping back almost in line with the profile. Most species are confined to the equatorial rain forests or follow the gallery forests along rivers. The largest members of the tribe, the yellow-backed duiker (*C. sylvicultor*) and Jentink's duiker (*C. jentinki*), stand 30 in. or more at the shoulder, but other species are smaller (height 16–24 in.). The blue duikers are the smallest members of the tribe; their horns are very small, usually present in both sexes. Their colour varies from bluish-gray to grayish-brown. They live in the forests but extend also into the bush country of South Africa. *Sylvicapra grimmia*, the gray or common duiker, is the sole representative of its genus. The males have slender horns, longer than those of other duikers. This duiker is widely distributed in south, central and east Africa.

Subfamily Hippotraginae.—The Hippotraginae are large- or medium-sized antelopes with ringed horns and high-crowned cheek teeth but without facial glands. There are three tribes, the Reduncini, Hippotragini and Alcelaphini.

Reduncini.—The Reduncini include five genera with sinuous or forward-curving horns, found only in the male. The muzzle is naked. *Kobus* includes the two species of waterbuck. *K. ellipsiprymnus*, the common form, is found in east and central Africa from Somalia to the Transvaal, and the defassa or sing-sing (*K. defassa*) occurs in the savannas south of the Sahara and in parts of east Africa. Their long spreading horns curve forward at the tips. The lechwes are smaller than the waterbucks, with long sinuous horns. There are two species: *K.* (*Adenota*) *megaceros*, almost black with white withers, is found in the upper Sudan, and *K.* (*Adenota*) *leche* occurs in central Africa and is reddish. The kobs, *Kobus* (*Adenota*), have short sinuous or lyrate horns; they are reddish in colour, sometimes with white facial markings. Kobs are widely distributed in Africa except for forests and deserts. The reedbucks (*Redunca*) have short tails, small lateral hoofs and, like the preceding species, have a bare spot below the ear. The shoulder height varies from 28 to 37 in. A small species, the mountain reedbuck (*R. fulvorufula*), is found in mountainous parts of east and south Africa, and the common reedbuck (*R. arundinum*) is found over most of Africa south of the Sahara. The South African gray or vaal rhebok (*Pelea capreolus*) is distinguished by its gray woolly hair and its rather long, spikelike horns.

W. SUSCHITZKY

FIG. 2.—DEFASSA OR SING-SING WATERBUCK (KOBUS DEFASSA)

Hippotragini.—The Hippotragini are generally large antelopes with long horns, straight, backward curving or, in one species, spirally twisted, present in both sexes. *Hippotragus* includes the extinct blaaubok, the roan antelope and the sable antelope. In it the horns rise nearly vertically above the eyes, then sweep backward in a bold scimitarlike curve. The roan antelope (*H. equinus*) is a large species, with stout and comparatively short horns, and of reddish-gray colour. Roan antelopes are widely distributed over the greater part of Africa south of the equator, excluding the rain forests of the equatorial zone. The blaaubok of South Africa was similar in appearance but was blue-gray in colour. The sable antelope (*H. niger*) is rather smaller than the roan, but its horns are longer, especially in the Angolan race, in which they may reach 64 in. in length. Sable antelopes are distributed over a large part of central and east Africa. *Addax*, with spiraling horns, contains a single desert species (*A. nasomaculatus*) found in north Africa from Senegal to Dongola. The gemsbok (*Oryx gazella*) and the

beisa (*O. beisa*) have nearly straight horns and are very similar except for the larger size of the former. The gemsbok inhabits southwestern Africa from the Kalahari desert to Angola and the beisa is found from the Red sea to northern Tanganyika. The very pale Arabian oryx (*O. leucoryx*) has straight horns; the north African scimitar-horned oryx (*O. algazel*) is also almost white, but its horns curve backward in a wide sweep.

Alcelaphini.—The tribe Alcelaphini contains the hartebeests, the blesbok, sassaby, tiang and the gnus. They are large antelopes, usually somewhat grotesque and ungainly in appearance, with horns in both sexes. The hartebeests (*Alcelaphus*) are characterized by their long faces and high horn pedicle; the horns, which are lyrate and more or less strongly ringed, rise almost vertically from the cylindrical pedicle. The neck is unmaned and the tail is moderately long; the height of the withers (43–54 in.) greatly exceeds that of the hindquarters. Several subspecies of hartebeests are recognized. The bubal (*A. buselaphus buselaphus*) of north Africa is nearly or quite extinct in typical form. A large race comes from the Senegal-Republic of Mali area. The lelwel (*A. b. lelwel*) has a high forehead; the horns are close together with the tips directed posteriorly. It occurs in the Sudan, and closely allied forms are found in Uganda and northern Kenya. Coke's hartebeest (*A. b. cokei*), with widely lyrate horns, is found on the plains of northern Tanganyika and southern Kenya. The tora (*A. b. tora*) is more richly coloured and occurs from Eritrea to the Blue Nile, but Swayne's hartebeest (*A. b. swaynei*) differs in having the face and upper forelegs black. These subspecies occasionally interbreed where their ranges overlap. The Cape hartebeest (*A. b. caama*) resembles the lelwel but is reddish in colour, with face and outsides of the limbs black. Lichtenstein's hartebeest (*A. lichtensteini*), found from Mozambique and northern Rhodesia to southern Tanganyika, is a pale species with short twisted horns. In *Damaliscus*, the bastard hartebeests, the withers are generally less elevated and the horns rise from the head. The hirola, or Hunter's hartebeest (*D. hunteri*), has a white chevronlike marking on the forehead; it is found only on the north side of the Tana valley in Jubaland, east Africa. The bontebok (*q.v.; D. dorcas dorcas*) and blesbok (*D. d. phillipsi*) are two closely allied South African forms which once existed in countless thousands but have been reduced to a few herds preserved on various farms in South Africa. The sassaby, or tsesebe (*D. lunatus*), is distributed over a large area of southeast Africa from the Orange river to Northern Rhodesia and Nyasaland. The gnu, or black wildebeest (*Connochaetes gnou*), differs from the hartebeests and their allies in the presence of tufts of hair on the face, a well-developed mane, a horselike tail and a very broad muzzle. As a truly wild animal this species no longer exists; formerly it was widely distributed over the plains of Cape Colony and the Orange Free State. The brindled gnu, or blue wildebeest (*C. taurinus*), is distinguished from the black wildebeest by the smaller hindquarters and higher withers and the horns spreading out laterally instead of curving forward over the face. The various races of brindled gnu range over a large part of central Africa from Kenya to south of the Zambezi.

Subfamily Antilopinae.—The subfamily Antilopinae is subdivided into two tribes, the Neotragini and the Antilopini.

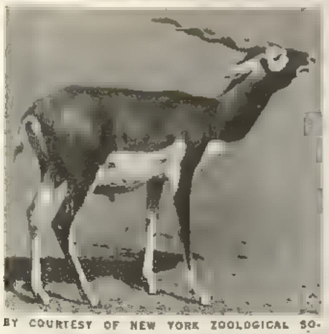

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FIG. 3.—BLACK BUCK (ANTILOPE CERVICAPRA)

Neotragini.—The Neotragini includes the klipspringers, oribis, dik-diks and pygmy antelope, all of which are small, delicately formed species, only the males of most kinds possessing horns. The klipspringer (*Oreotragus oreotragus*) is distinguished from its relatives by its coarse, brittle hair and narrow, high hoofs. Several races are widely distributed over the more mountainous parts of Africa from Ethiopia to Cape Province. The oribis (*Ourebia*) have a bare glandular patch beneath each ear; lateral hoofs are present and horns are slender and ringed basally. The grysbok (*Raphicerus melanotis*) and the other relatives lack the bare patch beneath the ear. The grysbok has a reddish-speckled coat and small lateral hoofs; it extends from the Cape as far north as the Zambezi and Mozambique. The steinbok (*Rhaphicerus campestris*) resembles the grysbok but lacks the lateral hoofs and its colour is a more pronounced buff. This species is found from South Africa to Angola and Mt. Elgon in east Africa. The suni (*Nesotragus*) stands only 13 or 14 in. at the shoulder and males possess slender, relatively long horns (up to 5 in.), which are strongly ringed. The various species and races are confined to east Africa from Zululand to Zanzibar. In the pygmy antelopes (*Hylarnus*) the shoulder height is about equal to that of the sunis, but the horns are smaller and nearly smooth; the genus is confined to west and equatorial Africa. The royal antelope (*Neotragus pygmaeus*), the only member of the genus, is only about ten inches high, being the smallest of all true ruminants; the horns are very small and unringed. This species inhabits the west coast from Liberia to southern Nigeria.

AUTHENTICATED NEWS

FIG. 4.—IMPALA (AEPYCEROS MELAMPUS)

The dik-diks (*Madoqua*) have a tuft of long hair on the crown and a more or less marked elongation of the snout; in the most extreme species this is almost a proboscis. The various species stand 13 or 14 in. high at the shoulder and are confined to east Africa from Ethiopia to Tanganyika, with another isolated species in Angola and South-West Africa. The beira (*Dorcatragus megalotis*) is larger than the dik-diks, measuring about 23 in. in height. The ears are extremely large, and the horns, which are spikelike and ringed basally, measure four to five inches in length. The beira is found only in Somalia and Ethiopia.

Antilopini.—The Antilopini comprise the black buck, the gazelles, the gerenuk, the springbuck, the impala and the dibatag. The black buck (*Antilope cervicapra*), confined to India, is recognized by the long, spirally twisted horns of the males, whose bodies are blackish with white markings. The females are buff. The gazelles (*Gazella*) are widely distributed over western and central Asia, peninsular India and northern and eastern Africa. Horns are present in both sexes, but the females of one Asiatic gazelle are hornless. Some of the African species are of fairly large size, standing 34 to 35½ in. at the shoulder. The springbuck (*Antidorcas marsupialis*) is distinguished from the gazelles by the presence on the middle line of the loins of an eversible pouch lined with long white hairs capable of erection. When alarmed, the springbuck turns the pouch inside out, exposing the white hairs. The range includes South Africa as far north as the Zambezi and Angola. The gerenuk (*Lithocranius walleri*) is at once distinguishable from the other members of the subfamily by the great elongation of the neck and legs. This species is found from Somalia to northern Tanganyika. The dibatag (*Ammodorcas clarkei*), a long-necked gazelle with short, forward-curving horns like those of the reedbuck, is found only in Somalia. The impala (*Aepyceros melampus*) is characterized by the splendid lyrate horns of the males and the absence of lateral hoofs. It ranges over a considerable part of Africa, as far north as Angola in the west and Kenya in the east. *See* also references under "Antelope" in the Index. (L. H. M.)

ANTENNA (AERIAL), a component of an electromagnetic system (such as radio, television, radar, direction finding) used for radiating electromagnetic waves from a transmitter or for intercepting and feeding them to a receiver, or both. When an

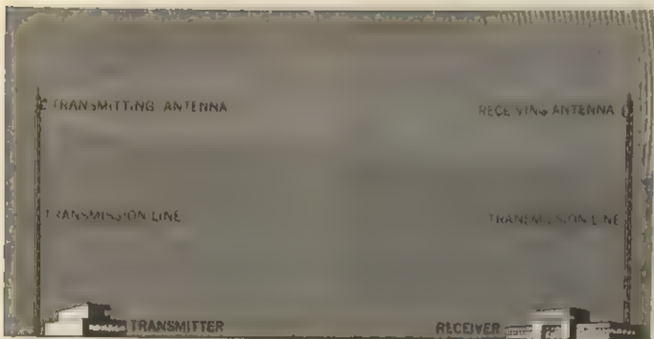

FIG. 1.—SCHEMATIC DIAGRAM OF AN ELECTROMAGNETIC COMMUNICATION SYSTEM

antenna is used for radiating, the energy is fed to it by a transmission line connected to the transmitter (*see* fig. 1). When used as a receiver, the antenna intercepts a portion of the energy radiated by the transmitting antenna and feeds it into a transmission line leading to the receiver. An antenna has identical transmitting and receiving properties and may be used simultaneously for transmitting and receiving. The performance of any electromagnetic communications system, including radio, television, radar and telemetering, is influenced to a large extent by the antennas used. For example, the accuracy with which a radar system determines the position of an object depends in part on the type of radiation pattern produced by the antenna. (*See* RADAR: *Antennas and Scanners.*)

Antennas are described according to their: (1) function in the system, whether transmitting or receiving; (2) use, such as bombing, telemetering, beacon, direction finding, television, radio, radio telescope or guidance; (3) shape, for example: parabolic, rhombic, vee or helical; (4) radiation pattern, whether omnidirectional, directive or cosecant beam; and (5) frequency of the signal used in operation: high frequency (HF), very high frequency (VHF) or ultrahigh frequency (UHF).

As an example of difference of function, television receiving antennas differ substantially from the television transmitting antennas since the transmitting antennas must be capable of handling power in kilowatt quantities and of radiating it in all directions, whereas television receiving antennas must handle power in microwatt amounts and receive from selected directions. In one case the antenna must be relatively omnidirectional, in the other case relatively directional.

The requirements of a given electromagnetic communication system together with the frequency of the signal determine the type of transmitting and receiving antenna to be used. On the radiobroadcast band the wave length is very long, with the signal frequency in kilocycles. Wave length (λ) in feet is obtained by dividing the velocity of light (984×10^6 ft. per second) by the frequency in cycles per second. For example, a radio transmitter operating at 1,000 kc. per second transmits electromagnetic energy with a wave length of 984 ft. This long wave length, to a large extent, limits the transmitting antenna to a vertical metal tower approximately one-fourth of a wave length in height. In most radio installations a counterpoise of radial wires is embedded in the ground under the antenna. Usually the energy is radiated equally in all horizontal directions (omnidirectional in the transverse planes). However, if the energy is to be directed in a preferred general direction (directive antenna), two or more such towers are used. Radio receiving antennas commonly are in the form of long wires or "whips" such as automobile antennas. These are very short in terms of a wave length and have very low efficiency.

FIG. 2.—TELEVISION RECEIVING ANTENNAS: (A) YAGI; (B) DOUBLE VEE; (C) FOLDED DIPOLE

At television signal frequencies the wave length is between 1 ft. and 17 ft., permitting greater leeway in the design of both transmitting and receiving antennas, especially at the higher frequencies (shorter wave lengths). The television transmitting antenna is mounted at an elevated site or on the top of a tower in order to increase the distance at which its signal can be received. In the vertical plane the television transmitting pattern is directive, and an attempt usually is made to direct the energy below the horizon in order not to waste energy by sending it upward into space. (Unlike waves at radiobroadcast frequencies, television waves are not reflected back to earth by the ionosphere, and thus reception normally is not possible beyond the horizon as viewed from the transmitting antenna.) In the transverse plane the television radiation pattern is omnidirectional. Near the transmitting antenna the receiving antenna usually is an indoor type because of the comparatively high strength of the signal. At greater distances rooftop antennas predominate; and at still greater distances, very directive antennas pointed in the general direction of the transmitter are used. Typical examples of rooftop or chimney-mounted television receiving antennas are the yagi, double vee and folded dipole (fig. 2). (*See* BROADCASTING: *The Broadcast Transmitter* and *The Broadcast Receiver.*)

In radar the same antenna is used for transmitting and receiving. The type of antenna selected depends on the purpose of the radar system; that is, whether it is used for searching, bombing, tracking, etc. The radiation patterns of these antennas are normally very directive or flared beams. Because of the high operating frequencies, many types of antennas are possible.

Radiation Pattern and Gain.—If it were possible to radiate electromagnetic energy from a geometric point (point source), the electromagnetic field would have constant amplitude on the surface of a sphere whose centre was the point source. Such an ideal radiator is called an isotropic radiator and its gain or directivity is zero. Hence, it is used as a reference for gain or directivity.

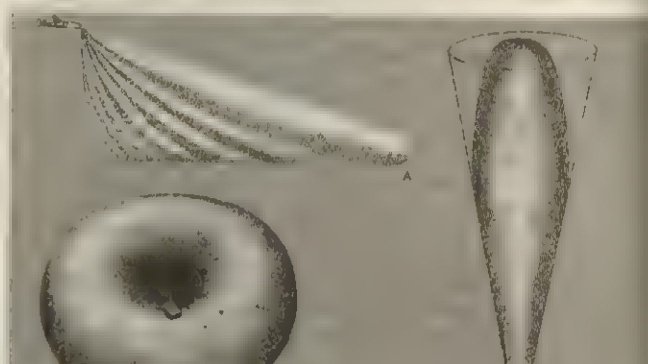

FIG. 3.—RADIATION PATTERNS: (A) SHAPED BEAM; (B) HALF-WAVE DIPOLE ANTENNA, MOUNTED VERTICALLY; (C) DIRECTIVE RADIATION PATTERN

The radiation pattern of a half-wave transmitting dipole (fig. 3[B]) has a gain in reference to isotropic of 2.2 decibels (db). (The gain in decibels equals 10 log P_2/P_1, where P_1 is the power radiated in a given direction from the reference antenna and P_2 is the power radiated in the same direction by the antenna being compared; this unit is borrowed from acoustics, where a decibel is considered as a readily distinguishable change in the intensity of a sound.) The radiation pattern of the dipole is directive in all planes containing the dipole and omnidirectional in all planes perpendicular to the dipole. The gain or directivity of an antenna increases as the energy is concentrated into a cone, with the maximum energy at the axis of the cone (fig. 3[A]); the smaller the vertex angle of the cone the greater the gain. In directive antennas (pencil beam antennas) there is energy outside this cone and if

the radiation pattern is plotted in polar co-ordinates, it will be found to have one dominating lobe (the main lobe) and a number of smaller lobes (side lobes). Hence, it is desirable to have as little energy as possible in the side lobes. Of course, the cross section of the ellipse need not always be circular because it may be desirable (as in search antennas) to have the cross section elliptical so that the beam is flared in one plane and very directive in the orthogonal plane. Again, the beam may be directive, for example, in the horizontal plane and shaped (fig. 3[C]) in the vertical plane in order to distribute the energy as a function of distance (a bombing antenna employs this type of beam). Also, there are antennas, such as those for television transmission, that require an omnidirectional pattern in one plane and a directive pattern in the perpendicular plane.

ANTENNA COMPONENTS

An antenna may consist of a single radiating element, a composite of radiating elements or a radiating element and a reflector.

Single Radiating Elements.—There are numerous types of radiating elements. The most common are (fig. 4) the dipole, loop, helix, electromagnetic horn and slot.

Dipole.—Considered as the fundamental radiator, the dipole consists of two collinear conductors, fed in phase opposition; *i.e.*, one half positive when the other is negative, and vice versa. The classical dipole is one-half wave length long. The radio transmitting tower is in effect a dipole, the other half being the electrical "image" in the counterpoise. This type is also referred to as a monopole. The half-wave dipole, or doublet, is used extensively as a reference antenna. Numerous directive antennas consist of an array of dipoles or a reflector with a dipole as the feeding element.

An important property of a dipole is that it is linearly polarized. The electric vector radiated by a dipole is parallel to the dipole; a receiving dipole aligned at right angles to the transmitting dipole would receive little or no energy from this radiated field. This condition is due to the fact that the electromagnetic field radiated by a dipole consists of electric and magnetic fields at right angles to each other with the magnetic field perpendicular to the direction of propagation. Since this field is linearly polarized, another use for a dipole is to check the polarization of a radiated field. (*See* ELECTROMAGNETIC WAVES.)

Loop Antenna.—Wire formed into an incomplete circle or square and fed in phase opposition at the discontinuity is called a loop antenna. It is popularly used in direction finding. (*See* NAVIGATION: *Radio Direction Finders.*)

Helical Antenna.—If a conductor forms a helix with the proper pitch and diameter, it will radiate in the direction of the axis of the helix. This relatively directive antenna radiates a circularly polarized field. If the electric vector rotates in the plane orthogonal to the direction of propagation, the electromagnetic field is called circularly polarized provided its amplitude is constant throughout its rotation. However, if it increases, then decreases and increases again, the field is said to be elliptically polarized.

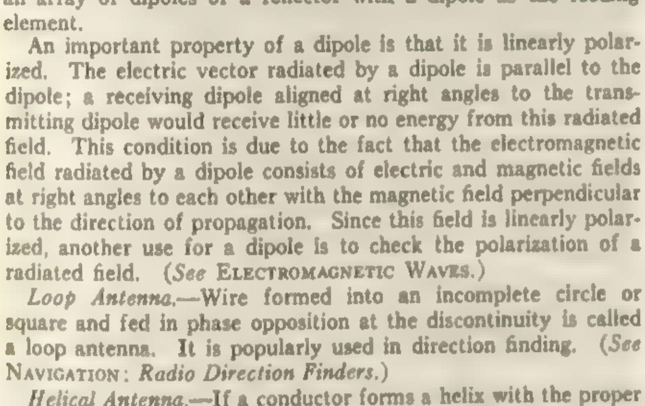

FIG. 4.—RADIATING ELEMENTS (*See* TEXT)

The helix is often used as a receiving antenna for radiated energy of unknown polarization and when the orientation of the linearly polarized field is varying. Similar to the dipole, it has been used to feed reflectors and as the radiating element in directive arrays.

Electromagnetic Horns.—If the sides of a wave guide are flared, it forms an electromagnetic horn. (Wave guides frequently are used in place of transmission lines to guide the electromagnetic field at microwave frequencies.) Horns generally are hollow rectangular tubes flared in one or both planes. If flared in one plane, the wave guide is called a sectoral horn; if flared in both planes, it is called a pyramidal horn. The radiation pattern of a horn depends on its flare and length. Horns can be used by themselves as directive antennas or as feeding elements in parabolic antennas.

Slots.—If a slot is cut out of a metallic sheet and fed at the centre of its longer sides, it forms a slot antenna. The slot may be in the shape of a rectangle, L, dumbbell, ring or cross. Like the dipole, the radiation pattern of a rectangular slot is linearly polarized. Radiation from a horizontal slot is vertically polarized, while that from a vertical slot is horizontally polarized, in contrast to a dipole, where the radiation from a vertical dipole is vertically polarized and from a horizontal dipole is horizontally polarized. The slot antenna is used extensively on aircraft and missiles when projections from the surface are not feasible. Slots

FIG. 5.—ARRAYS: (A) RECTANGULAR DIPOLE ARRAY. (B) LINEAR SLOT ARRAY

also can be formed into arrays for directive antennas.

Long-Wire Antennas.—There are two important long-wire antennas used for point-to-point communications; namely, the vee and rhombic. Both give directive radiation patterns.

Combination Radiating Elements.—*Arrays.*—A coplanar set of radiators is called a linear array. A coplanar parallel set of linear arrays forms a rectangular array. The radiation pattern of a linear array is determined by the fundamental radiation pattern of the individual elements forming the array as well as by the spacing between the elements and the amplitude and the phase of the input power. Arrays are designated according to the direction of the axis of their main lobe with respect to the array: broadside if perpendicular to the array, end fire if in the direction of the array, and arbitrary angle if the direction is intermediate between end fire and broadside.

Radiating elements used most frequently in linear arrays are dipoles (fig. 5[A]) and slots (fig. 5[B]). In general, the radiation pattern from a linear array is omnidirectional in the planes transverse to the array. To make the radiation pattern directive in the transverse planes, a set of arrays is used to form a rectangular array. Broadside rectangular arrays are used extensively as radar antennas in the VHF band. Arrays permit much leeway in forming the radiation pattern. They can be made to give a sharp pencil beam, a beam fanned in one plane and very directive in the orthogonal plane or a beam shaped in one plane and very directive in the orthogonal plane.

Reflectors.—A plane sheet, two sheets at right angles or a parabola are commonly used to increase directivity (fig. 6). A broadside rectangular array gives a directive beam in opposite directions. However, if a perfectly conducting plane sheet is placed behind the array at a distance of approximately one-quarter wave length, the energy is reflected forward, increasing the directivity of the antenna. A dipole or an array of dipoles with a corner reflector (fig. 6[A]) forms a directive array. Parabolas (fig. 6[B]) are universally used for very directive antennas in point-to-point communications, microwave relays, radar antennas and radio telescopes. The feeding element, a dipole or electromagnetic horn, is placed at the focus of the parabola. Radial rays emitted from the focus are reflected in parallel rays by the pa-

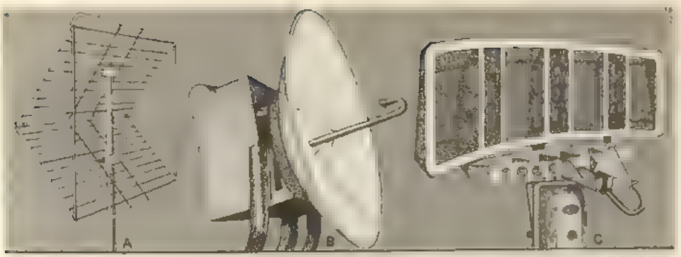

FIG. 6.—REFLECTORS: (A) CORNER REFLECTOR; (B) PARABOLIC REFLECTOR; (C) CURVED REFLECTOR FOR RADAR

rabola, thus producing a very directive radiation pattern with the maximum of the radiation pattern in the direction of the axis of the parabola. Actually, a paraboloid of revolution is used and if the feeding element is moved off the axis, the beam is tilted. If the displaced feeding element is rotated about the axis of the paraboloid and if the return signals, when the feeding element is at diametrically opposite positions, are electronically compared, a very accurate determination of the position of the target may be made. A reflector may be shaped so that a beam is flared or shaped in one plane and is very directive in the perpendicular plane. A curved reflector (fig. 6[C]) is commonly used to obtain shaped beams for ground-based, ship-borne and air-borne radar antennas.

See also RADIO; TELESCOPE, RADIO; TELEVISION: *The Television Receiver.*

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ANTEROS (ANTHERUS), **SAINT** (d. 236), pope for several weeks at the end of 235 and the beginning of 236. According to the *Liber Pontificalis,* he was martyred for having ordered a collection of the acts of the martyrs to be made and included in the archives of the church. The site of his burial in the catacombs was discovered by G. B. de Rossi in 1854. His feast day is Jan. 3.

ANTHEIL, GEORGE (1900–1959), U.S. composer known for the ultramodern music he wrote in the 1920s, was born in Trenton, N.J., July 8, 1900. He studied with Ernest Bloch in New York city; in 1921 he went to Europe and gave piano recitals. In Paris he became prominent in the literary and artistic circles of the avant-garde; Ezra Pound published a book about him, *Antheil and the Treatise on Harmony* (1924; with supplementary notes, 1927). His *Ballet mécanique,* scored for mechanical pianos, automobile horns, electric bells and airplane propellers, produced a sensation in Paris (June 19, 1926) and in Carnegie hall, New York city (April 10, 1927). His later works were less eventful; he wrote six symphonies; the operas *Transatlantic* (1930), *Helen Retires* (1934), *Volpone* (1953), *The Brothers* (1954) and *The Wish* (1955); chamber music; and an autobiography with the eloquent title *Bad Boy of Music* (1945). He died in New York city, Feb. 12, 1959. (N. SY.)

ANTHELMINTICS are drugs that act against helminths (worms) and are used to treat worm infections. The term vermifuge is often applied to remedies used to remove intestinal worms. Although the term vermicide is sometimes used for such drugs, very few justify this name since only rarely do they directly kill the parasites. None of the anthelmintics in use is completely effective against the worms or completely without toxic effect upon the host, particularly if taken in overdoses. Furthermore, none of the anthelmintics known is equally active against all worms. The search for better anthelmintics was intensified after World War II, and new and more effective drugs are regularly introduced, largely replacing the earlier carbon tetrachloride, gentian violet, oil of chenopodium, pelletierine, quassin, santonin and thymol. Several antibiotics show activity in the laboratory against some worms.

Intestinal worms are in general more effectively treated than others, since they need not be killed but merely eliminated. Some anthelmintics must be followed within an hour or two by a purgative, to remove both the injured worms before they recover and the drug, which may result in uncomfortable side effects.

The anthelmintic piperazine paralyzes certain species of intestinal worms, while exhibiting little toxic effect upon man or domesticated animals. It is very effective against the large intestinal roundworms, *Ascaris lumbricoides,* of man, and against the adult pinworm, *Enterobius vermicularis.* However, since it is less effective against immature pinworms, it is desirable to repeat the treatment a week to ten days later. Piperazine is also very effective against the ascarids of domesticated animals and against the pinworms of horses. However, it has little action against other intestinal worms in man or in domesticated animals.

Tetrachloroethylene has been used for the treatment of hookworm infection in man and of some of the intestinal parasites of domesticated animals. Quinacrine hydrochloride (Atabrine or Mepacrine), the World War II antimalarial drug, is used for treatment of tapeworm infections of man and of dogs; aspidium (male fern) is also used. Other drugs used in the treatment of intestinal worms in man and domesticated animals include arecoline hydrobromide, *n*-butyl chloride, β-naphthol, phthalofyne and toluene. Organic tin compounds are used to treat tapeworm infections in poultry. In the treatment of cattle such drugs as phenothiazine are used extensively in feed or in salt to decontaminate pastures and prevent reinfection. Phenothiazine interferes with the egg laying of the worms and with the development of the young worms from the eggs.

The treatment of worms in tissues or organs other than the intestine is more difficult than the treatment of intestinal worms, since they must be killed or critically injured by the treatment so that they may be destroyed and absorbed within the body. Furthermore, anthelmintics for such worms must either be injected into a vein or muscle or be absorbed from the intestine, with greater danger if the drugs are toxic. Drugs used include chloroquine, gentian violet, diethylcarbamazine citrate, lucanthone hydrochloride (Miracil D) and organic compounds of antimony or arsenic.

See also PARASITOLOGY. (G. F. O.)

ANTHEM, derived from the Greek *antiphona,* through the Saxon *antefn,* a word that originally had the same meaning as antiphon (*q.v.*). Although only an optional part of the Anglican morning and evening services and of certain other Protestant services, the anthem has been developed in England as a free type of musical composition since 1545. Its text is often biblical, but there have always been numerous examples of the use of other texts, both verse and prose.

The musical resources needed for the performance of an anthem have never been standardized: at first unaccompanied choral writing (full anthem) was the norm, but the growth in the 16th century of the verse anthem (which made extensive use of a solo vocal part, and eventually of many soloists) encouraged the use of instrumental accompaniment. The organ was clearly the first choice for this subsidiary though frequently important part, but there were many verse anthems provided with an elaborate accompaniment for an instrumental group such as viols or wind instruments. Shortly after the Restoration it was common, at least in the royal chapel, to perform anthems with orchestral accompaniment. In the 18th century the organ returned to favour, and the full anthem ousted to some extent the complex verse anthem, though solo passages were occasionally introduced for special effect.

Both full and verse anthems exploited the practice of antiphony between two sides of a choir, usually referred to as decani (the south, or dean's side) and cantoris (the north, or precentor's side). The alternation of these two sections of the choir, and those subsections specially designated in the more elaborate type of verse anthem, provided a subtle effect of fluctuating timbre and sonority

that often reflected the mood or sense of the text. In the 19th and 20th centuries not only church music composers but those whose main activities lay in other spheres have written anthems for use (to quote the Book of Common Prayer) "in choirs and places where they sing." *See* CHURCH MUSIC.

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ANTHEMION, a conventional design consisting of a number of radiating petals, developed by the Greeks from the Egyptian and Asiatic form known as the lotus palmette. One of the most fertile sources of decorative ornament, it was not only used widely by the Greeks and Romans but occurs also in Byzantine and Romanesque examples and is common in modern work. Used first by the Greeks as a decoration on painted pottery, it was soon

(LEFT) "ARCHITEKTONISCHEN ORDNUNGEN DER GRIECHEN UND RÖMERN," (ERNST UND KORN); (RIGHT) ALISON FRANTZ

(LEFT) PALMETTE ANTHEMION; (RIGHT) ALTERNATING LOTUS AND PALMETTE ANTHEMIA, FROM DETAIL OF FRIEZE ON SOUTH WALL OF ERECHTHEUM

adapted to architecture. The single palmette form is used for acroteria, antefixes and the top of vertical steles. The continuous pattern of alternating lotus and palmette springing from connecting spirals decorates especially the cymatium of the cornice. Although sometimes only painted, the majority of anthemia are molded or carved in relief.

ANTHEMIUS (d. 472), Western Roman emperor from April 12, 467, to July 11, 472, son-in-law of the emperor Marcian, was appointed by the Eastern emperor Leo I with a view to their uniting against Gaiseric and the Vandals of Africa. The patrician Ricimer (*q.v.*), all-powerful in Italy, was won over by an arrangement that he should marry Anthemius' daughter Alypia, but because Anthemius was a Greek and a philosopher, he was suspected of wishing to restore paganism and his high standard of justice added little to his popularity in Italy. Ricimer and he soon quarreled and in 472 the patrician besieged him in Rome, where the emperor's forces were defeated. Anthemius in disguise mingled with the beggars at the church of St. Chrysogonus, but was found and beheaded. He is the subject of a panegyric by Sidonius Apollinaris.

See J. B. Bury, *History of the Later Roman Empire*, vol. i (1923). (E. A. T.)

ANTHEMIUS OF TRALLES (fl. 6th century A.D.), Greek mathematician and architect, who with Isidorus of Miletus and under the patronage of Justinian planned and built the church of Hagia Sophia in Constantinople. He came from an eminent family. His father, Stephanus, was a physician and his brother Alexander was the last great medical author of antiquity. The plans for Hagia Sophia were original and daring. Started in 532, it was finished in 537, but in 558, after the death of Anthemius, it had to be restored, following the collapse of the dome.

In *Concerning Remarkable Mechanical Devices*, he dealt with burning mirrors and gave the first instance on record of the practical use of the directrix. Setting out to construct surfaces to reflect to one and the same point (1) all rays in whatever direction passing through another point and (2) a set of parallel rays, he assumed a property of an ellipse not found in Apollonius (the equality of the angles subtended at a focus by two tangents drawn from a point); and, having given the focus and a double ordinate, he used the focus and directrix to obtain any number of points on a parabola. (C. A. MO.)

ANTHESTERIA, one of the four (or five) Athenian festivals in honour of Dionysus, held annually for three days (11th–13th) in the month of Anthesterion (February–March). Its object was to celebrate the maturing of the wine stored at the previous vintage, and the beginning of spring. On the first day, called Pithoigia (opening of the casks), libations were offered from the newly opened casks to Dionysus, all the household joining in the festivities. The rooms and the drinking vessels in the homes were adorned with spring flowers, as were also the children over three years of age. The second day, named Choes (feast of cups), was a time of merrymaking. The people dressed themselves gaily, some in the disguise of the mythical personages in the suite of Dionysus, and paid a round of visits to their acquaintances. Others poured libations on the tombs of deceased relatives. On the part of the state, this day was the occasion of a peculiarly solemn and secret ceremony in one of the sanctuaries of Dionysus in the Lenaeum, in which the *basilinna*, wife of the *archon basileus* (king archon), went through a ceremony of marriage to Dionysus. On these days, it was believed, the souls of the dead came up from the underworld and walked abroad; people chewed leaves of whitethorn and smeared their doors with tar to protect themselves from evil. The third day was named Chytroi (feast of pots), a festival of the dead. Cooked pulse was offered to Hermes, in his capacity of a god of the lower world, and to the souls of the dead. J. E. Harrison believes that the entire festival was originally a great annual ceremony for the exorcism of the spirits of the dead; but that through confusion of burial cask/wine cask, and funeral libation/drinking libation, it came to be considered a festival of Dionysus. (T. V. B.)

ANTHOLOGY, a collection of short pieces or extracts usually from different authors, especially in verse, and usually of literary value. An anthology may consist of the best or the most representative work of given national groups (Edith Sitwell, ed., *The Atlantic Book of British and American Poetry*, 1958; Louis Untermeyer, ed., *The Britannica Library of Great American Writing*, 1960), of a period (Norman Ault, ed., *Elizabethan Lyrics*, 1949), of a school of poetry (Amy Lowell, ed., *Some Imagist Poets*, 1915, 1916, 1917) or of a literary kind (*The Best American Short Stories*, annual since 1915), and occasionally of an author (Harry Levin, ed., *The Portable James Joyce*, 1947); or it may consist of pieces all related to a given theme or subject (Walter Blair, ed., *Native American Humor, 1800–1900*, 1937) or taken from a particular periodical (Edward Weeks and Emily Flint, eds., *Jubilee: One Hundred Years of the Atlantic*, 1957). Annual publishers' lists demonstrate the enduring popularity of this long-established form which serves as a convenient and adaptable framework into which can be fitted a variety of material. Some anthologies have considerable literary significance in themselves, an example being Tottel's *Miscellany* (1557), in which were published for the first time the major poems of Sir Thomas Wyat and Henry Howard, earl of Surrey; some are historically significant as reflecting or forming the taste of their age, as Francis Palgrave's *Golden Treasury* (1861), a well-known Victorian anthology; and some have preserved works that might otherwise have been lost (for examples in Arabic literature *see* HAMASAH; MU'ALLAQAT; MUFADDALIYAT; and most of the Middle English lyric poetry now extant survived in collections of one kind or another). In modern times anthologies often serve to introduce new and unknown writers, as in *Five Young American Poets* (three series, 1940, 1941, 1944) and similar works which appear from time to time.

The "Greek Anthology."—The term anthology originally denoted a garland or collection of flowers (Gr. *anthologia*, Lat. *florilegium*), and hence a selection of choice pieces tastefully arranged, as in the *Garland* of Meleager which formed the basis for the best known of anthologies, the *Greek Anthology*. This is

the modern title of a collection of Greek epigrams, mostly in the elegiac couplet, together with some other pieces of lesser interest, dating from about 700 B.C. to A.D. 1000 or later. The history of the *Anthology* is a history of anthologies. Meleager's *Garland,* compiled in the early part of the 1st century B.C., contained, besides a number of his own epigrams, the work of 50 or more other poets from the earliest period to his own day; this is incorporated into the modern *Anthology* and is, all in all, its most valuable part. A similar *Garland* of later poets was compiled by Philippus of Thessalonica (1st century A.D.), and a third, which for the first time was called an *Anthology,* by Diogenianus (2nd century). The poems in each of these collections were arranged alphabetically by the initial letter of the opening line. The first collection in which the poems were arranged by subject was the *Circle* of Agathias (later 6th century), to which the compiler contributed some poems of his own and of others "a small portion, enough for a taste." All of these anthologies were incorporated into a larger collection by Constantinus Cephalas (late 9th century), who added to them extracts from the works of single authors. Shortly thereafter (around A.D. 980) the Cephalas version was further augmented and revised; this revision (discovered in 1606–07 in the library of the elector palatine at Heidelberg and known as the Palatine manuscript) constitutes the first 15 books of the *Anthology* in modern editions. The 16th and final book in modern editions consists of some additions from yet another manuscript version of Cephalas (the Planudean manuscript), compiled in 1301 and containing some epigrams not included in the Palatine manuscript.

The value of the *Anthology* lies in the distinction and charm of perhaps one-sixth of the whole. For the rest, it preserves a good deal that is of historical interest; it illustrates the continuity of Greek letters for almost 2,000 years, since the works of the latest period are in language, style and feeling not too distinct from the works of the earliest; and it has had a persistent and considerable influence on later literature. There are, for example, translations and imitations in Latin from the time of Quintus Lutatius Catulus (early 1st century B.C.) to the time of Decimus Magnus Ausonius and Claudius Claudianus (late 4th century A.D.). The modern influence begins with the publication of the Planudean manuscript in 1494. For the next century and a half there were countless versions and variations of Greek epigrams in Latin; those of Hugo Grotius (1583–1645) are generally regarded as the best. The influence on the vernacular literatures, especially on Italian and French, was most extensive in the period from 1550 to 1610; it usually came, however, not directly from the Greek text but by way of the contemporary poetry in Latin which was based on the *Anthology.* Thus Joachim du Bellay's (1522–60) *Voeu d'un vanneur de blés aux vents* was derived from a Latin version by the Venetian Andrea Navagero (1483–1529) of *Anthology* 6:53. In the criticism of the time the vernacular sonnet and madrigal were often considered the equivalents of the epigram in Greek and Latin so that the theory of the lyric became largely a theory of the epigram. With the development in the 17th and 18th centuries of a taste for the point and wit represented by the Latin epigrammatist Martial, the influence of the *Anthology* declined; in fact, the expression *à la grecque,* with reference to the unpointed epigram characteristic of the *Anthology,* became proverbial for something insipid and pointless. There was a revival of interest in the *Anthology* in the 19th century, but later there were a number of translations and imitations of particular poems. Modern renderings into English include those of Dudley Fitts whose *Poems from the Greek Anthology in English Paraphrase* (1956) incorporates two of his collections published earlier. As the title indicates, the treatment is free, and many of the Fitts poems are extraordinarily effective.

Later Anthologies.—Other works of the nature of anthologies existed in antiquity; a late example is the *Selections* of Joannes Stobaeus (5th century A.D.), which consists of a number of extracts in prose and verse, grouped under topics. In Latin there is nothing quite comparable to the *Greek Anthology,* although the Salmasian manuscript, compiled in Africa in the 6th century, is of the same general type. It contains the *Pervigilium Veneris* (*q.v.*) and epigrams ascribed to Seneca and Petronius; in modern editions it is augmented by other fugitive Latin verse and titled *Anthologia Latina* (eds., Alexander Riese, Franz Bücheler and Lommatzsch, 1894–1926). However, anthologies similar to Stobaeus' were common throughout the middle ages and furnished the medieval author with the greater part of his learning. These florilegia consisted of extracts, usually from classical authors, of striking sayings, most often of an ethical nature. Similar collections are found in the vernacular: *Proverbs of Diverse Prophets and of Poets and of Other Saints* (*c.* 1375) contains sayings in Latin, French and English attributed to Seneca and Solomon, among others. The culmination of this type is the Renaissance anthology of Desiderius Erasmus, the *Adagia* (1500–33).

Collections of later lyrics, often anonymous and belonging usually to a certain school of poetry, are represented in the middle ages by the *Carmina Burana* (13th century), a collection of rhymed poems in Latin by the Goliards (*q.v.*), or wandering scholars; and by manuscript Harley *2253* (*c.* 1320), an important collection of the early Middle English period, containing English, French, Latin and macaronic poems. The Renaissance was a great age for anthologies of lyric poetry. Among the best-known collections in English are the *Book of Songs and Sonnets* published by Richard Tottel in 1557 and usually referred to as Tottel's *Miscellany;* and *England's Helicon* (1600), containing poems by Spenser, Sidney, Greene, Lodge and Shakespeare. The anthology that explicitly presents a certain school or group of poets is represented in Germany by Julius Wilhelm Zincgref's *Anhang unterschiedlicher ausgesuchter Gedichten,* printed as a supplement to his edition of Martin Opitz's poems (1624). A later example in French is the famous *Le Parnasse contemporain* (1866, 1871–76). Such anthologies of a contemporary school of poets are quite common and sometimes appear as special issues of a magazine. The usual anthology in the 18th century was either such a *Collection of Poems by Several Hands* (1748–58) as Robert Dodsley's or a selection of "beauties" or "elegant extracts," as in Oliver Goldsmith's *The Beauties of English Poesy* (1767). In the same century appeared the first collections of popular or folk poetry, the best known being Thomas Percy's *Reliques of Ancient English Poetry* (1765).

The typical modern anthology in the sense of a collection of poems of a given period or nation selected for their excellence and representativeness seems to be an invention of the Latin Renaissance. The best-known examples are Jan Gruter's *Delitiae* of the Italian, French, German and Belgian Latin poets (1608–14). With the 19th century this sort of anthology begins to be arranged on chronological principles, showing the historical scope and development of a literature, and the works often include essays of a critical or historical nature: for example, Thomas Campbell's *Specimens of the British Poets* (1819). The standard anthology of lyric poetry in the Victorian period, Francis Turner Palgrave's *Golden Treasury of English Songs and Lyrics* (1861) (which, unlike Campbell and others, is divided into books by subject), fixed the educated taste for the lyric for several generations. It was superseded in general favour by Sir Arthur Quiller-Couch's *The Oxford Book of English Verse* (1900 and 1939); a companion volume, *The Oxford Book of American Verse,* ed. by F. O. Matthiessen (1950), is considered an excellent collection of American poetry. Among other 20th-century anthologies of poetry *The New Poetry* (1917; rev. and enlarged, 1932), edited by Harriet Monroe (*q.v.*) and A. C. Henderson, may be mentioned for its historical importance and Robert Bridges' *The Spirit of Man* (1916) for the excellence of its taste. There are similar anthologies in nearly every language. In fact, the general scope and kinds of modern anthologies can be indicated by an enumeration of the standard Oxford books of verse. There are books of English, American, Australasian, French, Spanish, Portuguese, German, Greek, Latin and medieval Latin verse, among others; books of ballads, carols, Christian verse and light verse; and, finally, books of the 16th-century verse, 17th and so on to modern verse.

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with text, translation and excellent introduction is by J. W. Mackail, *Select Epigrams from the Greek Anthology* (1890, rev. 1907). Scholars use Stadtmüller's unfinished edition (1894–1906) and the complete edition of Friedrich Dübner and Edme Cougy, pub. by Didot (1864–92). For the influence of the Anthology *see* James Hutton, *The Greek Anthology in Italy to the Year 1800* (1935) and *The Greek Anthology in France, and in the Latin Writers of the Netherlands to the Year 1800* (1946). Charles Homer Haskins, *The Renaissance of the Twelfth Century* (1927), gives some account of medieval anthologies. Useful bibliographies are Frédéric Lachère, *Bibliographie des recueils collectifs de poésies publiés de 1597 à 1700* (1901), and *Anthologies*, Bibliography No. 19, National Book Council (1928). (J. V. C.; X.)

ANTHONY (Antony), **SAINT,** of Egypt (*c.* A.D. 250–355), the first Christian monk, was born in middle Egypt. At the age of 20 he began to practise an ascetic life, and after 15 years withdrew for solitude to a mountain by the Nile, called Pispir (now Der al Memum). In the early years of the 4th century he emerged from his retreat to organize the monastic life of the hermits who imitated him. After a time he again withdrew to the mountain by the Red sea, where now stands the monastery that bears his name (Der Mar Antonios). Shortly before his death he ventured to Alexandria to preach against Arianism.

Anthony is noted for his combats with the hosts of evil. Athanasius says that he was first tempted by thoughts of family joys and duties and of the difficulty of his chosen life, but the Devil, finding argument of no avail and hoping to arouse in him the pride of success, appeared as a cringing black boy admitting that he had been defeated by the saint. At other times the Devil appeared under the guise of a monk bringing him bread during his fasts, or under the form of wild beasts, women or soldiers, sometimes beating the saint and leaving him as dead.

From these psychic struggles Anthony emerged as the sane and sensible father of Christian monachism. The monastic rule that bears his name was compiled from writings and discourses attributed to him in the *Life* (by Athanasius) and the *Apophthegmata Patrum.* The rule is still observed by a number of Coptic Syrian and Armenian monks. St. Anthony's feast day is Jan. 17. *See* Monasticism.

Bibliography.—The Greek *Vita Antonii* is among the works of St. Athanasius; for the almost contemporary Latin trans. *see* Rosweyd's *Vitae Patrum*, in J. P. Migne, *Patrologia Latina*, vol. lxxiii; English trans. by R. T. Meyer, "Ancient Christian Writers" (1950). Accounts of St. Anthony are given by J. H. Newman, *Church of the Fathers* (1931), and Butler-Thurston, *Lives of the Saints* (1956). Discussions of the historical and critical questions will be found in E. C. Butler, *Lausiac History of Palladius*, part i, pp. 197, 215–228, part ii, pp. 9–12 (1898, 1904); and Contzen, *Die Regel des hl. Antonius* (1896). For the modern literature, *see* J. Quasten, *Patrology*, vol. iii (1960).
(E. R. Hy.)

ANTHONY (Antony), **SAINT,** of Padua (1195–1231), Franciscan friar and saint, a doctor of the church, was born at Lisbon, Port., and baptized Ferdinand. At 15 he joined the Augustinian canons and probably became a priest. He joined the Franciscan order in 1220, hoping to preach to the Saracens and be martyred. Instead he taught theology at Bologna, Montpellier, Toulouse and Puy-en-Velay and won a great reputation as a preacher in southern France and Italy. After an attack of dropsy, he died June 13, 1231, at Arcella, en route to Padua, where he is buried. He was canonized by Gregory IX on May 30, 1232, his feast being kept on June 13. On Jan. 16, 1946, Pius XII declared him a doctor of the church. Padua and Portugal claim him as patron saint. In art he is shown with a book, with a heart, flame or lily, or with the Child Jesus. He is invoked for the return of lost property and is the patron of the poor. Among his authentic writings are sermons for Sundays and feast days, published at Padua, 1895–1913. A series of sermons on the Psalms is considered doubtful; several others are attributed to him without foundation.

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ANTHONY, SUSAN BROWNELL (1820–1906), pioneer leader of the women's suffrage movement in the United States, was born on Feb. 15, 1820, at Adams, Mass. Her work helped to pave the way for the adoption of the 19th amendment (1920) to the federal constitution and the world-wide recognition of human rights expressed in the charter of the United Nations. She taught school, organized temperance societies and, after 1854, devoted her life to the antislavery movement and woman's rights. From 1856 to the American Civil War she served as an agent for the American Antislavery society. In collaboration with Elizabeth Cady Stanton (*q.v.*) she published in New York a liberal weekly, *The Revolution* (1868–70). Demanding for women the same civil and political rights extended to male Negroes by the 14th and 15th amendments, she claimed her right to vote as a person and citizen in 1872. She was arrested, tried and convicted, but refused to pay the fine. From then on she campaigned for a federal women's suffrage amendment through the National Woman Suffrage association (1869–90), through the National American association (1890–1906), and by lecturing throughout the United States. With her close associates she compiled and published a four-volume work, *The History of Woman Suffrage* (1881–1902). In 1888 she organized the International Council of Women and in 1904 the International Woman Suffrage alliance. She died in Rochester, N.Y., March 13, 1906.

See Alma Lutz, *Susan B. Anthony, Rebel, Crusader, Humanitarian* (1959); Ida Husted Harper, *The Life and Work of Susan B. Anthony,* 3 vol. (1898). (A. Lu.)

ANTHOZOA (*i.e.,* "flower animals"), a group of marine animals belonging to the phylum Coelenterata. Many of them form a strong skeleton known as coral. The term "coral" refers to the hard parts of any coelenterate that secretes a firm skeletal support; most of these forms are Anthozoa, and among them the term "true coral" is applied only to the group Scleractinia. The flower-like shape and brilliant colouring of the soft parts of many species have attracted attention for hundreds of years, and the discovery that they are animals instead of plants, minerals or intermediate organizations did not gain acceptance until long after it was first made, in connection with the precious red coral of commerce, by J. A. de Peyssonel in 1727.

Not all the Anthozoa produce a skeleton. A hard support is lacking in the sea anemones, and, although it is present more often than not, among the other kinds of Anthozoa it does not necessarily form a mass sufficiently compact to retain its shape after the death of the soft parts.

An anthozoan may consist of a single polyp as in the case of a sea anemone; but more frequently a colony is formed, containing a number of polyps permanently united; and it is the skeletons built up by certain of these colonies that constitute coral in its characteristic form. (For a definition of polyp *see* Polyp; *see* also Coelenterata: *Polyp and Medusa.*)

The Anthozoa as a class are distinguished from all other Coelenterata not only by the structure of the individual polyps but also in that none of them at any time during their life history assumes the form of a medusa (jellyfish). The anthozoan individual or colony therefore corresponds to the polyp of any coelenterate that exhibits both polyp and medusa alternately during its life cycle. The anthozoan polyps themselves, though often small, tend to be more muscular and substantial than those of other coelenterates. They are characterized by a body that in principle is a cylinder, closed above and below by two discs of tissue. The upper disc or peristome is encircled by a corona of hollow tentacles and is perforated in the centre by a more or less slit-shaped mouth. Leading inward from the mouth is a flattened tube, the throat, which opens directly into the main cavity of the body (coelenteron). The latter cavity is partially subdivided into alcoves by a series of radially arranged membranous partitions, the mesenteries, some or all of which are inserted along the upper part of their inner edge into the outer wall of the throat. The mesenteries bear along their free edge a marginal thickening of epithelium known as the mesenterial filament; they also carry reproductive organs and muscles. The number and arrangement of the mesenteries as well as the structure of the throat, mesenteries and filaments vary from one group of Anthozoa to another. (*See* Coelenterata: *Structure of a Coelenterate.*)

The symmetry of the anthozoan body presents to the casual observer an external radial appearance similar to that exhibited by the Coelenterata in general. Underlying this external sym-

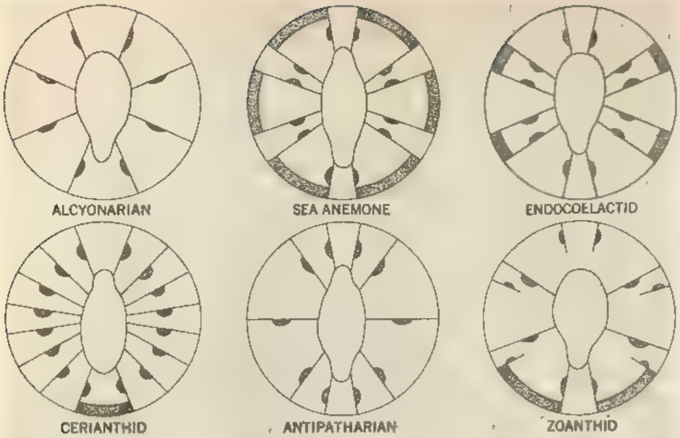


FIG. 1.—TRANSVERSE SECTIONS OF VARIOUS ANTHOZOAN POLYPS SHOWING THE ARRANGEMENT OF MESENTERIES AND ZONES OF GROWTH

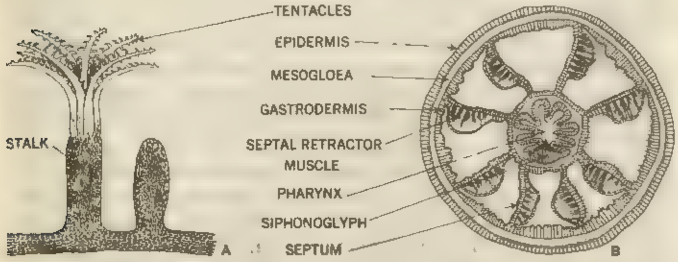
Outer circle represents the body wall; thickening on body wall indicates growth zone. Central oval is the throat, with siphonoglyphs indicated as bays. Radial lines represent the mesenteries, the thickening on each being its retractor

metry exists an internal bilateral symmetry so well defined that it is actually possible to divide a polyp into two perfectly equivalent halves along one plane. Much discussion has been aroused by this fact since there is no obvious function for such symmetry. A possible explanation is that the Anthozoa were not always the sedentary, radially arranged creatures they are today. There may have been a phase in their history when they were small creeping animals with definite head and tail ends, upper and lower sides and general bilateral symmetry. When such animals adopted a sedentary life and assumed a radial symmetry, the former bilateral condition would remain as a vestige of the former state of affairs. The bilateral arrangement of parts is very prominent during the early development of a polyp.

An important fact in the development of many Anthozoa is that the wall of the cylindrical body appears to become marked out, after the early stages are passed, into vertical strips, in some of which active differentiation of new parts (or growth direction) takes place; in other zones no new parts are added after a stated amount of structure has been formed (fig. 1). In various groups of Anthozoa the arrangement of the mesenteries in the adult polyp depends on the relationship between the zones of active growth and those in which only a certain amount of differentiation will take place. In other cases no new growth takes place after the early stages, and here a simpler plan of structure consequently prevails.

The axis of symmetry sometimes possesses a distinct significance with regard to the regeneration of parts of an adult polyp. In the sea anemone this axis coincides with a nongrowing zone; and if in a suitable anemone a fragment of reasonable size is cut away from the edge of the animal's base in such a way that the lower ends of the two directive mesenteries that flank the axis lie in its centre, the piece will in many cases regenerate an animal with two heads instead of one. A similar piece containing no directives will regenerate an ordinary one-headed adult.

There are three subclasses of living Anthozoa: (1) the Alcyonaria or Octocorals; (2) the Ceriantipatharia (including cerianthid anemones and the Antipatharia or sea whips); and (3) the Zoantharia. The latter include the Actiniaria (sea anemones), the Scleractinia or madreporarian corals and some obscure groups of solitary and colonial forms resembling sea anemones. In this article only the important groups of Alcyonaria, Actiniaria and Scleractinia are described.



FROM L. H. HYMAN, "THE INVERTEBRATES"; REPRINTED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC. (1940)

FIG. 2.—ALCYONARIA

(A) *Clavularia,* (left) expanded polyp, (right) contracted polyp; (B) *Alcyonium,* cross section through the pharyngeal region, showing septal arrangement

ALCYONARIA

The Alcyonaria contrast sharply with the Zoantharia. Alcyonarians almost invariably construct colonies; their polyps are usually small and extremely uniform in general structure; in this they are unlike the polyps of either of the other large series of forms. Diversity among the Alcyonaria therefore affects not so much the individual as the colony; and the colonies constructed vary most extensively in form, structure and mode of development. A skeleton sufficiently resistant to retain its shape after the death of the colony is often developed; in other cases either part or the whole of the colony relies for support upon large numbers of minute calcareous bodies, which abound in its tissues and are known as spicules. Thus, the Alcyonaria include a number of creatures that produce coral. They are a group of corals that in the main inhabit coastal waters down to 550 fathoms. In general, the great depths of the sea as well as temperature and salinity limit their occurrence. Their centre of distribution is the Indo-Pacific littoral; they form an important element in coral reefs.

A typical alcyonarian polyp (fig. 2) is simpler in structure and is less variable from one genus to another than most other Anthozoa. It possesses eight, and only eight, tentacles, and these are feathered by a paired series of lateral branches on each; *i.e.,* they are pinnate. Down one angle of the flattened throat runs a groove lined by strongly ciliated epithelium. This is the siphonoglyph, and it creates a downward current of water into the coelenteron of the polyp. There are eight mesenteries, which alternate in position with the eight tentacles. Each mesentery possesses a special strip of muscle down one side; the fibres in the strip run in a longitudinal direction and are supported by ridges or lamellae of mesogloea. The whole strip of muscle is known as a retractor. By their contraction these muscles pull the upper parts of the polyp downward and inward. Each mesentery also possesses a filament, but the filaments of all the mesenteries are not alike. Those that belong to the two mesenteries farthest from the siphonoglyph are long. Each has a groove along its free edge; the groove is lined by cells with long cilia; it is Y-shaped in a transverse section. The function of these filaments is circulatory. The filaments of the other six mesenteries are shorter and consist of an epithelial cord containing many glandular cells; these filaments are digestive organs. The six last-mentioned mesenteries also contain concentrations of sex cells (gonads).

The eggs of Alcyonaria usually develop into free-swimming larvae called planulae, which in due course settle down either upon a hard support or in sand or mud, become transformed into polyps and by budding begin to construct a colony. The process of budding is peculiar, however, in that no bud is produced directly from a polyp itself; the polyps give off hollow rootlike structures that are lined by endoderm and are known as solenia, and from these the new buds arise.

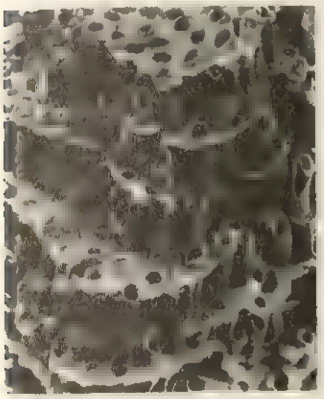
The Alcyonaria offer almost the only examples to be found among the Anthozoa of the phenomenon known as polymorphism (*see* HYDROZOA: *Polymorphism and Alternation of Generations*).

In certain alcyonarian colonies there are two kinds of polyps: the nutritive ones such as those already described and another kind known as a siphonozooid. These latter are polyps whose parts are more or less reduced, with the exception of the siphonoglyph, which is large and strongly ciliated. These individuals create water currents that circulate through the system of solenial canals penetrating the colony. In cases where a single original polyp becomes transformed into the axis of a colony this constitutes a further differentiation of individuals.

The living Alcyonaria are divided into six orders, and since the structure and mode of formation of the colonies are different in

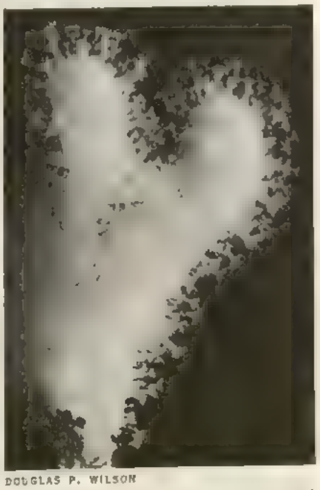
the Gorgonacea and Pennatulacea, these are described separately from the other four orders.

Orders Alcyonacea, Stolonifera, Telestacea and Coenothecalia.—The numerous Alcyonaria that belong to these orders possess this in common: although the colonies that they form are extremely various, there is never an axial skeleton forming a central support. A conception of the colony-forming activities of the polyps can be gained only by the study of a series of actual colonies. Fig. 3–5 will serve to illustrate the following remarks.

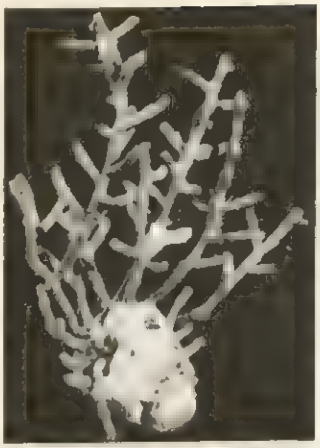

BY COURTESY OF THE TRUSTEES OF THE BRITISH NATURAL HISTORY MUSEUM
FIG. 3.—PORTION OF SKELETON OF ORGAN PIPE CORAL (TUBIPORA MUSICA) (ABOUT NATURAL SIZE)

In the simplest colonies (order Stolonifera) the polyps are attached to a foreign surface and connected with one another simply by a few creeping rootlets (solenia) arising from their bases. Such a condition exists in *Cornularia.* Somewhat more elaborate are colonies such as those of certain species of *Clavularia* in which the meshes of the network of solenia have been filled up by solid mesogloea, and the network of rootlets has been converted into a continuous mat with ramifying endodermal tubes inside it and a cover of ectoderm outside it both above and below. In neither of these colonies is there any firm skeleton; the support consists simply of an external horny layer covering the rootlets and the lower parts of the polyps (*Cornularia*) or spicules (*Clavularia*).

A different grade of organization appears in certain genera whose polyps tend to grow very tall and not unduly close to one another. In such a case bridges containing solenia may grow across from one polyp to another well above the level of the bases of the polyps (*Clavularia*). This process goes a stage further in *Tubipora.* In this the polyps become inordinately long and narrow and diverge from one another as they grow up; and instead of throwing out isolated bridges across the gaps between them, they develop a series of platelike horizontal platforms that run at intervals one above the other across the colony. These platforms consist of mesogloea containing solenia and are covered externally by ectoderm. From each successive platform new polyps arise. The original polyps grow upward until a considerable number of platforms have been formed; they then stop, the polyps continuing the colony. *Tubipora,* while it is living, produces a skeleton composed of firmly compacted spicules in the mesogloea of the polyps and platforms. The tentacles of the polyps are sometimes bright green, while the skeleton is crimson; after the death of the soft parts the skeleton remains as a brightly coloured mass of tubes, often of considerable size, and is known as organ-pipe coral.


DOUGLAS P. WILSON
FIG. 4.—"DEAD MEN'S FINGERS" (ALCYONIUM DIGITATUM) (REDUCED)

Colonies of different types are formed by other genera possessing long polyps (order Alcyonacea). In *Alcyonium,* for instance, there is formed a massive colony with a small number of stout, unwieldy lobes. Each lobe consists of a number of polyps that are inordinately elongated vertically; but here, instead of producing platforms, the polyps have filled in the whole space between them with solid mesogloea so that only the head end of each polyp projects beyond the general mass. Consequently ectoderm occurs only on the exposed parts of the polyps and on the external surface of the mass connecting these; the inner parts consist of mesogloea with solenia ramifying through it and connecting the deeper parts of the polyps with each other. New polyps arise from solenia at various levels between the old ones, as the colony grows. In this instance the skeleton consists entirely of scattered spicules; these occur not only in the mesogloea of the massive portion of the colony but also in the projecting upper ends of the polyps, which are retractile into the solid part. The common British *Alcyonium* is known as "dead men's fingers" from the suggestive appearance presented by the colony when removed from the water or stranded by the tide on the undersides of overhanging rocks. Its appearance when under water with the transparent glassy polyps fully expanded is as delicate and beautiful as its retracted state is repulsive.


BY COURTESY OF FREDERICK M. BAYER
FIG. 5.—COLONY OF TELESTO SANGUINEA GROWING ON A PEBBLE. (HEIGHT OF AXIAL POLYP ABOUT 4.5 CM.)

Treelike branching colonies (order Telestacea) of other Alcyonacea may be produced in more than one way. In *Telesto,* for example, lateral polyps are budded off from solenia lying in the walls of single original polyps, which become extremely elongated (fig. 5). Since each secondary polyp grows out at an angle from its parent and itself produces further lateral polyps, it constitutes in time a branch of the main stem formed by the original polyp. A number of such branching systems may be connected with one another by basal stolons.

Lastly in *Heliopora* (order Coenothecalia), the blue coral of tropical Indo-Pacific shores, a massive blue calcareous skeleton is produced.

Order Gorgonacea.—In these animals, except in a few unusual genera that appear to be transitional between a matlike colony and a treelike one, the skeleton forms a definite axis running up the centre of a treelike colony. The soft tissues by which the axis is surrounded contain spicules.


DOUGLAS P. WILSON
FIG. 6.—PORTION OF A COLONY OF SEA FAN (EUNICELLA VERRUCOSA) (ENLARGED). POLYPS IN LOWER RIGHT CORNER ARE CONTRACTED

A typical example of the Gorgonacea is *Eunicella verrucosa,* one of the sea fans (fig. 6). This forms a treelike colony attached by a narrow base and with slender twiglike branches. Each branch has an axis of blackish horny skeleton clothed on all sides by bright pink flesh containing solenia and studded with numerous small translucent pink polyps. In certain related gorgonians the horny skeleton contains calcareous inclusions.

In *Corallium,* the well-known precious coral of commerce, the "coral" is an axial skeleton similar to that of *Gorgonia,* but in this case it is stouter and less twiglike and is formed by the fusion of innumerable spicules into a solid calcareous mass. In *Corallium rubrum* the flesh of the colony as well as the axis is scarlet, but the polyps are white.

The skeleton of the Gorgonacea, although it varies considerably in structure from one form to another, is secreted by cells of ectodermal origin that are either embedded in the mesogloea or form a distinct layer around the axis itself; this is a communal internal skeleton and does not represent an elongated axial polyp. The colony is started by a polyp that gives rise to solenia in

LENNART NILSSON
FIG. 7.—SEA PEN (PENNATULA PHOSPHOREA), LARGE SPECIMENS OF WHICH MAY ATTAIN A FOOT OR MORE IN LENGTH

the basal part of its body; from these solenia new polyps arise.

Order Pennatulacea.—The colonies included in this group are of a nature very unlike anything hitherto described and include those animals popularly known as sea pens. In a typical form (*Pennatula*, fig. 7) the colony possesses a straight central axis developed from the body of a single greatly attenuated original polyp. This axis is complicated in structure and contains a supporting rod of calcified horny material. It bears laterally arranged leaflets, each consisting of a row of close-set polyps, and is itself provided with siphonozooids. The latter occur in a number of cases among the Alcyonacea and rarely among Gorgonacea; but among Pennatulacea they are universal. Moreover, the Pennatulacea are not attached at the base to a firm support but possess a contractile lower portion that anchors the colony in sand or mud. These animals exist at extreme depths; *Umbellula leptocautis* has been taken at 4,440 m.; others have been taken at even greater depths.

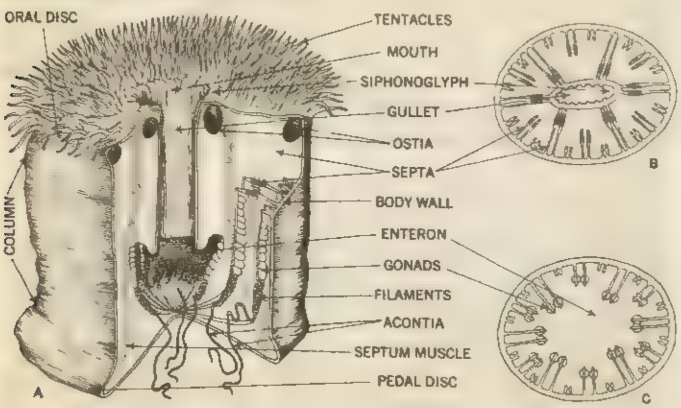
In other Pennatulids the form of the colony varies. In *Kophobelemnon*, instead of lateral leaflets the stem bears large isolated polyps; in *Virgularia* leaflets are present but reduced in size; in *Umbellula* a few large polyps occur in a rosette at the top of a long stem that is otherwise bare; in *Renilla* the basal peduncle is replaced by a flat kidney-shaped expansion bearing radially arranged polyps on its upper side.

General Note on the Skeleton.—Alcyonaria as a whole provide an extremely good example of the diversity that may exist in the skeleton within a single group. Instances have been quoted of both internal and external skeletons; of horny covering skeletons, horny axial skeletons; tubular skeletons and solid ones; skeletons formed of diffused spicules, of interlocked spicules and of fused spicules; cases in which spicules and a solid skeleton coexist, and in which horny and limy material coexist in the skeleton, not to mention the massive calcareous support of *Heliopora*. Whatever the nature of the skeleton, however, it is formed either by the ectoderm (*Cornularia*) or by cells of ectodermal origin that have penetrated the mesogloea.

ZOANTHARIA

The two important orders in this subclass are the Actiniaria and the Scleractinia (Madreporaria).

Order Actiniaria.—The sea anemones (fig. 8) constitute a large and varied group of Anthozoa that are closely related to the true corals (Scleractinia) but contrast with them in a number of ways. No sea anemone forms any skeleton; none produces a colony, so that the polyp that results from the development of an egg remains a single individual all its life except when it undergoes fission (*see* below). The polyps are of very variable dimensions, but the average order of size is relatively large, and in giant species (*Stoichactis*) an individual may exceed two feet in diameter; these are the largest anthozoan polyps in existence.

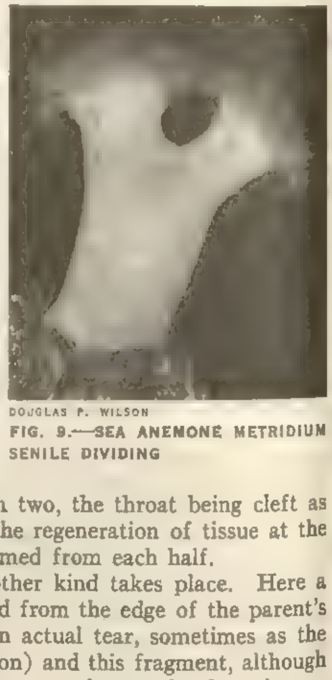


FROM R. I. USINGER & T. I. STORER, "GENERAL ZOOLOGY"; REPRINTED BY PERMISSION OF MCGRAW HILL BOOK CO., INC. (1957)
FIG. 8.—SEA ANEMONE METRIDIUM
(A) Cutaway view; cross sections (B) through gullet; (C) below gullet

An anemone is rarely completely sedentary, and, although it spends periods of varying length attached by its base to a foreign support, it can readily creep away. No other series of Coelenterata, taken as a whole, offers a parallel to this creeping habit of the anemones.

The general build of many anemones is stronger and more muscular than that of most other Anthozoan polyps; the retractor muscles of the mesenteries and the circular muscle of the body margin (sphincter) frequently attain a high degree of development. The variation in the external form of the polyp is very wide; but even greater is that of the internal organs. The number of mesenteries, their arrangement, their relation to one another with respect to size and to the degree of specialization of their musculature vary to such an extent that within limits imposed by certain fundamental principles almost any combination may be represented. No anemone possesses the characters of alcyonarian polyps, however.

The distribution of anemones is world wide. They occur at varying levels from the tidal zone to the greatest depths (10,190 m.) at which living animals have been taken in the sea. None occurs in fresh water, but a few are able to colonize brackish areas. Little is known of their geological range except that they must be of very great antiquity.



DOUGLAS P. WILSON
FIG. 9.—SEA ANEMONE METRIDIUM SENILE DIVIDING

Since sea anemones do not form colonies, the habit of budding, so prevalent in some groups of Coelenterata, is not much in evidence here. Asexual reproduction of other kinds, however, is of frequent occurrence.

In some species rapid longitudinal division (fission) of the whole anemone into two more or less equal parts is a regular habit; the animal literally tears itself in two, the throat being cleft as well as the other parts; and by the regeneration of tissue at the torn edge a new individual is formed from each half.

In other species fission of another kind takes place. Here a small fragment becomes separated from the edge of the parent's base (sometimes as a result of an actual tear, sometimes as the product of a process of constriction) and this fragment, although it contains no tentacles, peristome or throat, develops into a perfect, new anemone (fig. 9). In a few species the direction of fission is transverse.

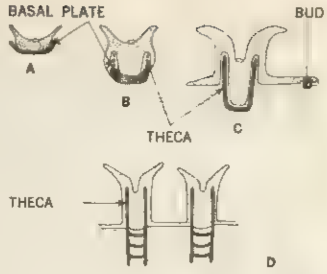
(For a classification of anemones *see* SEA ANEMONE.)

Order Scleractinia.—The Scleractinia, or Madreporaria, known zoologically as true corals, form a large group of Anthozoa characterized by their ability to secrete a limy skeleton that often is massive. The Madrepores differ from the other Coelenterata that secrete such a skeleton in that, although the size of individual polyps varies greatly, the average polyp size is large.

Moreover, the structure of the polyps is distinctive. The Scleractinia tend to form colonies containing few or many polyps; but in addition to the colonial species there is a large number of solitary forms in which a single polyp produces a single coral skeleton.

The polyps are similar to sea anemones in general build; but in their finer structure they are recognizably different. More-

over, their life is necessarily a purely sedentary one since after they have once secreted a skeleton they are permanently anchored to it, and in correlation with this and their other characteristics, they are less muscular than anemones and exhibit in particular a less marked development of the retractor muscles.



FROM THE "CAMBRIDGE NATURAL HISTORY," VOL. I, MACMILLAN & CO LTD

FIG. 10.—DEVELOPMENT OF MADREPORARIAN SKELETON

(A) Young stage of solitary coral; (B) solitary coral; (C) young stage of colonial coral; (D) zooids of advanced colonial coral

The variation of structure among coral polyps is wide; but it hardly parallels the extraordinary diversity found among the anemones. In the latter, diversity of the individual reaches its height, whereas in the colonial corals equally great diversity is reached in the relations of the polyps to one another and consequently in the form of the colony that they build up.

Corals are widely distributed in the seas of the world, and both solitary and colonial forms may occur in either shallow or deep water. The true reef-building corals, however, which are mainly colonial forms, are restricted to the tropical and subtropical zones; they flourish best in shallow water, and their depth limit is about 50 m.

The Scleractinia are an ancient group geologically, dating from Triassic times (about 200,000,000 years ago), and vast numbers of fossil forms are known. Many other corals that may or may not have been ancestral to them (the Tetracorallia, etc.) are known from much earlier times. Corals form the largest bulk of fossils belonging to the Coelenterata, and some limestones are composed almost entirely of their remains. In certain past epochs reef corals had a far wider distribution than in modern times, their remains being plentiful in latitudes at which they cannot now maintain themselves.

The skeleton of a solitary coral polyp such as *Caryophyllia* (a genus represented in Great Britain by *C. smithii,* the devonshire cup coral) is illustrated in fig. 10. It consists of a number of parts that together build up a shape definitely related to the soft parts that have secreted it. There is a basal plate attaching the whole structure to the substratum, a circular wall (theca) arising from this and a number of radially arranged vertical partitions (septa) that project inward from the inner surface of the theca toward the centre and partially subdivide its cavity. The septa are not all equal but belong to definite grades of size, which alternate regularly.

The polyp is seated in the cup of skeleton, and during life its body may extend well above and beyond the latter, overlapping also down the outside of the theca. If the polyp swallows a considerable mass of food, it must necessarily extend itself above the skeleton in order to make room in its coelenteron for the food. The tissues of its column and base form a lining in the skeletal cup, and its mesenteries alternate with the septa; the septa push the polyp's column wall inward; they nowhere penetrate into the coelenteron and are entirely external to the tissues of the animal. Thus, although there is deep interpenetration between the skeleton and the soft parts, morphologically speaking the skeleton is entirely an external structure. The skeleton is produced as a secretion of cells that are formed by the ectoderm of the base and sides of the polyp.

The eggs of corals develop into planulae that attach themselves after a time to a foreign surface, assume the form of miniature polyps and begin to build up a skeleton, which first appears between the base of the polyp and its support. Most corals are viviparous, that is, the planulae develop inside the parent polyp and are liberated as larvae. A few corals lie unattached and are anchored by the weight of their skeleton.

It must be understood that the growth of a colony is due to the continued deposition of calcareous material by the polyps, and as more and more is added the skeleton must necessarily increase in size, growing upward or outward or both. The form that any skeleton assumes is dictated by a number of factors affecting the polyps—by the way in which new polyps arise with relation to those already in existence; by their rate of formation and growth; by the relation between growth in height and growth in width; by the angle and plane of divergence between the polyps as the colony grows; by the presence or absence of a secretion of skeleton in the intervals between the polyps, and similar considerations. (For accounts of the formation of coral reefs *see* Coral Reef; also Pacific Islands: *Coral Islands.*)

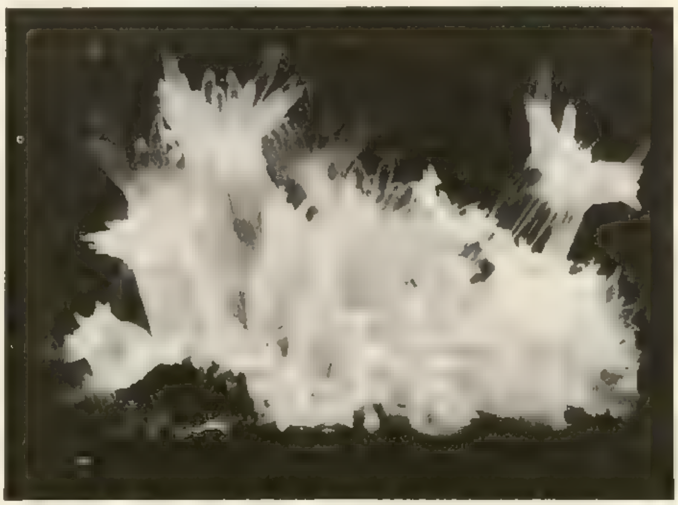
Each species of coral has inherent within its polyps the ability to develop in a given manner, and the form of the colony is also affected by the degree of its exposure to wave action. Something is known about the details of colony formation from actual observation and measurements of the growth rate. The older accounts concerning the processes by which the polyps increase in number should be read with reserve, since the ideas in vogue on this subject have until recently been largely speculative, and theories of colony formation have been too frequently based on the study of the skeleton. It is obvious that the skeleton is an imperfect even though permanent record of the activities of the polyps; studies of polyps reveal that in some cases conclusions as to the manner of growth may be entirely erroneous if based on the skeleton.

A study by G. Matthai of the soft parts of a number of corals from which the calcareous matter has been dissolved away leads to the conclusion that in the cases investigated (and probably in the group in general) polyps are formed in two ways. This has since been confirmed by direct observation.

Intratentacular Budding.—By intratentacular budding a polyp becomes compound. It has originally one mouth and throat surrounded by a peristome and a circlet of tentacles, and within the ring of tentacles, at given points on the peristome, one or more new mouths and throats arise. The form of a polyp with two or more mouths will become modified, and this process may reach an extraordinary degree of development, ending up in one or several branching polyps each with a number of mouths arranged in a row. The result is a colony of the type illustrated in fig. 11.

The skeleton in such a case consists of a series of winding ridges alternating with valleys containing septa, and is known as a meandriform coral. In other colonies formed by intratentacular budding, portions of the growing polyps, each containing a newly formed mouth, become separated from the rest of the polyp as growth proceeds; but this process is to be distinguished from true fission, which involves the cleavage of a polyp through its original mouth and throat and not the gradual separation of a portion of its tissues associated with a newly developed throat.

Extratentacular Budding.—By this method a new polyp is formed from tissues lying entirely outside the circlet of tentacles of any pre-existing polyp. The polyps in such colonies each have



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

FIG. 11.—YOUNG COLONY OF STAR CORAL (ASTRANGIA DANAE). EACH POLYP MAY REACH A HEIGHT OF ABOUT ONE-HALF AN INCH

one mouth and are therefore relatively easily recognized as entities. Extratentacular budding sometimes take place at the periphery of colonies in which intratentacular budding is characteristic; in colonies formed by extratentacular budding, polyps with two throats may occasionally arise by the opposite method.

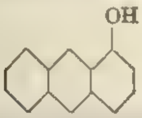
The classification of Scleractinia is a vexed question. The vital parts of the organisms are the polyps, and as yet too little is known of the structure and the potentialities of these throughout the group to make possible the construction of a satisfactory system.

BIBLIOGRAPHY.—For general accounts *see* bibliography to article COELENTERATA; and for lists of literature *see* W. G. Kükenthal, *Handbuch der Zoologie* (1923–25). For general accounts of Alcyonaria and Scleractinia *see* R. C. Moore (ed.), *Treatise on Invertebrate Paleontology* (1956); for budding in Madreporaria *see* G. Matthai, *Phil. Trans.*, B, 214, p. 313 (1926). Also *see* T. A. Stephenson, *The British Sea Anemones* (1928 and 1935); W. Saville-Kent, *The Great Barrier Reef of Australia* (1893). For the natural history of corals and coral reefs (including feeding, growth, breeding, budding, etc.) see *Scientific Reports of the Great Barrier Reef Expedition* (British Museum, 1930 *et seq.*). (T. A. S.; W. J. R.)

ANTHRACENE, a hydrocarbon obtained from the fraction of the coal-tar distillate boiling between 270° C. and 400° C. (from the Greek *anthrax*, "coal"). This high-boiling fraction is allowed to stand for some days, whereupon it partially solidifies. It is then separated in a centrifuge, the more fusible impurities are removed by means of hot water, and the residue is finally hot-pressed.

The crude anthracene cake is purified by treatment with the higher pyridine bases, the operation being carried out in large steam-jacketed boilers. The whole mass dissolves on heating, and the anthracene crystallizes out on cooling. The crystallized anthracene is then removed by a centrifugal separator and the process of solution in the pyridine bases is repeated. Finally the anthracene is purified by sublimation.

Many synthetic processes for preparation of anthracene and its derivatives are known. It is formed by the condensation of acetylene tetrabromide with benzene in the presence of aluminum chloride and similarly from methylene dibromide and benzene, and also when benzyl chloride is heated with aluminum chloride to 200° C. Anthracene ($C_{14}H_{10}$) crystallizes in colourless monoclinic tables which show a fine blue fluorescence. It melts at 213° C. and boils at 351° C. It is insoluble in water, sparingly soluble in alcohol and ether, but readily soluble in hot benzene. It unites with picric acid to form a picrate, $C_{14}H_{10}.C_6H_2(NO_2)_3.OH$, which crystallizes in needles, melting at 138° C. Anthracene and some of its derivatives are used in scintillation counters for the detection and measurement of ionizing radiation. (*See* NUCLEAR INSTRUMENTS: *Scintillation Counters.*)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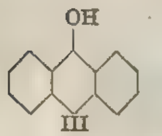
II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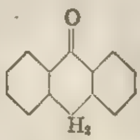
IV

The α- and β-hydroxyanthracenes (anthrols) with structures I and II, respectively, resemble the phenols. On the other hand, 9-hydroxyanthracene III reverts spontaneously to the ketonic anthrone form IV, from which it is made by the action of first a strong base and then an acid. Anthrone itself is made by the reduction of anthraquinone (*q.v.*).

Oxidizing agents convert anthracene into anthraquinone; the production of this substance by oxidizing anthracene in glacial acetic acid solution with chromic acid is the usual method employed for the estimation of anthracene.

ANTHRACITE: *see* COAL AND COAL MINING.

ANTHRAQUINONE, a paraquinone, is the most important derivative of anthracene. It was first prepared in 1834 by Auguste Laurent.

The most important physical property of anthraquinone ($C_{14}H_8O_2$) is that it is coloured, although but lightly so. It is in itself a chromophore. By the addition of groups such as hydroxy, amino, or substituted amino the colour of the substance is deepened to such an extent that derivatives can be made which cover every shade of the spectrum. The following table illustrates this property:

Substance		*Colour*
1 hydroxy	anthraquinone	lemon yellow
1 amino	"	reddish orange
1 methylamino	"	bluish red
1,2-dihydroxy	" (alizarin)	deep yellow
1,4-dihydroxy	"	red
1,4-diamino	"	violet
1,4-dimethylamino	"	blue
1,4-di-para-toluido	"	green
1,4,5,8-tetraamino	"	deep blue

Anthraquinone can be made by the oxidation of anthracene or by synthesis from phthalic anhydride (*q.v.*). Commercially it is made by both methods in most of the countries of Europe, Britain included; in the U.S., however, it is made by synthesis only.

Anthraquinone first became commercially important about 1870. In 1868 Karl Graebe and Karl Liebermann had established the chemical constitution of alizarin (*q.v.*), the base for very important dyestuffs and pigments, and had made it from 1,2-dibromoanthraquinone. Then in 1869 these investigators in Germany and W. H. Perkin in England simultaneously developed a commercially feasible process for making alizarin from sodium anthraquinone-2-sulfonate. With anthraquinone available commercially, much work was done on its derivatives. Within the next 30 years a whole line of dyestuffs, mostly for wool, was made from it. Then in 1901, R. Bohn discovered the first vat dyestuff derived from anthraquinone by fusing 2-aminoanthraquinone in molten caustic potash. The product, intensely blue in colour, was called indanthrene. It proved to be N,N′-dihydro-1.2:2′:1′-anthraquinoneazine. Chemically, this was a development of the first order, for over the next half century vat dyestuffs derived from anthraquinone became the most important class of the synthetic colouring matters. Like many other vat dyes, the anthraquinone derivatives are characterized by great fastness.

Several substituted anthraquinones, the 2-chloro and the 2-methyl, are also used for the manufacture of vat dyestuffs. They are prepared commercially by substituting chlorobenzene and toluene respectively for benzene in the above synthesis.

Anthraquinone crystallizes in yellow prisms, sublimes in yellow needles and melts in the neighbourhood of 285° C. It is extremely stable toward further oxidation but may be easily reduced under either acid or alkaline conditions to form a variety of products. One of the most important chemical properties of the substance is its ready reduction in alkaline solutions by means of sodium hydrosulfite, $Na_2S_2O_4$, to anthrahydroquinone, the alkali metal salts of which are soluble in water. With the derivatives of anthraquinone, corresponding reactions are used in the dyeing process. Another important chemical property is that it is readily sulfonated, nitrated and halogenated. (J. H. Ss.)

ANTHRAX (SPLENIC FEVER, MALIGNANT PUSTULE, WOOL-SORTERS' DISEASE; French *charbon*, German *Milzbrand*) is an acute, specific, infectious, febrile disease of animals including man caused by *Bacillus anthracis*, an organism which under certain conditions forms highly resistant spores that may persist and retain their virulence in contaminated soil or other material for many years. Primarily a disease of animals, chiefly Herbivora, the infection may be acquired by persons handling wool, hair, hides, bones or the carcasses of affected animals.

History.—Anthrax is one of the oldest recorded diseases of animals; it is mentioned by Moses in Ex. ix, 9, and by Homer, Hippocrates, Ovid, Galen and Pliny. Virgil in his *Georgics* describes it in epizootic form. Devastating epizootics of the disease are recorded by many medieval and modern writers.

In the 18th and 19th centuries it sometimes spread like a plague over the southern part of Europe, taking a heavy toll of human and animal life. Anthrax was the first disease of man and animals

in which the causative agent was definitely demonstrated as a specific microorganism—by C. J. Davaine in 1863, and in 1876 by Robert Koch, who isolated the organism in pure culture. It was also the first infectious disease against which a bacterial vaccine was found to be effective, by Louis Pasteur in 1881. These discoveries led to the origin and development of the modern sciences of bacteriology and immunology.

Anthrax occurs throughout the world. Repeated epizootics of the disease resulted in heavy contamination of the soil, especially in southern Europe and parts of Asia, Africa and North and South America. Districts of periodic contagion exist in Arabia, Argentina, Australia, Brazil, Chile, China, Egypt, France, Greece, India, Iran, Italy, Japan, Mexico, Morocco, Poland, Thailand, the U.S.S.R. (including Siberia), the United States and Uruguay.

The Disease in Animals.—Practically all animals are susceptible to anthrax.

Cattle, sheep, goats, horses and mules, the most commonly affected, usually acquire the disease by grazing on contaminated pastures. Outbreaks in swine, dogs, cats and wild animals held in captivity generally result from consumption of contaminated food.

The disease may occur in a peracute, acute, subacute form (internal anthrax) or in a chronic or localized form (external anthrax). The peracute form, most common in cattle, sheep and goats, occurs at the beginning of an outbreak and is characterized by its sudden onset and rapidly fatal course. Victims may show trembling, difficult breathing and convulsions but are frequently found dead without showing premonitory symptoms. In the acute and subacute forms, most common in cattle, horses and sheep, there is excitement and a rise in body temperature followed by depression, spasms, respiratory or cardiac distress, trembling, staggering, convulsions and death. Bloody discharges sometimes emanate from the natural body openings, and edematous swellings may appear on different parts of the body. During the course of the disease pregnant animals may abort, rumination ceases and the milk secretion is reduced. Horses show severe colic, fever, chills, a bloody diarrhea and swellings in the region of the neck, lower abdomen and external genitals.

The acute form usually terminates in death within a day or two; the subacute form may lead to death in three to five days or longer, or to complete recovery after several days.

Chronic anthrax occurs mostly in swine and dogs and is characterized by marked swelling of the throat, difficult breathing and a blood-stained frothy discharge from the mouth. Affected animals sometimes die of suffocation. Carcasses of animals dead of anthrax present a general picture of septicemia. There is usually rapid bloating and decomposition, dark-coloured blood that fails to clot rapidly, incomplete *rigor mortis*, oozing of blood from nostrils and anus, and a greatly enlarged spleen.

Prophylactic vaccination is extensively used in preventing anthrax in livestock. Excellent results are obtained when affected animals are treated in early stages with specific antiserum or penicillin. During outbreaks strict quarantine measures, proper disposition of diseased carcasses, fly control and good sanitation are essential in controlling the disease.

Anthrax in Man.—Anthrax in humans occurs as a cutaneous, pulmonary or intestinal infection; the most common type occurs as a primary localized infection of the skin in the form of a carbuncle. It usually results from handling infected material, lesions occurring mostly on the hands, arms or neck as a small pimple which develops rapidly into a large vesicle with black necrotic centre (the malignant pustule). Should this condition become generalized a fatal septicemia may ensue.

The pulmonary form ("woolsorters' disease") affects principally the lungs and pleura and results from inhaling anthrax spores where hair and wool are processed. This form of the disease usually runs a rapid course and terminates fatally. The intestinal form of the disease which sometimes follows the consumption of contaminated meat is characterized by an acute inflammation of the intestinal tract, vomiting and severe diarrhea. Anthrax is occasionally transmitted to man by spore-contaminated shaving brushes or by wearing apparel such as furs and leather goods.

The nearest approach to a human epidemic of anthrax during the 20th century occurred during World War I when large numbers of British and U.S. troops and many persons in the civilian population of England and the United States were infected by the use of shaving brushes imported from Japan.

Prompt diagnosis and early treatment are of great importance. Antianthrax serum, arsenicals and antibiotics such as penicillin, aureomycin, chloromycetin and terramycin are used with excellent results. The treatment of choice is penicillin or neoarsphenamine. The hazard of infection to industrial workers can be reduced by sterilization of potentially contaminated material before handling, protective clothing, use of respirators and good sanitary facilities, and in agricultural workers by avoiding the skinning or opening of animals dead of the disease.

See also references under "Anthrax" in the Index. (C. D. SN.)

ANTHROPOID APE: *see* APE.

ANTHROPOLOGY (ARTICLES ON). Anthropologists study human beings. In the 1960s, more than ever before, they were sharing in a search for systematic understanding of human nature (*q.v.*) with fellow scientists from other disciplines as well as with philosophers and theologians (*see* ETHICS, COMPARATIVE). The interests of anthropologists, as described in ANTHROPOLOGY, spill over into a wide spectrum of specialties in the physical, biological, behavioural, and social sciences.

Anthropologists have made considerable use of information provided by archaeologists in their attempt to understand the origins of modern customs, art, and social and political life. Atomic physics has contributed such techniques as radiocarbon dating for estimating the relative ages of archaeological finds. Efforts to establish the geographic origins of the different peoples have been supported with methods developed by biological scientists, particularly those concerned with the study of human heredity. In applying the techniques of genetics to the inheritance of blood types, for example, it has been possible to verify the conclusion that European gypsies originally came from India. Psychological principles, especially those from psychoanalytic theory, have been employed by anthropologists in an effort to understand family relationships, prohibitions against incest, and religious and legal practices among different peoples. Discussions of topics closely involved in modern anthropological practice may be found in such articles as ARCHAEOLOGY; RADIOCARBON DATING; PSYCHOANALYSIS; PSYCHOLOGY; SOCIOLOGY; and GENETICS, HUMAN.

Thus far, anthropologists have made their most distinctive contributions to an understanding of people as biological organisms (as studied in physical anthropology) that generate unique cultures (covered in cultural anthropology). Efforts in physical anthropology are summarized in RACES OF MANKIND; MAN, EVOLUTION OF; NEGRO; MONGOLOID; CAUCASOID; ANTHROPOMETRY; HAIR; BLOOD GROUPS; and SKULL: *The Skull in Anthropology*.

However, anthropology has contributed most heavily to an understanding of human cultures; much of this work is presented in overview as SOCIAL ANTHROPOLOGY; and CIVILIZATION AND CULTURE. Since most professionally trained anthropologists come from technologically sophisticated societies, they have tended to concentrate on lesser-known cultures of more primitive technology. Material aspects of such societies are discussed in DWELLINGS, PRIMITIVE; AGRICULTURE, PRIMITIVE; HUNTING AND FISHING, PRIMITIVE; ECONOMIC ANTHROPOLOGY; MATERIAL CULTURE; WEAPONS, PRIMITIVE; TRADE, PRIMITIVE; CURRENCY, PRIMITIVE; and are considered in such articles as TRANSPORTATION; MUSIC, PRIMITIVE; MUSICAL INSTRUMENTS; PRIMITIVE ART; WOOD CARVING; BARK CLOTH; and MATERIAL CULTURE.

Cultural variations involving family and group relationships receive attention in KINSHIP; KINSHIP TERMINOLOGY; DESCENT, SYSTEMS OF; CLAN; MATRILINY; MARRIAGE, PRIMITIVE; EXCHANGE MARRIAGE; COUSIN MARRIAGE; POLYGYNY; POLYANDRY; and DUAL ORGANIZATION, while additional questions of social and legal status are covered in such articles as CASTE (INDIAN); LAW, PRIMITIVE; COMMUNISM, PRIMITIVE; LAND TENURE, PRIMITIVE; and AGE SET. The reader who seeks to learn of unusual practices and beliefs in many cultures may be attracted to HEAD-HUNTING; MUTILATIONS AND DEFORMATIONS; INFANTICIDE; CANNIBALISM;

SCALPING; ORDEAL; SACRIFICE; SUPERSTITION; RELIGION, PRIMITIVE; MAGIC, PRIMITIVE; TOTEMISM; TABU; ANIMAL WORSHIP; ANIMISM; LYCANTHROPY; METEMPSYCHOSIS; SECRET SOCIETIES, PRIMITIVE; PEYOTISM; FUNERARY RITES AND CUSTOMS; MANA; LIGHTNING; DANCE, PRIMITIVE; MYTHOLOGY, PRIMITIVE; FOLKLORE (AMERICAN INDIAN); TATTOOING; RITES AND CEREMONIES; CIRCUMCISION; and TREE BURIAL.

The raw materials on which the generalizations of anthropology are based come from empirical study of many specific cultures. *Encyclopædia Britannica* abounds in reports of the history and modern status of these groups of people, including INDIAN, NORTH AMERICAN; INDIAN, LATIN-AMERICAN; ESKIMO; IROQUOIS; NAVAHO; ARAB; AUSTRALIAN ABORIGINES; AINU; BASQUE; BERBER; GYPSY; MALAY; MONGOL; and PAPUAN. The Index supplies references to many more. In addition, the anthropology of particular geographic areas is discussed under such titles as OCEANIA; MELANESIA; MICRONESIA; POLYNESIA; CAUCASUS, PEOPLES OF; as well as in articles dealing with the continents (AFRICA and ASIA, for example) and with more limited geographic or political units (NEW GUINEA or JAPAN, for example).

Clearly, the concerns of anthropology range widely, and are faithfully reflected in these volumes from ABIPÓN to ZUTUHIL, and from ACCULTURATION to ZUÑI.

ANTHROPOLOGY. Anthropology, in its development and branches, can be characterized as the naturalistic description and interpretation of the diverse features of mankind. Its approach to the manifold variations among peoples is at once universal and comparative. It cannot be effectively defined in terms of an exclusive subject matter or a single method of study. It differs from history, as commonly understood, not by excluding historical studies of peoples, institutions, beliefs or customs, but by using as far as possible direct observation of human beings, their activities and their products rather than documentary accounts; and also by viewing the results of any such study as part of the total human record and as a contribution to the better understanding of the complex processes involved in the biological and cultural development of man. Similarly, it differs in approach from physiology or psychology in concerning itself with variations and collective differences in human physique and mentality. Thus, anthropologists seek to study and interpret the special characteristics of any particular population or activity in terms of its time and place in the total history of mankind; but any claim that anthropology encompassed the study of man in its entirety including research and description concerning all human characteristics and activities would, of course, be both presumptuous and futile.

The present article is divided into the following sections:

I. GENERAL SURVEY

1. Historical Background.—It was through attempts to describe and explain physical types, customs, beliefs and forms of social organization that lay outside the more familiar world of earlier western knowledge and yet were held to be ultimately related to it that anthropology developed its generalizing tendency and its assumption that any particular people was, whether in physique or custom, to be viewed as a variation on a common human theme and to be described and explained in terms of characters and processes relevant to all mankind. This conception was developed in the 19th century, in an effort to integrate knowledge of all periods of human history and from all relevant branches of science. It was especially stimulated by the impact of the doctrine of biological evolution on ideas concerning human progress already developed by philosophers in the 18th century. The greatly lengthened perspective of the age of the earth and of the antiquity of mankind, which was opened up by the 19th-century geologists and naturalists, gave a new importance to speculations on cultural and social development, while the successes of 19th-century technology in bringing the whole world into view also encouraged attempts at reformulating man's place in nature. The variety of behaviour and belief among the many peoples of the world, on which travelers and scholars had been reporting and speculating since the Age of Discovery, challenged inquiry into both the causes of such diversity and the manifold connections between various aspects of human life.

The philosophers of the Enlightenment, both on the continent and in England, had sought to formulate general schemes of social and cultural advance whereby, as Hume expressed it, there had been a gradual "improvement of human society from rude beginnings to a state of greater perfection" through successive stages, later schematized by Lewis H. Morgan as savagery, barbarism and civilization. The great explanatory value of the evolutionary principle with regard to the complexity and diversity of organic life lent strong support to concepts whereby the diversity of human cultures in such fields as economy, government and religion could be interpreted in terms of progressive developments from simpler forms. The weight of Christian cosmology had been inimical to the general acceptance of these ideas until the geologists and naturalists undermined the dogmatic authority of the biblical story of creation. But the way was then opened for more objective study and comparison of the peoples of the world both past and present. The recognition in the late 19th century of an increasing number of fossil remains as those of human beings differing markedly from any living peoples demonstrated the great antiquity of "diluvial" man. Charles Darwin's hypothesis of natural selection as a mechanism of organic change heightened scientific interest in the relations between biological and cultural conditions and there was much early speculation as to the effects of environment on physical and cultural types and of biological factors on technical and social advances.

Herbert Spencer viewed the high level of organic complexity reached in man in the course of biological evolution as the foundation of what he called superorganic development. This he regarded as molded in part by the primary factors of biological inheritance and of the physical environment, but also by secondary factors which emerged in the social process itself, such as the tendency of society to increase in size and density; the internal reciprocal action of groups within any society; the action and reaction be-

tween societies; and finally the accumulation of "superorganic products," such as language, knowledge, morals and aesthetics, or what anthropologists would now call culture.

Stressing the importance of elucidating all the factors determining the qualities of a particular people or form of society, he emphasized the significance of comparative methods and of studying the widest range of peoples in seeking to understand the genesis and *raison d'être* of customs and institutions, paying special attention to primitive societies which were small in scale so that the totality of their way of life could more readily be grasped and analyzed.

Spencer's interests were essentially sociological, and while he recognized that social processes and systems could only be perceived and formulated by abstraction from actual manners and customs, he did not focus attention on the needs and difficulties of their objective and systematic examination. It was Sir Edward Burnett Tylor who, following Otto Klemm, provided the modern anthropological connotation of the term culture, opening his famous book, *Primitive Culture* (1871), with a descriptive definition of culture as "that complex whole which includes knowledge, belief, art, law, morals, custom and any other capabilities and habits acquired by man as a member of society." For Tylor the content of culture, its organization and variability were of direct and intrinsic interest. He placed greater stress than Spencer on the complexity of the long historical processes of cultural change, and also on the effects of specific environmental conditions, migrations and contacts in stimulating particular developments, and thus of the need for their detailed study. His empiricism and his interest in the character and determinants of cultural forms justify his title as the father of modern cultural anthropology. He accordingly stressed the need to tread the slow road of detailed ethnographic inquiry and of meticulous comparison of attendant circumstances before proceeding to the more abstract levels involved in generalizing about society and its evolution.

The close association of biological, cultural and sociological interests in the development of anthropology followed from the belief that human life as a whole was the complex result of a series of interconnected fields of development. Since their views were evolutionary, the early anthropologists were as interested in paleontological evidence concerning the physique of extinct peoples, and archaeological evidence concerning extinct cultures, as in racial variations and cultural differences among living peoples. All were recognized as contributing to the general interpretation of human development and activity. The primitive and ancient, then as now, were not emphasized exclusively or for their own sake, but because of the contribution that the study of early man and of the simpler living societies could make to a general understanding of man's place in nature.

However, the wide range of problems that emerged required investigation of different kinds of evidence by a variety of methods. It accordingly stimulated inquiry in many areas of knowledge that were developing during the later part of the 19th century and fostered the exchange of information and ideas among workers in diverse fields. Comparative anatomists, geologists and archaeologists began to co-operate in the study of early man as revealed in fossil remains and the stone tools of the Ice Age. Ethnographers recording the ways of life of living primitive peoples co-operated with ancient historians, folklorists and philologists in the study of early customs and social institutions. Inevitably, too, as knowledge further increased, still greater specialization developed. The elaboration of new methods and the growing body of material encouraged concentration in limited fields and on specific problems, so that anthropological research itself divided into a number of specialties. There was an early divergence between those concerned with the biological and with the sociocultural aspects of human development, which led to the recognition of the distinct branches of physical and cultural (or social) anthropology. In continental Europe this has long been recognized by restricting the term "anthropologie" to physical anthropology and by using the term "ethnologie" for cultural studies. Within these branches further distinctions have developed. In the former the study of the biological evolution of man has been advanced by paleontological and anatomical researches as an integral part of the study of the primates, the mammalian order to which man belongs, while the analysis and interpretation of the variations in physique among the peoples of the world have depended mainly for their advance on the application of statistical methods and later of genetical theory. In the sociocultural field, interests have also tended to divide according to whether the main concern has been, on the one hand, with the sequences of cultural development in particular regions or, on the other hand, in the elucidation of underlying processes involved in certain general aspects of human culture and social organization. These have given rise, respectively, to specialized researches in ethnology and into the functioning of cultures and social systems. The widely varying nature of the material available for study has again led to further specialization in methods. By increasingly systematic excavation of prehistoric sites and the comparative study of relics and their contexts it has been possible in the few regions that have been intensively studied by archaeological methods to recover at least in outline a continuous record of the cultures of the peoples that succeeded one another from the Stone Age down to the present. The prehistorians have increasingly specialized on particular periods or geographical areas, and their problems and techniques have differed according to whether they dealt with relic-bearing caves, beaches and peat bogs, with the dwelling sites and graves of primitive cultivators or with the deep deposits and elaborate constructions preserved in ruined prehistoric cities. In regions beyond the range of modern archaeological knowledge, notably over much of Africa, Australasia, Oceania and the new world, attempts have been made to reconstruct cultural sequences by comparative studies of the ethnography of their living peoples. Tentative as the results have often been, they have afforded valuable guides for the planning of later ethnographic and archaeological research.

Thus anthropology as a subject of study in English-speaking universities generally includes teaching and research in both the physical (biological) and the sociocultural fields, and in both of these there have been further specializations of approach. In physical anthropology, continuing discovery and examination of fossil remains provides material for the systematic morphological study of human evolution (human paleontology and primatology). Investigations of living populations are directed to defining and interpreting their variation; *i.e.*, to the study both of the gross differences in the predominant characters between populations from different major regions of the world (*e.g.*, Mongols of eastern Asia as compared with African Negroes) and of the variability of physical characteristics within a given population. Within this branch of the physical anthropology of living peoples, in addition to the earlier developed morphological and statistical studies, new studies in physiological variation and genetic analysis of variability are being developed.

In cultural and social anthropology, also, there are several perhaps less sharply defined specializations, not all of which are everywhere included in general teaching or equally emphasized, and some of which may be pursued in association with other disciplines such as psychology and sociology. The need remains for a broad presentation in general ethnography and culture history of the varieties, long-term development and processes of diversification of human cultures as well as for an evaluation of the influence of the many underlying factors. But intensive study can no longer embrace the broader phases of development, and simple schemes of cultural evolution are no longer of heuristic value.

Prehistoric archaeology, in the discovery and the analysis of surviving relics of extinct cultures and their environment, has become a highly specialized discipline of field excavation and laboratory study, the techniques of which vary according to the nature of the sites and the character of the cultural and other remains. In some regions, such as Europe, the intensity of research, the wealth and complexity of the material and the growing precision of chronological studies have required further specialization on particular phases; *e.g.*, the Paleolithic. In other parts of the world, notably North America, much archaeological research is concerned, in its later chronological phases, with the immediate ancestors of the living aboriginal populations available for study. Thus, for

example, in California or in the southwest of the United States there can be a direct continuity and community of interest between archaeological and ethnographical research in the study of the ethnology of particular peoples or areas.

Ethnography carried out by field research among an existing population provides the essential data for various more specialized sociocultural studies, whether topical or comparative. The study of general ethnography, which surveys the primitive world descriptively, and of ethnographic monographs, provides, as already mentioned, an essential background for appreciating the variations and problems which have given rise to different approaches in specialized studies. Within ethnography there is the specialized but basic field of primitive technology, in which the development, context and significance of crafts and art are studied. The term "ethnology" is now generally applied to studies chiefly concerned with the historical reconstruction of the cultural development of particular peoples or regions.

Social anthropology concentrates on the analysis and explanation of the whole range of social relations as parts of a system of social organization or social structure. It is concerned with the function of institutions, both in relation to the social system as a whole and as contributing to human needs. Both social organization and particular social institutions are analyzed, according to their relevance, with reference to the various fields, *e.g.*, political, legal and economic, of human interest and interaction. Religious beliefs and ritual are considered within this framework, especially for their significance in maintaining and sanctioning social norms.

A further specialization in the collection and study of ethnographic data which has become a main focus of interest for some American anthropologists is to be found in what are variously known as "configurational" or "culture and personality" studies. These are concerned with the analysis of differing basic values and underlying assumptions in the view of life of various cultures and their expression in the personalities of those who share in them. Such studies seek on the one hand to discover and portray the measure of unity and coherence in thought and judgment which provides the common understandings of a cultural group. They also often apply psychological principles and hypotheses of personality development to the explanation of the genesis and persistence of particular patterns and values.

Linguistics also has been considerably developed within the framework of anthropological studies. The recording and systematic analysis and comparison from several points of view of the innumerable speech forms of peoples outside the historic civilizations have been undertaken largely by anthropologists specializing in linguistics. Their attention is directed not only to the philological or genetic study of the historical development of particular languages, but often to the detailed analysis of the phonetic and grammatical structure of a language considered as a system of sound signals governed by implicit principles which maintain its unity and the direction of its changes. Languages are also studied and presented semantically as systems of meanings which deeply affect modes of thought and behaviour, and can thus provide an important key to the study of cultural values.

2. Evolution and Racial Variation in Man.—Physical anthropology (*see* below) is concerned with the related problems of tracing the emergence of man as an animal form and the nature, causes and significance of past and present variations in the biological characters of the various human species and breeds. Much research continues to be directed to the study of primate, and in particular, human, variation in time and space and to the determination of the mechanisms which have brought it about. But the focus of interest, in harmony with a trend throughout much of biology, has tended to shift from morphological comparisons to considerations of function. An outstanding feature of the primate order is the high development of the central nervous system, and especially of the brain. The importance for the emergence of man of a number of evolutionary changes in the organization of the primate brain has long been recognized, but a simple concept of increasing morphological complexity from lemurs, monkeys and apes culminating in man, accompanied by a corresponding change in mental complexity, does not do justice to the facts. It may be conjectured that physiological work, using electrical and other methods, on the functioning of the brain will eventually allow a reinterpretation of primate cerebral evolution on a more exact and critical foundation. Although some other physiological work, particularly on the primate sexual cycle, has been done, and there is a growing body of laboratory and field studies on primate behaviour, much remains to be done before a comprehensive view can be gained. There is also a tendency, again reflecting general trends in the biological sciences, to attempt a more quantitative treatment of anatomical problems. Very useful metrical work has, for example, been done on the varying bodily proportions of primates, so that the range of variation within a species can be appreciated and so that comparisons obtained by statistical methods càn replace subjective impressions.

The study of fossil remains of man and other primates is dependent for its advances on the discovery of new material, which is often as much a matter of chance as of planned research. Human fossils have always excited public interest and often, unfortunately, an unreasonable partisanship in scientific circles. The fragmentary character and rarity of most kinds of primate fossils have tended to encourage wild speculation and premature judgments on the basis of a small amount of evidence. Since 1930, however, finds have been made which are very important because of the number of individuals of the species represented and because the parts of the skeleton are more complete and extensive than those available before. A remarkable abundance of finds in south Africa of a fossil species or group of species of apelike form known as the Australopithecinae has renewed interest in an earlier stage of human evolution. Although many features of the skull, including the small brain, appear to be closer to the range in apes rather than in man, there is strong evidence that these creatures, which were not arboreal forest dwellers, may have been capable of erect locomotion. It may be remarked in this connection that, as intermediate forms become known in increasing numbers, the decision as to what is to be regarded as human will become arbitrary, depending on the criteria adopted. Fortunately, the controversies concerning the interpretation of these remains have every prospect of being cleared up by the discovery of more material. Meanwhile, the earlier history of the anthropoid apes has also been illuminated by rich discoveries of Miocene Age in Kenya. Previously, fossil anthropoid remains have been very rare and fragmentary and the newer finds tend to indicate a more complex variety of early forms than was previously envisaged, and that these early apes lacked the specialization of structure connected with arm-swinging arboreal locomotion, which characterizes modern anthropoids.

As Europeans after the Age of Discovery became better acquainted with the peoples of many outlying parts of the world, naturalists began to make classifications of human types. For this purpose J. F. Blumenbach at the end of the 18th century developed a method that included cranial measurement and constructed a five-fold division of mankind into white, yellow, black, Malayan and Amerindian races to correspond with what was then known about predominant differences in physical appearances of the peoplés of the several great regions of the world. Since measurement had great prestige and evolutionary theories in biology had not yet developed, anthropology inherited from this pioneer work an oversimple theory of racial divisions which assumed a fixity of separately created species. For the broad classification of mankind into a few types based on selected combinations of skin colour, hair form and head shape does not necessarily correspond to any over-all genetic unity within, or division between, the so-called "races" that are thus defined.

The modern study of living population has been increasingly influenced by Mendelian genetics, much advanced in scope and subtlety. For the purpose of tracing ancestral relationships it is the demonstrably inherited features of the organism which count. Variations within or between human populations may, in large measure, be determined by genetic contribution but they may also be the results of differences in conditions of life. A bald division into genetic and environmental factors is, it must also be remembered, an oversimplification, since the action of genes may itself be modified by environmental conditions, and one sometimes has to

deal with complex interactions between the two. Nevertheless, some features such as the human blood groups appear to be very little, if at all, affected by change in environment, while others, such as stature or, still more, intelligence, appear to be susceptible to extensive modification by environmental factors such as nutrition in the former instance and education and other cultural factors in the latter. It is generally accepted that the ultimate source of biological variation is gene mutation. By the processes of Mendelian inheritance a great variety of gene combinations can thus become available to be acted upon by natural selection. The work of genetical statisticians has provided a powerful theoretical background for evolutionary study by indicating the rate at which evolutionary change may be expected to occur under given particular mutation and selection rates.

The existence of physical differences between populations of different geographical areas and between individuals within any given population is an obvious fact. One task of physical anthropology has been to give an objective and thorough description of these differences as a preliminary step in determining how they have come about. Populations are never homogeneous with respect to a particular characteristic, and the variations in, for example, body measurements or skin pigmentation within any population are continuous; *i.e.*, given individuals may have any measure or degree of pigmentation within a certain range. The essentially statistical character of population differences is thus evident. The variability within populations and the gradual character of geographical differences being what they are, the distortion involved in attempting to classify mankind into sharply distinguished and mutually exclusive groups is apparent. At the same time, the substantially continuous predominance over wide geographical areas of particular combinations of skeletal, skin and hair features, such as characterize the Mongoloid, African Negroid and Caucasoid (white) populations in the old world, does suggest that there was an early differentiation of *Homo sapiens* into a number of populations each having some particular and stable combinations of characters, and that some of these came to predominate in different regions, affording a basis for the division of mankind into the "great races" of the earlier anthropologists.

An observed physical character is the end product of the activity of a few or of many genes. Even if the end result is not modified by environmental factors, it may still not give a precise clue to the genetic constitution. Characters which look alike by all available means of observation may not have the same genetic basis and may therefore be misleading in evolutionary studies. It seems that populations are seldom distinguished by the unique possession or complete absence of particular genes, though frequency differences may be large. For example, the curious inherited anomaly of the red blood cells known as sickle-cell trait, which has a frequency of 25% or more in some African tribes, has an incidence of only one in many thousands in western Europe.

These facts emphasize the essential biological unity of the human species. The notion of "pure races" is seen to be fallacious and classification into sharp categories cannot be achieved without doing violence to the statistical nature of the observed variation, which is one of degree.

The historical antecedents of these variations are likely to be difficult to determine. Although some may be plausibly explained as results of population hybridization which can be observed in progress, it is likely that extinct populations also must be postulated, whose genetic composition cannot be known. There are in addition some hints of the way gene frequencies may change under selective influences; in the Rh blood group system it is known, for example, that certain matings may give rise to incompatibility between the antigens of the fetus and the antibodies of the mother, resulting in the death of a certain proportion of children and thereby the elimination of certain genes. It is probable that further examples will be found for other genetic characters. The gene frequency in a population tends, it would seem, to be held in equilibrium by opposing selective forces.

The adaptive nature of some of the more obvious physical variations in man, such as skin colour, has long been surmised, but it cannot be said that there is much direct evidence on the matter. Suggestive correlations between body proportions and the climatic situation of populations have been presented, but physiological work on the comparative performance of tropical peoples and Europeans has been inconclusive or has tended to show that any differences are slight. The prevalence of various nutritional and parasitic diseases in many non-European populations may affect characters and so be an obstacle to valid comparisons. Thus, although it might ultimately make contributions of great significance to the understanding of cultural variations between peoples, and although differences in the intensity and balance of physiological processes might prove to be factors in many differences in behaviour and temperament, the comparative physiology of man was only beginning to be explored in the 1950s. Much progress had to be made in psychophysiology before it would become possible from the study of comparative data at both the physiological and cultural levels to determine not only the range and the morphological associations of variations of bodily function in different populations but also the extent to which cultural dispositions are affected by such differences.

Meanwhile, the question whether populations differ with respect to inherited capacities in mental functioning is apt to be prejudged in the political sphere, for the basis of "racist" doctrines is the quite illogical supposition that if two populations exhibit certain physical differences which are inherited and also show differences in mentality, then the latter are inherited in the same biological sense as the former and, by implication, cannot be changed very much. The scientific study of psychological differences between populations is beset with grave difficulties. It is no longer generally believed that the intelligence tests so widely used in European populations are a measure of genetically determined ability uninfluenced by educational or other environmental features, and therefore applicable to other cultural groups. Insofar as tests as free as possible from cultural bias have been used in comparative studies, the results appear to favour the view that differences between populations are relatively slight and that the same kind of overlapping in range occurs that is characteristic of physical traits.

3. Ethnology.—As indicated above, most early anthropologists, encouraged by the success of evolutionary doctrines in biology, attempted to outline schemes of cultural and social evolution for mankind. They were handicapped by the fragmentary and restricted character of the material then available, but still more serious was their frequent misconception of evolutionary principles as developed in biology. Despite the stress placed on diversification in the latter, a single pattern of cultural and social evolution applicable to all human societies was usually postulated, and different peoples past and present were conceived as having reached various stages in this common process of development. This notion of unilinear evolution was applied both separately to particular aspects of human life such as modes of production, social organization, art, religion and law, and also to sociocultural development as a whole. In consequence, ethnography, *i.e.*, descriptive accounts of particular peoples, was apt to be regarded as a source of illustration of preconceived schemes, and the evidence it could afford of the divergence of cultural forms and of a consequent multilinear evolution of cultural patterns tended to be neglected. The monumental studies of Sir James Frazer, in which a vast body of earlier ethnographic data was compiled to illustrate the supposed evolution of certain cosmological beliefs and some primitive social institutions, represented the culmination of this approach.

As more detailed knowledge of nonwestern peoples accumulated it was, however, increasingly recognized not only that a priori schemes of evolution in such fields as technology, economy, religion, art and social organization failed to account for the facts, but also that any given cultural pattern or form of social organization had to be examined minutely and comprehensively as a functioning system if the nature of its various features was to be elucidated to afford an adequate basis for comparative and developmental studies. This has encouraged not only much more intensive ethnographic study in the field, but also, according to the particular aspect of culture and society concerned, a wider knowledge of the relevant branches of cognate sciences such as psychology and sociology. On these foundations, ethnology, the study of the his-

tory of peoples and cultures, made great progress in the first half of the 20th century. Ethnologists have not only been concerned with marshaling evidence to disprove the older schemes of unilinear evolution, as was so effectively done by R. H. Lowie, but have also sought, notably in the work of A. L. Kroeber, to work out by more empirical methods phases of cultural development in particular regions. Others have, however, sought to replace the earlier views by equally world-wide schemes based on other criteria. Influential among these was the *Kulturkreislehre*, the doctrine of primitive culture spheres first formulated by F. Graebner, which held that the more primitive peoples of the world could be classified into a limited series of distinct and ancient culture types, each characterized by a particular mode of livelihood, pattern of descent, form of religious beliefs, etc. These various types, it was held, had developed, spread widely and later intermingled, at successive periods in the early history of man. The task of the ethnologist was, accordingly, to unravel from the tangled skein of living primitive cultures the elements contributed in any given case by one or more of these ancient "spheres." Formal similarities in way of life, mode of descent, ceremonial, etc., among peoples as widely separated as, for example, the natives of west Africa, Melanesia and California, were held to show that their cultures had all in substantial measure stemmed from a single archaic type. This Graebnerian scheme secured little recognition in the English-speaking world where, indeed, its artificialities were severely criticized. But in continental Europe it not only exerted considerable influence on ethnological theory but also stimulated ethnographic field research, more particularly as its principles and methods were adopted and developed by the Anthropos school of ethnology under Father W. Schmidt and formed part of the training of Roman Catholic missionaries posted in all parts of the world.

In England and North America great stress has been laid on the comprehensive description of the many primitive cultures that have been fast disappearing or extensively modified under western influence. From the early years of the 20th century, under the influence of A. C. Haddon in England and F. Boas in the United States, a considerable body of systematic ethnographical data has been accumulated for certain regions of the world, notably North America, Australia and parts of Africa and Oceania. Comparative work based on such studies has, among other things, strengthened the evidence of the importance of migrations and mingling of peoples and still more of widespread diffusions of cultural elements, in spheres as diverse as handicrafts, art styles, mythology and ritual patterns, in modifying one or another aspect of culture over considerable areas. Attempts have been made to reconstruct such processes in detail for particular regions such as North America, Melanesia and Polynesia. The far-reaching effects of diffusion on cultural developments among all peoples thus became generally recognized. Its role and the processes involved were, however, exaggerated and oversimplified in the claims, which were generally rejected, of Sir Grafton Elliot Smith and William Perry, who attempted to account for the salient features of the more advanced primitive cultures of the world in terms of a single world-wide diffusion of their elements from one early centre of discovery and invention in ancient Egypt. Many of the assumptions underlying this scheme, and notably that of the inherent conservatism and uninventiveness of man, have been contradicted by the growing body of ethnographic and archaeological evidence pointing to the ubiquity of innovation under favourable conditions.

In the special conditions of the new world, where the historic record is less than five centuries old and a direct continuity was often to be found between prehistoric remains and surviving Indian cultures, American anthropologists have found a favourable opportunity for the study of cultural development by the integration or close co-ordination of ethnographic, documentary and archaeological research in the intensive study of the culture history of several major regions, notably in the southwest of the United States, meso-America (from central Mexico to Central America) and the Andean region of South America. During the second quarter of the 20th century regional specialists such as W. C. Bennett, G. Willey, A. Caso and E. J. Thompson succeeded in charting the main phases of indigenous cultural development and in elucidating many of the environmental factors and the processes of diffusion and integration involved. Historical and contextual problems have continued to multiply as this work has proceeded and been extended by F. Rainey, I. Rouse, J. B. Griffin, R. Heizer and others to further areas including the arctic, the Caribbean, California and eastern North America, the ultimate objective being to describe and analyze the entire culture history of the new world from the still unknown time when the first human communities reached it. Considerable advances have been made and it is only in parts of Europe and the middle east that a comparable completeness of the total cultural record of man has been obtained. These studies of ethnohistory in the new world have at the same time maintained contact with the more theoretical interests developing in cultural anthropology, and significant contributions of data and hypotheses in connection with such problems have been made.

4. Archaeology and the Cultural Record.—Prehistoric archaeology—the recovery and study of the artifacts of extinct cultures for which there are few written records or for which such records are not contemporary—had its systematic beginnings in the later 19th century in an anthropological context, and prehistorians, although now necessarily specialists on a limited area or period, have continued to interest themselves in the relation of their findings to the general problems of cultural development. The conspectus available, when the results of this archaeological research are combined with those of ethnology over a given period, makes it possible to grasp the broad outlines of the cultural history of mankind and to assess more effectively some of the main processes involved in cultural and social development. Archaeological materials, unlike documentary or ethnographic ones, can only rarely afford direct information concerning ideas or social relations. But despite the fragmentary and selective character of the material, significant, if limited, inferences can be reached in these fields when it is appraised thoroughly and critically.

For the reconstruction of culture history, the date of archaeological material is vitally important and systems of relative chronology have been worked out by various methods such as those based on correlations with geological horizons (for the more remote periods), the stratification of occupied sites and the associations and overlaps of typological sequences of artifacts. Absolute dating has presented greater difficulties, but in the ancient east it has been possible to estimate the chronology of the Neolithic and later prehistoric phases by working back from the oldest written documents including calendrical records, and the main phases of the prehistory of Europe back to *c.* 3000 B.C. have also been dated through correlations with these. In the arid areas of the southwestern United States it has been found possible, by matching the overlapping annual growth rings on tree trunks cut for building in prehistoric sites, to establish an absolute dendrochronology extending back to the beginning of the Christian era. But the development by W. F. Libby and others since 1950 of a method of dating organic archaeological remains by the measurement of the radioactivity of their carbon-14 promised to provide a means for securing an absolute chronology within a definable margin of error for prehistoric cultures as far back as 25,000 years.

The widespread existence of human populations in the old world during the Pleistocene Ice Age has long been established by the geological dating of the chipped stone tools that afforded cutting instruments for early man. For the earlier periods, however, fossil remains of man are generally few and isolated, so that attempts at correlation of the early Stone Age cultures with particular species of *Homo* remain speculative. Before and during the early part of the last glaciation, the Neanderthal species of *Homo* occupied Europe and parts of southwest Asia with a culture which included tool forms derived from several older traditions. But it appears to have been completely displaced in Europe during that glaciation by populations of *Homo sapiens*, precursors of which may have already existed there but which now appeared equipped with stone tools of new types. These Upper Paleolithic industries indicate a very great technical advance, as shown in the greater specialization of stone tools, many of which were intended not for direct use but for the manufacture of other implements in bone,

ivory and wood, and in the importance of missile weapons, especially the use of the spear thrower and bow, for neither of which is there any evidence in Lower Paleolithic remains. Advance in skill and organization in hunting and the addition of fishing to the economy permitted larger communities and more prolonged occupation of sites. The Lower Paleolithic phase in Europe had been immensely long and on a conservative geological estimate endured for approximately 400,000 years. The Upper Paleolithic and the immediately postglacial Mesolithic food-gathering cultures of Neanthropic man in Europe, although they cover by far the greater part of the known history of *Homo Sapiens*, were by comparison short-lived, for they began to be supplemented after less than 100,000 years by the cultivation of plants and the domestication of animals.

The foraging, hunting and fishing economies to which all known human communities had hitherto been confined were then effectively supplemented in the old world for the first time by the development of grain cultivation and stock breeding in the warm, open and seasonally watered uplands of the middle east about 6,000 years ago. This momentous innovation, which made still larger and more stable human communities possible, spread widely during the next 1,000 years and, as it was generally associated with the manufacture and use of polished (as distinct from chipped) stone tools, has become known as the Neolithic phase. Early Neolithic communities were small populations of from 20 to 30 households generally dependent on shifting cultivation, but, contrary to what prevailed in the hunting economies of Paleolithic man, a food surplus was increasingly possible in most environments to foster the development of other crafts. Handmade pottery and the weaving of simple textiles were generally adopted.

Despite the clear evidence of the widespread diffusion of Neolithic crafts from early centres in the middle east, it is by no means definitively established that this was the only region of the old world in which men independently developed primitive cultivation and a settled life. But it was in this region again that still greater technical advances followed in comparatively rapid succession over the next 2,000 years, facilitated it would seem by the devising of a more productive system of irrigation agriculture. New crafts, including the smelting of copper and the manufacture of bronze and later of iron for cutting tools, led to an increasing specialization of labour, a more extensive system of exchange and an increase in the scale and centralization of society. This gave rise to a succession of city-states and later of empires from about 3000 B.C. in various parts of the wide region from the Nile to the Indus. Deriving their food supplies from plow cultivation, and equipped with increasingly specialized artisan-made tools, utensils and ornaments, they developed complex systems of exchange and written records under systems of centralized government. Some of the crafts of these urban civilizations of the ancient east were progressively introduced to the surrounding Neolithic peoples, whose cultures were thereby elaborated and specialized in various ways. On these foundations, the classical civilizations of the Mediterranean were later developed, while the influence of the ancient east was probably a crucial stimulus in eastern Asia.

In tropical Africa archaeological research is in its infancy and the ethnographic record is very incomplete. It appears unlikely that the early Neolithic complex of the ancient east was able to breach the Sahara toward the west and there is so far no evidence of an early Bronze Age phase there. However, in the Ethiopian highland zone millet cultivation with the rearing of small stock and later of cattle, all probably derived from the north, appear to have afforded an early basis for sedentary and expanding populations. Together with ironworking, these occupations later expanded westward and southward over the tropical grasslands. South Asiatic root and fruit crops were also introduced and may have afforded the initial basis for cultivation and sedentary life in the forest zone.

Although Australia had been colonized much earlier by hunting peoples with Paleolithic equipment, the outer archipelagoes of Oceania, in Micronesia and Polynesia, may not have been effectively colonized by man much before the beginning of the Christian era, when there developed a complex series of movements by sea which appear to have originated from culturally advanced peoples of Indonesia. Subsequent and diverse but sporadic contacts between Polynesia and the new world remain a possibility.

Man first reached the new world late in geological time. Paleogeographical conditions suggest that any early route of entry was through the region of the Bering strait. But both the antiquity and the number of such movements into the western hemisphere now appear likely to be greater than was formerly thought. In the second quarter of the 20th century, evidence of the widespread existence of man in the new world as early as the late Pleistocene era accumulated. These earlier groups were hunters using chipped-stone spear points. They probably used the spear thrower but were ignorant of the bow. Much later, from some time after *c.* 5000 B.C., a considerable range of new equipment spread widely in North America and by its character and distribution suggests further migrations from northern Eurasia. On these foundations more complex cultures developed later in Middle America between central Mexico and Peru. Sedentary life in small agricultural communities appears to have become widespread well before 1000 B.C. and was based nearly everywhere on the cultivation of primitive forms of maize, beans and cotton, to which many other plants were added later in different areas. Pottery also soon became general. Although there are many uncertainties as to the location and character of successive cultural advances, this wide Middle American region is generally accepted as a single cultural continuum within which, by processes of diffusion and of adaptation of discoveries and crafts, a Neolithic village economy of basically similar type was established. It would appear, however, that transmissions over wide areas were largely confined to knowledge of basic techniques and materials, for styles and emphases varied widely in different regions, providing the foundations for distinctive later developments whereby, more than 2,000 years later than in the old world, several complex civilizations were gradually built up after 1000 B.C., with their main centres in central and southern Mexico and in western Peru.

There are no clear indications of cultural connections with the old world in the earlier development of the older Middle American agricultural peoples, but the question of cultural effects of sporadic transmissions from Asia across the Pacific in the later phases is still an open one. It is claimed that certain elements of art style and ceremonial in the late Maya resemble contemporary southeast Asiatic forms, while there is also evidence to suggest that food plants spread west across the Pacific from the new world in pre-Columbian times. On the other hand, the significant and widespread effects of the diffusion of crafts and other cultural elements from Middle America over surrounding regions within the new world is undisputed.

Thus in both the old world and the new, a succession of discoveries, inventions and adaptations to new conditions made in different centres through the millennia and diffused to other peoples over wide areas gave human populations a progressively greater control over natural resources and resulted both in a growing complexity of cultural apparatus and an increasing scale and differentiation of social organization. Despite the setbacks or stagnation of some peoples there were always centres of development, and the cultures of the multiplying human societies were continually diversifying. The archaeological record thus confirms the 19th-century hypothesis that savagery (food-gathering), barbarism (nonliterate primitive cultivators) and civilization (literate societies organized in states with specialized occupations and class structure) have been consecutive phases in the history of mankind, but it equally refutes any idea that there has been an inevitable tendency for all peoples to pass autonomously and successively through such stages. The growth of human culture has clearly been an immensely complex process of discovery, innovation, diffusion and adaptation. (*See* also ARCHAEOLOGY; GEOCHRONOLOGY.)

5. Analysis of Culture and Society.—Parallel with the advances in ethnology and prehistoric archaeology, a distinct field of interest in anthropology has been greatly developed. This has stemmed from the desire to reach by more intensive and systematic

study, and as part of the general scientific study of the nature of culture and society, a clearer grasp of the inner workings of nonwestern societies and of the *raison d'être* of their customs and institutions. This could not be attained from the study and comparison of outer forms and led to a functional analysis of sociocultural systems as viable entities. A few fortunately situated and gifted observers had already made intensive studies of the lives of some primitive peoples, not in order to provide data for ethnologists or to illustrate evolutionary schemes, but with the object of discovering the internal processes and conditions and the inherent values which sustained and mutually adjusted the different aspects of their way of life. Robert H. Codrington's *The Melanesians,* Frank H. Cushing's *Zuni Breadstuffs* and Henri P. Junod's *Life of a South African Tribe* are early classics of this kind. The theoretical aspects of such an approach had hitherto received but little attention within anthropology itself mainly on account of the evolutionary or historical preoccupations of ethnologists. But within the framework of evolutionary anthropology there had been considerable achievement in analyzing and classifying the forms of primitive social organization. After J. J. Bachofen and Sir Henry Maine, whose main work was published in the 1860s, the great American pioneer Lewis H. Morgan, in his *Systems of Consanguinity* (1871), laid the foundation for a scientific analysis of kinship systems. Fifty years later, R. H. Lowie, in his *Primitive Society,* published a masterly critique of older theories which also surveyed and classified in the light of more recent ethnographic knowledge the whole range of primitive social groupings and the conditions which gave rise to them.

Meanwhile, in considering theoretical problems concerning the structure and function of human societies, a number of sociologists, notably Max Weber, Georg Simmel, Emile Durkheim and Marcel Mauss, had turned to the ethnographic literature on primitive peoples for material. Under their influence the application of such a functional approach to the study of primitive people was developed in England by W. H. Rivers, A. R. Radcliffe-Brown and B. Malinowski. But they stressed a new and essential point of method, namely, that the field study and the theoretical analysis of the ethnographic material should be carried out by the same investigator, who should go into the field not to record his findings according to a more or less routine schedule for the use of others but to investigate at first hand the living situation among a particular people and elucidate particular problems concerning the nature of culture and social organization. A. R. Radcliffe-Brown in his first studies on the Andaman Islanders (1906–08) analyzed the interrelations between their ecology, social organization, religious practices and symbolism. The Melanesian field work of B. Malinowski (1914–18) provided the basis for a detailed demonstration of the intricate interdependence of cultural norms and for an analysis of the social processes whereby patterns of customary activity were maintained and restored among the Trobriand Islanders. These studies laid the foundations of what is generally known as functional anthropology, which, while it has considerably developed its range of theoretical interests, has continued to stress the importance of intensive and comprehensive field work as the chief means of formulating and testing hypotheses concerning cultural and social processes and the roles of institutions. While Malinowski himself devoted his main attention to the ways in which the cultural system integrated the activities of a people and molded the outlook of the individual, providing for and co-ordinating the wide range of human needs which he traced back to their biological and psychological foundations, later work under Radcliffe-Brown's influence was more sociological in the sense that it sought to analyze various sectors of the complex system of social relations and compare them over a wide range of societies. It examined the functions and interrelations of institutions, constructed models of social structure and, through the comparative study of these structural features in different societies, sought to show both the interdependence of their elements and the conditions sustaining them. As was shown in later studies, such as those of R. Firth and E. E. Evans-Pritchard, the close observation of social relations in the field afforded a more adequate basis for the analysis of economic processes, social control and ritual activities and belief.

In the course of these developments new methods of field investigation have been elaborated and systematized to provide the data required for tackling these problems, which are concerned only initially with the externals of any cultural feature, be it a technical operation or a complex institution, and are mainly directed toward an analysis of its role in the sociocultural system of which it forms a part. While the study and description of cultural forms is always essential and may suffice to establish the occurrence of technical and stylistic changes and connections between patterns in different cultures, a functional approach of this kind is indispensable in attempting to isolate and analyze the processes involved in the integration and internal development of cultures and social systems. It has, in turn, raised many problems of theory and method which have loomed large in anthropological discussions, for the concept of function has itself been given various connotations. While Malinowski conceived it primarily in terms of the needs and motivations of the individual members of society by whom modes of satisfaction were elaborated in cultural terms, Radcliffe-Brown insisted on a more strictly sociological connotation directed toward the analysis of social structure and the function of institutions and beliefs as contributing to the maintenance of a given social system. While the approach in particular studies has often varied according to the material or the special problems in hand, and both motivational and structural analyses have sometimes been combined, the distinction in the two trends has been marked. The former has predominated in the United States, while structural studies of systems of ideas and social organization have predominated in the researches of British social anthropologists. (*See* also SOCIAL ANTHROPOLOGY.)

6. Cultural and Social Typologies.—The need for comparative study of functional relations, in order to define recurrent social and, as evidenced in the work of J. Steward and R. Redfield, cultural types and the conditions on which they depend, has also received growing recognition. Although systematic work is only beginning in this field, it has long been apparent that there are significant functional homologies between diverse societies which are manifested not so much in concrete cultural forms of behaviour as in more abstract qualities such as levels of material productivity and social aggregation, degrees and patterns of occupational specialization and of horizontal and vertical social differentiation. Typologies of this kind have long been recognized in the implicit classifications of types of social organization such as those distinguishing kin-based from various types of state systems, recognizing among the former such recurrent subtypes as the localized bilateral band, the polysegmentary lineage system and, among the latter, feudal and bureaucratically centralized varieties. Further comparative study promises to yield not only a more precise formulation of types but a more exact knowledge of the ecological, technical and demographic conditions to which they are related. Such typological studies are necessarily based on selected and abstract features. They seek to determine not the genetic and historical relations between peoples or cultures but the ways in which features common to certain societies are functionally related, through regular psychocultural processes, to particular kinds of external conditions and the nature of the cultural adaptation that is demonstrated by the recurrence of particular types in diverse places and periods.

7. Culture and Personality.—Theoretical interests in American anthropology, following up the early leads of A. L. Kroeber, C. Wissler and E. Sapir, included the pursuit of more comprehensive and explicit analyses of cultural phenomena and the study of the relations between different aspects of culture. This has led to a concern with the ways in which the personality and outlook of the individual are modified by the cultural system.

This approach, which first became widely known through Ruth Benedict's *Patterns of Culture* (1934), has been developed in scope and refined in technique in the works of Margaret Mead, Irving Hallowell, Clyde Kluckhohn and others, which have led to a fusion of interests between anthropologists and personality psychologists. Primitive peoples, distinctive and diverse in their

ways of life and comparatively isolated from the western world, not only show marked variations in their predominant patterns of emotional expression but have also afforded smaller-scale and more homogeneous units for the study of the cultural aspects of such problems as compared with those available in western societies. Anthropologists have accordingly sought by systematic field observation to discover the underlying and pervasive attitudes characteristic of particular peoples and to analyze the ways and conditions in which these differ. This has involved attempts to devise more objective criteria for defining the differences in temperament that have long been recognized by ethnographers, historians and others at the common-sense level. Besides directing attention to hitherto neglected cultural minutiae and so to formulating more precisely the "covert culture," it has led to the adaptation for anthropological use of projective tests devised by psychologists to reveal traits of personality; and also to a detailed examination of modes and emphases in child training among different peoples in connection with psychological hypotheses concerning the profound effects of the cultural setting and human relations in infancy on the adult personality. These approaches all derive from the view that the members of any persisting group of people will not only exhibit distinctive cultural features but will also manifest certain predominant traits of personality. The nexus between these is sought in the fact that the integration of experience by the individual and the maintenance and transmission of a cultural pattern involve the same psychological mechanisms whereby particular forms of apprehension and behaviour acquire an emotional and symbolic significance as part of a meaningful world of experience.

This approach has directed the attention of anthropologists to the symbolic meanings and emotional significance of cultural features hitherto only formally described and, on the other hand, has led psychologists to recognize the existence of an inevitable cultural component which, equally with biological endowment, immediate stimuli and neurological mechanisms, affects all processes of perception, motivation and learning. A human being, therefore, always perceives, feels, thinks and acts as a person sharing culturally derived characteristics with his group.

8. Culture and Society.—The distinction between cultural and sociological analysis, which is important in connection with these more recent developments, is one on which there has been much confusion. Both these terms have been taken from common speech and are often loosely used, but the distinction between their central meanings corresponds closely to significant differences of objective in much anthropological work, and there is an advantage to be gained from stricter usage. The term culture refers to the standardized patterns of activity and belief that are learned and manifested by people in their collective life. It includes categories as diverse and various in form and in range of significance as speech, craftsmanship, games, rituals, empirical knowledge and metaphysical beliefs. It consists essentially of certain kinds of regularity which are abstracted by the observer from the continuous flow of human activity, and from which he can infer a range of recurrent emotional attitudes or established values. Such cultural patterning is, of course, universally recognized. The anthropologist differs from the layman only in more fully appreciating the fact that this recognition involves abstraction and conceptualization, and in consciously attempting to formulate and analyze such patterns systematically in order to study their interrelations and implications. Among any given people the number and variety of cultural features that may be isolated for consideration are indefinitely great. It is, indeed, because the data and the corresponding problems are so diverse, ranging as they may from concern with the technical aspects of a productive activity or the formal analysis of an art style to the study of ideas implicit in actions and statements concerning religious belief or moral judgment, that anthropological studies of different aspects or fields of culture are so diverse and link up with problems in so many other recognized fields of knowledge. The kinds of inquiry that can be made about such patterns are, accordingly, quite various. Cultural features may be studied in sequence to determine changes through time in one or more continuing populations. They may, on the other hand, be isolated in order to discover the degree of interdependence among them and between them and selected extracultural conditions.

Sociological analysis, on the other hand, is essentially concerned, not with cultural forms, but with relations between categories of persons and the structure of the groupings they form. It operates with concepts such as social status, dominance and subordination, opposition and solidarity as applied to persons and groups. These concepts are also derived from the observation of a multitude of recurrent items of behaviour between individuals, certain aspects of which can be summarized in terms of such kinds of relationship. Thus the formulation of social relations is derived from observation of the same concrete collective activities in human populations as are cultural patterns, but they are abstracted in a different frame of reference. Since categories of social relations are often abstracted from certain recurrent patterns of behaviour they can be regarded as derived from, and more abstract than, cultural patterns. Furthermore, for their analysis attention is restricted to particular kinds of cultural patterns and to limited aspects of these, namely, those from which the relations between persons in a social system can be derived.

9. Science and History in Anthropology.—These various attempts to isolate and analyze the different factors underlying any given cultural or social feature and its changes through time have sustained critical interest in the problem of universal processes which, in differing combinations in particular situations, might account for the distinctive features of actual sociocultural patterns and for the differences among them. The variety of human cultures recorded by ethnography provides a laboratory in which, through the analysis of differing forms with their varying functions and contexts, such processes can, at least in part, be isolated by comparative study. This is the more strictly scientific or analytic approach in anthropology. It seeks to abstract from a given range of phenomena certain properties or attributes between which definite relations can be discovered. It does not seek to account in any one analysis for all the features of any concrete sociocultural situation or development. Selected properties are isolated for study in relation to others that may thus be found to be the preconditions of the first, or functionally interdependent with them.

At the same time, the direct and comprehensive interest in the concrete human situation, whether it concerns a general pattern of culture, a mode of social organization, particular forms of belief and ritual practice or techniques whereby artifacts are produced and employed, leads to explanation through integrated description or historical interpretation. Particular configurations are appraised and interpreted with regard to their contexts and antecedents. But integrated descriptions, which are the stuff of history, are themselves dependent on analytical hypotheses, for no explanatory account of how things have come to be as they are among a given people is possible without postulating more general properties and regularities with regard to human culture or social life. Thus, descriptive studies, whether they are what are commonly regarded as historical, tracing particular cultural and social developments over a considerable period of time, or whether they are ethnographic descriptions of very limited time depth, and, whether the range of activities and relations considered is wide, or is confined to the portrayal of a particular institution, always depend for the interpretation of the particular forms and their interconnections on the application of general principles posited as underlying the sociocultural behaviour of man. In this sense historical or descriptive studies are a species of applied science; for, just as the various branches of engineering depend on the postulated uniformities of the physical sciences, or as modern medicine depends for diagnosis and therapy on the application of biological concepts and principles, so the analysis and interpretation of particular cultural situations presuppose principles concerning human behaviour. The concepts and theories employed may be vaguely formulated; they may not be explicitly stated. Their verification may be weak and some may be shown to be irrelevant or fallacious. But conceptually they are of the same kind as the hypotheses and theories of natural science, for

a scientific theory is the most satisfactory hypothesis available at a given time, in respect of verification and comprehensiveness, concerning the properties of a certain range of phenomena and their interrelations.

The reasons why hypotheses concerning processes in human society differ in degree of explicitness, precision and verification from the theories of physical science, and are correspondingly more limited in their analytic and predictive value, are not far to seek. For in passing from the inorganic to the organic, and from the organic to the cultural field, the complexity and variability of the phenomena, *i.e.*, the number of variables involved in determining their properties, multiply progressively. So, too, do the difficulties of achieving systematic observation in requisite varieties of circumstance. Where, as in the study of the collective activities of man, the range and relative independence of the variables that determine any section of the pattern are so great, it is not surprising that hypotheses are, as compared with those in physical science, difficult to formulate, verify and apply. They are nevertheless of crucial importance. For every people has its own hypotheses as to various processes controlling its cultural activities and its social relations. Everywhere these beliefs are employed in explanation of the events that befall a people and in its judgments regarding the practical courses it should pursue. Hypotheses are also extended to other peoples, past and present. That such beliefs can often be shown to be inadequate or fallacious only serves to underline the fact that the particular cultural and social conditions in which men find themselves will be interpreted, and indeed can only have meaning, in terms of theories of culture and of society. From this follows the paramount importance of applying to sociocultural phenomena the inductive analysis and the critical testing of hypotheses which are the canons of science. In attempting such analyses anthropology has emphasized the need to consider particular problems within a framework that embraces the human species as a whole. Whether concerning the elaboration of particular crafts, the character of an art style, the pattern of economic or political organization or the foundations of religious beliefs and practices, the anthropologist eschews hypotheses of special creation.

10. Human Ecology.—Beyond the analysis and comparison of cultural patterns or social systems themselves there lies a further range of problems concerning the relations of such patterns to external conditions. The recognition of culture as, in significant measure, an instrumental apparatus for the satisfaction of psychobiological drives in man accounts for the universality of several broad categories from which any given culture can be viewed, such as the technical, economic, political or magico-religious, and for the common attributes of any social system in providing means of training, control and replacement of its personnel in various social roles. But the great variability in the content and context of this instrumentality remains a major problem of the student of culture and society and points to the need for closer analysis of the wide range of external conditions in which the cultural and social adjustments of any community are made. The physiological and psychological qualities of individuals, and thus of the groups they comprise, are variable; hence special characteristics in this field may prove to be significant determinants. The understanding of the significance for culture of physiological and psychological processes and of their variable incidence is obviously dependent on the advances made in these sciences by their own methods. This is but another instance of the familiar interdependence between different fields of science whereby one branch employs concepts and inferences whose validity depends on findings in other fields. The pervasive influence of the habitat and of past and present relations with other communities on the way of life, social institutions and outlook of any people has also long been recognized and often effectively presented in descriptive accounts. Although the subcultural or biopsychological foundations from which any cultural pattern must develop may account for certain universal qualities or categories, in the sociocultural field differences in habitat, resources and relations with other groups continually tend to produce great variety in the development of cultural patterns and social relations. Any explanation of cultural variation and of specific cultural and social features must, therefore, include an ecological approach in which these are comprehensively related to the biological and demographic character of the particular population, to the available material resources, to the techniques commanded and to the connections with other groups.

Cultural adaptation and social change are, however, profoundly affected by the inertia of the previously existing pattern. For the various elements of any cultural system inevitably acquire a symbolic value over and above their more direct instrumental significance. Emotional satisfactions and recognitions of social status become attached to them in such a way that the possibilities of modification and innovation are restricted and channeled by the already existing configuration. Thus the adaptive processes may be slowed down and biased and there may be not only a marked discrepancy between potentiality and achievement in any cultural sphere but also discordance between one part of the field and another under conditions of cultural change. Such maladjustment or discrepancy is equally apparent at the social level and has been the subject of close study in connection with the effects of the impact of western civilization on primitive societies. (See *Applied Anthropology*, below.)

An ecological approach of this kind views the biological, environmental, demographic and technical conditions of the life of any people and its previous patterning as an interrelated series of determinants of form and function in human cultures and social systems. It recognizes that a pattern of group behaviour is dependent for its maintenance upon the persistence of a specific range of resources and associated skills and upon a body of emotionally charged beliefs; these together give rise to a system of social relations that can be analyzed as a series of social structures. All of these are implemented by learning, or enculturation, on the part of the many human beings who participate in the sociocultural system and so maintain it. As such a system is at the same time a field for the release of human energies—the level of which is likely to be significantly dependent on biological factors—"racial," nutritional and immunity differences among peoples are likely to feature among the ultimate determinants of cultural and social differentiation. Human ecology, therefore, deals with a very complex series of interconnected systems in which the resultants in one are partial determinants in the others. As in the physical sciences, therefore, knowledge of relations and intensities in one system is needed to provide data for analysis and interpretation in others. Although the anthropologist, in investigating a particular problem or constructing a model of any one system, may neglect the many variables arising from others, it is in the recognition of this wide field of interdependence and of the need to integrate them in the final analysis that the outlook of anthropology, as distinct from that of any of the more limited approaches to human behaviour, essentially consists. (*See* also Ecology.)

11. Cultural and Social Evolution.—Although the common 19th-century misconception of a unilineal and progressive development of all human societies has long been discredited, the validity of the basic concepts of evolution has been confirmed. The cultures and social systems of mankind have shown the same general trend toward increasing complexity and differentiation through time as that found in organic evolution. There are accordingly many analogies with organic evolution in cultural development. Cultural innovation as one emergent manifestation of the most elaborate life form shows the same propensities found in life itself for the development of new forms and functions, for the radiation of forms that are more successfully adjusted to a given range of environment and for the reduction or extinction of other forms with which these compete successfully. But the processes involved differ basically from those in organic evolution, for they are psychological and not genetic, the units of modification are social groups and not individual organisms, and they include processes of assimilation which are not matched at the organic level. For whereas organic evolution depends on the transmission, perpetuation and recombination of new biological features or mutations through the processes of reproduction, cultural mutations

arise from the inventiveness of socially stimulated individuals and are established by precept and learning. If a cultural innovation is accepted in a population, the new patterns of activity and thought can be transmitted to all appropriate members of the succeeding generation and will furthermore not be restricted to that population but can be extended by diffusion to all the other receptive populations in contact with it. Cultural entities again appear to be more complex and fluid than genetic ones; the patterns of behaviour and mentality in which they are manifest can be subtly modified in the process of transmission and incorporation into a wider cultural system. Thus cultural and social evolution can proceed much more rapidly to produce a wide range of variations and, on the other hand, a successful cultural pattern can radiate much faster than a biological species. The result, moreover, is to produce not new species composed of many members closely resembling one another, but a new source of diversity in the many communities that come under the influence of a radiating diffusion. (D. F.)

12. Linguistics in Anthropology.—Although European linguistics developed from earlier philological studies, American linguistics began primarily as an anthropological discipline and has developed in close conjunction with ethnology, the science of culture. Nearly all of the early students of anthropology in the United States engaged in linguistic studies and regarded these as essential to a thorough knowledge of culture.

American linguists paid especial attention to the languages of the American Indians. In this field the major problem was to find a way to describe accurately a large number of highly diverse languages which had neither a written literature nor a documented history. Under the leadership of Franz Boas, American anthropological linguists concentrated on descriptive rather than historical studies. Their aim was to analyze and describe languages, not in terms of their historical antecedents (which were unknown) or in terms of traditional grammatical categories (which were inapplicable), but solely in terms of the structural and semantic categories evidenced in the languages under study. Such research required more than simply linguistic analysis; the Americanist also needed a sound knowledge of the culture to which the language belonged.

As a result there developed an interest in the relations between language and culture and in the role that language might play in the habitual behaviour and thought of its speakers. Boas (in 1911) suggested that linguistic inquiry is necessary to a thorough investigation of the psychology of the peoples of the world and especially important to an understanding of fundamental ethnic ideas. Edward Sapir, in 1916, investigated the contributions made by historical linguistics to the reconstruction of cultural history. But Sapir went further when he proposed (1931) that a thorough description of a linguistic structure and the ways in which it functioned in speech might throw considerable light on the perceptive and cognitive faculties of men and help in understanding the wide diversity in behaviour among peoples of different cultural backgrounds. Anthropological linguistics, as contrasted with linguistics per se, became concerned not only with the scientific study of language but also with language as an important influence in the molding of cultures and in the orientation of human thinking.

One of Sapir's students, Benjamin L. Whorf, took up this problem in a series of brilliant essays written from 1939 to 1941. This work, cut short by Whorf's death, led to further investigation of a problem which turned out to be bristling with complex and difficult questions. Some of these centre about the role of language in its cultural matrix. How do the patterns of a language (grammatical and semantic) relate to other cultural patterns? Does language exert a shaping influence on culture, and vice versa? The study of these problems (often called ethnolinguistics) has only begun, and much research is needed even to determine whether or not the questions raised are genuinely valid.

A second set of questions relates to the influence exerted by language on perception, cognition and thought. Here the terrain is less well explored, even though the problems have long been studied by linguists, psychologists, philosophers and others (*see* especially the work of the Neo-Humboldtians). A review of these problems in 1959 came to the conclusion that an understanding of the systemic conception of language presented by linguistic science was essential to the solution of many important problems of psychology. The language a people speak may well influence their thinking, but the problem of determining the precise nature of this influence remained to be solved. *See* also LINGUISTICS.

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II. PHYSICAL ANTHROPOLOGY

Physical anthropology is that branch of natural science which is concerned with the origin and evolution of man. Both the course which human evolution has taken and the causes or processes which have brought it about are of equal concern. In order to interpret the diversity within races and between races it has been necessary to search for the meaning of these differences by including as objects of study past races of fossil man as well as the nonhuman primates: anthropoid apes, monkeys, tarsiers and lemurs. Much light has been thrown upon man's relation to other primates and upon the nature of the transformation of his skeleton in the course of evolution from early man to modern man, a span of at least 500,000 years. Discovery of the South African man apes, the first in 1924, and of a similar form (*Zinjanthropus boisei*) in east Africa in 1959, has revealed unanticipated data concerning the diverse combinations of traits which can coexist and the singularly illuminating fact that erect posture preceded the great expansion of the brain in human evolution.

Many of the processes responsible for the differentiation of man into different races, although he still remained a single species, *Homo sapiens*, are known: selection, genetic drift, migration and mutation. Objective methods of isolating various kinds of traits and dealing mathematically with their frequencies, as well as their functional or phylogenetic significance, make it possible to understand the composition of human populations and to formulate hypotheses concerning their future. The resulting information accumulated by physical anthropologists makes available facts about the groups inhabiting the world as well as the individuals composing these groups. Thus, it is possible for a person to learn about his own genetic constitution with reference to traits ranging from blood types to the fissural patterns of his molar teeth and to know the frequency and distribution of these traits in the various races about the world. He is also able to secure some estimate of the probability with which his children will inherit these features.

Insight into the field of physical anthropology may be obtained by reviewing the general fields of investigation in which particular researchers are actively engaged.

1. The relationship of the human organism to its environment, or human ecology, is a bridge between the biological and social sciences. Problems of population, size and stability are important in many ways. A very immediate aspect is the varying rate of change which may occur in populations of different sizes. Theoretically, a small population is more susceptible to chance fluctuations than a large one. Both the natural environment and the economy of a particular society affect the population size. (*See* ECOLOGY: *Interactions of Populations.*)

2. Human evolution is another area which serves as a focus for research. The essential problems are not only the complete description of fossil forms but the evaluation of the significance of particular traits. Old concepts of orthogenesis, or evolution in a straight line, have had to be abandoned, and radiant and parallel evolution have come to the fore. It is clear that the course of human evolution may swing about so that what were formerly considered relatively modern forms may actually precede morphologically earlier ones, as in the case of the more modern

kind of Neanderthal man who apparently preceded the more primitive or early form. Fossil man of considerable antiquity has been found in Europe, Asia and Africa. No area in the world is without skeletal remains, so that researchers may everywhere engage in skeletal studies. (*See* MAN, EVOLUTION OF.)

3. Primatology is an area in which man's place in nature is no longer the major point of focus. Researchers are concerned with experimental, medical and ecological aspects of primates and it is from these studies that much of the functional significance of various bone and muscle complexes has been derived. The different kinds of adaptations which groups of monkeys have made to life in the trees or to life on the ground have had many consequences in the proportions of their limbs or in the elaboration of various groups of muscles. Similarly, the mode of progression through trees by the use of the arms, known as brachiation, is accompanied by the elongation of the arms, reduced size of the thumb and many other structural arrangements in the anthropoid apes. Thus the primates provide a natural laboratory of many kinds of experiments in physical adaptation to fundamentally different ways of life or adaptive zones. (*See* PRIMATES.)

4. Genetics is a fourth major area of research. The study of inherited traits in individuals and the behaviour of the genes responsible for these traits in populations is essential to understanding human variability. Although the blood groups have provided the bulk of the data, many other traits are being analyzed and theories of their inheritance tested. As a result of research in this area it is possible to describe races in terms of gene frequencies and to calculate amounts of race mixture. (*See* GENETICS OF POPULATIONS.)

5. Growth studies, both of humans and other primates, engage the attention of many physical anthropologists in medical and dental schools as well as in independent clinics and universities. Methods of assessing rates of growth, skeletal age compared with chronological age and the genetic, endocrinological and nutritional factors are some of the aspects involved in these studies. The relation between growth and socioeconomic status and other cultural features receives considerable attention. Dentitions have been frequently studied, often because the emergence of the teeth is of great practical importance and serves as an index of development. As a result of research in this area it is possible to describe races in terms of gene frequencies and to calculate amounts of race mixture.

6. Measurement or anthropometry (*q.v.*) has been a mainstay of anthropological research for well over a century. More attention is being given to the judicious selection of measurements than to the simple techniques with which calipers are handled. Many traditional measurements cannot be analyzed and the addition of multivariate statistics does not make them any more intelligible. Statistical considerations are especially important in genetic and anthropometric research, and part of the history of statistics is identical with the history of the development of these two research interests. Quite certainly the end results of growth can only be studied by measurement. Newer growth studies have followed children through their morphological and biochemical changes with the aim of discerning why children grow.

7. Many of the applications of physical anthropology lie in the field of measurement. Thus, the problems involved in providing military and civilian clothing for large numbers of people depend on measurement and statistical treatment. Substantial savings have been made possible by measuring the people of a particular area and adjusting the clothing tariffs to these known distributions of body sizes. There is sufficient variation within most countries so that the geographical variations in size of the body and intermembral proportions are of practical importance. Human constitution is another area of research interest. Several descriptive systems exist for classifying persons who vary from a lateral or relatively squat body build through a relatively muscular to a linear body build. The components of body build, the different tissues and dimensions, were being studied in the early 1960s by means of factor analysis and comparisons of siblings and twins, and their actual mode of inheritance and response to environmental conditions were slowly being specified. The various areas of interest referred to above are, of course, not mutually exclusive; ideally they should all form part of the training of researchers in the origin and evolution of man. (*See also* GROWTH.)

A. IDENTIFICATION OF SKELETAL REMAINS

Law enforcement agencies frequently call upon physical anthropologists to identify skeletal remains. A summary of the kinds of information which may be derived from a skeleton, and the method by which they are secured, provides an index of the usefulness of skeletons. Under optimum conditions, seven categories of information may be derived from the examination of a complete skeleton, or one which is at least represented by the skull and mandible, the two hipbones, and some long bones such as those of the thigh and upper arm. With varying degrees of precision estimates may be made of the sex, age, stature, race, bone diseases, individual structural peculiarities, such as right- or left-handedness, and the major blood type, O, A, B or AB. These determinations are based upon measurements and observations of the morphological characters. The 20 or 30 measurements commonly used indicate the absolute size of the various portions of the skull and other bones. Indices expressing the proportion of one diameter to another may be derived from these. The cranial index, the proportion of the breadth of the head expressed as a percentage of the length, is often useful when distinguishing Negro crania, which are often relatively narrow and long, from American Indian crania which, in many groups, are broader. Morphological observations may be made of a great number of characters, though about 30 are usually adequate for most purposes. These observations are of two kinds: (1) form or conformation (*e.g.*, the foreheads of Negro crania are often bulbous whereas the foreheads of Australian aborigines are more often flatter and more sloping); (2) the presence or absence of discrete traits or configurations (*e.g.*, the upper front teeth of Mongoloids often have a depression on the posterior or lingual surface, known as "shoveling," and the first lower molars of Eskimo crania most often have five cusps). Combinations of traits based on size, proportion, presence or absence of particular items, are distinctive of different populations, and thus an individual skeleton may be classified as a member of a particular group. Age of the individual skeleton is estimated primarily from five principal characteristics: (1) appearance of epiphyseal centres; (2) formation and emergence of deciduous, then permanent teeth; (3) union of the end of the long bones with their shafts, many of which unite between ages 13 and 19; (4) changes in the surface conformation and texture of the faces of the pubic symphysis; (5) closure and obliteration of the cranial sutures separating the bones, many of which gradually unite between the ages of 21 and 65.

It should be kept clearly in mind that identification of a single skeleton is an application of the data concerning combinations of characters which are secured from many other studies of a large series of skeletons from known populations. In the sense that each specimen is unique, this application of research does not contribute to generalization. In the same way, a single specimen of fossil man is of limited utility in constructing a body of knowledge about a population. The fact fundamental to the identification of a single skeleton or the attempt to place a single fossil find in its relation to other fossil men is that a single individual is not a race. A race is a population and is always variable in its physical characteristics. Some skeletons may be more easily identified with reference to the population from which they were drawn owing in part to the fact that the population is relatively homogeneous, the range of variability is known for that population and the population is relatively distinct from others. The eastern or arctic Eskimo skull is comparatively easy to recognize because it is characterized by a high frequency of nine or ten traits: (1) the skull is relatively long and narrow; (2) a ridgelike elevation extends along the top from front to back; (3) there is a marked protuberance of the occipital or rear portion of the skull; (4) the face is extremely broad; (5) cheekbones are prominent and form a sharp angle at the turn from the face to the side of the skull; (6) the nasal bones are narrow; (7)

the tympanic plate is often thick; (8) a dehiscence or aperture may be present; (9) the mandible, which is large, often has a torus or bony reinforcement on the inside; and (10) a bony ridge may also occur on the palate. Combinations of sorting criteria such as these are assembled for each skeletal population and they enable the anthropologist to estimate the likelihood that an individual specimen belongs to such a population. In many groups there is so much overlap that an individual cannot be assigned to one or the other. Thus, there are some American Indian crania which resemble those of Australian aborigines on the basis of the sorting criteria commonly employed, and this similarity has given rise to fallacious theories of Australoid migrations to the new world.

The major blood type of the skeleton may be determined because blood group substance is present in several tissues and fluids of the body, including the spongy tissue found inside the vertebrae and the heads of the long bones. This group substance is also situated on the red blood cells and responds to the typing serum containing the antibodies by agglutinating or clumping the red cells together. Although it is not possible to agglutinate the bone cells, an absorption technique can be employed which will indicate the presence of the group substance for A or B in the bone by reducing the titre of the serum specific to it when the two are placed together in a test tube. The group substance may be extracted from the bone and tested separately. This technique might prove to have great future significance in that it makes possible the tracing of the genetic composition of various skeletal races back in time, since the group substance is very stable and resistant to alteration.

Another kind of test which may be applied to skeletal material is that of the fluorine-dating method. This is a chemical test which measures the amount of fluorine present in the specimen. This amount may then be checked with that found in other bones from the same deposits and their contemporaneity established. In addition, the relative amount of fluorine varies with geological antiquity, though it must always be related to the amounts found in specimens from a particular site. Thus it is possible to secure a reliable estimate of the antiquity of skeletons. This method enabled the British museum to announce in 1953 the relatively recent age of the Piltdown skull and to demonstrate that the mandible associated with it, an object of much dispute because of its simian appearance, did not belong with the skull.

B. Old and New Concepts in Physical Anthropology

1. Early Investigations.—Inasmuch as the history of physical anthropology is, in large part, a history of man's attempt to determine his place in nature, to compare himself with other primates and to interpret the physical differences, more is to be gained from examining the kinds of problems which have been studied and the nature of the evidence that has been used than from reviewing the succession of great names. Twentieth-century familiarity with primates tends to obscure the fact that the precise distinction between man and the apes, based on evidence secured from actual dissection, had not been made before 1699. At that time Edward Tyson published the comparative anatomy of a chimpanzee and correctly deduced that the chimpanzee was not a human being. Succeeding Tyson is a distinguished series of men who launched into the formidable task of describing and classifying human beings as well as the other primates. Georges L. Buffon, Immanuel Kant, Johann Friedrich Blumenbach, Jean B. Lamarck and Georges Cuvier in the 18th century all made notable contributions. Of these, Blumenbach (1752–1840) is recognized as the father of physical anthropology. Although many early classifications of human races failed to distinguish between physical and cultural characteristics and leaned heavily upon the concept of primordial types with a corresponding minimization of variability, it is noteworthy that Blumenbach as early as 1775 observed that the "innumerable varieties of mankind run into each other by insensible degrees." He also initiated use of the term Caucasian to describe members of the white race, basing the choice of this term upon the race of men of Georgia on the southern slope of the Caucasus mountains who enjoyed a remarkable reputation for beauty. Blumenbach anticipated 20th-century analyses of locomotion in his critical observation that the chimpanzee was essentially quadrupedal in spite of occasionally erect posture, and cited as evidence the receding heel bones and the elongated pelvis.

2. Great Chain of Being and the "Missing Link."—A basic concept that constituted the organizing assumption of primate taxonomy, from its inception to well after the formal appearance of a theory of evolution in 1859, is the idea of the "great chain of being" or the hierarchical arrangement of nature. This great explanatory theory made necessary a correlative concept, that of the famous "missing link." The missing link proved to be of less value to scientists than to P. T. Barnum, who entertained the public with specimens of every conceivable link between groups of animals, including for good measure a mermaid. One useful result of this belief in unilinear gradation was the search for previously unknown forms which would complete man's knowledge of the chain of being. With this inclusive charter, the scientists of western Europe were ordained to take an inventory of nature and to determine the appropriate place of each newly described form. In practice, it of course supplied the theory for understanding not only man's place in nature but that of all other organisms and was extended to cultures as well. In the absence of genetics and a concept of culture, personality traits as well as skin colour were used for classification. The period between Tyson and the later study by Thomas Huxley, *Man's Place in Nature* (1863), is filled with works devoted to the positioning of the anthropoid apes, monkeys and newly discovered "races." While some persons investigated the anthropoids others were impressed with the possibility that various groups of unknown aborigines might be the missing link or links. Thus, the "savage Hottentot" or the "stupid native of Nova Zembla" (Novaya Zemlya) was pressed into service to fill the gap between anthropoid apes and man. Two important misleading research practices came into being in this period and remained in effect long after the formal recognition of a theory of evolution as expressed by Charles Darwin, and even after the development of genetics in the 20th century. First is the habit of ranking existing human races in a hierarchical order, and second, the practice of comparing human races with the contemporary apes for purposes of ranking rather than for functional or behavioural equivalents. That both these practices pose real obstacles to contemporary research may be seen in a statement by S. L. Washburn.

> The practice of comparing individual races directly to the apes should be abandoned. It is usually done with the best intent to show that, although the White is more like the ape in one character, the Negro is in another. But what this practice actually does is to keep alive the idea that it is reasonable and scientifically defensible to compare living men with living apes for the purposes of arranging races in some hierarchical order. What meaning have these comparisons when the races have nearly all their ancestry in common? (S. L. Washburn, "Thinking About Race," Smithsonian *Report*, publication 3833, pp. 371–372 [1945].)

3. Darwin's Theory of Evolution.—Publication of *The Origin of Species* by Charles Darwin in 1859 provided the outstanding theoretical contribution of the 19th century. The essential concept for the evolution of man was that of natural selection, though many more decades were to pass before its implications were either appreciated or employed. Darwin not only showed that evolution took place in the different organisms but he also provided an explanation which was sound in its major outline and which subsequently was given more precise meaning. The idea that nature selects those forms which are better adapted to a particular geographic zone and way of life laid the basis for understanding the adaptive radiations of the primates. Anthropologists were slow to appreciate the implications of adaptation and continued to measure and to observe traits which were felt to be nonadaptive. Linnaean species, the hypothetical prototypes of which individual specimens were copies in varying degrees of perfection, continued to be described. The weight of attention remained on classification rather than on processes of evolution, and research continued to focus on description without a corresponding concern for understanding the functional significance of traits or the role they might play in the adaptation of a species to its ecological zone.

in the morphology of the skull. The discoverers of the first fossil remains were placed in the unenviable position of having to generalize and interpret on the basis of the smallest possible sample before a skeptical if not hostile scientific world.

One of the chance happenings which shaped much subsequent interpretation of fossil man was the discovery of Neanderthal man before the discovery of older forms of man. Neanderthal man became a kind of benchmark from which surveys of other fossil men were sighted. In addition the generally primitive character of Neanderthal man preadapted scientific minds to expect a corresponding uniformity of primitive characters in other finds. Thus, the idea of a modern femur associated with *Pithecanthropus* or of a modern pelvis with an apelike skull appeared incongruous or disharmonic.

In 1924 Raymond Dart discovered a portion of skull and cast of the inside of the skull of an immature apelike individual. The cave deposit from which it was removed was located at Taungs, Cape Province, S.Af. He applied the name *Australopithecus*, or southern ape, and this name is now used to designate the subfamily Australopithecinae into which the several subsequent and related finds are commonly grouped. The australopithecines, usually treated as a genus with two major subgeneric forms, *Australopithecus* and *Paranthropus*, are well known from five sites at three localities. The *Paranthropus* group is larger in body size and occurs somewhat later, possibly persisting into the early Middle Pleistocene period. The other appears to begin as early as the Pleistocene-Pliocene boundary approximately 1,000,000 years ago. Simple stone tools have been found which suggest that the australopithecines were actually tool-making and tool-using animals. Another form similar to *Paranthropus* was found at Olduvai gorge, Tanganyika, Tanzania, in 1959 by L. S. B. Leakey and named *Zinjanthropus boisei*. The massive skull appears to have been well balanced in spite of exceptionally large teeth. A sagittal crest of bone provided additional area for the temporalis muscle. His diet included rodents, birds, snakes and immature large animals. Pebble tools of the Oldowan, pre-Chelles-Acheul, culture are said to testify to his human status.

The combination of characters in these forms demonstrates quite neatly the different inferences which may be drawn depending on the evaluative premises employed. The brain is comparable in size to that of the modern large apes, about 600 c.c., but as their body size is smaller the brains are relatively larger than in contemporary apes. The face protrudes but in many specimens the muscular ridges are not as prominent as in modern apes. The forehead is much more rounded and there is not the continuous bar of bone across the brows. The spinal cord enters the base of the skull at a point further forward than in modern apes. This indicates a better balanced skull, commonly associated with erect posture, though not as well balanced as in modern man. Flat crowns indicate that the teeth were worn down by the rotary movement characteristic of human mastication. The canine teeth, ordinarily large in the great apes, are not as robust in the Australopithecinae. The hipbone is of essentially modern human type and bears clear evidence that these beings stood and walked erect. This combination of characters demonstrates that the evolution of the lower limbs preceded that of the brain. The same precedence of limb development preceding brain expansion has been noted in some Eocene lemurs. The Australopithecinae clearly are well-qualified candidates for the position of human being. If their lagging brain size is emphasized, then they constitute the most manlike apes known. If the bipedal complex, the pelvis, lower limbs, skull structure and dental anatomy are emphasized, then they constitute one of the most apelike forms of man. Special mention should be made of the diversity within this subfamily. *Paranthropus crassidens* presents one of the largest mandibles found and a cranial capacity that may be as much as 980 c.c. It is possible that the final studies will indicate cranial capacities well in excess of those of the apes. If the Australopithecinae are too late to be an ancestral population of modern man, they nevertheless remain models of the kind of adaptive radiation specialized for walking which led to man.

The Australopithecinae illustrate the notable fact that different parts of the body evolved at different rates. These forms had entered a completely different adaptive zone with erect posture. Selective pressure was apparently directed toward the locomotor complex, and the other characters of the body necessarily lagged behind. The idea of a missing link which would be halfway between man and the apes is clearly illusory. Such a generalized ancestor is an unnecessary postulate. Ancestral forms must be specialized for a particular time and place and this means a morphological commitment to a means of locomotion prior to the later elaboration of the brain. (*See* also AUSTRALOPITHECINE.)

2. Java and North China Finds.—The first indubitable remains of man are those of the pithecanthropoid and sinanthropoid groups of Java and north China. Geological evidence places them in the Middle Pleistocene. ***Pithecanthropus erectus***, first discovered by Eugène Dubois in 1891–92, is known from the further finds of G. H. R. von Koenigswald. *Pithecanthropus* possessed a cranial capacity of about 900 c.c. The first, and the succeeding skulls, are characterized by a large, continuous brow ridge, a low vault with sloping forehead, thick bones and a heavy reinforcement system in general. One unusually massive skull, *Pithecanthropus robustus*, skull iv, found in 1939, displays an interesting keel-like ridge running over the top of the skull. As with the others the greatest breadth is at the base of the skull rather than above the level of the ears as in modern man. *Homo modjokertensis*, belonging to the Lower Pleistocene, is a baby *Pithecanthropus*, possibly of the robust type.

The possibility of giant forms preceding *Pithecanthropus* could not be judiciously dealt with until more evidence became available. A massive lower jaw fragment, *Meganthropus palaeojavanicus*, was found by Von Koenigswald. This and the finds of three enormous molar teeth of *Gigantopithecus blacki* and a mandible have been construed as possible giant forms of early man preceding *Pithecanthropus*. A similarity to African australopithecines has also been noted. Additional evidence must be presented before a reliable hypothesis can be constructed.

Of the long list of comparable characters in *Sinanthropus* the most noteworthy is the greater average cranial capacity of 1,04[illegible] c.c. This is a significant advance over *Pithecanthropus*, who average 860 c.c. for three skulls. The total range of both the Javanese and the Chinese capacities is from 775 c.c. in one of the Javanese skulls to 1,300 c.c. in one of the Chinese skulls. This is a high degree of variability and constitutes one of the reminders that fossil men were no less variable than modern men. Considerable prognathism or forward protrusion of the jaws is characteristic of these forms. At the same time, the limb bones indicate that the erect posture and gait of modern man had been achieved though the stature was short. Both these groups can easily be accommodated within one taxonomic category such as *Pithecanthropus*. Two Middle Pleistocene mandibles (*Atlanthropus*) associated with handaxes, from Ternifine, Algeria, may also belong in the *Pithecanthropus* group

The next major collection of human crania in Asia is that of Solo man from Java. The presence of 11 skulls gives a rather fair idea of the range and variability in this group of Upper Pleistocene man. Unfortunately, none of the faces are present and there is evidence that the skull bases have been artificially removed, possibly an evidence of cannibalism. If so, a rather generous meal was provided, for the cranial capacities of these men range from 1,150 to 1,300 c.c. The bony reinforcement system has begun to disintegrate, though the vaults are low with long sloping foreheads. They have the distinction of being among the longest human skulls of either fossil or modern man. Solo man is considered by some as an Asiatic representative of the Neanderthal race of Europe. The Saldanha and Rhodesian skulls of Africa may similarly be considered variants of the Neanderthal race. Another single but clearly ancient skull is that of Mapa, Kwangtung province, south China, found in 1958. It is Middle Pleistocene in age and may help fill the gap between *Sinanthropus* and Solo. Other fossil finds such as those of two large skulls from Wadjak, Java, and the Keilor skull of Australia have been used to construct a lineage for the modern Australian aborigines, leading back through Solo man to *Pithecanthropus*.

3. Neanderthal Man.—The Neanderthal fossil remains fall [illegible] early or progressive. They differ in morphology, [illegible] to the fourth glaciation and has been found in Europe associated [illegible] is characterized by a heavy, bi arched shelf [illegible] low, retreating forehead [illegible] without the hollow area [illegible] man; large orbits; small cheekbones, large palate and teeth, receding chin, and rounded angles where the horizontal body of the jaw meets the vertical body. The cranial capacity is remarkable [illegible] mately 100 c.c. above that of modern man. The skeleton is characterized by robust development except [illegible] curved bones of the leg and [illegible] ones of modern man; a round barrel chest; large hands and feet; large condyles at the ends of the long bones; long [illegible] vertebrae to [illegible]

In contrast to this classic form is the early or [illegible] which for the most part is third interglacial in time and is more modern in appearance. The frontal brow ridges are divided into three parts, the vault is higher, the face is shorter [illegible] steeper and higher, the cheekbones are more strongly developed, the bones of the skull are lighter and [illegible] shorter and the skull is better balanced, and there [illegible] complexes will indicate the interdependence of [illegible] characters. The weak development of the [illegible] portion of the orbit, the weak development of the cheekbone and also the corner of the mandible [illegible] facial complex possibly related to a small masseter muscle.

One result of the large number of [illegible] fundamentally different kinds is [illegible] guishing modern man from [illegible] skeletal population from Mt. [illegible] that combine varying degrees of Neanderthal with modern traits. [illegible] a population can be interpreted as hybrid, intermediate or [illegible] found in Mousterian deposits of only 43,000 years ago at Shanidar, [illegible] there is not an inexorable sequence in [illegible] continuously from primitive to modern.

4. Modern Man.—Modern forms of man are [illegible] Pleistocene remains [illegible] for investigation. Unfortunately the conte[illegible] England [illegible] more tha[illegible] usual [illegible] Fontéchevade [illegible] graphic [illegible] resemblances to modern man.

[illegible] of modern man [illegible] remains were found. [illegible] an old man, [illegible] Europe, a M[illegible] It is highly improbable [illegible] there. This is a [illegible] found inside a [illegible] a race.

The principal trends in the transformation of the [illegible] of early man into that of modern man may be summarized in [illegible] descriptive points. It [illegible] of what has happened to various characters and does not separate out those traits which are independent from those that belong to the same functional complex: (1) the brain case has increased in size and the face has been correspondingly reduced; (2) the forehead rose; (3) the face and jaws withdrew; (4) the skull increased its height further back behind the coronal suture, thus creating the "hominid hump"; (5) the area where the neck muscles attach at the back of the skull moved down and the condyles on which [illegible] such as the greater efficiency in balancing a more globular head, could not be determined on the basis of information available in the early 1960s.

5. Generic Relationships of Fossil Men.—It is probable that [illegible] species ever existed at one time. The scien[illegible] generic relationships. There is no evidence that any groups of fossil man were incapable of exchanging genes, and there is considerable evidence in the morphology that the course of human evolution was reticulate with many interchanges between contiguous populations. Man speciated only once—when he branched [illegible] stock. The history of fossil man reveals the development of many local or geographic races. There has been no development of genuine species, however, in the sense that a discontinuity, resulting from reproductive isolation either in time or space, has ever occurred.

II. The Rationale of Race Formation and Classification

Accompanying the realization that a race is essentially an epi[illegible] of race is comparatively simple; calculation of the effects of some of the processes of race formation is quite [illegible]

1. Breeding Populations.—Although [illegible]

distinctive in the high frequency of the blood factor Rh negative and group O. The term "continental race" for the major continental groups and "local race" for the component populations has also come into general use.

The outlines of a breeding population are delimited by cultural factors in most cases. Those people speaking a common language and sharing a common cultural heritage naturally mate with each other, at least more frequently than they do with people of another culture area. The castes of India provide a splendid example of the cultural compartments which reduce the exchange of genes. The Eskimo and Indians of North America contact each other in part of their geographic distribution, yet they seldom mate with each other. They are separated by mutually unintelligible languages and by cultures which have different value systems. The Pygmies of Africa and the adjoining Bantu Negroes speak the same language but have different economies and social organizations. Geographical features may also separate populations, as the Sahara desert which separates Negro Africa from northern Africa, the latter being occupied by members of the Mediterranean race. The task of distinguishing the outlines of a breeding area is essentially ethnological; such an area is defined by noting who marries whom and not by the physical traits which are shared by the resulting population. The close relation between the distribution of culturally defined groups, whether by language, economy or some other aspect of culture, and the distribution of races has led some persons to infer a causal relationship between race and culture. There are no biologically inherited cultural features as such and the relationship is purely one of correlation or historical association. As a particular culture enhances the interaction between its members and reduces the interaction with outsiders a breeding group is defined. In the event of social stratification or of geographic dispersion, breeding isolates within the over-all population come into being. Growth studies and racial anthropometry have demonstrated that upper classes, classified as upper either in terms of social or economic criteria, are invariably taller than the lower strata of the same society. Geographic differences occur similarly within over-all breeding populations, as, for example, the Aleut-Eskimo population or stock. Eastern Eskimos of Greenland are significantly different in some characters from the western Eskimos of Alaska; and the eastern Aleuts are significantly different in a few characters from the western Aleuts.

2. Single Species.—Although cultures serve to maintain group differences it should be noted that one of the over-all effects of human culture is the maintenance of a single species. Darwin observed that races are incipient species. Interestingly, in human beings these subdivisions of the one species have always remained as subdivisions and have never differentiated into separate species. Man is able to successfully occupy all the known ecological niches that are accessible to such a creature and thus he cannot speciate. He is able to occupy these diverse zones largely as a result of his culture, which in each place enables a specific adaptation, such as the ability to make tailored clothing in the Arctic. Man has thus specialized in despecialization.

3. Phenotype and Genotype.—Races represent combinations of discrete traits. The visible manifestations of traits are referred to as the phenotype; the genetic constitution of an individual is known as the genotype. Individuals inherit the genes or capacities for traits in their germ plasm. Each person receives 23 chromosomes from each of his parents. Each of these chromosomes contains or is composed of several hundred genes. Mendel demonstrated that traits are not fused in inheritance but remain distinct and segregate out in various ratios. Mendel's law of segregation is also the basis for the concept of genetic equilibrium which illustrates the way in which traits remain in a population whether they are dominant or recessive. Thus, brown-eyed parents may have a child with blue eyes if they each carried a gene for blue eyes. The old blood theory of inheritance is clearly invalid. It implied that a population with members mixing at random would, in time, become uniform. This rested on the false assumption that the variability would decline with each generation because children of the same parents must inherit the same traits. It is, in fact, possible to determine the genotype of parents by seeing the traits which appear in their children. Thus, two parents of blood types A and B may have a child of blood type O. It is obvious then that each of the parents also had a gene for blood type O (not detected by conventional tests) and that the child received the genes for type O rather than for A or B. When the number of genes responsible for phenotypic traits is known, as in the case of the blood groups, it is possible to compare races on the frequencies of those genes. The gene frequency method of describing races is one of the major accomplishments in race studies. A racial classification based on gene frequencies has been formulated by W. C. Boyd:

1. Early European group (hypothetical). Possessing the highest incidence (over 30%) of Rh negative type (gene frequency *rh* 0.6) and probably no group B. A relatively high incidence of the gene Rh_1 and A_2. Gene *N* possibly somewhat higher than in present-day Europeans. Represented by their modern descendants, the Basques.
2. European (Caucasoid) group. Possessing the next highest incidence of *rh* (the Rh negative gene) and relatively high incidence of the genes Rh_1 and A_2, with moderate frequencies of other blood-group genes. "Normal" frequencies of M and N; *i.e.*, M = *c.* 30%, MN = *c.* 49%, N = *c.* 21%. (The italicized symbols stand for the genes, as opposed to the groups.)
3. African (Negroid) group. Possessing a tremendously high incidence of the gene Rh^0, a moderate frequency of *rh*, relatively high incidence of genes A_2 and the rare intermediate *A* (A_1, A_2, etc.) and Rh genes, rather high incidence of gene *B*. Probably normal M and N.
4. Asiatic (Mongoloid) group. Possessing high frequencies of genes A_1 and *B*, and the highest known incidence of the rare gene Rh^z, but little, if any, of the genes A_2 and *rh* (the Rh negative gene). Normal M and N. (It is possible that the inhabitants of India will prove to belong to an Asiatic subrace, or even a separate race, serologically, but information is still lacking.)
5. American Indian group. Possessing varying (sometimes high, sometimes zero) incidence of gene A_1, no A_2 and probably no *B* or *rh*; high incidence of gene *M*. Possessing Rh^z.
6. Australoid group. Possessing high incidence of gene A_1, no A_2, no *rh*, high incidence of gene *N* (and consequently a low incidence of gene *M*). Possessing Rh^z.

One of the most important antigens for which sufficient population studies have been made to permit generalization is the Diego factor. It is found in highest frequency in South American Indians, in varying frequency in other American Indians, and in Asiatic Mongoloids. It is not found in Negroes, Europeans, Oceanic peoples nor, oddly, in Eskimos.

Abnormal hemoglobins, haptoglobins and other biochemical traits show great variations between populations. The sickle-cell trait (Hemoglobin S) is found in highest frequency in east Africa, less in west Africa, India and about the Mediterranean. It confers an advantage to the possessor of one gene (thus a heterozygous individual) in resisting the effects of malaria. Persons with two genes (homozygous) are more likely to die of anemia early in life, and those with no gene have least resistance to malaria. In this case, and probably in many more, selection favors the heterozygous individuals, who would not exist without maintenance of the other two genotypes. For particular environmental stresses evolution must proceed with the production of "unfit" individuals in order to produce the more "fit."

It should be kept clearly in mind that a blood type is a phenotypic trait, even though it is under the skin. It happens that the number of genes responsible for the blood groups can be accurately inferred. Human races can be differentiated by using the percentage of the blood types, rather than the gene frequencies, in precisely the same way that the percentage of black hair or blue eyes may be used to differentiate populations. It is still common practice to cite the percentage differences in the Rh types. Thus, the early racial classifications which cited the varying percentages of hair colour or eye colour, etc., were adequate in many respects. However, much greater precision, especially in calculating the effects of selection of mixture, is possible when the exact number of genes is known. By using the frequencies of genes in various populations it is possible to find gradients or places where the frequencies change quickly. Thus, the problem of intergradation between populations may be dealt with.

Where the frequency of one kind of gene will not distinguish between two races, other unrelated genes will do so. Egyptians are similar to Micronesians in the frequencies of the three genes

responsible for the ABO blood groups, yet they are different in the frequency of the Rh genes. This simply points up the fact that a number of criteria must be used for differentiating races. Chance similarities are not likely to occur in many different systems of unrelated traits.

It must be noted that the constituent elements of races are discrete traits and not genotypes or types. A single population contains within it many different combinations, each of which may be called a type. There is no gene for a type. Any combination of traits may occur, and the likelihood of occurrence is dependent solely on the number of constituent genes in the population. We may note that an individual is of blood type AB or of the Nordic morphological type. These are not units of inheritance and cannot be treated in the same way. The combination of blue eyes, light brown hair, long head and tall, linear body is a chance combination depending on the frequency of the individual characters in the population for its appearance. There is no inheritance of a Nordic type and children of the same parents may belong to quite different types. In the same way a child does not inherit its genotype as such but inherits the genes, from both parents, which then compose its genotype.

The idea of racial types is essentially pre-Darwinian. It implies original or ideal forms which became mixed or from which many individuals deviated. Actually, the fossil record provides ample evidence that populations have always been characterized by variability in many traits; no ancestral types have ever appeared. A concept related to type is that of a "primary" race. A necessary corollary is the idea of secondary races which presumably arose from the primary ones, with tertiary and quaternary races logically following. From the standpoint of population genetics such postulates are superfluous.

The basic concept of gene equilibrium explains how genes behave in a population which is not in a process of change; *i.e.,* not undergoing evolution. Recessive and dominant genes will be maintained in the same proportion with which the population started; in other words, the variability of the population will be indefinitely perpetuated from one generation to the next. This assumes random mating and equal survival of all kinds of offspring. Assuming that eye colour is controlled by a single pair of genes, one for brown eyes, which are dominant, and one for blue eyes, which are recessive, those children who receive a gene for brown eyes, indicated here by A, from one parent and a gene for blue eyes, indicated here by a, from the other parent, will have brown eyes since brown is dominant. This may be placed in the Hardy-Weinberg formula by letting q stand for the sex cells with gene A, and $(1\text{-}q)$ for the sex cells with gene a. This formula illustrates the way in which the frequencies of q and $(1\text{-}q)$ remain constant generation after generation and in which the proportions of persons with brown and blue eyes then remains the same:

$$q^2AA \text{ (brown eyes)} : 2q(1\text{-}q)\ Aa \text{ (brown eyes)} : (1\text{-}q)^2aa \text{ (blue eyes)}$$

There are four major processes which alter gene frequencies: mutation, genetic drift, selection and hybridization. A mutation is a sudden change in the genetic materials, and thus mutations are the raw materials of evolution. A new mutation, such as a new Rh factor in the blood, may be increased in frequency by selection, or it may be lost. Random genetic drift, the Sewall Wright effect, refers to the chance loss of genes in a small population. A small migrant group may branch off a larger group and by chance have no individuals with a particular gene. Or such a small isolate might have only a few carriers of the gene and by chance none of those genes would be passed on to succeeding generations. It is likely that blood group B was lost by the small isolated group of Arctic Eskimo of north Greenland. The great variability of the American Indians in their blood groups may possibly be the result of the operation of genetic drift. Primitive peoples who live in small groups with uncertain economic foundations are more likely to display chance fluctuations in gene frequencies than are large and stable populations. Genetic drift may have been of much more importance in the past when most of the world's populations lived in small, isolated groups. Selection, best defined as differential fertility, is the favouring of certain genes whereby their frequency is increased. With even a very slight selective advantage gene frequencies may be considerably altered. Though selection is often considered as a screening agency which removes deleterious genes it may equally well be considered a creative force as it provides direction by favouring or disfavouring certain genes. The general increase of roundheads in Europe may be an example of selection operating in favour of better balanced heads, though this hypothesis could not, as of the early 1960s, be demonstrated. The long-term tendency for heads to become more globular, as noted in the review of cranial transformation, may provide evidence for this speculation. Hybridization is one of the most common ways in which gene frequencies are altered, though this may not have always been the case. Race mixture obliterates the differences between the participating groups and enhances the differences between individuals within the new hybrid population.

Adaptation in traits whose mode of inheritance is not yet known is as important for the survival of populations as for the single gene traits. Comparative racial physiology has accumulated much valuable data on body size, tissue distribution, pigmentation, nutrition and climate. True physiological adaptation to cold climate has been found among the central Australian aborigines. They permit greater body cooling without metabolic compensation, while sleeping in the cold, than do other peoples tested.

Human races are constantly changing, though at different rates, and the boundaries are constantly shifting. Natural selection continues to operate; *i.e.,* there is differential survival of different genotypes. It is quite likely that natural selection favours the maintenance of a range of mental capacities in all different races. There is clearly the need for considerable innovative ability on the part of any society in the world. Selection for educability places a premium upon diversity of individuals as well as cultures.

Many of the traits commonly used for racial classification such as stature, pigmentation, cephalic index, are expressions of several interacting genes, each one contributing only a small effect. These polygenic traits vary continuously and as a consequence have been described in terms of averages or arithmetic means with certain measures of dispersion. Certain limitations are imposed by the use of these kinds of traits in that phenotypically similar individuals and populations may not be genotypically similar. Another disadvantage is that they cannot be manipulated as conveniently for analysis. Thus, we cannot predict how tall a hybrid population will be which is the result of crossing a population with a mean stature of 168 cm. (66.14 in.) with a population averaging 161 cm. (63.39 in.).

The degree of morphological similarity between groups is an adequate measure, when sufficient numbers of traits are used, of the degree of actual genetic relatedness. Various coefficients of divergence can be used for comparing three or more groups. If only a few features are used the results may be misleading. It is not, for example, possible to establish the relationship of Oceanic Negroids of Melanesia to the Negroes of Africa even though they bear a number of phenotypic similarities. The Bushmen of south Africa were formerly thought to show traces of Mongoloid parentage on the bases of their yellowish skin colour, broad cheekbones and eyelid fold covering the inner corner of the eyes. However, there is nothing in the blood group systems which confirms such a parentage nor is there any skeletal evidence that would support such a view.

There is a substantial correlation between the gene-frequency method and the morphological method of evaluating the biological differences between populations. This is to be expected inasmuch as these are two methods of describing a population which is defined by independent ethnological criteria; *e.g.,* mating patterns laid down by the culture. Such a study has been done for five caste groups of India (L. D. Sanghvi, 1953). In studying the causes and processes of race formation the interpretation of human evolution in the remote past becomes infinitely more meaningful.

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III. APPLIED ANTHROPOLOGY

The term applied anthropology (and its forerunner "practical anthropology") came into use between the late 1920s and middle 1930s. It indicated, and in a sense proclaimed, the new interest of social (or cultural) anthropologists in research meant to give practical aid and guidance to governments and other bodies controlling public life. It should be emphasized that the term marked off an area of interest rather than a separate branch of social anthropology. Many anthropologists worked in both fields. Nor was there any difference in the methods employed; even in its applied form anthropology involved the systematic study, at first hand, of societies as yet unknown or inadequately known. The difference lay in the scope of the research, which, in applied studies, centered upon problems of practical importance, and in the commitment of the research worker, who expected to place his skill and knowledge at the disposal of the nonscientist and "practical man."

Applied anthropology thus came to mean essentially employed anthropology, if the term is understood sufficiently widely to include, besides salaried employment, also the mere encouragement and sponsorship of particular investigations. Since the anthropologist studied primarily "primitive" and exotic peoples, it was natural that his researches should be of special interest to colonial governments and that these should have become his principal employers. Though this took time and was not accomplished without considerable pleading on the part of leading anthropologists such as Bronislaw Malinowski, A. R. Radcliffe-Brown and C. G. Seligman, the case for applied anthropology definitely seemed to be convincing.

1. The Need for Applied Anthropology.—In our own society the men entrusted with public affairs are, as a matter of course, familiar with the general social situation and ready to rely on such disciplines as history, economics or political science for the solution of more specialized problems. It seemed common sense to expect colonial administrators to possess a similar knowledge of the peoples and problems they were dealing with, and to rely on anthropology as the scientific discipline providing it. Nor would this knowledge prove less useful to others—missionaries, educators, doctors and the like—working among "primitive" and exotic peoples.

Many examples could be quoted of political measures failing in their purpose, or even leading to disastrous results, because they were taken in ignorance of native custom and the factors underlying it. The Ashanti War of 1900 is a classical case. It was provoked by the ill-advised demand of the British governor for the surrender of the golden stool of the tribe, which he took to be a symbol of sovereignty while in reality it was a sacred relic, not to be exposed to profane eyes. Other misunderstandings had less spectacular though still serious effects, such as the efforts of administrators and missionaries to suppress the African custom of bride wealth, paid by a man for his future wife, on the grounds that it reduced women to mere chattels, or the attempt of the Canadian government to abolish the potlatch feasts of the northwest American Indians, in which it saw merely a wasteful, wanton destruction of property.

The anthropologist could have shown that the bride wealth corresponded, in these societies, to a contract of marriage and, far from lowering the dignity of women, gave them full legal status; and that the "wastefulness" of the potlatch enabled men to achieve prestige and display social prominence. Above all, the anthropologist could have predicted that the disregard of customs playing so crucial a part was bound to disrupt the native society and undermine its morale. If the understanding of the indigenous way of life could have prevented the more disastrous consequences, it would also have helped to dispel many of the popular prejudices about native races—that they are "by nature" lazy, dishonest, improvident, mentally backward, or hopelessly conservative.

The helpfulness of anthropology must not, however, be exaggerated. The discovery of the true significance of a custom did not necessarily dispose of the difficulties of government created by it. In coping with these the administrator had to claim a free hand, even to the extent of radically interfering with tradition. And clearly, no modern, humanitarian government could permit the continuance of tribal wars or blood feuds, countenance practices endangering human life or recognize sorcery and witchcraft. But there were other factors also. Even native ways of life wholly justifiable and inoffensive were sacrificed when they conflicted with "higher policy": indigenous land titles were overruled by a policy encouraging white settlement; the disruption of community life counted for less than the need of recruiting able-bodied men for labour or service in colonial armies.

Even so, anthropological information was not reduced to futility. At the least, it enabled the administrator to calculate the consequences of his actions; often, it would suggest to him the best course in the circumstances—a policy of judicious transition, a workable compromise or safeguards of some kind. For example, the anthropological study of labour migration in Bechuanaland, carried out by the South African anthropologist I. Schapera, established that its most disruptive effects were the result, not of the numbers of migrants, but of their prolonged absence from home, and that in the case of young men, especially those better educated, migration even proved to be a beneficial influence. These were clearly findings which opened the way for a useful policy of compromise.

2. Division of Responsibility.—All this indicated a division of responsibility whereby the anthropologist was to provide the relevant information while its actual utilization, its application in the strict sense of the word, lay with the administrator. It did not seem feasible to advocate a fuller merging of the two roles by giving the anthropologist administrative powers or turning the administrator into a professional anthropologist.

The qualities required of the good anthropologist did not necessarily make a successful administrator; only in exceptional cases would the same individual possess both or, for that matter, find it easy to reconcile the divergent viewpoints of the scientific student

of society and the man responsible for efficient government. Furthermore, once the anthropologist was identified with the regime he risked losing the vantage point of the impartial observer—the chance of winning the confidence of the people he studied or that of gaining an unbiased picture of their lives and interests. Finally, it became increasingly difficult to combine competent anthropological work with other professional duties. Though the semiprofessional, part-time anthropologist had in the past made valuable contributions to ethnographic knowledge, his work fell seriously short of the more exacting standards of modern research.

But some familiarity with anthropological thought and methods could only be of profit to the administrator, and similarly to the missionary or educator. The first steps in this direction were taken in Belgium, France and the Netherlands, where the normal training of colonial officials for many years included instruction in indigenous languages and cultures, offered at universities and similar institutions (such as the Université coloniale in Brussels and the École coloniale in Paris). In Great Britain studies of this kind were optional until 1946, when social anthropology was made a regular subject in the training courses for colonial officials (given at Oxford, Cambridge and London universities). Allowing for somewhat different interests, the U.S. Foreign Service institute in Washington, D.C., founded in 1947 for the training of foreign service personnel, similarly included cultural anthropology among the subjects taught.

It was not the object of this instruction, which was mostly on an elementary level, to produce competent research workers; it served its purpose best in teaching the future administrator to look at certain problems with the anthropologist's eyes and to recognize where anthropological investigations were needed. In this sense his training corresponded, as Melville J. Herskovits pointed out, to an "indirect" form of applied anthropology.

A. The Growth of Applied Anthropology

1. Early Beginnings.—Even before World War I colonial governments, especially the British, Dutch and German, in various ways encouraged anthropological investigations in their territories. In most cases no sharp distinction was drawn between studies by professional anthropologists and the amateur observations of officials, missionaries or explorers; but there were also significant exceptions, such as the expeditions, sponsored by the respective governments, of R. Thurnwald to German New Guinea (1912–14) and of C. G. and Brenda Seligman to the pagan tribes of the Anglo-Egyptian Sudan (1909 and 1911). In the United States the Bureau of American Ethnology, founded as early as 1879 for the study of the Indian tribes, at least laid the foundations for applied anthropological research, though this was slow in coming. There was little development until 1933 when John Collier, a keen supporter of anthropology, was appointed as commissioner of Indian affairs.

Generally speaking, applied anthropology began to come into its own between 1920 and 1930. It was then that several British colonies and dominions seconded political officers for anthropological work or appointed special government anthropologists, among whom were R. S. Rattray (in the Gold Coast—now Ghana), P. A. Talbot and C. K. Meek (in Nigeria), J. H. Hutton (in India), F. E. Williams and E. W. Chinnery (in Papua and New Guinea). In 1926 the foundation of the International Institute of African Languages and Cultures (later renamed International African institute) marked a further important advance. Its five-year plan of research, inaugurated in 1932, was explicitly intended to "bring scientific knowledge and political affairs into closer association" and to provide "a scientific basis for dealing with the practical questions of administration and education." The following years saw a great deal of applied research, mainly in British African territories, as well as, in 1938, the setting up of the first research centre located in colonial Africa, the Rhodes-Livingstone institute in Northern Rhodesia.

The concentration of research in British Africa was no accident. For there the policy of indirect rule, envisaging the government of native peoples through their own leaders and political institutions, made accurate knowledge of their societies a prerequisite of political planning. Furthermore, the native peoples of Africa had been exposed to far-reaching contacts with western civilization, which were rapidly changing their way of life; the need to assess and guide the changes thus added to the problems requiring anthropological study. This latter reason held, of course, also for territories outside Africa; in consequence, research in applied anthropology tended to be increasingly focused upon, and in fact identified with, studies of culture contact and change.

2. World War II.—Though World War II temporarily interrupted most studies of this kind, anthropology also found a place in the wartime organization of the allied countries. Several anthropologists were attached to government departments or appointed to advisory committees; others, who had joined the services, were assigned to special duties requiring their particular skills and expert knowledge. Their duties were in the main concerned with military government in conquered or liberated territories, with intelligence work and with the planning of psychological warfare. Thus, in the British military administration of Italian east and north Africa anthropologists were given charge of native affairs. A team of anthropologists joined the Australian military government of New Guinea. In the United States, anthropologists taught at civil-affairs training schools, served in the military government set up by the navy in Micronesia or worked for the Office of Strategic Services.

The U.S. wartime researches extended far beyond colonial or primitive peoples. A team of anthropologists worked in the relocation centres set up for Japanese, both of U.S. citizenship and aliens; others, including Ruth Benedict and John Embree, undertook studies of the "national character" and morale of enemy countries, especially of Japan. In the latter studies the conventional anthropological approach, through the direct observation of a people in its environment, was of necessity replaced by the use of published sources, historical or contemporary, and by interviews with individuals exiled from their countries; also, parallel investigations were carried out by psychologists and psychiatrists, so that the contribution expected of the anthropologist consisted in his viewpoint, in his manner of interpreting the data, rather than in any particular research technique.

3. Developments After World War II.—After the war, applied anthropology expanded widely and rapidly. In Great Britain, where the program of colonial development offered a wide scope for applied research, the Colonial Social Science Research council, set up in 1944, commissioned numerous anthropological investigations in Africa, the West Indies, Borneo and elsewhere; the colonial office appointed anthropologists as consultants and established research centres in the new colonial university colleges in Uganda, Nigeria and the Gold Coast. In Australia the School of Pacific Administration, itself a postwar creation, had anthropologists on its staff and anthropology in its syllabus. In South Africa, the department of native affairs employed a team of anthropologists. India and Malaya were beginning to utilize anthropological research in the solution of their political and social problems. The government of French Equatorial Africa created a Commission d'Études Sociologiques, other French territories taking similar steps. International bodies like the Trusteeship council of the United Nations, the United Nations Educational, Scientific and Cultural organization and the South Pacific commission appointed anthropologists to their research divisions and on occasion sponsored investigations in the field.

In the United States, government agencies and private research foundations alike were keenly interested in applied anthropological work, which found a place in the administration of the U.S. trust territories and in several of the postwar projects of technical assistance to backward countries, especially in southeast Asia and the middle east. One American university, Cornell (Ithaca, N.Y.), specialized in the training of applied anthropologists. The Society for Applied Anthropology, founded in 1941, aimed at encouraging and co-ordinating such research, and also published its own periodical (*Applied Anthropology*, renamed in 1949 *Human Organization*). Largely stimulated by the North American example, scholars and government agencies in the Philippines, in Mexico and South America began to think on similar lines, of anthropology

applied to the problems of economic and political development.

As social anthropologists in general had come to extend their researches to advanced cultures and western societies, so applied anthropology widened its scope in the same sense. Two new types of applied research may here be mentioned, though both were subject to considerable controversy. First, the combined anthropological and psychological studies started during the war, of national trends or "national character," were continued in various European countries under U.S. auspices and the leadership especially of Margaret Mead. Secondly, a group of U.S. anthropologists, headed by Eliot D. Chapple, turned their attention to the problems of social and human relations in industry, accepting contracts for research from private firms. Anthropologists in Great Britain were moving more cautiously in the same direction.

The interest in mental health, finally, which had developed strongly since the war, opened up a further field for the application of anthropological knowledge and techniques and for the collaboration between anthropologists, psychiatrists and those concerned with social welfare.

B. Scope of Research

Regarding the more conventional type of applied anthropology, among primitive or exotic societies, three main lines of research may be distinguished, though in practice they tended to overlap: (1) general ethnographic studies, meant to provide information about a certain society or group of societies in a region; (2) specialized investigations of particular practices or institutions; (3) predictive analyses, needed for policies of political reconstruction, economic development, etc.

The first kind of study was also the earliest, and hardly differed from the descriptive studies of ordinary or general social anthropology. Colonial governments simply desired to have full reports on the people they governed, on their customs and institutions, even in the absence of any definite plans for utilizing the information.

1. Political Organization and Land.—The specialized investigations were usually suggested by some difficulty or weakness of administration. One such difficulty, widely encountered, concerned the location of effective authority. Chiefs and other political functionaries appointed by the government often proved ineffectual, either because the men in question were without traditional authority or because the latter was much more rigidly circumscribed than were the powers thrust upon these men under modern conditions. Sometimes no centralized authority existed at all which could provide the kind of leadership governments wished to see established. The religious sanctions behind chieftainship posed a special problem; for they might both buttress the secular office and restrict the freedom of action necessary for its efficient performance, as when a chief also had priestly functions or was invested with semidivinity. The investigation of indigenous political systems in consequence became one of the recurrent subjects of applied anthropological research.

Other problems demanding continuous research were land and land tenure. A great deal of research was devoted to the customary law of indigenous societies, so that it might be utilized or at least reckoned with by the government of the country. The principles of land tenure in turn had to furnish the legal basis for land litigation, for any registration of land titles and for land policy at large. Here the anthropologist could show that the modern concept of individual property, implying the right of free disposal by the owner, was largely inapplicable to primitive societies. Nor was land communally owned as many administrators thought. Rather, individual usufruct was combined with corporate titles giving kin groups or communities reversionary rights or rights of disposal. Religious factors again entered since land was often bound up with the worship of ancestors or otherwise associated with supernatural conceptions.

2. Culture Contact and Planned Change.—There were, further, the many instances of culture contact—the impact, upon primitive societies, of western technology and economy, of Christianity and western moral standards, and of other factors equally alien. The lesson that emerged most clearly was that their effects were rarely localized but tended to spread widely through the social fabric; wherever the change might start, ultimately it was likely to affect family structure, the relationship between the generations, group morality, even religious beliefs. It was chiefly these remote, and uncalculated, effects which gave culture contact its potentially disruptive character.

The lessons here learned had a direct bearing on policies of development and reconstruction. For whatever their specific objective—political reforms, economic advancement, education, health—they were essentially experiments in calculated social change. The anthropologist, by his analysis of the situation, had to provide the relevant social data needed for any reliable prediction of results. Often his responsibilities extended further, to giving advice on the most appropriate method of implementing a particular policy or even, if more rarely, on the wisdom of the policy itself.

This wider responsibility, however, placed the anthropologist in a genuine dilemma; for while it enabled him to act as a sympathetic intermediary between rulers and ruled, it also meant that his role was radically changed, ceasing to be that of the strictly scientific, disinterested student of society.

C. Results and Prospects

From the anthropologist's point of view the applied studies have in many ways been an undoubted gain. Concerned as they so often were with the effects of social change, they offered the nearest approach to the controlled experiment in the social sciences. The specialized inquiries greatly deepened our knowledge of particular aspects of primitive society and culture, especially of economic and political organization, land tenure and law. Scientific value apart, work in the applied field also offered to many anthropologists the purely human satisfaction of aiding backward peoples in their struggle to meet and master the forces of western civilization.

The concrete gains derived by colonial governments were more difficult to assess, partly because these were not bound to act upon the anthropological findings and partly because the value of the latter was not always wholeheartedly accepted. Sometimes, it is true, the anthropologist found himself embarrassed by the excessive confidence of his employers that he had the key to all problems. More often, they were inclined to question whether anthropology was in fact as helpful and the information it provided as indispensable as enthusiasts would make it out to be. Some impatience was felt with the "academic" anthropologist who would insist on comprehensive studies when only some specific information was asked for, or who seemed to deal in a complicated fashion, using complicated language, with issues which to the practical man appeared straightforward. To all this anthropologists could reply that, though the knowledge they stood for was not indispensable to government, it facilitated informed and smooth government.

But anthropologists also had to face another, more disturbing criticism—that they overemphasized the importance of tradition and were hostile to modern development. Nor was this view limited to colonial administrators; educated Africans and Indonesians openly expressed their distrust of a science whose primary interest was in "primitive" peoples and which might play into the hands of reactionaries and upholders of "colonialism."

If these objections did not promise too well for the future of applied anthropology, anthropologists themselves had grown more cautious. They came to fear that the applied work might entice too many of the younger anthropologists away from general and theoretical research, so that the very progress of the discipline might be endangered. Conversely, the man fully committed to applied work, like the permanent government anthropologist, would be in danger of losing touch with universities and academic centres, and hence with the advances achieved in his discipline. He would turn into a mere technician, perhaps still useful to his employers but no longer truly representing anthropological knowledge.

There were graver problems that were of an ethical nature. The change of roles forced upon the anthropologist when he is

consulted on the best way to implement government policies has been mentioned previously. To be sure, he might see no cause for disagreeing with the policy, and the best way of imposing it might well be understood to be the one best serving the interests of the native peoples. Even so, the anthropologist would abandon the standpoint of the scientist; he must pronounce upon the merits and demerits of particular courses of action, and thus introduce value judgments. Nor will the issues always be as clear-cut and uncontroversial, so that the anthropologist might have to take sides and argue from his own political and moral convictions. And if these had little chance against administrative considerations or the dictates of "higher policy," personal frustrations would be added to the dubiousness of his position.

Yet if the anthropologist presented his facts without adding recommendations or warnings, he would furnish information that might be put to uses with which he could not in good conscience agree. Or again, he might be tempted to restrict his advice to the most efficient means for achieving certain ends, dismissing the ends themselves, the policy to be implemented as not of his concern—which would hardly diminish his ethical commitment.

All these issues were widely and on occasion heatedly debated among U.S. and British anthropologists. In an attempt to clear the air the Society for Applied Anthropology published in 1951 a carefully worded *Code of Ethics*. It appealed to the social conscience of the individual research worker and to his responsibility at all times to uphold the moral tenets of our civilization—respect for the individual and for human rights, and the promotion of human and social well-being. Not all anthropologists were prepared to endorse this assumption of a moral mission on the part of the "disinterested" scientist. The dilemma, then, though vital for the future of applied anthropology, remained unresolved.

See also SOCIAL ANTHROPOLOGY and references under "Anthropology" in the Index.

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ANTHROPOLOGY AND ETHNOLOGY, SOCIETIES OF. In the 1960s there were about 350 anthropological societies in the world. These vary greatly in size of membership and in geographical breadth of interest. The vast majority of them are nongovernmental, devoted exclusively to anthropology or to a subdiscipline thereof, and have as their major purpose the exchange and dissemination of scientific information, notably via regular publications and meetings. Most of these societies, including the oldest ones still active, are found in the United States, in Europe and in former European dependencies in Asia, and in Japan. More recent societies have originated in Africa and in Oceania, predominantly at the instance of Europeans. In most of Latin America, anthropological societies are still small and with local purposes, and individuals of broader interests follow the activities of their national scientific bodies.

Nations throughout the world often have some sort of national scientific body wherein anthropology is one subject for attention or even the focus for a special "section." There exist, also, relevant national committees of anthropologists, national liaison societies composed of representatives from several other societies, intergovernmental organizations, international nongovernmental organizations, and international nongovernmental regional organizations with regional headquarters. Membership in many of these is institutional only, appointive, or otherwise restricted.

See *International Directory of Anthropological Institutions*, edited by William L. Thomas, Jr., and Anna M. Pikelis (1953). (A. M. P.; F. R. E.)

ANTHROPOMETRY, a term coined by the naturalist Georges Cuvier (1769–1832), means the measurement of man, and is derived from the Greek roots for "man" and "measurement." Long used by physical anthropologists for the comparison of man to other primates, and for the comparison of different racial groups, anthropometric measurements are now employed in a variety of disciplines. Anthropometry assists in the diagnosis of endocrine disorders, in the assessment of growth and development and in the evaluation of nutritional status. Anthropometric measurements are employed in the design of equipment, in the sizing of clothing, shoes and sunglasses, and in automotive and air-frame construction. In space travel, the techniques of anthropometry are necessary to assure man both comfort and protection.

The simplest anthropometric measurements, such as stature, are made with familiar equipment. By selecting reliable measuring points, or "landmarks," and standardizing the techniques, such static measurements can be made with great accuracy. Where these measurements are to be used as norms, or standards (as for height or weight), the primary problems are those of sampling. The sample used for comparison must be large enough to provide an idea of the total range of measurements, and it must be representative of the population the anthropometrist intends to describe.

Modern anthropometry, however, has gone beyond the limits of meter-sticks, calipers and tapes. Equipment now reads directly on counters or dials, can be adjusted for constant tension and can feed measurements directly to punch cards or computers. Some of the measuring devices are designed to determine the thickness of the fat layer beneath the skin, and others meter the percentage reflectance of the exposed or unexposed skin. Anthropometric measurements of bone, fat and muscle are made directly on X-ray films, and ultrasonics is used to determine the depth of fat and muscle in living human beings. Often, anthropometric measurements are made directly on photographs.

A variety of techniques have proved useful in measuring the component tissues of the body. Underwater weighing, using Archimedes' principle, yields the specific gravity of the human being. Dyes or trace substances injected into the blood indicate, by the extent of dilution, the size of the fat-free volume. Through measurements of the density of X-rays of the fingers, the mineral mass of the entire body can be estimated.

Anthropometric measurements can be summarized by averages or means, as for stature or weight. Frequently, proportions or ratios are used, as when relating limb length to body length, or comparing the length of the upper and lower limbs. In reporting data on body composition the amount of fat is usually expressed as a percentage of gross body weight. Thus in adults, those whose fat is less than 5% of total weight are lean, while those with over 25% fat are obese. Such quantitative information is more meaningful than expressions of underweight or overweight. There are fat underweight individuals and lean overweight individuals.

Stature, weight, percentage of fat and the reflectance of the skin are static measurements, and they are one- or two-dimensional at best. It is also possible to provide true three-dimensional anthropometric data, using the Cartesian system of co-ordinates. The field of "dynamic" anthropometry, moreover, measures man in motion, or the effective body size of an individual engaged in a particular task. For the volume of a seated man quietly engaged in reading a book, this effective body size is approximately 54 in. high, 30 in. wide and 36 in. deep. The living human being engaged in any particular occupation occupies a space-envelope far larger than his minimum corporeal dimensions. Thus, time-lapse photography has become an adjunct to direct anthropometry.

The design of ready-made clothing involves complicated uses of anthropometric data. Any system of sizes must be keyed to simple body measurements such as stature, chest girth and leg length. But for each combination of measurements used to define a size (such as 36-long) as many as one hundred supplementary

measurements must also be incorporated into the patterns or model-forms. Similar complexities relate to automobile seats, airplane cockpits and space capsules. Controls, levers and switches must be close enough to grasp or operate, but not so close as to invite accidental operation. In such applications, designs based on anthropometric measurements must be subjected to actual fitting tests. Such tests combined with anthropometric data help to eliminate driver or pilot error.

Anthropometry, as in Cuvier's time, is the measurement of man, but today it involves man in motion, three- or even four-dimensional measurements, apportioning of the tissue components of the human body, and measurements of strength, reaction time and fatigue. Man in space must be protected against heat, cold, radiation and acceleration (*g* force), yet his protective clothing must not become an encumbrance in itself. Spaceman must be able to operate controls, read dials and receive and transmit information within the limitations set by man, under stress, and enveloped in protective gear.

See also ANTHROPOLOGY: *Physical Anthropology;* INVESTIGATION, CRIMINAL; PHYSIOGNOMY; SKULL: *The Skull in Anthropology.*

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ANTHROPOMORPHISM, the ascribing of human form, or the characteristics of humanity, to deity; in a wider sense, the ascribing of human form or characteristics to any nonhuman object. The term is most properly applied to any religious statement, with either literal or symbolic intent, that depicts deity as subsisting wholly or partially in bodily form resembling that of a man, or as possessing qualities of thought, will, or feeling that are continuous with those experienced by men. Thus, expressions such as the "hand of God" and the "wrath of God" are equally illustrative of anthropomorphism.

In the wider sense of the word, anthropomorphism may be illustrated by any analogical transfer of human qualities to the lower animals, as when referring to their reasoning powers or ascribing to them such traits as courage or cowardice. The word may be applied even to descriptions of inanimate levels of reality in metaphors taken from human experience, as in speaking of the anger of a storm (*see* FIGURES OF SPEECH).

Throughout the history of religious thought various attitudes have been taken with respect to the propriety of anthropomorphism in statements purporting to describe God or the gods. One of the earliest in western thought to take explicit and critical note of religious anthropomorphism was Xenophanes (*c.* 580–485 B.C.), who perceived the provincialism in much theistic belief, observing, for example, that the Ethiopians and the Thracians fancied their gods, respectively, as black-skinned and as blue-eyed. He thought it unfitting that Homer and Hesiod "have ascribed to the gods all deeds that are a shame and a disgrace among men: thieving, adultery, fraud" (*Fragments*). Similarly, Plato repudiated the crass anthropomorphism of the popular Homeric mythology, enforcing the idea, in accord with Xenophanes, that God is one, and beyond human powers of comprehension. It is to be noted, though, that Plato defended the didactic value of anthropomorphic myth, if only God were assigned the highest virtues and not the lowest vices of men.

The classical Hebrew prophets, such as Amos and Isaiah, were vigorous critics of the gross forms of anthropomorphism popular in their times, reminding their hearers, for example, that the moral judgments of God were not based upon the tribal preferences that influence human judgments. The prophets did not entirely abandon anthropomorphism, however, but freely employed refined anthropomorphic symbols as indispensable to their concept of God as personal. The author of Ecclesiastes carried the critique of anthropomorphism further, approaching the idea of an impersonal cosmic force in place of the Hebraic personal God. It should be remarked that while many of the anthropomorphisms in the Hebrew scriptures are undoubtedly taken literally by their authors, many more are recognized and intended as poetic metaphors. In this regard, there is evidently a real difference between the intention of the relatively early statement that "the Lord used to speak to Moses face to face, as a man speaks to his friend" (Ex. xxxiii, 11), and that of the consciously poetic question directed by the Psalmist to God: "How long wilt thou hide thy face from me?" (Ps. xiii, 1).

While many thinkers have believed it possible to purge theism (*q.v.*) of all traces of anthropomorphism, many others have regarded anthropomorphism as not only inevitable, in some degree, but as essential to theistic knowledge and language. The latter judgment has been premised upon the observation that human knowledge and language in general are necessarily conditioned by man's experience of himself; if this is true, then the human subject invariably interprets nonhuman reality after analogies drawn from human experience.

There are those who have concluded from this apparent inevitability of anthropomorphism in human thought that theism as such is invalid and false. The view that the idea of God is merely an illusory projection of the human self, argued by such thinkers as Ludwig Feuerbach and Sigmund Freud, has been an influential example of this general position.

Others, equally convinced that anthropomorphism is inescapable in language about God, have argued as plausibly that there is no logical connection between this fact and the question of the validity and truth of theistic belief as such; the presumption that our *thought* and *speech* about God are subjectively coloured by our human experience is not a proper argument against the objective *reality* of God. It is often urged that the alternative to anthropomorphism in any form is either *agnosticism* (*q.v.*) or a view of God so abstract as to be religiously neutral.

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ANTIARCHA: *see* PLACODERM.

ANTIBES, a town in southeastern France in the *département* of Alpes-Maritimes, is on the eastern side of the Garoupe Peninsula across the bay from Nice, from which it is 13 mi. by road. Pop. (1962) 24,370. The town is a holiday resort and a port for pleasure craft. Juan-les-Pins, close by, has a casino and long sandy beaches. The Grimaldi Museum contains a collection of paintings, including works by Pablo Picasso.

ANTIBIOTICS are chemical compounds, elaborated by particular species of plants and animals, that in very small amounts are harmful to certain other living things. The word derives from antibiosis (*see* below). The ability to form antagonistic substances occurs widely in nature, among organisms large and small, aquatic and terrestrial; but commonly the term antibiotic is restricted to compounds of microbial origin, especially those produced and used to combat other, injurious microorganisms. Among such "germs" are the parasites (notably bacteria) that infect and sicken man, his domesticated animals, and his crops: hence the utility—scientifically exploited only since the mid-20th century—of antibiotics in medicine and husbandry.

History.—Certain moldy materials—soils, lichens, decayed vegetable matter—were used empirically by primitive peoples to treat disease long before the role of microbes in infection was understood. Once this became known, in the 19th century, Pasteur and others began purposeful attempts to exploit microbial antagonism for man's benefit. Curing an infectious disease by trying to establish a second, antagonistic infection seemed logical but proved impractical: the task of extracting the active principle

from antagonistic microbes so as to obtain pure materials of uniform potency was beyond the technology of that era. At least one crystalline substance, mycophenolic acid, was isolated (1896) but it was not thoroughly evaluated.

Interest in the possibility of chemotherapy (*q.v.*) was quickened with the development of medicinal arsenicals (1910 and after) and the sulfonamides (1932 and after), and by the discovery of penicillin (*q.v.*) by A. Fleming (*q.v.;* 1928), gliotoxin (1936), griseofulvin and tyrothricin (1939), and other antimicrobial products of microorganisms. Successful isolation of Fleming's penicillin by E. Chain and H. W. Florey (*qq.v.*) at Oxford University (beginning in 1939) and of actinomycin (1940) and streptomycin (1944) by S. A. Waksman (*q.v.*) and associates at Rutgers University prompted intensive, worldwide exploration of antibiotics. More than 1,000 were reported in the ensuing quarter-century and several proved to be sufficiently safe and effective for therapeutic use in human medicine. Penicillin largely replaced the sulfonamides for the treatment of infection by Gram-positive cocci. (Positive, negative, or variable response to Gram's staining technique is a criterion for classifying bacteria in fundamental ways, including their reaction to antibiotics; *see* BACTERIA.) Streptomycin, which affects many Gram-negative pathogens, proved useful against tuberculosis. Bacitracin was announced in 1945 and polymyxin in 1947. Chloramphenicol (1947) was the first truly broad-spectrum antibiotic, active against rickettsial and typhoid fevers as well as many other bacterial infections. Other antibiotics followed in rapid succession, among them chlortetracycline (1948), neomycin (1949), oxytetracycline and nystatin (1950), viomycin (1951), erythromycin and carbomycin (1952), tetracycline (1953), oleandomycin and spiramycin (1954), amphotericin, cycloserine, novobiocin, and vancomycin (1955), ristocetin (1956), kanamycin (1957), paromomycin and rifamycin (1959), and lincomycin (1962). Meanwhile, numerous structural modifications of penicillin, cephalosporin, and tetracycline were prepared, and several of these proved to possess medicinal value.

Some Widely Used Antibiotics

Group and chemical nature	Nonproprietary name (with proprietary examples)	Empirical formula	Chief source microorganism	Active mainly against*	Routes of administration
penicillins and cephalosporins (water-soluble acids, α-amino-β-lactams fused to a sulfur-containing ring)	benzylpenicillin, or penicillin G	$C_{16}H_{18}N_2O_4S$	*Penicillium chrysogenum*	G+ bacteria	oral, parenteral, topical
	phenoxymethylpenicillin, or penicillin V	$C_{16}H_{18}N_2O_5S$	*Penicillium chrysogenum*	G+ bacteria	oral
	methicillin (Celbenin, Dimocillin, Staphcillin)	$C_{17}H_{20}N_2O_6S$	semisynthetic from 6-aminopenicillanic acid (6-APA)	G+ bacteria, including staphylococci resistant to benzylpenicillin	parenteral
	cloxacillin (Orbenin, Tegopen)	$C_{19}H_{18}ClN_3O_5S$	semisynthetic from 6-APA	G+ bacteria, including staphylococci resistant to benzylpenicillin	oral
	ampicillin (Omnipen, Penbritin, Polycillin)	$C_{16}H_{19}N_3O_4S$	semisynthetic from 6-APA	G+ and some G− bacteria	oral, parenteral
	cephalothin (Keflin)	$C_{16}H_{16}N_2O_6S_2$	semisynthetic from 7-aminocephalosporanic acid	G+ and some G− bacteria	parenteral
tetracyclines (amphoteric, highly substituted naphthacene derivatives)	chlortetracycline (Aureomycin)	$C_{22}H_{23}ClN_2O_8$	*Streptomyces aureofaciens*	G+ and G− bacteria, rickettsiae	oral, parenteral, topical
	demethylchlortetracycline (Declomycin, Ledermycin, Declostatin with nystatin)	$C_{21}H_{21}ClN_2O_8$	*Streptomyces aureofaciens*	G+ and G− bacteria, rickettsiae	oral, topical
	oxytetracycline (Terramycin, Terrastatin with nystatin)	$C_{22}H_{24}N_2O_9$	*Streptomyces rimosus*	G+ and G− bacteria, rickettsiae	oral, parenteral, topical
	tetracycline (Achromycin, Omegamycin, Panmycin, Polycycline, Steclin, Sumycin, Tetracyn, Tetrex)	$C_{22}H_{24}N_2O_8$	*Streptomyces* (spp.) or dechlorination of chlortetracycline	G+ and G− bacteria, rickettsiae	oral, parenteral
miscellaneous	chloramphenicol (Chloromycetin)	$C_{11}H_{12}Cl_2N_2O_5$ (*p*-nitrophenylserinol derivative)	*Streptomyces venezuelae* or synthesis	G+ and G− bacteria, including *Salmonella typhosa;* rickettsiae	oral, parenteral, topical
	novobiocin (Albamycin, Cathomycin, Panalba with tetracycline)	$C_{31}H_{36}N_2O_{11}$ (3-aminocoumarin derivative)	*Streptomyces* various species	G+ bacteria	oral, parenteral
	lincomycin (Lincocin)	$C_{18}H_{34}N_2O_6S$ (derivative of methyl 6-amino-1-thioöctapyranoside)	*Streptomyces lincolnensis*	G+ bacteria	oral, parenteral
	griseofulvin (Fulvicin, Grifulvin, Grisovin)	$C_{17}H_{17}ClO_6$ (substituted coumaranone derivative)	*Penicillium griseofulvum* and *P. janczewskii*	fungi	oral
macrolides (large ring lactones with at least one sugar moiety)	erythromycin (Erythrocin, Ilotycin, Ilosone, Pediamycin)	$C_{37}H_{67}NO_{13}$	*Streptomyces erythreus*	G+ bacteria	oral, parenteral, topical
	triacetyloleandomycin (TAO, Cyclamycin)	$C_{41}H_{67}NO_{15}$	*Streptomyces antibioticus*	G+ bacteria	oral
	nystatin (Mycostatin, Mysteclin with tetracycline)	$C_{46}H_{77}NO_{19}$ amphoteric tetraene	*Streptomyces noursei* (and other species)	fungi	oral, topical
aminoglycosides (water-soluble bases containing amino sugars)	streptomycin	$C_{21}H_{39}N_7O_{12}$	*Streptomyces griseus*	G+ and G− bacteria, tubercle bacillus	oral (not absorbed), parenteral, topical
	neomycin B	$C_{23}H_{46}N_6O_{13}$	*Streptomyces fradiae*	G+ and G− bacteria	oral (not absorbed), topical
	kanamycin A (Kantrex)	$C_{18}H_{36}N_4O_{11}$	*Streptomyces kanamyceticus*	G+ and G− bacteria	oral (not absorbed), parenteral
	paromomycin I (Humatin)	$C_{23}H_{45}N_5O_{14}$	*Streptomyces rimosus* forma *paromomycinus*	G+ and G− bacteria, some protozoa	oral (not absorbed), topical
polypeptides (cyclic polyamides)	bacitracin A	$C_{66}H_{103}N_{17}O_{16}S$	*Bacillus licheniformis*	G+ bacteria	oral, parenteral, topical
	polymyxin B (Aerosporin)	$C_{56}H_{98}N_{16}O_{13}$	*Bacillus polymyxa*	G− bacteria, particularly *Pseudomonas aeruginosa*	oral, parenteral, topical
	polymyxin E = colistin A (Coly-Mycin)	$C_{53}H_{100}N_{16}O_{13}$	*Bacillus colistinus*	G− bacteria, particularly *Pseudomonas aeruginosa*	oral, parenteral, topical

*G+ denotes bacteria that are stained by Gram's stain, and G− those that are not.

Antibiosis (Greek for "against life") is antagonistic association between organisms; *i.e.*, the opposite of symbiosis. It results in harm to one of the associates, manifested by reduced or distorted growth or by death. Antibiotic substances, as agents of antibiosis, damage or destroy vital processes or structures of susceptible organisms.

Modes of Action.—How do antibiotics act? Surely so diverse an array of substances must act in diverse ways and upon more than one of the countless biochemical activities of organisms. The penicillins, D-cycloserine, novobiocin, and bacitracin accumulate in the cytoplasmic membrane of staphylococci and other Gram-positive bacteria and there prevent the formation of new cell wall, thus blocking the completion of cell division which is the basis of multiplication and growth. Polymyxins and certain other antibi-

otics act on Gram-negative bacteria in the resting stage as well as the dividing stage, combining with constituents of the cell membrane in a way that increases membrane permeability and hence allows the escape of vital substances. Chloramphenicol and several other antibiotics act on Gram-positive and Gram-negative bacteria by interfering with crucial steps in intracellular protein synthesis, upon which depend the very substance as well as all the metabolic activities of the organism. (*See* also ANTIMETABOLITES.)

Resistance.—Among the characteristics peculiar to life are diversity, adaptability, change; and these features are no less true of microbes than of men. We may think of the presence of an antibiotic as an environmental stress that eliminates the susceptible members of a microbial population so that only resistant members survive and multiply. In theory, after a time the entire population may become resistant and the antibiotic ineffective; but, in spite of this tendency, drastic change in microbial populations is uncommon. Furthermore, science has been able to deal quickly and effectively with the resistance problem. Thus, emergence of benzylpenicillin-resistant strains of staphylococci, particularly in hospitals in the 1950s, was the incentive for intensified research that resulted in the development of many new antibiotics, among them penicillins with new properties.

Medical Uses.—*Groupings.*—Antibiotics may be grouped to suit the biologist interested in classification of the source microbes; the organic chemist concerned with antibiotic structure and hence properties; or the biochemist concerned with mode of action. The physician is best served by grouping on the basis of the spectrum, or scope, of their antibiotic activity. The broad-spectrum antibacterial and antirickettsial group encompasses chloramphenicol and the tetracyclines. Bacitracin, the macrolides, novobiocin, lincomycin, the penicillins, and cephalothin exemplify the medium-spectrum group active principally against Gram-positive bacteria. Other widely used medium-spectrum antibiotics active against many Gram-negative as well as Gram-positive bacteria include streptomycin, neomycin, kanamycin, and paromomycin—all water-soluble, basic aminoglycosides. The polymyxins are examples of narrow-spectrum antibacterials. Among antifungal antibiotics are griseofulvin and several polyenes (*e.g.*, amphotericin, candicidin, nystatin). Antibiotics active against parasitic protozoa include fumagillin and paromomycin. Several antibiotics possess activity that is inhibitory to viruses and the growth of cancers, but in the late 1960s none was considered sufficiently safe and effective for general use in clinical medicine.

Administration.—Mode of administration to patients is governed by the properties of the antibiotic and by the anatomic locale of the infection. If the drug is poorly absorbed from the intestinal tract (*i.e.*, if it remains within the tract) it may be given by mouth to treat a gastrointestinal infection; conversely, if it is well absorbed (*i.e.*, if it spreads from the tract to other parts of the body) it may be given by mouth to treat a systemic or topical infection. Some antibiotics are commonly administered parenterally (typically by injection) for systemic infection or locally (typically in salves or lotions) for topical infection. Size and frequency of the dose are determined by the susceptibility of the infecting microbe; the accessibility and the acuteness or chronicity of the infection; the absorption, distribution, and fate of the drug in the body; and the patient's age and his weight or surface area. All of these factors must be correlated with the amount of active ingredient in the drug, since a variety of pharmaceutical preparations is available. Some of the early antibiotics, notably penicillin and streptomycin, were first used before they had been purified, and this necessitated the employment of arbitrarily defined "units" to quantify the antibiotic activity; such units still persist. A few antibiotics act synergistically (*i.e.*, they reinforce each other in combination), and these may be given together at the discretion of the physician; but products containing quantitatively fixed combinations of antibiotics are deprecated by expert clinicians.

Side Effects.—Being potent substances, antibiotics frequently cause biological effects other than the anti-infective action intended. The physician must therefore weigh the desired benefits against predictable side effects. Orally administered antibiotics disrupt the normal, mixed microbial flora of the bowel and may

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GROWING CULTURES OF MOLD FROM SOIL SAMPLES IN LABORATORY DISHES. CULTURES SUCH AS THESE ARE USED IN ANTIBIOTIC RESEARCH

thereby cause intestinal disturbances or permit certain species of bowel bacteria or yeasts to multiply to pathogenic levels. Parenterally or topically administered antibiotics may incite drug reactions of the skin, such as flushes, rashes, wheals, or swelling of the lips or tongue. Injection of some antibiotics may so hypersensitize a patient as to make him intolerant to further treatment with the same or a related antibiotic. Unless dosage is carefully regulated, some antibiotics may damage peculiarly vulnerable internal structures such as the hearing and balance mechanism of the inner ear or the excretory tissues of the kidney; or they may inhibit normal activity of the blood-forming tissues of the bone marrow. Some antibiotics may accumulate to toxic levels if dosage is not appropriately reduced for infants, with their immature detoxification mechanisms, or for persons with infection-impaired kidney function.

Nonmedical Uses.—A few antibiotics are widely used in animal husbandry, principally as feed additives to enhance the fattening of food animals but also to preserve semen for artificial insemination. Antibiotics have been used by food processors to lessen spoilage of poultry, fish, and vegetables. Such uses are scattered and are subject to legal limitation in some countries because prolonged exposure of healthy human beings to low residual levels of an antibiotic in food may be harmful: individuals could become sensitized and hence unable to tolerate an antibiotic that might be needed later to treat a serious infection. Possible effects on the microflora of the human body and environment might be even more harmful. Low levels of antibiotics could perhaps replace normally drug-susceptible microbes with resistant strains difficult to combat if they should ever become pathogenic. It has been suggested that these hazards could be avoided by using only nonmedicinal antibiotics in feeds and foods.

Antibiotics are sometimes used to combat infectious diseases of cultivated plants, and to prevent microbial contamination of industrial processes and products and of mammalian-cell cultures used to propagate viruses. Narrow-spectrum antibiotics added to laboratory media inhibit unwanted microorganisms and thus facilitate isolation of desired microbes from contaminated specimens.

Commercial Production.—Most industrialized countries produce at least one antibiotic, and many produce several, in privately or publicly owned manufacturing plants. Because of the specialized technical training and equipment required, extensive research and development personnel and facilities are associated with the production enterprises. The antibiotic industry in the United States produced in 1965 more than 6,500,000 lb. (3,000,000 kg.) of product with a manufacturers' value of $437,000,000.

Most of the commercial antibiotics are manufactured by cultivating a highly productive strain of the source microorganism in tanks of about 5,000 to 20,000 gal. (19,000 to 76,000 l.) capacity and isolating the pure antibiotic from the fermented broth. The

fermentation tank is partly filled with a suitable liquid culture medium, sealed to prevent contamination, and seeded with the culture. The required aerobic conditions are achieved by bubbling sterilized air through the broth medium and stirring vigorously and more or less continuously during the several days needed by the organism to multiply and form the antibiotic. Temperature and other factors are precisely regulated. Isolation of the pure antibiotic from the fermented broth involves several steps (modified to suit the nature and properties of the compound): filtration, extraction, precipitation, adsorption and elution, ion-exchange chromatography, and crystallization. Yield may be as high as several grams of pure antibiotic per litre of fermented broth.

Some of the commercial antibiotics—certain of the penicillins, cephalosporins, and tetracyclines—are manufactured by chemical modification of a related fermentation product. A few, including chloramphenicol and cycloserine, are so simple in molecular structure as to be amenable to artificial synthesis, and these are manufactured chemically.

The labels of all commercial antibiotics give the common, or nonproprietary, name of the antibiotic. Most also bear the proprietary name or trademark of the manufacturer. Since a patient's physiologic response depends on pharmaceutical formulation as well as on the active ingredient, factors such as particle size, solubility, disintegration time, and freedom from contaminants affect the quality and reliability of the prescription. Such characteristics are more likely to be found in the trademarked products because the manufacturers must meet high standards of continuous quality control.

See also references under "Antibiotics" in the Index.

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ANTICATHODE, the target inserted in an X-ray tube on which the high-speed electrons, or cathode rays (*q.v.*), are directed. In tubes with a separate anode the anticathode is generally connected electrically, and outside the tube, to the anode. In a Coolidge tube the anticathode acts also as the anode. On the impact of a sufficiently swift electron, the anticathode gives forth an X radiation characteristic of the material of which it is composed. *See* X Rays: *Excitation of X Rays;* Electricity: *The Coolidge X-Ray Tube.*

ANTICHRIST, the chief of the enemies of Christ. The earliest mention of the name Antichrist, which was probably first coined in Christian eschatological literature, is in the Epistles of St. John (I John ii, 18, 22; iv, 3; II John, 7). The conception of a mighty ruler who will appear at the end of time, and whose essence will be enmity to God, however, is older, and traceable to Jewish eschatology.

Jewish Conception.—The origin of the conception is to be sought in the first place in the prophecy of Daniel, written at the beginning of the Maccabaean period. The historical figure who served as a model for the Antichrist was Antiochus IV Epiphanes, the persecutor of the Jews, and he impressed indelible traits upon the conception. Since then ever-recurring characteristics of this figure are that he would appear as a mighty ruler at the head of gigantic armies, that he would destroy three rulers (the three horns, Dan. vii, 8, 24), persecute the saints (vii, 25) and devastate the Temple of God. In later times the tyrant who was God's enemy became a figure of prophecy, applied to various situations of crisis. Thus for the author of the Psalms of Solomon (*c.* 60 B.C.) the Roman general Pompey was the Adversary of God; the tyrant whom the Assumption of Moses (*c.* A.D. 30) expects at the end of all things possesses, besides the traits of Antiochus IV, those of Herod the Great. The eschatological imagination of the Jews was later influenced by the figure of the emperor Caligula (A.D. 37–41), who is known to have given the order, never carried out, to erect his statue in the Temple of Jerusalem. The so-called "little apocalypse" of Mark xiii (Matt. xxiv) may have been influenced in transmission by this event or, more probably, by the book of Daniel. Later Jewish and Christian writers of apocalypses saw in Nero the tyrant of the end of time.

Some of the roots of this eschatological fancy probably are to be sought in a purely mythological and speculative expectation of a battle at the end of days between God and the Devil, which has no reference whatever to historical occurrences. This idea had its original source in the apocalypses of Iran, for these are based upon the conflict between Ahura Mazda and Ahriman (*qq.v.*) and its consummation at the end of the world. This Iranian dualism entered late Jewish eschatology in the 2nd century before Christ, as is shown by the Dead sea scrolls. In this literature the name of the Devil often appears as Belial, a name which also played a part in the Antichrist tradition. The conception of the strife of God with the Devil was further interwoven, before its introduction into the Antichrist myth, with another idea of different origin, namely, the myth derived from the Babylonian religion of the battle of the supreme God (Marduk) with the dragon of chaos (Tiamat). This was originally a myth of the origin of things, which, later perhaps, was changed into an eschatological one, again under Iranian influence (*see* Babylonia and Assyria: *Religion*). Thus the Devil, the opponent of God, appeared in the end often also in the form of a terrible dragon-monster; this appears most clearly in Rev. xii. This myth—that the mighty Adversary of God was but the equivalent in human form of the Devil or of the dragon of chaos—exercised a formative influence on the conception of Antichrist. Only thus can it be explained how his figure acquired numerous superhuman and ghostly traits, which cannot be explained by any particular historical phenomenon. Thus the figure of Antiochus IV had already become superhuman when, in Dan. viii, 10, it is said that the little horn "grew great, even to the host of heaven; and some of the host of the stars it cast down to the ground." Similarly Pompey, in the second psalm of Solomon, was obviously represented as the dragon of chaos, and his figure exalted into myth. Finally, Antichrist received, at least in the later sources, the name originally proper to the Devil.

Early Church.—From the Jews, Christianity took over the idea. It is present in certain passages specifically traceable to Judaism. A fundamental change of the whole idea from the specifically Christian point of view is signified by II Thess. ii. Antichrist here appears as a tempter who works by signs and wonders and seeks to obtain divine honours; it is further signified that this "man of lawlessness" will obtain credence, more especially among the Jews because they have not accepted the truth. The conception, moreover, has become almost more superhuman than ever (*cf.* ii, 4, "proclaiming himself to be God"). The destruction of the Adversary is drawn from Isa. xi, 4, where it is said of the Messiah: "with the breath of his lips he shall slay the wicked." The idea that Antichrist was to establish himself in the Temple of Jerusalem (II Thess. ii, 4) is very enigmatical, and has not been explained. The "abomination (*q.v.*) of desolation" has naturally had its influence upon it, and possibly also the experience of the time of Caligula. Remarkable also is the allusion to a power that still retards the revelation of Antichrist (ii, 6, etc.), an allusion that, in the tradition of the Fathers, came to be universally, and probably correctly, referred to the Roman empire.

This version of the figure of Antichrist, who may now really for the first time be described by this name, appears to have been at once widely accepted in Christendom. The idea that the Jews would believe in Antichrist, as punishment for not having believed in the true Christ, seems to be expressed by the author of the fourth gospel (John v, 43). The conception of Antichrist as a perverter of men led naturally to his connection with false doctrine (I John ii, 18, 22; iv, 3; II John 7). Finally the author of Revelation also made use of the new conception of Antichrist as a worker of wonders and seducer, and set his figure beside that of the "first" beast, which was for him the actual embodiment of Antichrist (xiii, 11, etc.).

As the figure of Nero ceased to dominate Christian imagination, the unhistorical, unpolitical and anti-Jewish conception of Antichrist, based especially on II Thess. ii, gained the upper hand, having usually become associated with the description of the universal

conflagration of the world which had also originated in the Iranian eschatology. In this form it is in great part present in the eschatological portions of Irenaeus' *Against the Heresies* (2nd century) and in Hippolytus' *de Antichristo* and commentary on Daniel (early 3rd century). In times of political excitement, during the following centuries, men appealed again and again to the prophecy of Antichrist. Then special prophecies, having reference to contemporary events, were pushed to the front, but in the background remained standing, with scarcely a change, the prophecy of Antichrist that is bound up with no particular time. In the 3rd century, the period of Aurelian and Gallienus with its wild warfare of Romans and Persians, and of Roman pretenders one with another, seemed especially to have aroused the spirit of prophecy. Antichrist prophecies also flourished during the period of the rise of Islam and of the crusaders.

Middle Ages.—In the middle ages the whole complex of these dramatic eschatological conceptions developed into a most powerful historical and political factor, especially in times of crisis. From the 11th century Antichrist, "the mystery of iniquity," became the predominant element. The tradition was chiefly based on the *Pseudo-Methodius* (in a Latin version) and the letter, *De ortu et tempore Antichristi*, in which the monk Adso allayed the anxieties of Queen Gerberga, wife of Louis IV (d. 954). Theoretically canonical teaching remained stable on the whole; there was, however, much elaboration in commentaries on the Apocalypse and in the Sibylline prophecies, especially the Tiburtine and Erythrean. At the end of the 12th century the apocalyptic writings of the abbot Joachim of Floris gave an exceedingly strong and optimistic impulse to the anxious eschatological expectations by predicting, for 1260, a third age of the Holy Spirit. But while Joachim only indicated to Richard I (Coeur-de-Lion) in 1190 that Antichrist was already born in Rome (which he often identified with Babylon), his fanatical followers, the Joachites among the Franciscan Spirituals, were nearly the first to brand as Antichrist a Christian emperor, Frederick II, whose cruelty and doubtful faith, whose oriental pomp and great stature fitted their conceptions of Antichrist. Thus the idea of incarnate evil was transferred into the midst of Christianity itself; but later others saw Antichrist also at the head of the church, in the imperious Boniface VIII and the wealthy John XXII. It became quite common for opponents, popes and emperors, Guelphs and Ghibellines, etc., to hurl this name at each other. Thus the conception of Antichrist was somewhat trivialized. In the 13th century the tradition of Antichrist had been summarized in the great encyclopaedias (Vincent of Beauvais) and systematized by the great scholastics (Thomas Aquinas). Equally special tracts on his advent increased on a considerable scale, especially at the University of Paris. But some prophets of Antichrist who followed reformatory purposes came into conflict with the inquisition; *e.g.*, the famous Catalan physician and lay theologian Arnaldus de Villa Nova (1297). Scholastic refutation of all eschatological conjectures was intensified and (for instance) presented in a most comprehensive survey by Henry of Harclay, chancellor of Oxford university (1313). But immense interest continued to be focused on the person and the date of the coming of Antichrist and "the signs of the times" preceding it: upheavals in nature, wars, pestilence, famine and other disasters. All those calculations survived failure after failure. Preachers spread warnings of the coming of Antichrist in order to call the people to repentance throughout the 14th and 15th centuries. But the resulting anxieties seem to have become so aggravated that at the fifth Lateran council (1516) preachers were prohibited from presenting the coming of Antichrist as imminent. The imagination of the laity had been also deeply stirred by representations of Antichrist in paintings, sculpture and poetry. Miracle plays popularized the fearful figure of Antichrist, the earliest being the German *Ludus de Antichristo* (12th century) which had a Ghibelline bias.

The conceptions of Antichrist took yet another turn when used as a terrifying weapon in the violent controversy of the great reformatory movements. Reformist leaders did not attack individual popes but the papacy itself as being Antichrist. In England John Wycliffe, his follower John Purvey and others used it as a most effective argument. In Bohemia where, from the 14th century, a great cultural development was associated with strong opposition to the evils in the church and in political and social life, Matthias of Janow, the forerunner of John Huss, also declared Antichrist to be present within the church, at its very head, and placed hopes of a reformation on the pope's destruction. This idea that evil was embodied in the head of the church itself, with the clergy as the "body of Antichrist," became the most powerful weapon to discredit and denigrate the see in Rome. In similar terms Huss contrasted Christ with his vicar, the pope, who, when given to the vices of pride, avarice, etc., blasphemously called himself *papa*. All these ideas became the dynamic force which drove Luther on in his contest with the papacy. He even incorporated them in the Articles of Schmalkalden. He did not attack the person of the pope as Antichrist, but the institution of the papacy, which in his view placed itself above the Word of God.

After the Reformation, emphasis on the Antichrist figure gradually diminished; for German pietists any church that was spiritually dead could be regarded as its equivalent. Among some modern Protestant theologians the "Antichrist" can be interpreted as whatever resists or denies the Lordship of Christ and tends to deify a political power, within either the church or the state. The Antichrist, however, must be specifically related to the Gospel in such a way as to provide a pseudo-Christian imitation of Christ. It has been argued that the very spread of Christianity means that the possibility of rebellion against God has grown. Generally speaking, the Antichrist figure is less significant in churches of a more Catholic or Orthodox nature, where there has been less concern about the details of apocalyptic predictions.

See also APOCALYPTIC LITERATURE; ESCHATOLOGY; REVELATION, BOOK OF.

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(B. M. H.-R.; R. McQ. G.)

ANTICLERICALISM, a term applied to public opinion hostile to the influence of the clergy in political and social affairs, has been used in Europe since the time of the Cathari (*q.v.*) but is associated in more recent history with the French Revolution and its aftermath. Becoming a political movement, it first sought to separate religious authority from civil government but later attempted also when possible to subordinate the church to state control. In Latin countries, particularly France, anticlericals became numerous and influential as early as 1650. Opposition to clerical influence also grew in Austria-Hungary and Germany after 1800, and gradually took root throughout Europe as well as in Central and South America. (For anticlericalism in the U.S., *see* KNOW-NOTHING PARTY.) Three principal forms may be identified. The first, developing during the 18th century, was based on opposition to clerical privilege, often corrupt, as established by feudalism. The second is associated with the rise of liberalism, which in general deemed the clergy servile to the throne, or outmoded from the point of view of science. The third, endorsed by totalitarian systems of the right or left, considered religion the "opiate of the people," administered by a clergy chronically opposed to the "race," the "nation," or "democracy."

France.—Protestantism was seldom a major target of anticlerical sentiment until after the rise of Communist, Fascist or National Socialist governments. But the Catholic ideal of a universal church transcending national allegiances, committed to accepting the supremacy of the papacy in the realms of morals and belief, and sharing with the monarchies over a long period the rule of human society, was strongly under attack in France during the 18th century. Though fed to some extent by the tradition of

Gallicanism, skeptical inquiry, ably represented by Voltaire and the Encyclopaedists, was above all the concern of men who chafed under royal censorship and the influence of a clergy they thought medieval and obscurantist. They inveighed against *l'infâme*, by which Voltaire meant not religion but a priestly caste he termed hidebound, illiterate and absolutist. The plight of peasant and urban worker alike then aided the rapid growth of anticlericalism in the cities and some countrysides. The culmination was the French Revolution's bloody and uncompromising assault on the Catholic Church. The Revolution began by abolishing privileges and confiscating property; it ended in violent persecution, the mutilation of churches and civil war. In 1801 Napoleon ended the Revolution, signed a concordat with the papacy, and "established" the church as a religious agency supported by and subservient to the emperor. The manner in which all this was done, by making a virtual satrap of the pope, aroused sympathy with the church.

The Holy Alliance that liquidated the era of Napoleon reflected the mood of a Europe appalled by the consequence of political passion and therefore at least in part eager to restore older political institutions. Romantic admiration for the middle ages and monasticism won many writers and intellectuals over to conservatism. New religious orders were established, having educational or caritative (rather than contemplative) objectives. Not all Catholics supported the "reunion of throne and altar," but in France the majority of them did. In reality the Revolution had profoundly changed the social order. The bourgeois had become the hub the economic and intellectual activity turned round, and the bourgeois was nationalistic and emancipated. When he reacted against Bourbon rule, he gave a once more emerging anticlericalism an opportunity to ally itself with liberalism and constitutionalism. The new anticlerical was normally a rationalist, or freethinker, who considered the church outmoded, indifferent to life in this world, superstitious and unable to evaluate modern scientific progress. Anticlericals advocated a "lay state," neutral to all faiths and restricting each to the purely spiritual realm. Catholicism was to become one of the varieties of religious opinion, competing with other opinions in a free market of ideas, and not a privileged creed. Anticlericals were also motivated by nationalism, which had emerged as an ideal during the Revolution. (*See* also ROMAN CATHOLIC CHURCH: *The Church After 1815*.)

The program of the anticlerical liberals included the suppression of religious orders, separation of church and state, civil marriage and divorce, secular education, and complete freedom to profess a religion or none. Because of restrictions imposed by the proclerical governments then in power, anticlericalism was often forced underground. Secret societies, notably the Freemasons, became centres of anticlerical activity. For their part supporters of the Bourbons were dubbed the *parti prêtre*, and as their opponents grew in number they also enlisted prominent Catholics. The Revolution of 1830, which brought the Orleanist Louis Phillipe to the throne, was a setback to clericalism and absolutism alike.

Italy.—Spreading from France, anticlerical ideas and methods were adopted, in varying ways, in Italy, Spain, Portugal, Belgium and Central and South America. In Italy anticlericalism was fused with nationalism and liberalism. Pope Pius IX, defending his position as temporal ruler of the Papal States, opposed Italian unity. When Camillo Cavour embarked on his career as architect of a united Italy, he put through the Piedmontese parliament a series of anticlerical laws, abolishing the civil jurisdiction of canonical courts and suppressing many monasteries. Cavour's slogan, "a free church in a free state," was adopted by the anticlerical liberals of Italy.

Spain.—The Napoleonic invasion (1808) started an anticlerical movement in Spain. The constitution of 1812 abolished the Inquisition and restricted the number of religious orders but recognized Catholicism as the established church. This constitution was in turn abrogated when Ferdinand VII was restored to the throne in 1814. Anticlericals reacted bitterly, and from that time until 1939 the struggle between the right and left in Spain was far more a conflict between clericals and anticlericals than elsewhere in Latin Europe. Carlos, brother of Ferdinand, revolted against Queen Isabel II. The wars (1872–1876) which attended these uprisings saw many atrocities committed by clericals and their foes alike. Then the growth of the socialist movement after 1870 increased the truculence of anticlericalism. The socialists put the church in the position of being the chief defender of the established social and economic order. But by 1848 many bourgeois liberals, fearing that socialism would overthrow that order, had begun to desert anticlericalism. This trend was reversed when, in 1864, Pope Pius IX issued the *Syllabus of Errors*, the more advanced liberals viewing this *Syllabus* as a declaration of war on modern progress.

France.—The creation of the Third Republic in France (1870) was followed by constant conflict between clericals and anticlericals. First came the struggle of the years between 1871 and 1879, when royalist-clerical parties opposed republican-anticlerical parties. Léon Gambetta phrased the slogan, *"le cléricalisme, voilà l'ennemi."* The victorious republicans enacted a good deal of anticlerical legislation. The Jesuits were suppressed (1880), and the Ferry laws (1881–1882) established free, secular education, compulsory civil marriage, and the opportunity for divorce. The second conflict took place as a result of the bid of Georges Boulanger (*q.v.*) for dictatorial powers, and ended with a republican, anticlerical triumph. The third took place during the Alfred Dreyfus (*q.v.*) affair (1894–1906), when an anticlerical republican bloc was formed, consisting of all republican groups in the chamber of deputies, determined to oust royalists, militarists and clericals from public life. Further anticlerical legislation resulted. The Law of Associations (1901) suppressed nearly all of the religious orders in France and confiscated their property, and the separation law (1905) sundered church and state.

During World War I clericals and anticlericals joined in the defense of the country. Anticlericalism subsided, despite minor incidents. During the following three decades, some reconciliation was effected. Pope Pius XI condemned the antirepublican movement, *l'Action française*, and the popular front government formed by Leon Blum (1936–1937) fostered cordial relations with the church. After the fall of France during World War II, many Catholics joined in the underground struggle against the forces of Hitler. When hostilities had ended, a new prodemocratic Catholic party emerged. While anticlericalism had not disappeared in liberal circles, it was now identified with Communism.

Italy.—In Italy, after the unification, the struggle between clericals and anticlericals continued, though in a milder form than in France. The designation of Rome as the capital city ended the temporal power of the popes. A series of anticlerical laws were passed, decreasing the number of monastic foundations, suppressing university theological faculties, and establishing civil marriage. But no divorce law was enacted, nor was religious instruction banned from the schools. The Law of Guarantees accorded the pope full power to exercise his spiritual functions. Pius IX did not, however, recognize the Italian government and in 1874 forbade Catholics to participate in political activities. This caveat was not ended until 1919. The advent to power of Benito Mussolini in 1922 for a time intensified anticlericalism in Italy, Fascism claiming absolute control by the state. But despite some continuing papal opposition, no serious conflict occurred. In 1929, the Lateran treaty was signed, ending the dispute over the temporal power by making the pope ruler of the small state of Vatican City. A subsequent concordat made religion obligatory in elementary and secondary instruction. Bishops were required to take an oath of loyalty to the state. These actions angered anti-Fascists and there were signs that Cavour's policy would again dominate if the regime fell. But when World War II ended, the ominous strength of Communism in Italy evoked strong support for the Christian Democratic party.

Spain.—In Spain the conflict between church and state was intensified after 1870. Barcelona, traditionally a centre of anti-Catholic feeling, now witnessed the formation of powerful syndicalist and anarchist groups. The first Spanish republic (1873) enacted some anticlerical laws but these were repealed or disregarded when the monarchy was restored in 1875. During an anticlerical outbreak in 1909, mobs burned churches and attacked

priests. As a pacification measure, religious orders were restricted in number and taxes were levied on their industrial enterprises. Civil marriage was made compulsory. The revolution of 1931 which established the second republic brought to power an anticlerical government. The legislation adopted resembled that of France. The government was, however, unable to curb mob attacks on churches and monasteries, during which priests and nuns were slain. Catholics mustered their forces in opposition. Counterrevolutionaries led by Gen. Francisco Franco Bahamonde declared war on the republic, and were reinforced by troops from Morocco. Hitler and Mussolini aided Franco; Stalin aided the republic, which in its death struggle fell under Communist domination. A Falangist dictatorship was established which repealed or ignored the anticlerical laws, though conflict between church and state did not cease.

Central and South America.—The struggle for independence from Spain and Portugal, which characterized the history of Central and South America during the 19th century, was often strongly influenced by ideas associated with the French Revolution, among them anticlericalism. Educated citizens, including upon numerous occasions some of the lower clergy, were attracted by currents of thought that seemed novel and vital by contrast with a generally stagnant ecclesiastical culture. The Freemasons in particular were respected as spokesmen for freedom, toleration and the scientific outlook. But it is difficult, in view of turbulent political events that led almost everywhere to a succession of dictators, to determine whether the recurring patterns of anticlerical activity—the suppression of religious orders, primarily the Jesuits; the confiscation of ecclesiastical property; the fostering of secular education, sometimes with a caveat against religious instruction; and the introduction of civil marriage and divorce—were due to an intellectual ferment caused by the French Revolution or whether they were primarily incidents in the constant tussle between factions for political control. The situation varied considerably from country to country. Though Colombia, for example, witnessed the enactment of anticlerical legislation and its enforcement during more than three decades (1849–1884), it soon restored "full liberty and independence from the civil power" to the Catholic Church (1888). In Venezuela on the other hand the government of Antonio Guzmán Blanco (1870–1888) virtually crushed the institutional life of the Church, even attempting to legalize the marriage of priests. Some of the restrictions were later relaxed, but on the whole anticlericalism remained dominant. Developments elsewhere were comparable either for rigour or eventual moderation. Not merely the impoverishment and enfeeblement of the church resulted, but a mounting reluctance on the part of the hierarchy to become embroiled in any controversy. As the lines between the wealthy, whether landholders or industrialists, and the indigent masses were drawn more sharply, the leaders of labour unions and other agencies struggling for social improvement were likely to repeat the dictum that "religion is the opiate of the people," or to seek affiliation with totalitarian movements, whether of the right or the left. Upon occasion there were strong outbursts of anticlerical resentment, one of the most noteworthy being that which took place in Mexico (1924–1938). Suppressive anticlerical legislation accompanied social reform. There were sanguinary uprisings by Catholics. Meanwhile the Papacy had manifested an increasingly liberal outlook, as evidenced by a series of concordats signed with Central and South American states after 1919; and subsequent to World War II efforts to form a Christian Democratic movement were begun.

Austria-Hungary and Germany.—In Austria-Hungary anticlericalism marked the reign of Joseph II (1765–1790). Strongly influenced by the ideas of the French Encyclopaedists and those of a kindred group in southwest Germany, Joseph held that the state must control all religious activities not identified with the "inner life" of the Church. Monasteries were secularized, the education of priests was regulated, and a number of provisions governing religious cult and practice were adopted. Most of these regulations were rescinded by later emperors, and for a time anticlericalism could be identified with opposition to the Habsburgs. But toward the close of the 19th century Socialism became the effective advocate of the lay state, and was opposed by the peasants, much of the middle class and the aristocracy. After the dissolution of the monarchy in 1918 anticlericalism was rampant in some of the succession states but by 1925 the struggle had abated. After the formation of a one-party, clerical *Volksfront* government in 1934 anticlerical sentiment waxed strong in Austria proper. But it lost its virulence during the period of Nazi rule.

Anticlericalism was not novel in Germany but it was strengthened intellectually by ideas generally accepted during the French Revolution. Free thought, with its principle of the "lay state," made headway particularly in southern Germany, and played a part in the revolutionary incidents of 1848. The rise of Marxian Socialism likewise brought large segments of the working population into the anticlerical camp. But Catholics in the populous Rhenish areas were prevailingly constitutionalists, in sympathy with some tenets of liberalism, and vigorous in support of social and electoral reform. Their political program, which led to the formation of the Centre party, included the defense of the rights of all religious minorities.

Shortly after the unification of Germany in 1871 Otto von Bismarck, adopting part of the liberal program, began the series of attacks on the Catholic Church known as the *Kulturkampf*. Anticlerical legislation was enacted, applicable in part to the empire as a whole and in part to the kingdom of Prussia. The number of religious orders was restricted, the Jesuits were banned, civil marriage was sanctioned, unco-operative priests were removed from their parishes, and a variety of measures were adopted to curb the freedom of the clergy. Resistance was punished, and some bishops were deposed. But by 1878 a desire to end the *Kulturkampf* was manifest, and during the next decade most of the anticlerical legislation was removed from the statute books. (*See* also LEO: *Leo XIII*.) The prohibition of the Jesuits remained in force, however, until 1917. The period of the Weimar Republic (1919–1933) was characterized by the grant of complete freedom to Catholics, though as a result of the activity of the Centre party some anticlerical comment was engendered.

The Nazi dictatorship (1933–1945) enforced its own anticlerical program on Catholics and Protestants alike. Hitler attempted to regulate his relations with the Vatican through a concordat, signed in 1933, but this was honoured in the breach rather than in the observance. Protestants were united, by ruse or force, in a German Christian Church. The ablest Protestant clergymen dissented, forming the heroic Confessing Church upon which heavy blows fell. Catholics opposed, often with genuine courage, a series of decrees affecting the liberty of preaching, the treatment of minorities, the control of education and the silencing of the press. Hundreds of clergymen, both Catholic and Protestant, were brought to trial, imprisoned or executed. Rigour was even greater in the conquered lands. Hitler planned, in the event of final victory, to reduce the Christian religion in his dominions to impotence. A decade after the end of World War II it appeared that the Nazi and Fascist ideologies had lost all but minor vestiges of their influence. Anticlericalism in Europe became a normal consequence of the support given by the Catholic Church to the Christian Democratic parties, or part of Communist doctrine.

Soviet Anticlericalism.—After the seizure by the U.S.S.R. of the Baltic states and of eastern Poland in 1939, repression fell heavily on the Catholic and Protestant Churches of Estonia, Latvia, Lithuania and Poland. Occupation and eventual subjection of the satellite countries and eastern Germany after the war were followed by usually less violent but nonetheless implacable actions in the area of religious activity. At the conclusion of notorious trials, the foremost prelates of Yugoslavia, Czechoslovakia, Hungary, Poland and Rumania were imprisoned. Many thousands of bishops, clergymen and faithful layfolk were sent to prisons or slave labour camps. Religious education and publishing were forbidden, only a handful of convents and monasteries were suffered to remain, and hospitals were secularized. The Catholic clergy in Albania was decimated, and the Uniate Churches in Rumania and Bulgaria were destroyed. During 1956 some amelioration of the situation was permitted in Poland. Russian (Communist) anticlericalism is characterized by unrelenting hostility to religion in

any form save that of complete subservience to the Kremlin. Its watchword is not the "lay state," but the "classless society."

See ULTRAMONTANISM.

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(J. S. So.; G. N. S.)

ANTICOSTI, an island in the Gulf of St. Lawrence, a part of Saguenay county, in the province of Quebec, Can., about 400 mi. downstream from Quebec. It is 135 mi. long, and its greatest breadth is 30 mi. With a total area of 3,043 sq.mi., it contains an estimated 500,000,000 spruce, balsam and pine trees and some species of hardwood.

It was first sighted by Jacques Cartier in 1534 and named Assomption Island. Its present name, derived from an Indian dialect, was already used in the 17th century; it means "where bears are hunted." The island was ceded by France to Great Britain in 1763 and annexed to New Brunswick; under the terms of the Quebec act (*q.v.*) it became part of the Province of Quebec in 1774. Uninhabited for more than two centuries, the island was leased in 1895 by Henri Menier, French chocolate manufacturer, who developed the local resources and built a château at Port Menier, near the west end of the island. In 1926 ownership of Anticosti was transferred to the Consolidated Paper corporation of Montreal which has since administered the island, conducting lumbering operations and shipping pulpwood to its plants in the vicinity of Trois-Rivières on the St. Lawrence. The population is less than 1,000. (P. CA.)

ANTICYCLONE, a feature of weather maps and climatic charts appearing as a region in which the pressure is higher than in the surroundings; in common meteorological parlance, anticyclones often are simply referred to as "highs." The name anticyclone was introduced by Sir Francis Galton in 1861 to denote an atmospheric system opposite to a cyclone (*q.v.*). Whereas in a cyclone or low-pressure area the winds circulate in a counterclockwise sense in the northern hemisphere and clockwise in the southern hemisphere, the anticyclonic circulation is clockwise in the northern and counterclockwise in the southern hemisphere. In contrast with cyclones, which are usually areas of strong winds and bad weather, anticyclones ordinarily are characterized by fine weather and weak winds.

The most prominent anticyclones of the earth are the more or less permanent ones found over the oceans of both hemispheres at about latitude 30°. (*See* WIND.) They are oblong in shape, covering nearly the entire breadth of the oceans in these latitudes with the highest pressure centre somewhat to the east of the geometric centre. Their position and strength are important factors in forecasting weather for all latitudes, and for this reason they are referred to as the "centres of action" for the general circulation. In winter, anticyclones are found more or less regularly over the cold, high-latitude continents, notably in eastern Siberia, where they are the principal feature of the Asiatic winter monsoon (*see* MONSOON). These are called thermal anticyclones, since their formation is caused by cooling in the lower atmosphere, and they disappear or are displaced equatorward at upper levels. The oceanic anticyclones contain warm air, except possibly in a shallow layer next to the surface of the earth, and are called dynamic anticyclones. They maintain or even increase their intensity aloft.

See also Index references under "Anticyclone" in the Index volume. (H. R. B.)

ANTIDOTES, remedies for counteracting poisons. The following antidotes for special poisons are sometimes given in case of emergency, usually following and followed by an emetic, and whenever possible under the supervision of a physician. In general, antidotes for acid poisons are: ammonia (a teaspoonful to one-half pint of water) or limewater, plaster, magnesia or chalk. For alkali poisons, antidotes are vinegar, dilute acetic acid or lemon juice.

For an unidentified poison, the general rule is to give eggs, salad oil (except in phosphorus poisoning), flour and water or limewater (except for alkaline poisons), preceded by large drafts of water or milk, and to induce vomiting by placing the finger in the throat or by an emetic. Kitchen soap and water may be used several times repeated. The antidote is only one part of the treatment, which may include first an emetic, often followed by stimulants such as strong black coffee.

ANTIDOTES FOR SPECIAL POISONINGS

Alkalies: Dilute acids; vinegar, one glass to one quart of water; dilute acetic acid, 2%–3%; lemon juice; soothing fluid; oils; melted fat; milk; cream. (No emetic.)

Alkaloids (aconite, belladonna, strychnine, etc.): Gastric lavage with tannic acid or potassium permanganate; artificial respiration or oxygen therapy. Control excitement with barbiturates.

Antimony (tartar emetic, wine of antimony): Same as for mercury. Strong coffee or tea; one teaspoonful of tannic acid in one-half glass of water followed by eggs or milk.

Arsenic (Fowler's solution, paris green, Scheele's green, Schweinfurt green, arsenical dyes in papers and candies): Gastric lavage with sodium thiosulfate: sodium thiosulfate intravenously. Prevent dehydration with parenteral fluids.

Carbolic acid (creosote, guaiacol, creosol): Soluble sulfates, such as magnesium sulfate, sodium sulfate (epsom and Glauber's salts), dilute alcohol, raw eggs, flour and water, milk, castor or sweet oil. (No emetic.)

Copper (blue vitriol or bluestone, verdigris): Milk; eggs; soap; flour and water.

Depressants (chloral, barbiturates, etc.): Gastric lavage. Stimulants such as picrotoxin or metrazol; artificial respiration.

Formaldehyde: Bland drinks; milk; and oils.

Hydrochloric (muriatic), nitric (aqua fortis), oxalic, acetic, sulfuric (vitriol) acids: Weak alkaline drinks at once; ammonia (eight teaspoonfuls in one-half pint of water); baking soda; magnesia; chalk; lime; soap and water; or tooth powder. (No emetic.)

Iodine: Starch and water.

Lead: Gastric lavage and epsom salts to hasten elimination. If symptoms are acute, demobilize the lead by diet rich in calcium and phosphorus.

Mercury (corrosive sublimate or bichloride of mercury, blue ointment, oxide of mercury, black wash, yellow wash, cinnabar vermilion): Gastric lavage with sodium formaldehyde sulfoxylate; raw eggs; or milk. Sodium lactate for acidosis; parenteral fluids and sodium formaldehyde sulfoxylate intravenously. Treatment for shock.

Opium: No antidote (emetics and stimulants used). Artificial respiration if breathing stops. Repeated doses of central-nervous-system stimulants. Do not exhaust the patient by making him walk the floor.

Phosphorus: Magnesia in water; potassium permanganate, 1 to 1,000 solution in water; copper sulfate (bluestone in water); repeated five-grain doses to cause vomiting; turpentine; one-half teaspoonful in a glass of milk or water. Do not give oils or fats.

Plant poisoning: Plant poisons in general do not require an antidote, being treated by induced vomiting, stimulants and brisk purging, as with castor oil.

Prussic acid: Gastric lavage; amyl nitrite by inhalation followed by sodium nitrite and sodium thiosulfate intravenously. Methylene blue intravenously.

Ptomaine (poison from decayed meats, fish, vegetables, contaminated canned foods): (After emetic) castor oil, epsom salts

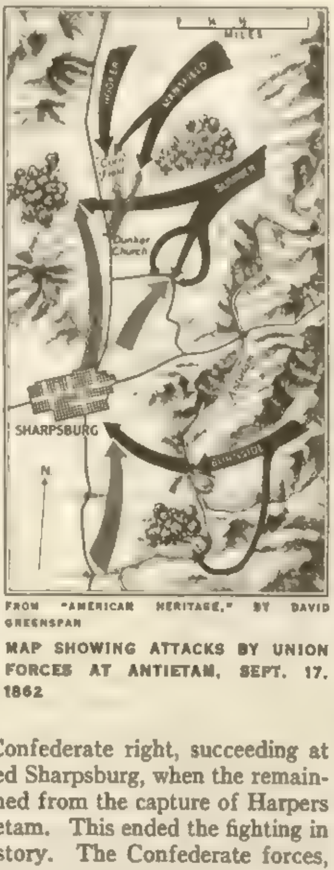
or other rapidly acting cathartic; enema of warm soapsuds with one teaspoonful of turpentine to the pint or two teaspoons of glycerine.

Silver preparations (silver nitrate, lunar caustic): Large drinks of salt water; soap; drafts of milk; baking soda.

ANTIENZYMES: *see* ANTIMETABOLITES.

ANTIETAM, BATTLE OF, one of the more important engagements of the American Civil War. It was fought on Sept. 17, 1862, and took its name from Antietam creek that has its source near Gettysburg, Pa., and flows almost due south to the Potomac river near Harpers Ferry, W.Va. It is sometimes referred to as the battle of Sharpsburg because the main fighting took place near the town of that name.

Following Gen. John Pope's defeat at the second battle of Bull Run (*q.v.*), Gen. *Robert E. Lee* advanced into Maryland as far as Frederick, northwest of Washington, D.C., with some assurance that he might capture the city. When he learned that Gen. George B. McClellan, again in command of the reorganized Federal army, was opposing his further advance, he withdrew toward the southwest. His plan was to hold McClellan at a possible stronghold at South mountain, which paralleled Antietam creek. Meanwhile, "*Stonewall*" *Jackson* was ordered to capture Harpers Ferry and rejoin *Lee*. With his forces thus divided, *Lee* was unable to hold South mountain and therefore took up positions due west of it along Antietam creek.



FROM "AMERICAN HERITAGE," BY DAVID GREENSPAN

MAP SHOWING ATTACKS BY UNION FORCES AT ANTIETAM, SEPT. 17, 1862

Here the battle of Antietam was fought as McClellan moved his army west against *Lee*. Gen. Joseph Hooker's corps attacked *Jackson* on *Lee's* left at 5 A.M. on Sept. 17. Hooker's advance promised well but met stubborn resistance and had to be supported by Gen. Joseph Mansfield's corps. Confederate counterattacks stopped and drove back the Federal forces, and then Gen. Edwin Sumner's corps was thrown into the battle, followed by a counterattack by Gen. *James Longstreet's* corps. The battle proceeded without notable success on either side from early morning until afternoon. McClellan's next move was to send Gen. Ambrose E. Burnside's corps against the Confederate right, succeeding at first. Burnside had almost captured Sharpsburg, when the remainder of *Jackson's* corps, freshly armed from the capture of Harpers Ferry, drove him back to the Antietam. This ended the fighting in one of the bloodiest battles of history. The Confederate forces, variously estimated at from 40,000 to 60,000, had lost between 9,000 and 10,000 killed and wounded; McClellan's force of from 70,000 to 90,000 (a portion of whom were not actively engaged) lost about 12,000. McClellan's orders for the day after the battle and following indicate that he expected another attack by *Lee* and he was therefore relieved when *Lee* retired into Virginia. Most military historians have strongly criticized McClellan's conduct of the battle.

Antietam is regarded as one of the decisive battles of the Civil War because it stopped one of the greatest threats to Washington during the war. McClellan blocked *Lee's* advance but failed to win a victory over him. The battle is sometimes cited as influencing Great Britain not to recognize the Confederacy, but this is largely conjecture. The outcome of the battle led Pres. Abraham Lincoln to issue a proclamation (Sept. 22, 1862) stating that he would, on the opening day of the new year, declare all slaves in the seceding states "forever free."

See also AMERICAN CIVIL WAR.

See Douglas S. Freeman, *Biography of Robert E. Lee*, vol. ii, ch. 25–28 (1934–35). (FR. H. H.)

ANTIFEDERALISTS, the name given to those who opposed ratification of the United States constitution of 1787. Though a mixed group with diverse reasons for opposition, they were united by fear of the proposed increase in the authority of the national government and in the powers to be exercised by the congress. They believed that one republican government could not operate successfully over the entire nation, that the small size of the lower house of the legislature would make it impossible for all interests in the country to be represented and that the electoral system would operate to the advantage of the upper classes. They believed the proposed constitution violated the principle of separation of powers, and that it was drafted so loosely as to leave congress a dangerous latitude of discretion. They criticized the lack of a Bill of Rights, but were also opposed to the prohibition of religious qualifications for office-holding included in the constitution. They shared the distrust of human nature expressed in *The Federalist*, and feared that their liberties and interests would be jeopardized by a national government which would be beyond the control of the people of any particular state, and which many believed would have an aristocratic bias.

The Antifederalists were strong in the key states of Massachusetts, New York and Virginia; in North Carolina and Rhode Island they prevented ratification until after the new government had been established. Their advocacy of a Bill of Rights led to its adoption, and their opposition to a strong central government has not been without adherents in the subsequent history of the United States.

See also FEDERALIST PARTY; UNITED STATES (OF AMERICA): *Government*.

See Forrest McDonald, *We the People: the Economic Origins of the Constitution* (1958); C. M. Kenyon, "Men of Little Faith: the Anti-Federalists on the Nature of Representative Government," *William and Mary Quarterly*, third series, vol. xii, no. 1 (1955). (C. M. KE.)

ANTIFREEZE, a liquid used in cooling systems, particularly those of automobiles, to prevent freezing.

The various commercial brands of so-called permanent antifreezes are basically ethylene glycol, $C_2H_4(OH)_2$, a synthetic dihydroxy alcohol. Its boiling point of about 375° F. is well above the maximum cooling-system temperature and prevents loss by evaporation. Most other commercial antifreezes are basically methanol, CH_3OH, which boils at about 150° F. The boiling point of water is reduced by adding methanol. A solution that is one-third methanol and two-thirds water boils at about 180° F., a temperature that is not attained in normal operation with a thermostat set to open at 160° F. When stronger solutions are necessary, they must be tested periodically and replenished because of evaporation of the methanol. Test hydrometers indicate the percentages of antifreeze in solutions and their freezing points, employing the fact that addition of methanol makes the solution lighter and glycol makes it heavier than water.

Periodic maintenance checks for dilution and for the effectiveness of corrosion inhibitors are necessary for all antifreeze solutions. Also, seepage into the cylinders may cause serious lubrication difficulties. Though some factory-installed coolants (glycol ethers) have been recommended for continuous use over a two-year period, any significant dilution could result in loss of protection from freeze-ups or from rust and corrosion.

The following tabulation shows the percentages of either of the two types of antifreezes in water solutions corresponding to several freezing temperatures.

Temp. (° F.)	10	5	0	−5	−10	−15	−20	−25	−30	−35	−40
Glycol (%)	24	28	32	35	38	41	43	45	48	50	52
Methanol (%)	21	24	27	30	32	35	37	39	42	44	46

(O. C. C.)

ANTIFRICTION BEARINGS: *see* BEARING METALS; BEARINGS.

ANTIGONE, the name of two figures in Greek legend.

1. Antigone was the daughter born of the incestuous union of Oedipus (*q.v.*) and his mother, Jocasta. After her father's blinding, Antigone and her sister Ismene served as Oedipus' guides,

following him from Thebes into exile until his death near Athens (related by Sophocles in *Oedipus at Colonus*). Returning to Thebes they attempted to reconcile their quarreling brothers, but failed, afterward suffering the siege of the Seven Against Thebes (*q.v.*), in which both brothers were killed, Eteocles defending the city and his crown, Polyneices attacking. Their uncle Creon thereupon became king, and having visited the body of Eteocles with elaborate obsequies, forbad the removal of the corpse of Polyneices, condemning it to lie unburied to rot on the argument that he was a traitor. Antigone, moved by love of her brother and convinced of the injustice of the command, which violated divine law and normal usage, buried Polyneices secretly and performed his funeral service. For this she was ordered executed by Creon and was interred in a cave, where she hanged herself. Her beloved, Haemon, son of Creon, committed suicide. (This according to Sophocles' *Antigone;* but in Euripides, Antigone escaped and lived happily with Haemon, at least for several years.)

2. Antigone, sister of Priam, boasted to Hera of her beautiful hair, which the goddess then transformed to a mass of snakes. The gods took pity on her and turned her into a stork (Ovid, *Metamorphoses*). (T. V. B.)

ANTIGONUS I Cyclops or Monophthalmus ("the One-Eyed") (382–301 B.C.), Macedonian general and, after the death of Alexander III the Great (323 B.C.), ruler of a major part of the Macedonian empire. In 333 Alexander made him satrap of Greater Phrygia with the duty of protecting the communications of the invading army in this recently conquered area. After Alexander's death he was driven out by Perdiccas (*q.v.*), but was restored by Antipater (*q.v.*). At the settlement at Triparadisus in Syria (321), when Antipater became regent of the Macedonian empire, Antigonus was appointed commander of the royal army in the war against Eumenes (*q.v.*), whom he defeated in Asia Minor (320) and later, in a hard-fought campaign (318–316), in Mesopotamia and Media.

Antigonus revealed his ambition to reunite the divided Macedonian empire under himself when, after the final defeat and death of Eumenes at Gabiene in Persis (316), he claimed authority over the whole of Asia, dismissed and appointed satraps at will and seized royal treasure for his own use. The other leading generals of the empire, Ptolemy (*see* Ptolemies), Antipater's son Cassander, Lysimachus and Seleucus (*qq.v.*), formed a coalition against him, and a long war began. The first period of this war brought no decision; Antigonus had won over much of Greece, but he had lost a battle at Gaza in southern Palestine (312), as a result of which Seleucus conquered Babylonia and the eastern satrapies of Media and Susiana. In 311 Antigonus made peace with the other allies in order to concentrate his forces against Seleucus. During the next four years Antigonus failed to dislodge Seleucus from the eastern regions of the empire. In 306, after his son Demetrius, who had seized Athens from Cassander in 307, defeated Ptolemy's forces on Cyprus, Antigonus took the title of king for himself and his son, at last explicitly claiming the succession to Alexander. Both his attempt to invade Egypt (winter 306–305) and his siege of Rhodes, conducted by Demetrius (304), failed. But a new campaign by Demetrius in Greece (303–302) was brilliantly successful. In 301, however, the allies Cassander, Lysimachus and Seleucus brought about the defeat and death of Antigonus in the battle of Ipsus (*q.v.*) in Phrygia.

Antigonus was an excellent general and a vigorous and capable ruler. His support of the right of Greek cities to enjoy autonomy was essentially a weapon for use against his enemies (as was his revival of the Greek league—the League of Corinth—of Philip II of Macedonia and Alexander); but his policy was a sensible one, and it won him the friendship of the Greek states, notably Athens.

See also Index references under "Antigonus I" in the Index volume.

See R. H. Simpson, "Antigonus the One-Eyed and the Greeks," *Historia*, vol. viii (1959). (R. H. Si.)

ANTIGONUS II Gonatas (*c.* 319–239 B.C.), king of Macedonia from 276, was the son of Demetrius I Poliorcetes (*q.v.*). Left in charge of Greece when his father set out upon his final campaign in Asia (287), he at first had great difficulty in holding his own in wars against Pyrrhus, king of Epirus; Lysimachus; Antiochus I (*qq.v.*); Ptolemy Ceraunus (*see* Ptolemies); and some of the Greek cities. He assumed the title of king on his father's death in 283, but it was not until 276 that he gained control of Macedonia. In 279 he had concluded peace with Antiochus, whose sister Phila he married, and thereafter his foreign policy was marked by friendship with the Seleucids. However, he had Ptolemy II as a dangerous enemy in Greece and the Aegean.

When Pyrrhus returned from Italy in 274 after the battle of Beneventum he attacked Macedonia and deprived Antigonus of large tracts of territory before passing on to southern Greece where he was killed at Argos in 272. Antigonus thereupon recovered his position in Macedonia and Greece. Sparta and Athens, supported by Egypt, fought against him (unsuccessfully) in the Chremonidean War (267–262); later, by defeating the Egyptian fleet in an important battle off Cos (258), he won control of the Aegean sea. Between 250 and 245 a disloyal lieutenant called Alexander deprived him of control of Corinth and Chalcis in Euboea, the two bases from which he dominated southern Greece; but he won a second victory at sea over Ptolemy off Andros (246) and once more secured his position on the mainland. The end of his reign saw Corinth again lost (243) and an inconclusive struggle with the Achaean league under Aratus (*q.v.*) of Sicyon.

Antigonus was a moderate man with many admirable qualities. He rebuilt the power of Macedonia, seriously weakened since the death of Cassander (*q.v.*) in 297 B.C., and safeguarded Macedonian interests by keeping Greece divided without attempting to conquer the whole country. He encouraged the arts; in his literary circle poetry, history and philosophy were represented. He himself was considerably influenced by personal contact with the philosophers Menedemus of Eretria and Zeno, the founder of Stoicism.

See W. W. Tarn, *Antigonos Gonatas* (1913). (R. H. Si.)

ANTIGUA, an island of the Lesser Antilles in the Caribbean. With Barbuda and Redonda it forms a British colony and was one of the 12 territories comprising The West Indies federation (*q.v.*). Antigua lies at the southern end of the Leeward Islands chain, and has an area of 108 sq.mi. The coast line is intricate with many bays and headlands fringed with reefs and shoals; several inlets, including St. Johns, Parham and English Harbour, afford anchorage for shipping. The island is low and undulating but in the south a range of hills rises to 1,319 ft. at Boggy Peak. An absence of mountains and thorough deforestation distinguish Antigua from the other Leeward Islands. As there are no rivers and few springs, prolonged droughts occur despite a mean annual rainfall of about 44 in.

The Leeward Islands colony was defederated in 1956, and in 1958 Antigua joined The West Indies federation. The system of government is ministerial, and the executive council consists of four elected, one nominated and one official member, presided over by the administrator. In the federal parliament Antigua is represented by two members in the lower house and two in the senate.

The population of Antigua (1960) was 54,354 (including Barbuda), of which 21,396 lived in St. Johns, the capital city. There is chronic unemployment and underemployment, and, of a total of 9,500 wage earners about 4,000 are employed in the sugar industry, though numbers are higher during the harvesting season. The main products are sugar, cotton and molasses; in the late 1950s sugar constituted about 45% of the value of exports, with cotton, in second place, furnishing 20%. Exports in this period totaled about B.W.I. $7,000,000 and imports between B.W.I. $11,000,000 and $13,000,000. Tourism is an important industry, and Antigua has good hotels. The former naval base at English Harbour has been restored and is a favoured berth for yachts. Main imports consist of food, clothes, timber and nonedible oils. A number of shipping lines call at St. Johns and airlines provide regular services to Coolidge field in the north of the island. In the late 1950s government revenues and expenditures balanced out at slightly less than B.W.I. $9,000,000. Provisions for grant-in-aid are made by the British government. By the end of the development planning period in 1960, Antigua had received B.W.I. $6,123,200 since 1945.

Primary and post-primary education is compulsory at 34 government and 11 private schools. There are 7 secondary schools attended by 2,000 children, and a teachers' training college.

Antigua was discovered in 1493 by Christopher Columbus who named it after the church of Santa Maria la Antigua in Seville, Spain. It was colonized by English settlers in 1632 and remained a British possession, although raided by the French in 1666. In 1941 the United States obtained a base on a 99-year lease under the lend-lease agreement. This base was partially reactivated in 1955 in connection with the firing of long-range missiles.

Barbuda, formerly Dulcina, lies 25 mi. N. of Antigua. It is 62 sq.mi. in area and had a population of 1,145 in 1960. Barbuda is a coral island, flat and well-wooded, with highlands rising to 200 ft. in the northeast. Codrington, the only settlement, lies on a lagoon on the west of the island; an anchorage at The River, the nearest point to Antigua, is favoured by sloops. The inhabitants are fishermen, smugglers, farmers and charcoal burners. There is a government stock farm and the island has long been used as a game reserve.

Barbuda was colonized in 1628 and granted to the Codrington family in 1680. It reverted to the crown in the late 19th century. There is an Anglican church and primary school, and several chapels.

Redonda, an uninhabited rock, lies 34 mi. W.S.W. of Antigua. It rises sheer to a height of 1,000 ft. and is ½ sq.mi. in area. Phosphate of alumina (discovered in 1865) was worked there until 1916 with an annual output of about 7,000 tons.

See *Colonial Office List* (H.M.S.O., annually). (R. To.)

ANTIGUA (ANTIGUA GUATEMALA), a city in Sacatepéquez department, Guatemala, was capital of the former captaincy general and once the most important seat of Spanish colonial government between Mexico City and Lima, Peru. Pop. (1957 est.) 13,367. Founded as Santiago de los Caballeros (Ciudad Vieja) in 1527, it was destroyed by a torrent that swept down from the slopes of the volcano Agua. Antigua, which was constructed in 1542 near the site of Ciudad Vieja following this disaster, was demolished by an earthquake in 1773 and the capital was moved 15 mi. to the site of modern Guatemala City in the hope of avoiding further disasters; the previous seat of government became known as *la antigua capital* (the old capital), or Antigua.

The present city is noted chiefly for the ruins of colonial edifices that make it a museum of Spanish colonial history. On or near the central plaza, several of the principal buildings of the colonial capital still serve public functions: the palace of the captains general, the cathedral, the municipal palace and the University of San Carlos. Among the larger ruins of religious structures that dot the city are the churches and convents of San Francisco, Capuchinas, Compañia de Jesús and La Recolección. The church of La Merced survived the earthquake and is still in use. Several private dwellings of the colonial period have been restored, the most famous of which is the Wilson Popenoe house.

In the environs are San Juan del Obispo, restored countryseat of colonial churchmen; Ciudad Vieja; Indian villages such as San Antonio Aguas Calientes, noted for its quality weaving; and Santa María de Jesús, a town of palisaded compounds high on the slopes of Agua.

Antigua has several modern hotels situated in quiet, picturesque surroundings. The grandeur of its setting, at the base of towering volcanoes, and its benign climate make the city a favourite resort and residential site. A paved highway leads to Guatemala City.

(W. J. G.)

ANTIHISTAMINES are a group of drugs which reduce or prevent the physiological action of histamine (*q.v.*) by competing with it at the places in the body where it normally acts. True antihistamine drugs are competitive inhibitors of the action of histamine and have no clear-cut action in its absence. They act differently from drugs such as epinephrine (*see* ADRENALINE AND NORADRENALINE) which tend to act as antidotes to histamine by producing opposite physiological actions.

Medicinal use of antihistamines is based upon evidence that histamine causes many of the symptoms of various allergic disorders. Normally histamine is present in tissues in a bound, physiologically inactive form, and only under certain conditions in which it is released from the bound form does it exhibit toxicity. Therefore, in various allergic conditions, the symptoms which are relieved by the antihistamines are believed to be due to histamine which has been released from its bound form in the tissues.

The first specific antihistamine drug to be used therapeutically was Antergan (dimethylaminoethylbenzoyl-aniline), which was introduced in 1942 in France. Soon afterward a similar compound with lower toxicity, called Neo-Antergan, was developed in the same country. In 1945 Diphenhydramine, an ethanolamine derivative, was introduced in the United States, and thereafter numerous antihistamine drugs were developed. All of them have the same basic structure, which may be represented as follows:

$$R-X-\underset{|}{\overset{|}{C}}-\underset{|}{\overset{|}{C}}-N\Big<$$

The commonly used antihistamine drugs are derivatives of ethylenediamine, ethanolamine and propylamine, which have nitrogen, oxygen and carbon respectively for the X in the type formula shown above. Each has its special virtue: ethylenediamines generally are effective in lower doses; ethanolamines have the most powerful sedative actions; and propylamines exhibit lower toxicity and fewer side effects.

The antihistamine drugs inhibit or abolish many of the actions of histamine, including histamine-induced intestinal spasm, fall in blood pressure and increased capillary permeability. They are used most widely in the treatment of hay fever and other allergies. In general, they have been disappointing for the treatment of asthma, although in some cases they afford partial relief. Some but not all of the antihistamine drugs relieve the nausea and vertigo which occur in such conditions as motion sickness, early pregnancy and radiation sickness.

All the antihistamines have some toxic effects that are unrelated to their ability to antagonize histamine. The commonest untoward reactions are due to central nervous system depression; they include drowsiness, delirium and coma. Neuropsychiatric manifestations such as nightmares, confusion and mental depression may occur as well as headache, dryness of the mouth, dilated pupils and blurred vision. Respiratory failure, sometimes preceded by convulsions, follows the administration of a lethal dose.

See also ALLERGY AND ANAPHYLAXIS; HAY FEVER.

(K. P. DU.)

ANTILEGOMENA (Gr. "contradicted," "disputed"), an epithet used by early Christian writers to denote books whose claim to be included in the New Testament canon was in doubt. As examples, Eusebius of Caesarea (4th century) lists the epistles of James and Jude, II Peter and II–III John.

ANTILIA (ANTILLA or ISLAND OF THE SEVEN CITIES; Port. ILHA DAS SETE CIDADES), a legendary island in the Atlantic ocean. It is marked in several 15th-century maps, being accompanied in most of them by smaller *insulae de novo repertae*, "newly discovered islands," Royllo, St. Atanagio and Tanmar. The Florentine Paolo Toscanelli, in letters to Columbus and the Portuguese court (1474), takes Antilia as the principal landmark for measuring the distance between Lisbon and the island of Cipango or Zipangu (Japan). According to Portuguese tradition, after the Moors had conquered Spain and Portugal, the island of Antilia or Septe Cidades was colonized by Christian refugees under the archbishop of Oporto and six bishops. Each leader founded and ruled a city, free from the disorders of less Utopian states. Later tradition localized Antilia in the largest of the Azores, St. Michael's. The legend may commemorate some imperfectly recorded discovery or may embody the idea of a western elysium like the Isles of the Blest, or Fortunate Islands.

ANTILLES comprise all the islands of the West Indies (*q.v.*) except the Bahamas. They are distinguished according to size, being divided into two major groups: the Greater Antilles include Cuba, Hispaniola (Haiti and Dominican Republic), Jamaica and Puerto Rico; the Lesser Antilles are the rest of the islands. The chain of islands curves for about 2,500 mi. in a broad arc from Florida to the northern coast of Venezuela. In general, the islands

are mountainous with tropical climate and vegetation.

The term dates traditionally from a period before the discovery of the new world, when it was called *Antilia* and referred to semi-mythical lands located somewhere west of Europe across the Atlantic. On medieval charts it was sometimes indicated as a continent or large island and sometimes as an archipelago. After discovery of the West Indies by Columbus, the Spanish term *Antillas* was commonly assigned to the new lands. (D. R. D.)

ANTILOCHUS, in Greek legend, son of Nestor, king of Pylos. One of the suitors of Helen, he accompanied his father to the Trojan War and distinguished himself as acting commander of the Pylians. He was a friend of Achilles, to whom he was commissioned to announce the death of Patroclus. When Nestor was attacked by Memnon, he saved his father's life at the sacrifice of his own, thus fulfilling the oracle that had bidden him "beware of an Ethiopian." According to late accounts, he was slain by Hector or by Paris in the temple of the Thymbraean Apollo together with Achilles.

ANTIMACHUS (fl. *c.* 400 B.C.), of Colophon or Claros, Greek poet and grammarian, wrote a lengthy epic *Thebais*, an account of the expedition of the Seven Against Thebes and the war of the Epigoni. He thus became the founder of "learned" epic poetry and the forerunner of the Alexandrian school, whose canon allotted him the next place to Homer. He also wrote an elegiac poem *Lyde*, so called after his mistress. These poems, though not popular, were praised by Plato. He also prepared a critical recension of the Homeric poems (mentioned 12 times in the Venetian scholia).

See C. B. Wyss, *Antimachi Colophonii Reliquiae* (1936); T. Bergk, *Poetae Lyrici Graeci*, various editions (1843–1915).

ANTIMASONIC PARTY, a U.S. political organization influential between 1827 and 1836. The Antimasonic movement was touched off in western New York state by the mysterious disappearance of William Morgan of Batavia, N.Y., a Freemason and itinerant worker with some intellectual doubts concerning the Order of the Masons. Morgan had prepared for publication a book, *Illustrations of Masonry*, revealing the order's secrets. Charged with stealing and indebtedness, apparently as a pretext for seizing and arraigning him, Morgan was committed in Sept. 1826 to an Ontario county, N.Y., jail and was reportedly kidnapped shortly after his release. His ultimate fate was never known; the opinion was widely held that he had been murdered. When Masonic leaders refused to co-operate in the excited and prolonged search for clues and culprits, the press, churches, temperance and antislavery elements joined in condemning all Freemasonry as responsible for the "murder." The democratic and libertarian spirit uniting these elements attracted the support of many farmers and workers, a political fact not lost upon the leaders of the declining National Republican party in the state. Although not yet openly identified with the National Republicans, Thurlow Weed (*q.v.*), publisher of the *Rochester* (N.Y.) *Telegraph* and subsequently of the *Anti-Masonic Enquirer* led the press assault on Freemasonry, editorially endorsing Antimasonic candidates for state offices in the fall campaign of 1827. When 15 of these candidates were elected to the state assembly, the Antimasonic party came into being. During 1828 New York members held their first state party convention and in Feb. 1829 held a second. National conventions met at Philadelphia on Sept. 11, 1830, and at Baltimore Sept. 1831, the latter to nominate candidates for president and vice-president.

Between 1828 and 1831 the Antimasonic movement had spread across the middle Atlantic states into New England, usually through church, temperance and antislavery channels. As it developed, however, New England Antimasonic collaboration in elections was with Jacksonian Democrats, rather than National Republicans as in New York.

The Antimasonic national nominating convention of 1831 in Baltimore was the first of its kind in U.S. political history. Thirteen states were represented by 116 Antimasons. The convention required a special three-fourths majority to nominate, establishing the precedent for the two-thirds rule used by the Democrats in subsequent national conventions for more than a century. William Wirt of Maryland, attorney general under James Monroe and John Quincy Adams, was nominated for president, although substantial elements in the convention favoured endorsing Henry Clay, about to become the National Republican nominee. The Antimasonry issue had by this time, however, become secondary to internal improvement and the protective tariff; Wirt himself was a Freemason.

The Antimasonic party's achievements in national elections were few. In the presidential contest of 1832 it carried only Vermont. The party at the same time won a large number of seats in the 23rd congress (1833–1835), but few thereafter. Nonetheless, its influence lingered on in other ways. Its national convention system was followed in 1831 and 1832 by the National Republicans and the Jacksonian Democrats, and subsequently by the present major U.S. political parties. Further, several of the party's prominent leaders became founders of the national Whig and Democratic parties. *See* also FREEMASONRY.

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(R. M. G.)

ANTIMATTER. An atom of ordinary matter is composed of a nucleus of positively charged protons and uncharged neutrons that is surrounded by a cloud of orbiting, negatively charged electrons (*see* ATOM). In 1928, the existence of an elementary particle equal in mass to the electron but bearing a positive electric charge was foreseen by P. A. M. Dirac in his relativistic quantum theory (*see* ELECTRON; QUANTUM MECHANICS). This particle, called a positron, was discovered by C. D. Anderson in 1932 in studies of cosmic-ray interactions observed in a Wilson cloud chamber. In 1955 Emilio Segrè, Owen Chamberlain and their co-workers at the University of California discovered the antiproton, an elementary particle having the same mass as the proton (*q.v.*) but carrying a negative charge. In 1956 these men and others at the University of California confirmed the existence of the antineutron, a particle identical to the neutron except that its magnetic properties are reversed in sign. Atoms composed of nuclei of antiprotons and antineutrons with orbiting positrons surrounding these nuclei would constitute antimatter.

Antimatter would be completely stable if isolated from ordinary matter; however, if an atom of antimatter were to collide with an atom of ordinary matter, the two would immediately undergo mutual and complete annihilation, with π mesons and other unstable particles being created. Within a fraction of a second, all of these unstable particles would be spontaneously transformed into radiant energy—gamma rays (high-frequency electromagnetic radiation) and stable, massless particles called neutrinos. For comparison, it may be noted that in the processes of nuclear fission, used in the so-called atomic bomb, and nuclear fusion, used in the hydrogen bomb, only a small percentage of the reacting mass is converted into energy (*see* ATOMIC ENERGY).

Although antimatter does not exist in a stable form on earth, it has been speculated that distant galaxies in the universe are composed entirely of antimatter. A careful search for indications of positrons and antimatter nuclei in the primary cosmic rays entering the earth's atmosphere from outer space has been made, but as of the early 1960s this search had been unsuccessful; it has been proved that if antimatter is indeed contained in primary cosmic rays, it exists only in extremely small amounts (*see* COSMIC RAYS). The principal argument against it lies in the absence in cosmic rays of the expected gamma radiation that would be produced in profusion by the mutual annihilation of matter and antimatter.

The idea that antimatter exists in profuse amounts elsewhere in the universe has more than an aesthetic appeal. A corresponding antiparticle has been discovered for most of the known types of "ordinary" particles, as explained in PARTICLES, ELEMENTARY. Furthermore, material particles (electrons and positrons) have been created from electromagnetic radiation (gamma rays) in the

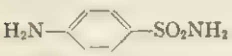
presence of matter in terrestrial laboratories. This process, known as "pair production," also results naturally from certain cosmic-ray interactions. However, whenever an electron is created from radiation, its antiparticle, *i.e.*, the positron, is simultaneously created. If the not illogical concept of symmetry in creation is assumed, then for every elementary particle that has been created there must exist somewhere in the universe its antiparticle, so that in the universe as a whole the total amounts of ordinary matter and antimatter are equal. Segrè has stated: "When God made the universe—if you assume he did—is there any reason to believe he preferred matter to antimatter?"

If all material matter in the world were suddenly replaced by antimatter, such a world would be essentially undistinguishable from the present world. All the laws of physics would remain the same except for certain laws governing the so-called "weak" interactions of the elementary particles, which do not observe symmetry.

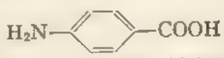
The 30-Bev particle accelerator in the CERN laboratory near Geneva, Switzerland, has produced beams of antiprotons, but whether antimatter will someday be created in profusion, and whether it can ever be utilized to provide useful energy or to produce an "antimatter bomb," remain challenging questions for the future.

ANTIMETABOLITES. An antimetabolite is a specific antagonist of a particular substance in metabolic reactions of living organisms. Various food substances (nutrients) or essential substances produced from nutrients (essential metabolites) can be prevented from performing their biochemical roles by their specific antagonists. Substances for which such metabolic antagonists are known include vitamins, amino acids (which are essential for protein synthesis), certain hormones, purines (*qq.v.*) and pyrimidines (which among other functions are also essential for the synthesis of the genetic material of cells) and certain carbohydrates (*q.v.*).

Often a compound structurally related to a nutrient or essential metabolite is one of its specific metabolic antagonists. For example, the sulfa drugs (*see* SULFONAMIDES) are metabolic antagonists of para-aminobenzoic acid (PABA), a vitaminlike nutrient, or essential metabolite, for many bacteria. The similarities of the chemical structures are demonstrated below:



Sulfanilamide



Para-aminobenzoic acid (PABA)

The sulfa drugs are effective chemotherapeutically in the treatment of certain bacterial infections because they disrupt bacterial metabolism. Specifically, the sulfa drugs prevent bacterial utilization of PABA for folic acid synthesis. It appears that the bacteria cannot "discriminate" between these structural analogues, and the antagonistic sulfa molecule is "mistaken" for the essential PABA molecule. The functions of the animal host, which does not synthesize its own folic acid, are not affected by sulfa drugs.

The requirements of a growing cell differ from those of a nongrowing cell; hence, certain antimetabolites can affect the growth of rapidly dividing cells without appreciably damaging nongrowing cells, and some antimetabolites have thus found limited use as antitumour agents. Antagonisms are of prime importance in pharmacological drugs such as the antihistamines (*q.v.*). Certain natural antibiotics are known to be antimetabolites; in fact, most antibiotics may ultimately be found to exert their biological effects in this manner. Antimetabolites are also useful in the study of the biochemistry of living organisms.

An antimetabolite exerts its effect by interacting with a particular biological catalyst (an enzyme, *q.v.*) in such a manner as to prevent the enzyme from promoting a specific biochemical reaction. This mode of action is known as enzyme inhibition, and the antimetabolite is an inhibitor of enzymic catalysis. An enzyme exerts its catalytic effect by interacting with a specific substance, which is called its substrate, to form a complex; the complex undergoes further chemical change so that it finally dissociates into a specific product and the free enzyme which can again transform more of the substrate. An analogous compound, structurally related to the substrate, can frequently interact with the enzyme at the same site as the substrate to form an enzyme-inhibitor complex which is incapable of forming the normal product of the enzyme system. This mode of action which represents that of most antimetabolites is indicated by the following equations:

$$\text{enzyme} + \text{substrate} \rightleftarrows \begin{array}{c}\text{enzyme-substrate}\\ \text{complex}\end{array} \longrightarrow \text{product} + \text{enzyme}$$

$$\text{enzyme} + \text{inhibitor} \rightleftarrows \text{enzyme-inhibitor complex}$$

If the substrate and inhibitor both compete for the same site on the enzyme to form a complex in a reversible manner, the inhibition is competitive, and the ratio of the concentration of inhibitor to that of the substrate determines approximately the degree of inhibition rather than the absolute concentration of inhibitor. This ratio is termed the inhibition index for a defined degree of inhibition. An example of an inhibitor structurally related to the substrate is malonic acid ($HOOC—CH_2—COOH$), which interacts with the enzyme succinic acid dehydrogenase to prevent succinic acid ($HOOC—CH_2—CH_2—COOH$) from complexing with the enzyme and undergoing dehydrogenation to fumaric acid ($HOOC—CH{=}CH—COOH$). Such examples were known before it was generally realized that analogues of metabolites could exert inhibitory effects of this type within living organisms.

An inhibitor may interact at a site different from that of the substrate so that an inactive complex of enzyme-substrate-inhibitor is formed. Such an inhibition is noncompetitive, and the inhibitor is capable of preventing enzyme activity regardless of substrate concentration. Occasionally an inhibitor may interact only with the enzyme-substrate complex and not with free enzyme, resulting in an inhibition which is termed uncompetitive.

By specifically blocking the utilization of a particular nutrient or essential metabolite with an antimetabolite and studying the effects of other nutrients and essential metabolites upon the inhibition, one can determine the sequences of biochemical reactions in living organisms. This method, termed inhibition analysis, has been particularly useful with microorganisms in developing assay methods for the detection necessary for the isolation of new vitamins and growth-promoting factors, in elucidating the metabolic roles of vitamins and vitaminlike substances and in discovering new metabolic interrelationships and intermediates.

See D. Woolley, *A Study of Antimetabolites* (1952). (W. SH.)

ANTIMONY is a bright, silvery-white, metallic element having a hard, brittle crystalline structure. It occurs in nature primarily as the mineral stibnite (*q.v.*), and is employed chiefly to impart hardness to lead alloys used in storage batteries and other products. Its many peculiar characteristics make it valuable as a component of flameproofing chemicals, ceramic enamels, compound semiconductors, smoke generators, explosives and medicines. This article deals with the history of antimony, and its physical and chemical properties, uses, occurrence and production.

HISTORY

Man's use of antimony predates the Christian era by many thousand years. A Chaldean vase dated approximately 4000 B.C. attests that these ancient people knew the art of winning antimony from its ores. In St. Jerome's translation of the Bible, Jezebel, the wicked wife of Ahab, is reported to have painted her eyes with stibium, a name that has given antimony its chemical symbol, Sb. Egyptian women used cosmetics of antimony to beautify their faces, and water from Egyptian wells was often borne in antimony vessels. Pliny the Elder (1st century, A.D.) gave an interesting description of a stibnite occurrence in a silver mine. "... There are two kinds of it, male and female, the female being most desirable, more radiant, smoother and brighter." With his gift for picturesque inaccuracy, Pliny also described a process for reduction of the ore. He cautioned that improper care in roasting the stibnite with manure and quenching it with milk would result in its turning to lead.

In *The Triumphant Chariot of Antimony* (1604; Eng. trans., 1660; 1661; ed. by E. A. Waite, 1893), attributed to Basil Valentine (in alchemy signifying "valiant king") who was supposed to have been a 15th century German monk, the author (Johann

Thölde), an early and enthusiastic investigator of the properties of antimony, noted the ability of antimony to free gold from its impurities and concluded it had a similar effect on man: ". . . Let men know that antimony purgeth gold and frees it from all foreign matter, but also by an innate power effects the same in men and beasts." According to this belief cattle were often fed antimony to fatten them. Monks reportedly used the same method to avoid the effects of fasting, often being fatally poisoned. Some speculators, therefore, attribute the name "antimony" to the combination of the Greek *anti*, "against," and *monos*, "one who dwells alone"—a monk. A probably more accurate interpretation suggested by a lexicographer is *antimonos*, "a metal seldom found alone."

PHYSICAL AND CHEMICAL PROPERTIES

The atomic weight of antimony is 121.75, and the atomic number is 51. Stable isotopes are 121 and 123; radioactive ones are 120, 122, 124, 125, 127, 129, and 132. Antimony is above bismuth and below arsenic in main Group V of the periodic table (*see* PERIODIC LAW). It has principal valences of 3 and 5.

Antimony forms many binary intermetallic compounds, some of which have useful electrical semiconducting qualities. Combinations of elements in Group III and Group V in many instances exhibit characteristics quite similar to single elements of Group IV. For example, aluminum-antimony responds electrically very much like silicon, a metal highly valued for its transistor and rectifier qualities. Aluminum, gallium, and indium unite with antimony to form compound face-centred cubic crystals that resemble the simple structures of diamond, silicon, and germanium (*qq.v.*). The energy gaps between saturated and conducting bands of these III–V compounds range from 0.40 electron volts for indium-antimony to 1.55 ev for aluminum-antimony, a range of values that encompasses the activation energies of all popular semiconductors.

Some Properties of Antimony

Chemical symbol	Sb
Crystal system	hexagonal
Specific gravity at 20° C.	6.62
Tensile strength, p.s.i.	1560
Hardness (Mohs' scale)	3 – 3.5
Coefficient of linear expansion at 20° C.	10.9×10^{-6}
Melting point	630.5° C.
Boiling point	1380° C.
Heat of fusion, cal./g. atom	4,780
Heat of vaporization, cal./g. atom	45,400
Specific heat, cal./g./°C.	0.0493
Vapour pressure of liquid, at 1,075° C.	54 mm.
Thermal conductivity, cal./cm.²/cm./° C./sec.	0.0444
Electrical resistivity, microhm-cm. at 20° C.	41.7
Specific magnetic susceptibility, at 20° C.	0.82×10^{-6}

Antimony exists in many allotropic forms, gray antimony being the most common and stable one. The properties of gray antimony are shown in the accompanying table. Electrolysis of an antimony trichloride solution produces an explosive form of the metal on a platinum foil cathode at the expense of a gray antimony anode. Friction causes the cathode metal to detonate loudly, evolving light and heat. Black antimony, another unstable form, is produced by rapid cooling of the metal vapour. The resulting black powder is quite active chemically and is subject to spontaneous combustion. It slowly reverts to gray antimony, but if heated to 400° C. the change is instantaneous.

Antimony is oxidized but slightly under atmospheric conditions. When heated in air, however, it burns with a bright bluish flame yielding Sb_2O_3 (or Sb_2O_4). Nitric acid also oxidizes the metal, forming the trioxide.

Antimony is amphoteric; that is, its hydroxide acts either as a base, $Sb(OH)_3$, or as an acid, H_3SbO_3.

Solution of the trioxide in hydrochloric acid yields a trichloride of large soft crystals known as butter of antimony that hydrolyzes and reacts with water to form the insoluble oxychloride.

Antimony trisulfide, Sb_2S_3, is readily prepared by heating stoichiometric proportions (*i.e.*, the combining weights) of the two powdered ingredients in a mortar. The beautiful orange-red sulfide pigment is precipitated from an antimony trichloride solution by addition of hydrogen sulfide gas. Dissolving the trisulfide in yellow ammonium sulfide produces a soluble ammonium thioantimonate solution that, when treated with acid, yields an orange precipitate of antimony pentasulfide, Sb_2S_5.

Antimony combines directly with the halogens (*q.v.*) to form compounds of type SbX_3 and SbX_5. Like other salts of antimony, halides are partly hydrolyzed by water, forming basic salts.

USES

Antimony in its pure state has essentially no uses; yet, in physical and chemical combination with other substances it is one of man's most useful metals. Approximately one-half of the yearly world supply is consumed in alloy fabrication. Chemical uses in fireworks, pottery, glass, paints, plastics, rubber and fabrics account for one-half the industrial consumption of antimony.

A Hardening Agent.—Even added in small quantities, antimony imparts strength and hardness to other metals, particularly lead. The largest single use of antimony is in the manufacture of automobile storage batteries. From 4% to 11% antimony added to lead yields strong, corrosive resistant grids and terminals. Other items in which antimony is used to harden alloys and/or inhibit chemical decay are pumps, tank linings, roofing sheets, plumbing fixtures and pipes, cable sheaths, foil and bullets.

Antifriction Bearings.—A series of alloys called babbitt or "white metal" that are indispensable to a machine-age civilization contain 5% to 18% antimony as an essential component. Other constituents of these so-called antifriction alloys are tin, lead, and copper. In the tin-base group, SnSb is present as hard discrete cubes in a matrix of $SnCu_3$, needle-shaped, relatively soft crystals. The antifriction quality of the alloy is obtained from the force-absorbing features of such a hard-soft binary combination. (*See* BEARING METALS.) A similar, though less pronounced, effect is obtained in the lead-base babbitt wherein hard SnSb is imbedded in lead. The antimony content of lead-base antifriction alloys ranges from 10% to 18% (*see* also BABBITT'S METAL).

Type Metal.—Lead containing 13% to 30% antimony and minor amounts of tin is used in linotype and stereotype machines to produce accurate cast printing type. (*See* TYPE METAL.) Antimony increases the hardness, lowers the melting point of the lead, and imparts sharp definition to the type. Maximum fusibility is obtained from the near eutectic mixture (that is, having the lowest melting point possible for the constituents) of 13 Sb, 85 Pb, 2 Sn, whereas maximum precision in duplication of type requires large portions of antimony at the expense of the lead content.

Decorative Castings.—Low melting point, precision duplication, durability, metallic beauty, and economy make antimonial alloys desirable materials from which statuettes, candlesticks and other useful and decorative objects are cast. Britannia metal (*q.v.*), a silvery white alloy from which hollow ware and tableware are made, contains 5% to 10% antimony dissolved in tin. Varieties of pewter contain a maximum of 7% antimony.

Solder.—The ability of antimony to form low-melting-point eutectics and increase the hardness of alloys makes it useful in solders.

Semiconductors.—Aluminum-antimony, though having an energy gap too great for ordinary rectifier and transistor applications, has a redeeming feature—its electrical properties vary widely with even minute changes in the amount of atomic imperfections within the crystal lattice. Control processing produces both P- and N-type crystals (*see* TRANSISTOR) whose electrical resistivity, in experimental tests, has been varied by a factor of 500,000 and rectification ratios near 10,000 have been achieved. Its behaviour at elevated temperatures has suggested possible uses in high-temperature electronic devices. Aluminum-antimony has attracted interest to its photoconductive and photogenerative effects. Contact devices can be produced to act as electrical switches on exposure to light and can directly convert light to electrical energy.

Electrical resistance elements of indium-antimony are extremely sensitive to changes in an applied magnetic field. When an indium-antimony current-carrying conductor is placed in a properly oriented magnetic field it is polarized transverse to the current flow.

By suitable electrocoupling a transverse secondary current is generated, giving rise to a flux field that opposes current flow in the primary circuit. The resulting effective resistance is proportional to the applied magnetic field intensity. Sensitivity and strength of the response are such that many uses are possible in control circuits.

Flameproofing.—Fabrics are made fire resistant by treatment with a solution of antimony trioxide or trichloride in an organic solvent. Flames accompanying initial combustion are extinguished by chemical reactants released as the impregnating solution is heated. Antimony oxide (Sb_2O_3) is used in the paint and plastics industries both as a pigment and fire-retarding agent. In wartime the premium placed on fire prevention and control greatly expands the use of antimonial flame retardants.

Paints.—Finely powdered antimony trioxide is a dense white pigment used as a constituent of paints. It is also used as an opacifying agent in white ceramic enamels imparting a blister-free, brilliant finish. "Antimony black" is precipitated, finely subdivided, metallic antimony used as a bronzing agent for metals and plaster casts. Antimony vermilion is a pigment of red trisulfide precipitated from an antimonial solution by hydrogen sulfide gas. The "antimony yellow" is produced by controlled oxidation of the sulfide. Oranges, blues and greens are produced by blending with other mineral pigments.

Ammunition.—Antimony sulfide in the form of liquated crudum (see *Production*, below) is a component of ammunition primers and of military pyrotechnics such as smoke generators, visual range-finding shells and tracer bullets. A small amount of sulfide is also used in friction matches.

Rubber Industry.—Antimony pentasulfide is a commonly used vulcanizing agent.

Textile Industry.—In the dyeing of fabrics, tartar emetic and antimonine are used as mordants. Chlorinated paraffin, antimony oxide and calcium carbonate are combined as a "finishing" additive to textile fibres. The role of antimony oxide is filtering out fibre-destroying, ultraviolet wave lengths of normal light.

Glass Industry.—Antimony oxide, like silica, is a glass-forming substance. Mixed with suitable stabilizers, antimony-oxide glass exhibits superior light transmitting ability near the infrared end of the spectrum. With sufficient colouring additives glass can be made opaque to all visible light except long wave infrared rays.

Medicine.—Though a number of organic antimony compounds have been used successfully in the treatment of parasitic diseases, antimony is highly toxic to the human body giving rise to symptoms similar to those produced by arsenic. It is an irritant internally and externally and affects the heartbeat, respiration and nervous systems. Tartar emetic (potassium antimonyl tartrate) has been used as a nauseant and expectorant.

OCCURRENCE

The mineral stibnite, Sb_2S_3, is the primary ore mineral of antimony. It (with its oxidized equivalents) is found in fissure veins in the western United States, Mexico, Bolivia, Yugoslavia, Turkey, Algeria, Morocco, Union of South Africa and China. The deposits are hydrothermal in origin; that is, the mineralizing fluids were generated during the process of emplacement of igneous intrusive rock masses. The more common genetic associations are with granites, granodiorites and monzonites. The mineralogy of the veins and their almost invariable shallow depth suggest a low temperature of formation at near-surface positions, possibly related to configuration of the water table at time of deposition. Typically, stibnite (*q.v.*) deposits are small and discontinuous.

Antimony also occurs as a minor constituent of other metalliferous ores. In the process of refining the major metal values, an antimony-enriched product is segregated. Often it appears in the bullion at lead refineries and is redeemed as antimony metal, antimonial lead or commercial grade antimony oxide. Because the antimony thus redeemed has no economic value until it is incidently concentrated by many intermediate processes, the antimony content of the ores from which the bullion was derived is obscured.

There are few deposits of antimony wherein ore is developed in advance of current mining requirements. World reserves therefore are necessarily based on known correlative data, such as historical production levels and geologic patterns of occurrence. China is the dominant possessor of ore reserves. Estimates range from 2,000,000 to 5,700,000 tons of contained antimony—a quantity that dwarfs the reserves of any other country. In the second half of the 20th century the bureau of mines and the geological survey, U.S. department of the interior, estimated world reserves, excluding China, at approximately 2,000,000 tons. Bolivia was estimated to have 400,000 tons; Mexico, U. of S.Af., U.S.S.R., each 250,000 tons; U.S., Yugoslavia, Australia, Algeria-Morocco, 100,000 tons each. Canada, Peru, Turkey, Czechoslovakia (collectively) had 225,000 tons.

PRODUCTION

Metallurgy.—Antimony sulfide may be separated from the associated rock gangue by liquation. The ore is heated above the fusion point, and maintained below the boiling temperature, of stibnite. The resulting molten sulfide seeps by gravity through the hot mass of ore and is collected and cooled in a lower container. The rather pure liquated sulfide is referred to as crudum or needle antimony and is used directly in many industrial processes. That which is not sold as crudum is roasted to produce the volatile antimony trioxide which is recovered from the condensed roaster gases. The portion of the oxide that is not directly marketed is reduced to metal (regulus) by smelting in small reverberatory furnaces with ground charcoal and suitable fluxes. Antimony sulfide may be roasted and smelted directly to metal in a blast furnace by a method quite similar to lead smelting.

Antimony metal, antimony oxide and antimonial lead are often recovered as a byproduct at lead refineries in processing lead bullion that contains antimony as an impurity. In the method called softening, air is bubbled into a bath of molten lead at about 850° C.; antimony and arsenic impurities are selectively oxidized in preference to the lead and form oxides that float to the surface of the bath and can be skimmed off. In the less widely used electrolytic method, lead anodes are electrolyzed in a fluosilicic acid bath to yield high purity lead cathodes. The anode residue contains the metallic impurities with which the lead was associated. Often the antimony content is sufficiently high to permit economic recovery. World supply of antimony is augmented by a large secondary production of antimonial alloys from antimony-containing scrap metal. Old automobile battery grids is the major source material on which secondary plants depend.

Mine Production.—World mine output of antimony is quite responsive to fluctuations in the business cycle. In 1931, at the depth of the worldwide economic depression, mine production fell to 17,000 short tons. The war-stimulated industrial level of 1943 evoked a mine output of nearly 60,000 short tons. The highest production was in 1951 during the Korean conflict when recorded world mine output rose to 70,000 short tons. Prior to 1935 China supplied two-thirds of the annual world total antimony production, but with progress of the Chinese-Japanese War the centre of principal production shifted to the Americas. The United States, Mexico and Bolivia were leading world suppliers of antimony during and immediately after World War II. In the years immediately following the Korean war, the mines of China and the Republic of South Africa became the dominant contributors of antimony.

See also Index references under "Antimony" in the Index volume.

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ANTIN, MARY (1881–1949), Russian-born U.S. author of the autobiography *The Promised Land* (1912), an account of the experiences of European Jews and the contrast with life in the United States. Born in Polotzk, Russia, in 1881, Mary Antin emigrated to the United States in 1894 and attended Teachers college of Columbia university and Barnard college, New York city, 1901–04.

She wrote about her voyage to the United States in her first book, *From Polotzk to Boston* (Eng. trans., 1899), originally writ-

ten in Yiddish. After the publication of *The Promised Land*, which first appeared as a serial in the *Atlantic Monthly* and won wide acclaim, she toured the United States for a number of years as a lecturer.

Her third book on immigrants, *They Who Knock at Our Gates*, was published in 1914. She was later a resident worker at Gould farm, a social service community at Great Barrington, Mass. In 1901 she was married to Amadeus Grabau, U.S. paleontologist and professor at Columbia university. She died at Suffern, N.Y., on May 15, 1949.

ANTINOMIANISM (*anti*, "against," and *nomos*, "law"), first attributed to Martin Luther's collaborator Johann Agricola (*q.v.*), a doctrine according to which Christians are freed by grace from the necessity of obeying the Mosaic Law. The Antinomians rejected the very notion of obedience as legalistic; to them the good life flowed from the inner working of the Holy Spirit. In this they could and did appeal not only to Luther but also to Paul and Augustine.

Antinomianism appeared also in the Reformed branch of Protestantism. John Calvin wrote against "the sect of Libertines who call themselves Spiritual." The left-wing Anabaptists (*q.v.*) were accused of Antinomianism, not only for theological reasons but also because they opposed the co-operation of church and state, which was considered necessary for law and order. For similar reasons, in the first half of the 17th century, Separatists, Familists, Ranters and Independents in England were called Antinomians by theologians of the established churches. In New England, Anne Hutchinson was accused of Antinomianism when she said that the churches were preaching "the covenant of works." The Wesleyan movement at the end of the 18th century produced its own Antinomians who claimed an inner experience and a "new life" which they considered as the true source of good works. Since in Jesus Christ and by the working of the Spirit in their hearts they were saved from sin, they sought to live in purity without the benefit of the Law. However, they fell into legalisms of their own.

Antinomianism grew out of Protestant controversies on the Law and the Gospel, but it was not unknown previously. In the early church there were those who said, "Let us sin that grace may abound" (*see* Rom. vi, 15 ff.). To some Gnostic heretics, freedom from the Law meant freedom for licence. "The spiritual," being above vulgar morality, were prone to indulge the flesh and its lusts. However, Antinomianism in the ancient and medieval church, as represented by Montanists and Marcionites (*q.v.*), and later by the Spiritual Franciscans and sundry popular pietistic movements, frequently was a protest against worldliness, legalism and clericalism in Christendom.

Bibliography.—Gertrude Huehns, *Antinomianism in English History* (1952); William Haller, *The Rise of Puritanism* (1938); Herbert W. Schneider, *The Puritan Mind* (1930). (Jo. Ha.)

ANTINOMY, a contradiction, real or apparent, between two principles or conclusions, both of which seem equally justified. An approximate synonym is paradox. Kant used the word in elaborating his doctrine that "pure Reason" generates contradictions in seeking to grasp the "unconditioned." He offered "proofs" of the proposition: (1) that the universe had a beginning and is of finite extent (the thesis)—and also of a contrary proposition (the antithesis). Similarly for the three propositions: (2) that every complex substance consists of simple parts; (3) that not every phenomenon has a sufficient "natural" cause, *i.e.*, that there is freedom in the universe; (4) that there exists a necessary Being, either within or outside the universe. Kant used the first two of these antinomies to infer that space and time are subjective. He resolved all four by a distinction between phenomena and noumena (intelligible things).

A series of logical antinomies (also known as logical paradoxes) have played an important part in the development of modern logic. One of the best known and least technical of these is the paradox of the class of all classes that are not members of themselves (published by Bertrand Russell in 1903).

The line of argument runs: Given any class of things, c for example, either c is a member of itself, or else not—one or the other, but not both. (Thus if c is the class of men, c is not a member of c, since the class of men is not a man; while if c is the class of all classes, c is a member of c, since the class of all classes is itself a class.) Let a class that is not a member of itself be called an exclusive class. Consider the class of all exclusive classes, K for example. The object is to determine whether K itself is exclusive or not. If K is exclusive, it has to be a member of K (since K was defined as the class of all exclusive classes). But exclusive means: not a member of itself. So K has to be not exclusive. Suppose, then, that K is not exclusive. This means it is a member of itself. But all the members of K are exclusive classes. Hence, K is exclusive. It would seem, then, that K can be neither exclusive nor nonexclusive, though every class must be one or the other.

In this way Russell's paradox derives a contradiction from definitions and modes of reasoning previously accepted as correct in both logic and mathematics. Much ingenuity has been expended in finding flaws in the argument, or in making compensatory revisions in logical doctrine. Among the best-known methods are the so-called simple theory of types (a modification of Russell's own solution) and certain types of axiomatic set theory (introduced by Ernst Zermelo, and subsequently improved by many writers). Many similar logical paradoxes have been formulated. Among those having direct bearing upon the foundations of mathematics are Cesare Burali-Forti's paradox of the greatest ordinal number (published 1897) and the paradox of the greatest cardinal number (published by Russell, 1903). *See* also Semantics in Logic, and Logic, History of, for the closely related semantical paradoxes.

Bibliography.—W. Windelband, *History of Philosophy*, Eng. trans. by J. H. Tufts, 2nd ed. (1910); A. N. Whitehead and B. Russell, *Principia mathematica*, 2nd ed., vol. i (1925). (M. Bx.)

ANTINOÜS, a beautiful youth of Claudiopolis in Bithynia, was the favourite of the emperor Hadrian, whom he accompanied on his journeys. During one of these he was drowned in the Nile (A.D. 130) near Besa. Hadrian said his death was accidental, but rumour had it that he had voluntarily sacrificed his life to fulfill a prophecy that death was soon to affect the emperor closely. Hadrian deified him after his death, and temples were built for his worship all over the Roman world, particularly in Bithynia, at Mantinea in Arcadia (which claimed to be the mother city of the Bithynians) and at Athens. The city of Antinoöpolis was founded (Oct. 30, 130) at the place of his death, partly in his honour, but probably with the further object of strengthening Hellenism in Middle Egypt.

A great number of statues, busts, gems and coins survive depicting Antinoüs as an ideal type of youthful beauty, often with the attributes of some appropriate god. Notable examples are in the Vatican, the Louvre and the Villa Albani at Rome.

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ANTIOCH (Antakya in southeastern Turkey), sometimes called "Antioch near Daphne" or "Antioch on the Orontes" to distinguish it from other Antiochs, was once considered the third city (Antiochia) of the Roman empire in size and importance. It was disposed on the left bank of the virtually unnavigable Orontes river (Asi Nehri) at the point where, having made a sharp bend, it breaks out of the Syrian rift valley toward the Mediterranean through a defile about 16 mi. in length. The route down the valley led no farther than the river's mouth, movement along the coast being blocked by the spurs of Mt. Pieria and Mt. Cassius. But Antioch also controlled the passage of the coastal ranges 20 mi. to the north through the Syrian Gates (the Belen or Bailan pass). From there a highway went westward through Cilicia and across Asia Minor, while to the east the commercial and military route (through Aleppo) turned the flank of the Syrian desert and was the regular approach to the Mediterranean from the direction of Mesopotamia. To the south extended the populous valley of Coele-Syria (Lebanon), rich in cereals and fruit. A continuation of the same depression to the northeast opened access to the high valleys of the upper Euphrates and the plateaus of Armenia.

HISTORY

Classical Antioch.—Antioch was founded at the end of the 4th century B.C. by Seleucus I Nicator together with the coastal town of Seleucia Pieria, which served as its port. He named it after his father, the Macedonian general Antiochus, and laid it out on a simple squared plan between the river and the slopes of Mt. Silpius. All settlers of whatever race were given equal privileges of citizenship, and the population was divided into 18 constituencies which elected a common council. A new walled quarter, containing many fine temples, was added on the east side by the founder's son Antiochus I Soter. Seleucus II Callinicus constructed a third section on an island in the river; there the intersection of the two main streets was marked by a magnificent four-faced arch, and the extension was connected with the main city to the south by five bridges. About 170 B.C. Antiochus IV Epiphanes constructed a fourth quarter of Antioch, which thus gained the title of "Tetrapolis" (the "four-citied").

In 64 B.C. Syria became a Roman province, and more temples, theatres, baths and aqueducts were added to Antioch. Unlike Rome, Constantinople, Athens and Alexandria, cities of comparable size under the Roman empire, Antioch has contracted appreciably since the time of its early prosperity. Despite this, remarkably little of the ancient metropolis can now be seen. The scale and architecture of the bastions and wall-walks on the summit and slopes of Mt. Silpius can still be appreciated, and the superstructure of the famous Iron Gate, where the perimeter wall crossed a ravine of the mountain, and parts of an aqueduct leading from the direction of Daphne are still substantially intact. But between the lower hill slopes and the river the ancient city has been buried beneath a thick deposit of alluvium, probably occasioned by some change in the slope of the river bed following an earthquake. The topography of the lower part of the city has been altered, and no trace of the island where Seleucus II Callinicus added his suburb can now be descried. Excavations in the olive groves on the lower slopes of the citadel, where the overlying deposit is only moderately thick, yielded numerous mosaic pavements.

In imperial Roman times Antioch was the military base for operations against the Persians in Mesopotamia. From Antioch many orientals migrated to Rome, so that the satirist Juvenal complained that the Orontes had become a tributary of the Tiber. The city was famous at an early date as a centre of Christianity, but at the same time notorious for the profligacy of its pagan population. It underwent several substantial reconstructions after being devastated by earthquakes or overrun by invaders. The Persian king Shapur I took the place by surprise in A.D. 260, and it was severely shaken by an earthquake during the reign of Constantine I. Even so, St. John Chrysostom estimated the number of its inhabitants in the 4th century A.D. as 200,000, without reckoning children and slaves. The city, however, never fully recovered

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ANTIOCH, SITUATED ON THE LEFT BANK OF THE ORONTES RIVER

from the double disaster of the great earthquake of 526, which is said to have killed 250,000 people, and its sack by Khosrau I in 540.

Medieval Antioch.—Arab armies took Antioch in A.D. 636, and though the Byzantines recaptured it in 969, it fell once more into Muslim hands when the Seljuk Turks overran it in 1084. After an ineffectual siege of more than seven months, a force of 300,000 crusaders stormed the city with the help of a traitor in 1098. Though in possession, they were quickly overtaken by disease and famine, and were only inspired to drive off a relieving Muslim force by the timely discovery of the Holy Lance. The Latin principality of Antioch, under Bohemund I (*q.v.*) and his successors, was administered in virtual independence of the kings of Jerusalem, though these retained their claim to it as a fief. It finally fell to Baybars I, sultan of Egypt and Syria, in 1268, when 17,000 of its inhabitants are said to have been killed and 100,000 taken captive. In 1401 it was further scourged by Timur, so that 31 years later the traveler Bertrandon de la Brocquière found no more than 300 houses occupied in Antioch, and they almost all by Turkmen and Arab herdsmen. (WM. C. B.)

Modern Antioch (Antakya).—In 1516 Antioch was captured by the Turkish sultan Selim I. Under Ottoman rule it lost its importance owing to the competition of Damascus. It was part of the Turkish empire until after World War I, when it was transferred to Syria under French mandate. A Turko-French agreement of July 1938 gave the Turkish army the right to take part in the administration of Hatay *il* (province), and later the town shared in the independence of the *il* which became the Republic of Hatay. On June 23, 1939, this territory voted to join Turkey.

Antioch (1960 pop. 45,848) is the capital of Hatay *il*. The larger part of the town is on the eastern bank of the Orontes and climbs the slopes of Mt. Habib-Necar, which is crowned by considerable remains of the ancient citadel. The newer quarters are on the western bank and a bridge (partly ancient) links the two parts. The town is irregular in plan and consists of narrow, winding streets and a mass of crowded houses, usually stone-built in Roman or old Persian style with a single story enclosing a courtyard with a fountain. It is surrounded by extensive orchards. The archaeological museum contains collections of mosaics, coins and other items. The climate is healthy; winters are rainy and mild, and summers dry and hot, but a steady cool breeze mitigates the heat.

The town stands at the junction of important roads, one eastward to Aleppo and the other north-south from Syria to Adana and the southern Turkish coast. The importance of the town has varied with the economic and political significance of these roads. Today its activities are based mainly on the agricultural produce of the adjacent area, including the intensively cultivated Amik plain. The chief crops are wheat, cotton, grapes, rice, olives, vegetables and fruit; the town possesses soap and olive-oil factories and cotton ginning and other processing industries. Silk, shoes and knives are also manufactured. To the south are the cascades of Daphne (Harbiye), a popular resort.

See also references under "Antioch" in the Index volume.

See G. Downey, *A History of Antioch in Syria* (1961).

(N. TU.; S. ER.; E. TU.)

ANTIOCH, GREEK ORTHODOX PATRIARCHATE OF. The patriarch of Antioch and all the east, who is in communion with the Greek and other Eastern Orthodox Churches, is generally called the Greek Orthodox patriarch. He is regarded as the successor of St. Peter in the see of Antioch and the third in rank of the Orthodox patriarchs, after the ecumenical patriarch (of Constantinople) and the patriarch of Alexandria.

In the 5th, 6th and 7th centuries, after the Council of Chalcedon in 451, the christological conflicts which arose in Syria and in regions east of Syria caused the authority of the patriarch of Antioch to be limited, for practical purposes, to the community of people known as "Romans" or "Melkites" (*i.e.*, emperor's men) because they were in communion with the Byzantine (east Roman) emperor. The literary language of this community was Greek; Syriac was associated with the people who were not in communion with the Greeks. There is, however, much evidence of the use of a Syriac translation of the services of the Greek Church in various

parts of Syria after the separations just mentioned, so that it cannot be said that it was only the Greeks who remained Orthodox and in communion with Constantinople. From the 9th century onward there were parishes where Arabic was the only language generally known, and therefore parts of the church services were translated into Arabic. In modern times the growth of nationalism, the breakup of the Ottoman empire and the disappearance of the Greeks from Asia Minor have caused the Greek Orthodox patriarchate of Antioch to assume the character of an Arab Eastern Orthodox Christian institution.

Since the 14th century the patriarch has resided in Damascus. There are metropolitans under his jurisdiction in Syria (Homs, Hama, Aleppo, Latakia and Suweida), Lebanon (Beirut, Tripoli, Hadeth, Halba, Zahle and Merj'Uyun), Baghdad and New York. This last metropolitan, together with an archbishop in Toledo, O., and a patriarchal delegate in Buenos Aires, take charge of the Arab Eastern Orthodox in the Americas. The principal liturgical language of the patriarchate is now Arabic, but Greek is still used, and English in the United States.

The number of members of the Eastern Orthodox Church under the patriarch's jurisdiction is variously estimated, but there are probably at least 400,000. In Syria they form the largest Christian community. In Lebanon they are the second largest church after the Maronites (*q.v.*). In both countries they are Arab in their conception of their nationality, whereas the Maronites and the "Syrian Orthodox" are inclined to think of themselves as survivals of pre-Arab nations. They call themselves Greek or "Roum" for historical reasons and in order to distinguish themselves from other churches using the word Orthodox in their names, but they are nevertheless an indigenous community, with an indigenous hierarchy, although there are naturally a few parishes of Greek residents. *See* also ORTHODOX EASTERN CHURCH.

See C. Karalevsky, "Antioche," in A. Baudrillart, *Dictionnaire d'histoire et de géographie ecclésiastique,* vol. iii, col. 563–703 (1924). (E. E.)

ANTIOCH, SYRIAN ORTHODOX PATRIARCHATE OF. This patriarchate administers the affairs of a body of Syrian Christians frequently called Jacobites. In the 5th and 6th centuries A.D. a large body of Christians in Syria and beyond its borders repudiated as heretics the patriarchs of Antioch who were supporters of the Council of Chalcedon (451) and set up their own patriarchs of Antioch in opposition to the Chalcedonian patriarchs, whom they called Melkites (emperor's men). Like the Copts, Ethiopians and Armenians, they held the doctrine called "monophysite," that Christ is not "in two natures," but is "one nature out of two natures" (*see* COPTIC CHURCH; MONOPHYSITES). They were called Jacobites because of the important part played by the celebrated Jacob Baradaeus, bishop of Edessa (d. 578), in organizing their community. They were also called the Syriani when their doctrine had been extinguished among Greek-speaking people and was associated with the use of Syriac. The Chalcedonians of Syria were known as Roumi (*see* ANTIOCH, GREEK ORTHODOX PATRIARCHATE OF).

After the Arab conquest of Syria each church in the Arab caliphate and in Muslim states generally was treated as a millet (religious community), being governed by its own laws and law courts under the leadership of its own clergy. The Syriani were recognized as the West Syrian millet (the East Syrian millet being the Assyrians or Nestorians, *q.v.*). Since the 17th century, when a minority of them were united with Rome and became the Syrian Catholics, the rest of the West Syrians have been known as Syrian Orthodox. Their liturgical language is the literary Syriac of Edessa, which they preserve as a living tongue; it is closely akin to the Aramaic spoken by Jesus Christ and his apostles.

The Syrian Orthodox patriarch of Antioch has very seldom lived in Antioch itself; his usual residence was the monastery of Deir al Zapharan near Mardin, near Diyarbakir in eastern Asia Minor. The Syrian Orthodox had villages in the mountains in that region and also near Mosul and in the districts of Aleppo and Homs. During World War I most of them left Turkey and their patriarch moved to Homs (1921) and then to Damascus (1959). They now live in Lebanon, Iraq, Turkey and Syria and in smaller numbers in Jordan, Egypt and the United States. Since the 17th century those Syrian Christians on the Malabar coast of southern India who have not been united with Rome have been, for the most part, under the ecclesiastical authority of the Syrian Orthodox patriarch of Antioch (*see* MALABAR CHRISTIANS).

See W. A. Wigram, *The Separation of the Monophysites* (1960). (E. E.)

ANTIOCH COLLEGE, in Yellow Springs, O., founded in 1852 as an interracial, coeducational college, was also a pioneer in the co-operative work-study plan. *See* YELLOW SPRINGS.

ANTIOCH IN PISIDIA, an ancient city, the remains of which lie close to the modern Yalvac, in the *il* of Isparta in Turkey. It was situated on the slopes of the Sultan Daglari range on the more southerly of the two great highways which led from the Maeander valley to the Cilician Gates. Founded by Seleucus I on the territory of a Phrygian sanctuary, it became a Greek-speaking centre in a Phrygian area, with a mixed population, including many Jews. The Romans made it a free city in 189 B.C. Before 11 B.C., however, the emperor Augustus made it a colony, with the title Caesarea, and confiscated the temple lands as imperial estates. It became the centre of civil and military administration in southern Galatia, the romanization of which was progressing rapidly when, in the time of the emperor Claudius, St. Paul made it one of the centres of his mission in that province. In 1097 the crusaders found rest and shelter within its walls. The ruins include those of fortifications, of a theatre, a temple, a church, an aqueduct and also of a rock cutting which may have held the temple of Men Ascaenus, the local Phrygian deity. (WM. C. B.)

ANTIOCHUS, the name of 13 kings and of several other princes of the Seleucid dynasty (*q.v.*), and also of four kings of Commagene (69 B.C.–A.D. 72), where the dynasty was related to the Seleucids.

The more important Seleucids of that name are described below.

ANTIOCHUS I SOTER (324–262 or 261 B.C.), the son of Seleucus I Nicator and the Iranian princess Apama, from *c.* 293 ruled the eastern regions of his father's kingdom from Seleucia on the Tigris, having the royal title and an equal share of power. At his accession to the rest of his father's kingdom (280) there was a serious revolt in Syria and movements toward local independence in Asia Minor; consequently he did not attempt the occupation of Thrace and Macedonia envisaged by his father. At first he fought with Antigonus II Gonatas, but came to terms with him in 279. About 275 he won a victory over the Celts in Asia Minor and took the name Soter ("saviour"). The First Syrian War with Egypt (276–272) caused the loss of much Seleucid territory along the southern and western coasts of Asia Minor and in the Aegean, and a war with Eumenes I of Pergamum ended in the defeat of Antiochus near Sardis (262). He died soon afterward.

Antiochus I spent much time in his eastern provinces, where his half-Iranian origin was an advantage. He founded new Greek settlements, chiefly in Iran and Asia Minor. He was an able successor to his father, whose work he consolidated in the face of great difficulties.

ANTIOCHUS II THEOS (*c.* 287–*c.* 247 B.C.) was the second son of Antiochus I, whom he succeeded *c.* 261. He fought a war with Egypt (*c.* 260–255), the Second Syrian War, of which few details are preserved; probably he recovered much ground lost by his father in Asia Minor. He married a cousin, Laodice, but repudiated her *c.* 252 and married Berenice (*q.v.*), daughter of the Egyptian king Ptolemy II Philadelphus. It is not clear why he should have fallen under Ptolemy's influence after opposing him vigorously earlier in his reign.

The designation of Antiochus II as Theos ("the God") in public documents indicates that the Seleucid kingdom had by this time adopted the cult of the living ruler.

ANTIOCHUS HIERAX or "the Hawk" (*c.* 263–226 B.C.) was a son of Antiochus II and the younger brother of Seleucus II Callinicus. Thanks to his mother Laodice's influence and his brother's difficulties in the Third Syrian War (246–241) against Ptolemy III Euergetes I, he became independent ruler of the Seleucid domains in Asia Minor north of Mt. Taurus, a position he maintained by means of alliances with Galatia, Bithynia and Pontus until his

exile (227) and death in Thrace.

Antiochus III the Great (*c.* 242–187 B.C.) was the younger son of Seleucus II and the brother of Seleucus III Soter whom he succeeded as king in 223. Still quite young, he had to rely at first upon the leading men in the state; his cousin Achaeus was entrusted with Asia Minor and the conduct of the war against Attalus I of Pergamum; control over the eastern provinces was given to Molon and his brother Alexander, governors of Media and Persis respectively; at the centre of the kingdom the guidance of the chief minister Hermias was all-important.

In 221 Molon set himself up as independent ruler of the central regions of the empire, after the manner of the Bactrian and Parthian kings. Antiochus on the advice of Hermias had begun a campaign against the Ptolemaic forces in southern Syria, but Molon's secession was so grave a threat to the empire that he abandoned the campaign in Syria, marched eastward and defeated Molon in a battle beyond the Tigris (220). Shortly afterward Antiochus killed Hermias and thus came to exercise full power.

In the Fourth Syrian War with Egypt Antiochus won victories in Palestine and Phoenicia in the years 219 and 218, and in 217 he marched to the frontier of Egypt itself and engaged Ptolemy IV Philopator in a major battle at Raphia (Rafa), with 68,000 men against 55,000. He himself was victorious against the enemy's left, but in the centre his phalanx was defeated by the newly formed Egyptian phalanx. Unable to retrieve the situation, Antiochus fled north to Antioch on the Orontes. Coele-Syria (Lebanon), Palestine and Phoenicia reverted to Ptolemy's control, but the latter did not exploit his advantage. Antiochus was granted a peace and left a free hand against Achaeus, who had assumed the royal title in Asia Minor (220) and whom he eventually captured and executed (214).

Antiochus now turned to the formidable task of rebuilding his empire in the east. In 212 he brought Armenia back to its tributary status; the next two years he spent in preparing a great expedition against the Parthian and Bactrian kingdoms, which had absorbed large tracts of Seleucid territory since their formation in the middle of the century (*see* Bactria; Parthia). In the following years (209–205) Antiochus defeated the Parthian and Bactrian kings and recovered the eastern provinces. This immense achievement justified the king's assumption, on his return to Babylon, of the ancient Achaemenid title of "great king." Henceforth he is known to the world as Antiochus the Great.

About 203 Antiochus formed a secret pact with Philip V of Macedonia for the partition of the Ptolemaic empire outside Egypt. The events of the next five years are obscure, but it appears that Antiochus overran Coele-Syria, Palestine and Phoenicia and confirmed his conquest of these territories later by a decisive victory over the Ptolemaic general Scopas at Panium near the source of the Jordan (*c.* 200). He did not, however, attack Egypt itself, and eventually he made peace with the young Ptolemy V Epiphanes, giving him his daughter Cleopatra in marriage (*c.* 195).

After the victory of Panium Antiochus tried to strengthen his position in western Asia Minor, apparently by exploiting the weaknesses of both Egypt and Macedonia so as to make easy conquests for himself. He was resisted by Pergamum and Rhodes, and these states persuaded Rome to send him messages of warning. Undeterred, he pressed on, winning several cities in Aeolis and Ionia. In 196 he crossed into Europe and made conquests in Thrace, where he claimed sovereignty over territory won by Seleucus I on the death of Lysimachus (281). Roman orders to withdraw from these and the earlier conquests he rejected.

About 195 Hannibal (*q.v.*) took refuge at the Seleucid court, a happening which increased Roman fears and suspicion. Antiochus, exasperated both by the encouragement given to his enemies by Roman ambassadors and by the Roman senate's refusal to grant him a treaty of friendship under which his territorial rights would be secured, decided to intervene in Greece, where he could embarrass Rome by posing as a liberator. The Aetolians offered to join him, and he landed in Greece in the autumn of 192.

He accomplished little: his expedition had been badly prepared, his army was too small, Aetolian help was inadequate and Philip and the Achaean league joined hands with Rome to frustrate him. Routed by the Romans at Thermopylae (191), he withdrew to Asia. At sea the Seleucid fleet was beaten in several engagements by the Roman, Pergamene and Rhodian forces; the Roman army crossed unopposed into Asia. The final battle was fought at Magnesia ad Sipylum west of Sardis (winter 190–189). Antiochus' army (70,000) heavily outnumbered that of the Romans and their allies (30,000), and Antiochus fought bravely but was in the end completely defeated. By the treaty of Apamea (188) he was obliged to renounce all Seleucid claims in Europe and north of Mt. Taurus, to pay an indemnity of 15,000 talents over a period of several years, to hand over 20 selected hostages and to surrender the fleet and the elephants. In the next year Antiochus was killed in Elymaïs (Elam) while engaged in plundering a temple.

Antiochus III combined personal bravery with prudent judgment and a strict devotion to his duties as a king. His achievements in the east and against Egypt greatly strengthened his kingdom, and in spite of his failure against Rome (caused by a pardonable miscalculation of the chances) he may be ranked as the most successful of the Seleucid kings after Seleucus I.

Antiochus IV Epiphanes (*c.* 215–163 B.C.), ruler of the Seleucid kingdom from 175, was the third son of Antiochus III. After the battle of Magnesia he was one of the hostages sent to Rome, where he received kind treatment and learned to admire Roman institutions and policies. After the assassination of his brother Seleucus IV Philopator he seized the throne from the usurper Heliodorus (175), being aided by Eumenes II of Pergamum with whom he subsequently concluded an alliance.

In 170 Egypt attempted to reconquer Palestine. Antiochus easily defeated this attempt and in his turn invaded and occupied Egypt, where he set up a protectorate over Ptolemy VI Philometor. When he withdrew, however, his political system in Egypt collapsed, and he returned to besiege Alexandria. Rome then intervened, ordering Antiochus to evacuate both Egypt and Cyprus, which he had already seized. He complied after undergoing public humiliation in a scene with the Roman envoy Gaius Popilius Laenas at Alexandria (168), for he realized that to challenge Rome would be a hopeless venture.

Within his empire Antiochus encouraged city life and the diffusion of Greek culture—a policy that he carried out with especial fervour (his passionate attachment to Hellenism had first been revealed before his accession, when he was living in Athens). Enthusiastic for republican forms, he ignored his kingly rank and mingled familiarly with the citizens of Antioch. His general policy, however, was to unify and strengthen his empire by means of a common culture. Noteworthy marks of his religious policy were his assumption of the title Epiphanes ("god manifest") and his identification with Zeus, perhaps in deliberate imitation of Alexander III the Great.

Antiochus IV's contact with the Jews is known chiefly from Jewish writers hostile to him, and the documents that they cite are perhaps not authentic (in particular a supposed letter of his to the Jews). It seems certain, however, that he placed a permanent garrison in Jerusalem in 167 and set up the worship of Olympian Zeus in the Temple. To him these actions were merely the local application of his general policy; to the stricter kind of Jew they were an intolerable provocation that could be answered only by armed defiance. As a result the Seleucid government became involved in a long and difficult war with a large part of the Jewish people. (*See* Jews.)

Under Antiochus IV the Seleucid empire recovered much of the strength it had lost through the Roman victory over Antiochus III; probably many new Greek settlers were brought in, especially to Cilicia and the eastern provinces. The great review of the army at Daphne near Antioch in 166 was intended as a political demonstration to impress the Greek world, and it may also have been a triumph to celebrate the success of Eucratides in overthrowing Demetrius, the king of Bactria, if it is true that Eucratides had acted as an agent or ally of Antiochus.

The final years of the reign saw the start of an attempt to move against Parthia, perhaps with the collaboration of Eucratides. But after traversing the central districts of the empire, and be-

fore he could engage the enemy, Antiochus died of consumption at Gabae (Isfahan) in Persis in 163.

Some aspects of Antiochus IV's behaviour seemed eccentric to his contemporaries, but in the main he was well regarded and his abilities were considerable.

ANTIOCHUS VII SIDETES (*c.* 159–129 B.C.) was the second son of Demetrius I Soter and succeeded his brother Demetrius II Nicator as ruler of the Seleucid empire in 139. After subduing Judaea (134) he drove the Parthians out of Babylonia and recovered much of the territory they had overrun (130). The next year he was defeated and killed by the Parthians in Media, and the last hope of saving the eastern provinces of the empire died with him. He was the last Seleucid king of importance. The name Sidetes refers to his having been brought up in the Greek city of Side in Pamphylia.

See SELEUCID DYNASTY for bibliography. (R. H. SI.)

ANTIOCHUS OF ASCALON (? d. 68 B.C.), Greek philosopher, succeeded Philo of Larissa as head of the Academy (*see* ACADEMY, GREEK). He redirected the main stream of Platonism from the skepticism of Arcesilaus and Carneades to positive philosophy. His view that Platonism, Peripateticism and Stoicism differed more in terminology than in fact influenced many who did not entirely accept it, including Cicero, who heard his lectures in 79–78 and leaned heavily on his writings (now entirely lost) for the composition of his *Academica,* his *De Finibus* and, probably, others of his philosophical works. Antiochus' own philosophy was eclectic in the sense that he tried to construct a consistent body of doctrine from the material offered by the three schools, but its form was largely determined by Stoicism. (F. H. SH.)

ANTIOPE, the name of two figures in Greek legend.

1. Antiope, the mother by Zeus of Amphion and Zethus. Her beauty attracted Zeus, who, assuming the form of a satyr, took her by force. Pregnant, she escaped the threats of her father by running away and marrying Epopeus, king of Sicyon. Thereupon her father killed himself, first bidding his brother Lycus punish her. Lycus killed Epopeus, brought Antiope back, and imprisoned and tormented her. (In another account Antiope had been married to Lycus, but was rejected by him after an affair with Epopeus. Lycus' second wife, Dirce, daughter of Helios, captured and tortured Antiope out of jealousy.) On the way back from Sicyon, or after escaping from prison, Antiope bore twins, Amphion and Zethus, who were brought up by herdsmen. Long afterward, she escaped and joined her sons; they recognized her, killed Lycus, and bound Dirce to the horns of a wild bull, in which posture she died. After Dirce's death her body was cast into a spring near Thebes, later called by her name. Because of her murder, Dionysus, to whose worship Dirce had been devoted, visited Antiope with madness, which caused her to wander restlessly all over Greece until she was cured and married by Phocus of Tithorea, on Mt. Parnassus, where both were buried in one grave.

2. Antiope, daughter of Ares, sister of Hippolyte, queen of the Amazons. Theseus (*q.v.*) stole her for his wife. (T. V. B.)

ANTIOQUIA, a mountainous interior department in the northernmost Andes of Colombia, bounded by Bolívar and Córdoba on the north, the Magdalena river (*q.v.*) on the east and Chocó and Caldas on the west and south. A narrow corridor reaches to the Caribbean sea at Turbo. Area 24,324 sq.mi.; pop. (1961 est.) 1,931,690. Its rugged mountain mass is bisected by the deep gorge of the Cauca river (*q.v.*). Most of the eastern half, between the Cauca and the Magdalena, is an ancient granitic batholith (average elevation 8,000 ft.), the northernmost extension of the Central Cordillera. Unlike the country to the south, Antioquia has been little affected by recent volcanic activity, and its upland soils are for the most part deeply weathered and rather infertile. The Antioquia highland is diagonally pierced by the deep canyon of the Porce river, a Cauca tributary, which widens out in its upper reaches into the lovely, mile-high valley where the capital city of Medellín (*q.v.*) is situated. The surrounding uplands are laced with gold-bearing quartz and calcite veins.

The colonial economy of Antioquia was based on mining, but as the mines gave out agriculture became increasingly important. Coffee, introduced in the 1880s, is the principal export crop. The manufacturing industries of the valley of Medellín, especially textiles, have made Antioquia the leading industrial department of Colombia despite its relative geographical isolation.

After 1800 Antioqueño colonists began moving onto the empty volcanic-ash slopes to the south in a wave of colonization that has continued to the present day. More than one-half of the people who call themselves Antioqueños live outside Antioquia. Long isolation has made the Antioqueños noteworthy for their cultural conservatism, reflected in dress, diet and speech. Their aggressive individualism is legendary in Colombia. The rural society is composed largely of small holders. (Js. J. P.)

ANTIOXIDANTS, chemical compounds sometimes added to certain foods, natural and synthetic rubbers, gasolines and other substances to retard autoxidation, the process in which these substances combine with oxygen in the air at room temperature. Retarding autoxidation delays the appearance of such undesirable qualities as rancidity in foods, loss of elasticity in rubbers and formation of gum in gasolines. The activity of most antioxidants is due to their ability to donate hydrogen atoms. They are effective at very low concentrations, sometimes as low as 0.001%. The efficient antioxidants are organic compounds, such as aromatic amines, phenols and aminophenols.

This article does not deal with oxidation at high temperatures (*see* COMBUSTION), biological oxidation (*see* RESPIRATION) or oxidation of metals (*see* CORROSION AND OXIDATION OF METALS).

The Four Stages of Autoxidation.—The general course of autoxidation usually can be divided into four successive stages in regard to the rate of reaction with oxygen: (1) the initial period of negligible rate; (2) the period of accelerating rate; (3) the period of nearly constant rate; and (4) the final period of declining rate. The duration of the first stage plus the slow portion of the second is termed the induction period and, in most cases, indicates the useful lifetime of the autoxidizable substances.

These facts are consistent with a mechanism of oxidation based on the theory of chain reactions, the modern form of which was developed through the works of many investigators beginning with Walther Nernst (1911), Max Bodenstein (1913) and J. A. Christiansen and H. A. Kramers (1923).

A chain reaction consists of a series of successive reactions occurring in repetitive cycles, in each of which intermediate products called chain carriers are regenerated. Such a reaction will continue as long as the chain carriers persist. In autoxidation the chain carriers are free radicals. They are electrically neutral molecular fragments resulting from the rupture of covalent bonds and always containing one or more unpaired electrons. The covalent bond is the ordinary chemical bond in organic compounds and is formed by the union of a pair of electrons. When this bond is broken the two fragments divide the pair of electrons, thus giving rise to two free radicals, each with an unpaired electron. Although different kinds of free radicals vary greatly in reactivity they all combine, two by two, to form stable molecules containing a new covalent bond. The carriers that propagate chain reactions, however, are always very reactive free radicals. In most cases the bond that breaks is one of the weakest carbon-hydrogen bonds in the autoxidizable molecule. The different reactions involved in autoxidation can be represented as follows:

Let R:H be the autoxidizable compound, the H be the hydrogen atom of the weak C:H bond, the : be the electron pair of the covalent bond, and . be the unpaired electron of an atom or a free radical.

1. Chain initiation

   $R{:}H \rightarrow R. +$ (H. removed by the initiating agent)

2. Chain propagation

   a. $R. + O_2 \rightarrow R{:}O{:}O.$ (hydroperoxide free radical)

   b. $R{:}O{:}O. + R{:}H \rightarrow R. + R{:}O{:}O{:}H$ (hydroperoxide)

3. Chain termination

   Elimination of R. and R:O:O. in different ways.

The chain can be initiated by thermally excited molecules, free radicals, metal catalysts or light, but in any case this requires a greater input of energy than any of the other steps. The number of times the propagation reactions are repeated determines the chain length; a short chain consists of a few cycles while a

long one goes into the thousands. Hence, the destruction of the original R. or R:O:O. right after its formation will prevent the creation of that number of chain-propagating free radicals which would have been formed if the chain reactions had been permitted to proceed.

Most hydroperoxides are not stable enough to accumulate to any great extent in the autoxidizing system, but are converted into oxygen-containing products. In the course of this conversion free radicals are formed which initiate additional chain reactions to speed up the rate of oxidation. This process is called degenerative chain branching because it is dependent upon the decomposition of the hydroperoxides and causes the chains to branch or multiply.

Antioxidants Inhibit Deterioration.—Antioxidants, by reacting with chain carriers from all sources, prolong the induction period and thereby retard the oxidative deterioration of the products. They, in turn, become free radicals of low energy content that change into stable compounds. Antioxidants can react with a free radical R. (or R:O:O.) in two different ways.

1. R. + antioxidant → R:H + stable products
2. R. + antioxidant → stable products containing R:

In the first case the antioxidant must contain an easily available hydrogen atom, and in the second it must have a double bond to which R. can be added. It is also conceivable that the antioxidant is first converted by partial oxidation into relatively stable free radicals that capture the chain carriers. Within practical limits the increase in induction period for a given system tends to be directly proportional to the concentration of a particular antioxidant. The response of autoxidizable substances to antioxidants varies greatly, and the efficiencies of different antioxidants in a specific product cover a wide range. Examples of commercial antioxidants are given below.

Antioxidants that are destroyed while performing their function are referred to as sacrificial antioxidants. They can also be destroyed in the autoxidizable system: (1) by reacting with hydroperoxides, but this can happen to a significant extent only if hydroperoxides had been formed during active autoxidation before the addition of the antioxidants; and (2) by reacting directly with molecular oxygen, in which case they are wasted. Antioxidants, therefore, should be added to the products to be protected as soon as possible after recovery or production, and they should not react too easily with oxygen.

Autoxidation is greatly influenced by the presence of acidic and basic compounds, heavy metal catalysts, divalent sulfur compounds and by light. The choice of antioxidant will depend to some extent upon these factors, but it is better to counter the catalysts with anticatalysts that render them ineffective. Metal catalysts can be deactivated with compounds that convert them into inert metal complexes, such as N,N′-disalicylidene-1,2-diaminopropane for copper salts. Acids and bases can be neutralized. Most of the common antioxidants are not suited for use in products exposed to direct sunlight because they tend to initiate photo-reactions, unless opacity minimizes this danger.

Finally, before an antioxidant can be considered satisfactory for practical use it must meet certain subsidiary requirements depending upon the particular use: (1) it must be sufficiently soluble in the product; (2) its volatility must be relatively low; (3) it must not be extracted by water; (4) it must not be coloured; (5) it must be odourless and tasteless; (6) it must not be toxic or irritating to the skin; and (7) it must not cost too much.

Many products, such as rubber latex, wheat germ oil, thermally cracked gasoline and lubricating oil, contain natural antioxidants, but they are frequently lost during refining or are not effective enough when the products are put to human use.

Acrolein.—Although some efforts were made to control autoxidation by chemical means prior to the work of Charles Moureu and Charles Dufraisse on acrolein beginning in 1917, these investigators must be given the credit for having started the modern developments in commercial antioxidants. Thereafter antioxidants helped to improve many critically important materials, including rubber, gasoline, lubricants and vinyl compounds and foods.

On aging, rubber darkens and loses its elasticity and tensile strength. N-Phenyl-beta-napthylamine, 4,4′-dimethoxydiphenylamine, N,N′-diphenyl-para-phenylenediamine and 2,2′-methlene-bis-(4-methyl-6-tertiary-butylphenol) are good antioxidants, the last being considered a light stable one. They are used at about 0.5% to 3% by weight on the rubber.

The autoxidation of cracked gasoline results in the formation of gums that foul the engine. N-Butyl-para-aminophenol and N,N′-di-(secondary butyl)-para-phenylenediamine are effective antioxidants at 0.001% to 0.01% by weight. Phenols with alkyl substituents in the ring are also used.

Nordihydroguaiaretic acid, ring-alkylated para-hydroxyanisole, propyl gallate and tocopherol are added to fats and oils to retard the development of rancidity. The dosage ranges from 0.005% to 0.1% by weight. They are frequently used in combination with lecithin, citric acid or ascorbic acid. In this case efficiency must be made secondary to edibility because compounds put into foods for human consumption must meet stringent government specifications.

Although antioxidants are not necessarily inhibitors of polymerization, they are used to prevent the formation of peroxides in vinyl monomers because the peroxides are sometimes dangerous and usually cause polymerization. Hydroquinone, catechol, alpha-naphthol and phenothiazine are examples of such antioxidants.

Many aldehydes autoxidize rapidly to give high yields of carboxylic acids. Benzaldehyde, for example, goes to benzoic acid. Most of the antioxidants mentioned above protect aldehydes.

The mechanism of antioxidant action has been studied by means of the deuterium isotope effect, but by the early 1960s the mechanism had not been fully elucidated.

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ANTIPAROS (mod. Gr., ANDIPAROS), a Greek island, one of the Cyclades, lies in the Aegean sea, in the modern eparchy of Naxos, separated by a narrow strait from the west coast of Paros. It is 7 mi. long by 3.4 mi. broad. The two islands lie about half way between the Greek and Turkish coasts. The population (1951) of 680, mostly in Kastro on the north coast, is employed in agriculture and fishing. Its ancient name was Oliaros. It shared the Early Bronze Age culture of the Cyclades, but little is heard of it in the classical period, when its fortunes were bound with those of Paros. In later times piracy was common. The only remarkable feature in the island is a stalactite cavern on the south coast, reached by a dangerous descent. The grotto is about 150 by 100 ft. and 50 ft. high, and was visited in antiquity. The island is well cultivated and fertile. (J. Bo.)

ANTIPATER (*c.* 397–319 B.C.), Macedonian general and regent of Macedonia from 334 to 323 B.C. and of the Macedonian empire from 321 to 319. He was entrusted with high responsibilities by Philip II of Macedonia, such as the negotiation of the peace of Philocrates with Athens in 346. One of the leading men in the state at Philip's death in 336, he helped to secure the succession for Alexander III the Great (*q.v.*), who, on his departure for Asia (334), appointed Antipater regent in Macedonia with the title of general in Europe. His main tasks were to hold the northern frontiers against barbarian tribes and to keep order among the Greek states. He ruled Greece by co-operating with the League of Corinth, but was unpopular because he restored tyrants expelled from their cities and favoured oligarchic governments.

In 331 at Megalopolis he defeated the Spartan king Agis III.

The settlement of the satrapies of the Macedonian empire by Perdiccas (*q.v.*) at Babylon in 323, immediately after Alexander's death, left Antipater as general in control of Macedonia and Greece, though his status in relation to that of Perdiccas was not clearly defined. From 323 to 322 he had to fight a difficult campaign against the Athenians, Aetolians and Thessalians, the so-called Lamian War, which he eventually won at Crannon after receiving reinforcements from Asia. He took the side of the Macedonian generals Antigonus, Seleucus (*qq.v.*) and Ptolemy (*see* PTOLEMIES) who were opposed to the claims of Perdiccas, and in the settlement at Triparadisus in Syria (321) he became regent of the Macedonian empire for the two kings Philip III Arrhidaeus and the infant Alexander IV, until his death in 319 which was the signal for the regional governors to throw off allegiance to central authority. (R. H. SI.)

ANTIPHANES (fl. early 4th century B.C.), Greek poet, was the most important writer of Middle Attic Comedy with the exception of Alexis. He was apparently a foreigner who settled in Athens and may have been producing by 387 B.C. About 120 of the many comedies attributed to him are known from their titles and considerable fragments are preserved in Athenaeus' *Deipnosophistai*. In all over 300 fragments survive. For the fragments *see* T. Kock, *Comicorum Atticorum fragmenta*, vol. ii (1884).

See T. B. L. Webster, *Studies in Later Greek Comedy* (1953).

ANTIPHON OF RHAMNUS in Attica (*c.* 480–411 B.C.) was one of the earliest professional speech-writers in Greece. An extreme oligarch, he played a leading part in overthrowing the democratic system at Athens in 411 B.C. When later in the same year the oligarchic government was deposed he was accused of treason, condemned and executed. The speech he made in his own defense, of which papyrus fragments have survived, was highly praised by Thucydides. There is little reliable information about his earlier life. He wrote speeches for public and private litigants and probably taught rhetoric. According to Thucydides he was reluctant to speak in public himself as his reputation for rhetorical skill made the people suspect him.

Three speeches written for actual lawsuits are extant. All deal with cases of homicide. In *Kategoria Pharmakeias Kata tes Metruias* ("Charge of Poisoning Against the Stepmother") a man accuses his stepmother of murdering his father by inducing a slavewoman to poison his wine. Some scholars have held that Antiphon was not the author or that he wrote it merely as an illustrative model for his pupils, but it is now generally believed to be a real speech by Antiphon. *Peri tou Heroidou Phonou* ("The Murder of Herodes") is the defense of a man accused of murdering his companion when they had put ashore during a voyage. *Peri tou Choreutou* ("On the Choreutes") defends a *choregus*, or chorus trainer, alleged to have been responsible for the death of a chorister who had been given a drug to improve his voice.

The *Tetralogies* ascribed to Antiphon by antiquity concern three imaginary cases of homicide. In each case there are two speeches for the prosecution and two for the defense after the usual Athenian procedure. They were evidently written to show students of rhetoric how real cases should be handled. Although they deal with processes which might have arisen in everyday life at Athens, they do not aim to be realistic imitations of genuine speeches. They are rather outline-speeches inculcating general principles, and little is said about the details of each particular case. No one in ancient times seems to have doubted their authenticity, but this has aroused considerable controversy among modern scholars. Objections to Antiphon's authorship are based both on the matter and the language. The speakers do not recognize the distinction between different types of homicide which was well established in Athenian law by Antiphon's time, and there are striking divergences in grammar and vocabulary from his three real speeches. The controversy has not been resolved, but the difficulty of comparing fictitious speeches with those written for actual processes has probably inclined scholars to accept Antiphon's authorship. Fragments of other speeches attributed to Antiphon survive; these come from speeches written for public as well as private suits. He was also said to have written a handbook of rhetoric, and a collection of prefaces and perorations.

Antiphon is the author of the earliest extant legal speeches; it is even stated by some ancient authorities that he was the first to commit legal speeches to writing. Oratory had for long been a highly developed art at Athens, but in Antiphon's day two new factors combined to shape its growth. The first was the theoretical study of forensic speaking, which began in Sicily after the fall of the tyrants. The second was the increased importance of prose literature generally and the desire to give it a beauty of form analogous to that of verse. Both these factors had their effect on Antiphon's work. The influence of Sicilian rhetoric is seen in the formal structure of his speeches and the character of his arguments. The real speeches are divided into five sections: (1) a preface; (2) an introduction describing the circumstances of the case; (3) a narrative of facts; (4) proofs and arguments; (5) a peroration. The *Tetralogies* omit the introduction and narrative of facts. In all the speeches the arguments depend more on abstract probabilities than on close reasoning from factual evidence. Rhetorical chicanery is not infrequent.

Antiphon's prose reflects stylistic experiments which were being made in the last part of the 5th century B.C. By comparison with Gorgias he is economical in the use of pretentious embellishments, but even in the speeches written for delivery in court carefully balanced clauses and forced antitheses show a self-conscious artistry. In the *Tetralogies* this is still more evident. After Antiphon practical oratory tended to avoid such ornament. A jury might appreciate it, but would suspect that it concealed a weak case. Antiphon lacked Lysias' talent for adapting his style and language to the character of the client by whom the speech was to be delivered. The general tone is one of dignity, even of grandeur. He avoids colloquial expressions and does not descend to the personal invective which was common among later orators, notably Demosthenes.

Editions of Antiphon include F. Blass and T. Thalheim, Teubner series (1914); L. Gernet, with French translation, Budé series (1923); K. J. Maidment in *Minor Attic Orators*, vol. i, with English translation, Loeb series (1954).

BIBLIOGRAPHY.—*Index:* F. L. Van Cleef (1895). *General:* F. Blass, *Die attische Beredsamkeit*, vol. i, 2nd ed. (1887); R. C. Jebb, *The Attic Orators from Antiphon to Isaeos*, vol. i, 2nd ed. (1893); F. Solmsen, *Antiphonstudien* (1931). For two articles expressing opposite views on the authenticity of the *Tetralogies*, *see* P. van der Mühll, "Zur Unechtheit der antiphontischen Tetralogien," *Museum Helveticum*, vol. v (1948), and G. Zuntz, "Once Again the Antiphontean Tetralogies," *Museum Helveticum*, vol. vi (1949). (H. L. H.-W.)

ANTIPHON, a chant sung by two alternating choirs. The earliest reference to this method of singing occurs in *De vita contemplativa* by the Jewish chronicler Philo, writing in the first half of the 1st century A.D., where two choirs of men and women in a religious sect near Alexandria sing in a manner compared by Philo to that mentioned in connection with Moses' "Hymn of Victory" (Ex. xv, 20–21). The Syrian Church developed the practice of antiphonal singing and the liturgical chants sung in that manner were called antiphons. Their place in the church service is in the hours of the office (*see* HOURS, CANONICAL) before and after a psalm or canticle. There are in the repertory of the Roman Catholic Church several thousand antiphons, which can be reduced to a small number of melodic types of a simple structure. *See* PLAINSONG; ANTIPHONARY. (E. J. WZ.)

ANTIPHONARY, a term first used *c.* A.D. 760 by Pope Paul I in a letter sent with some liturgical books to the Frankish king Pepin III. The term was then used to mean the repertory of chants for the choir: the soloists sang from the cantatorium. Later, it came to mean the collection of melodies used for the office, while those for the mass were collected in the gradual. The first compilation of an antiphonary is attributed to Pope Gregory the Great, in *c.* 600. The most important work in compiling a standard antiphonary, however, was done in 831–832 by Amalarius of Metz (*c.* 780–850), a pupil of Alcuin, who explained his task in a famous treatise, *Liber de ordine antiphonarii*. In present liturgical practice the term antiphonary is used for the collection of melodies sung during hours of the office (*see* HOURS, CANONICAL). *See* also PLAINSONG.

Bibliography.—P. Wagner, *Introduction to the Gregorian Melodies*, Eng. trans. of *Ursprung und Entwicklung der liturgischen Gesangsformen*, I (1895; 2nd ed. 1901) (1901); A. Gastoué, *Les origines du chant romain* (1907); W. Apel, *Gregorian Chant* (1958). (E. J. Wz.)

ANTIPHON SOPHISTA, an Athenian sophist of the 5th century B.C., usually regarded as distinct from his contemporary Antiphon the orator, though possibly identical with him. He wrote treatises *On Truth, On Concord, The Statesman* and *On the Interpretation of Dreams*. He was not regarded as a thinker of importance until the publication in 1915 and 1922 of fragments of his *On Truth* found at Oxyrhynchus. These compelled a revision of opinion, but no agreement as to his doctrines was reached.

On one view, his appeal to nature as against convention in morals and in politics was almost wholly nihilistic in character and destructive of the state. On another and probably better view, he believed that nature found full expression only in concord and harmony. He also discussed problems in ontology and attempted to square the circle by a method of inscribed polygons.

For fragments and testimonia *see* H. Diels and W. Kranz, *Fragmente der Vorsokratiker*, vol. ii, 7th ed. (1954). *See* also E. Bignone, *Studi sul pensiero antico*, ch. 1–3 (1938); and M. Untersteiner, *The Sophists*, Eng. trans. (1954). (G. B. Kd.)

ANTIPOPE, one who opposes the legitimately elected bishop of Rome, endeavours to secure the papal throne and, in an extreme instance, succeeds materially in the attempt. This abstract definition is necessarily broad and does not reckon with the complexity of individual cases. The elections of several antipopes are greatly obscured by incomplete or biased records. Indeed, even their contemporaries at times could not decide who was the true pope. One cannot claim, therefore, to formulate a definitively accurate list of antipopes. This article emphasizes the type of historical situation that occasioned the rise of antipopes.

Doctrinal Disagreement.—During the reign of Pope Zephyrinus (*c.* 199–217), the Roman priest Hippolytus vigorously opposed the spread of Monarchianism (*q.v.*), a Trinitarian heresy brought to Rome by Sabellius, which identified the Father and the Son. Hippolytus considered Pope Zephyrinus and his deacon Calixtus culpable for being unwilling to enter the theological debate. When, at the death of Zephyrinus, Calixtus became pope, Hippolytus tried to supplant him. This first antipope was later reconciled to Pope Pontianus during the persecution of Maximinus and died a martyr's death (235).

Deportation of the Pope.—The Arian emperor Constantius II, having exiled Pope Liberius for his orthodoxy (357), imposed the archdeacon Felix on the Roman clergy. He became Felix II. Later Liberius was allowed to return to Rome, the emperor contemplating some form of coexistence. The faithful, however, found the compromise intolerable, and Felix had to leave the city. Having later returned to threaten Liberius' position, he was once more rejected. Felix lived in retirement until his death (365).

Double Election Arbitrated by the Secular Authority.—In 418 the archdeacon Eulalius was elected by a faction partial to him. In protest the rest of the clergy chose the priest Boniface. Eulalius enjoyed the support of the imperial prefect and the Byzantine court. At this juncture the empress began to take an interest in Boniface's cause and asked that the case be reopened. Until a council could be held to decide the issue, the emperor ordered both claimants to leave Rome. Eulalius imprudently returned to perform the Holy Week services at the Lateran, and for this "revolt" official recognition was given to Boniface instead.

Double Election and Subsequent Recourse to a Third Candidate.—On the death of John V (686) no agreement could be reached about his successor. The army favoured the priest Theodore; the clergy, the archpriest Peter. Various attempts at arbitration brought no solution. Finally the clergy set aside Peter to elect Conon, who was also accepted by the army. His reign was short, however, and at his death division reasserted itself. This time Paschal and, once again, Theodore, were rivals for the papal throne. Both were unwilling to renounce their claims. Finally a part of the community more inclined to moderation put forward Sergius and, in the end, obtained the papacy for him.

Political Instability at Rome.—The years 936–973 were marred by continued turbulence as the Theophylact family nominated and deposed popes at will. In 955 the temporal ruler of Rome, Octavian, a boy still in his teens, was elected pope. He became John XII, whose life and court were to be a scandal to Christendom. To consolidate his position John XII appealed for aid to the German emperor, Otto I, giving him in return certain prerogatives in future papal elections. When John later joined an armed conspiracy against Otto, the emperor with his armies descended upon Rome and there presided over a council that gladly deposed the pope and chose in his place Leo VIII (963). When Otto left, John and his partisans returned to expel Leo. At John's death the Romans ignored the emperor's candidate and elected Benedict V. Otto again came to Rome, there to reinstate Leo. Unfortunately peace did not come to Rome and the papacy, even with the eventual triumph of Otto's family.

Change in the Manner of Choosing the Pope.—In 1059 Nicholas II promulgated a decree fixing a new procedure for papal elections. This juridical *coup d'état* deprived the German emperors of the leading role they had played in previous elections. The legates sent by Nicholas to the German court with the decree were refused a hearing; and Nicholas himself was condemned by a council of German bishops and his acts declared null. On his death (1061) the cardinal bishops elected Alexander II in accord with the decree of 1059. Alexander was unacceptable to the German bishops, who resented the limitation put upon their sovereign's power, and to the Roman nobility, likewise deprived of a role in the election. At this point Honorius II was put forward as the candidate of the German court and enjoyed its armed support. When, for a number of reasons, circumstances began to favour Alexander, this patronage was withdrawn. In 1063 St. Peter Damian was instrumental in persuading a diet of German bishops at Augsburg to give its allegiance to Alexander. Soon thereafter, at a council presided over by the imperial legate, the Germans gave Alexander their undivided loyalty. *See* also Papacy.

Tentative List of Antipopes

Hippolytus (217 218–235)	Theoderic (1100)
Novatian (251)	Albert (1102)
Felix II (355–365)	Silvester IV (1105–11)
Ursinus (366–367)	Gregory VIII (1118–21)
Eulalius (418–419)	Celestine II (1124)
Laurentius (498–*c.* 505)	Anacletus II (1130–38)
Dioscorus (530)	Victor IV (Gregory) (1138)
Theodore (687)	Victor IV (Octavian) (1159–64)
Paschal (687)	Paschal III (1164–68)
Constantine II (767–768)	Calixtus III (1168–78)
Philip (768)	Innocent III (1179–80)
John (844)	Nicholas V (1328–30)
Anastasius (855)	Clement VII (1378–94)
Christopher (903–904)	Benedict XIII (1394–1423)
Boniface VII (974 and 984–985)	Alexander V (1409–10)
John XVI (997–998)	John XXIII (1410–15)
Gregory (1012)	Clement VIII (1423–29)
Benedict X (1058–59)	Benedict XIV (1425–30)
Honorius II (1061–72)	Felix V (1439–49)
Clement III (1080, 1084–1100)	

Bibliography.—G. Jacquemet, "Antipape" in *Catholicisme*; A. Amanieu, "Antipapes" in *Dictionnaire de Droit Canonique*; Philip Hughes, *A History of the Church*, 3 vol. (1934–47); Fliche-Martin, *Histoire de l'Eglise* (1934); Ludwig von Pastor, *The History of the Popes From the Close of the Middle Ages*; also, under the names of particular antipopes, articles in *The Catholic Encyclopedia* and *Catholicisme*. (F. B. N.)

ANTIPYRETICS are agents used to lower the temperature in fever. The most widely used group includes such drugs as antipyrine, acetanilid, phenacetin, quinine and the salicylates which increase heat loss by blood dilution and dilation of the skin capillaries, thus causing an increase in perspiration. Drugs may also produce a lowering in body temperature by dilation of the skin vessels (nitrites) or by slowing the circulation (aconite and veratrum). Heat loss may also be effected by such physical means as cold baths and ice packs.

ANTIQUE, a term meaning "old," but also carrying connotations of aesthetic, historic and financial value. Formerly it referred only to the remains of the classical cultures of Greece and Rome; gradually decorative arts, courtly, bourgeois and peasant,

of all past eras came to be considered antique.

Antiques have been variously defined by law for tariff purposes. Great Britain's customs and excise tariff law of 1959 specified: "To qualify for admission without payment of duty as an antique, an article must have been manufactured or produced as a whole, and in the form as imported, more than one hundred years before the date of importation." The same standard was set by most European countries. The Canadian customs tariff act in 1948 defined as antiquities "all objects for the adornment of mankind and his dwelling and all objects of educational value and museum interest, if produced prior to 1st January 1847." The United States tariff act of 1930 exempted from duty "Artistic antiquities, collections in illustration of the progress of the arts, objects of art of educational value or ornamental character . . . which shall have been produced prior to the year 1830 . . . ," a year widely accepted as proper because it marks approximately the end of traditional handicrafts and the beginning of industrialization. Industrial products at first were poor in design and in quality; attempting to recover earlier standards people became more and more interested in the products of ages past.

The collecting of antiques goes back almost as far as history, beginning with preservation of temple treasures. In England concern for the historical as well as aesthetic significance of antiques led, as early as the 16th century, to collections illustrating the national past; in subsequent centuries such collecting notably increased, stimulated by the rise of Romanticism and the start of archaeology. In 1857 the museum now called the Victoria and Albert opened in London as a repository for decorative arts, intended to stimulate designers as well as collectors. It was followed in 1863 by a great public collection in Vienna, in 1882 by the Musée des Arts Décoratifs in Paris and in 1897 by the Cooper Union Museum for the Arts of Decoration in New York. Antique collecting in the United States was given its first strong impetus by the Philadelphia Centennial exhibition, 1876, which awakened interest in the national past. Collecting antiques became a truly popular pursuit in the 20th century. Private collecting also influenced museum displays and stimulated the preservation, restoration and furnishing of historic buildings.

The design and construction of furniture, including that which would now be called "antique," is discussed in FURNITURE DESIGN and in articles about pieces of furniture. Similarly, other antique objects are discussed in various articles about the decorative arts, such as LACQUER; POTTERY AND PORCELAIN; GLASS; and others. *See* also ART FORGERY. (A. WI.)

ANTI-SEMITISM, consisting of hostile expressions or actions against Jews, has been a more or less constant feature of Jewish life in the Diaspora (*q.v.*). The term, apparently first coined by Wilhelm Marr or Ernest Renan in the 1870s, connoted the new forms of Jew-baiting generated during the era of Jewish emancipation, which stressed racial and socio-economic antagonisms above the religious issues which earlier had dominated Jewish-gentile controversies. Nevertheless, the heritage of ancient and medieval hostilities remained and coloured many arguments as well as legislative enactments.

The persistence of anti-Semitic feelings under various civilizations has been explained by a variety of psychological and sociological motivations. The general factors creating antagonisms among groups—such as dislike of the different, the search for scapegoats in periods of crisis and the tendency to generalize the shortcomings or transgressions of individuals and attribute them to the entire group—have been aggravated in the case of Jews by the heritage of religious hatreds and folkloristic superstitions. Jewish involvement in the crucifixion of Jesus and "stubborn" refusal to join the ranks of the majority were easily combined in the popular mind with an alleged Jewish alliance with the devil. Such alliance and the use of magic arts seemed also to explain the frequent successes in business and medicine by members of the "synagogue of Satan." These successes, moreover, often were an independent source of anti-Jewish feeling, especially among economic competitors and classes adversely affected by major economic changes. The frequent alliance of the Jewish communities with the ruling classes under whose protection they lived often brought down upon them the wrath of revolutionary groups, just as, conversely, in modern times the prominence of many Jewish leaders in leftist movements aroused the ire of many conservative elements and vested interests against the whole Jewish people. With the rise of modern nationalism, moreover, Jewish separatism and "unassimilability," as well as Jewish internationalism and "cosmopolitanism," became major targets for anti-Semitism. Racial anti-Semitism reached its climax during the period of Nazi domination over Germany, but it has continued since the downfall of Hitler despite the fairly unanimous repudiation by experts of the underlying biological theories.

EARLY MANIFESTATIONS

Anti-Jewish feeling appeared in ancient times. Sometimes this antagonism, shared by other minorities, assumed a specific character owing to the extraordinary situation and outlook of the Jewish people. In the book of Esther, Haman is reported to have underscored the Jews' unique distinctiveness among all the ethnic and religious groups inhabiting the Persian empire. This theme was taken up by a chorus of anti-Jewish writers in the Greco-Roman world, including the rhetorician Apollonius Molon, the rabble rouser Apion of Alexandria and even such Roman intellectuals as Cicero, Seneca and Tacitus. Seneca not only resented Jewish "separatism" but also the great influence of Judaism on his own compatriots. Juvenal actually attributed to Jews an unwavering hostility toward the whole outside world. Some of these concepts grew out of the clash between Hellenism and Judaism during the reign of Antiochus IV of Seleucid Syria, which led to the violent suppression of Jewish worship in Jerusalem and the ensuing Maccabaean revolt (165–140 B.C.; *see* MACCABEES). To justify the violation of the Jewish Temple, Seleucid propagandists invented stories about Jewish donkey worship and other allegedly barbaric Jewish rituals. These fables also laid the foundations for recurrent ritual murder accusations against both Jews and early Christians. Above all, the Jewish imageless worship found little understanding in the classical world. "They adore only clouds," exclaimed Juvenal, while others saw in the Jewish refusal to participate in the imperial worship, that main symbol of the unity of empire, utter lack of patriotism and, to use a modern term, a sign of divided loyalties. The frequently contradictory nature of these accusations, a permanent feature of anti-Semitic literature of all ages, was pointed out by Josephus (1st century A.D.) when he described Apollonius' *Diatribe Against the Jews* as "reviling us in one place as atheists and misanthropes, in another reproaching us as cowards, whereas elsewhere, on the contrary, he accuses us of temerity and reckless madness" (*Against Apion,* ii: 14, 148).

These religio-cultural controversies were aggravated by frequent political clashes. In its attempt to divide and rule, the Roman empire often protected the Jewish minority against the local majorities and even insisted upon a measure of equality of rights for the former. Particularly in Alexandria, the commercial and cultural metropolis of the eastern Mediterranean, the ruling classes contested the claim of the local Jewish community, probably the largest in the world, to Alexandrian citizenship. The ensuing controversies led to bloody outbreaks, sometimes followed by execution of the anti-Semitic ringleaders by the Roman authorities. They generated a Jewish apologetical literature culminating in Josephus' *Against Apion.*

Many arguments of the classical anti-Semites were taken over by the apologists of the nascent Christian church, although during the first three centuries it, too, felt the force of similar accusations by pagan rulers and writers, and was often more sharply persecuted than the Jews. Now, however, these denunciations were overshadowed by those relating to the specific Jewish "sin" of having crucified Christ and the assertion that Jews misinterpreted materialistically (*i.e.,* literally) the Old Testament passages foretelling the coming of the Messiah. Jews were also often accused of informing on their Christian compatriots to the Roman or Persian oppressors, as well as of undermining the faith of orthodox Christians by their own teachings and rituals.

Out of this array of accusations grew the demand for sharp

segregation between Jews and Christians. When after 313 the Christian faith became dominant in the Roman empire, ecclesiastical leaders inspired a long series of legislative enactments by Roman emperors designed to lower the status of the synagogue and its worshipers, to segregate Jews from believing Christians and to curtail Jewish religious self-determination where it might become a dangerous rival to ecclesiastical domination. In the laws of the Christian Roman empire and the contemporary patristic letters were laid down the principles of the Christian outlook on Jews and Judaism which were to colour the entire relationship between the two faiths in the middle ages and early modern times. For the first time the Jew was declared a permanent alien and wanderer who, because of his repudiation of Christ, had lost his home and was condemned to perpetual migration. While he was to be protected against total extinction to the end of days, when the second coming of Christ would be ushered in by the full conversion of Jews to Christianity, he was to be maintained in a status of legal and social inferiority and removed from close social contact with believers.

At times leading churchmen, such as St. John Chrysostom in the 5th century and Agobard, archbishop of Lyons, in the 9th, stressed the anti-Jewish more than the tolerant aspects of church doctrine. Agobard fulminated especially against the Jewish "superstitions" and the Jews' "insolent" domination of the economic and political life of the Carolingian empire. The distinguished medieval philosopher John Duns Scotus, admitting the necessity of preserving a Jewish remnant to the messianic era, suggested that a certain number of Jews be deported to a distant island and maintained there at Christianity's expense to the end of days. In view of the changed economic situation, in the later medieval period—when Christians increasingly participated in commerce, and money lending became a major Jewish enterprise—Jews were accused (*c.* 1140) by Peter the Venerable, abbot of Cluny, and others of usury and parasitic exploitation of the Christian population.

The masses went further. Envious of Jewish economic and cultural successes, they accused Jews of using magic arts as the willing associates of Satan. Not prepared to understand or accept the fine nuances of church doctrine, oscillating as it did between basic toleration and the lowering of Jewry's social standing, the masses often reacted violently by massacring Jews or by demanding their expulsion. Wherever total exclusion proved impracticable, Jews were often sharply segregated from the Christian population in quarters of their own and forced to wear the yellow badge (*see* GHETTO). From the 12th century (Norwich in 1144, Blois in 1171, etc.) the ancient ritual murder accusation reappeared with ever greater frequency (*see* HUMAN SACRIFICE: *Ritual Murder*).

These and other arguments, by constant reiteration, sank deeply into the minds of the Christian nations. In those countries which, like Germany and Poland, had not gone through the total expulsion of Jews and hence carried the ancient traditions of hostility in unbroken historic continuity, this was a particularly fateful heritage. Much of that heritage merely needed to be translated into modern secular terms to serve as incendiary material in the new secular environment of the emancipation era.

18TH AND 19TH CENTURIES

After the peace of Westphalia freedom of religion began to be increasingly accepted as a dominant principle of public law, and from that time the anti-Semites shifted their emphasis from the religious to the political and socio-economic issues. Most spokesmen of the Enlightenment era extolled the idea of mutual toleration. They began viewing Jews principally as individuals and members of humanity at large, and as such entitled to the rights of man. During the protracted debates on the Jewish question at the French national assembly in 1790–91 the opposition to Jewish equality of rights stressed either the social-cultural unassimilability of the Jews and their forever forming a "state within the state" (Abbé J. S. Maury and the conservative faction) or the Jewish economic "exploitation" of the peasantry (J. F. Reubell and other Alsatian radicals). Although repudiated by the French majority, these slogans influenced Napoleon's "Infamous Decree" of 1808. (*See* JEWS: *Modern Period: Period of Emancipation.*) They soon were echoed especially in Germany, where anti-Semitism achieved a new respectability and gained much popular support as part of the rising tide of German nationalism after the wars of liberation. Formulated by reputable academicians such as Friedrich Rühs and J. F. Fries, the idea that, despite emancipation, Jews could never become full-fledged members of the German nation eventually led to popular outbreaks in 1819.

In the following decades the various clerical parties used these arguments to rationalize their old religious antagonisms without incurring the odium of religious intolerance. The newly arising socialist parties, on the other hand, effectively employed them in their agitation against the established order. Viewing the Jews of western Europe as leading representatives of capitalist society, Charles Fourier and his disciple Alphonse Toussenel attacked Jewish economic domination (Toussenel's *Les Juifs, rois de l'époque*, published in 1846, strongly argued that point), while the then youthful Karl Marx, although himself born a Jew and descendant of a long line of rabbis, contended in 1843 that the Jews were but exponents of "civil society" (*bürgerliche Gesellschaft*) and, with the disappearance of the latter after the forthcoming victory of socialism, they, too, would vanish from the world scene.

New German Empire.—These anti-Semitic utterances and actions, however, did not crystallize into regular movements or into political parties with anti-Semitic programs. These emerged in Germany only after unification, very largely as a consequence of the ruin brought about by the financial crisis of 1873. In that year a Hamburg journalist, Wilhelm Marr, published *Der Sieg des Judenthums über das Germanenthum* ("The Victory of Judaism Over Germanism"; frequently reissued), which applied to the ancient prejudices a theory of nationality that, under the sponsorship of G. W. F. Hegel, had seized the minds of the German youth and to which the stirring events of 1870 had given practical significance. It also provided a welcome scapegoat for sufferers from the depression. The conservative and ultramontane press rang with the sins of the Jews, and in Oct. 1880 an anti-Semitic league was founded in Berlin and Dresden.

Leadership of the German agitation was assumed by Adolf Stöcker, one of the court preachers who had embraced the doctrines of Christian socialism and had formed a society called the Christian Social Workingman's union. He was also a Conservative member of the Prussian diet. Under his leadership the years 1880–81 became a period of bitter conflict with the Jews. The Conservatives supported him, partly because Christian socialism was likely to weaken the hold of the Social Democrats on the lower classes. Violent debates took place in the Prussian diet. A petition to exclude the Jews from the national schools and universities and to disqualify them from holding public appointments was presented to Bismarck. Jews were boycotted and insulted. Duels between Jews and anti-Semites, many of them fatal, became daily occurrences. On their side the Jews did not lack friends. The crown prince (afterward Emperor Frederick) and crown princess boldly set themselves at the head of the party of protest, the prince publicly declaring that the agitation was "a shame and a disgrace to Germany." A manifesto denouncing the movement as a blot on German culture, a danger to German unity and a flagrant injustice to the Jews themselves was signed by a long list of illustrious men.

The first severe blow suffered by the German anti-Semites was struck in 1881, when, to the indignation of the whole civilized world, the riots against the Jews in Russia and the revival of the medieval blood accusation in Hungary illustrated the incendiary nature of the new anti-Semitism. Some of the extremists among the racial anti-Semites began to extend their campaign against Judaism to its offspring, Christianity. In 1879 Johann Sepp, arguing that Jesus was of no human race, had proposed that Christianity should reject the Hebrew Scriptures and seek a fresh historical basis in the cuneiform inscriptions. Later Eugen Dühring in several brochures attacked Christianity as a manifestation of the Semitic spirit which was not compatible with the theological and ethical conceptions of the Germanic peoples. With these tendencies the Christian Socialists could have no sympathy, and

the consequence was that when in March 1881 a political organization of anti-Semitism was attempted, two rival bodies were created, the Deutsche Volksverein, under the conservative auspices of Liebermann von Sonnenberg, later author of the much-quoted *Beiträge zur Geschichte der antisemitischen Bewegung* ("Contributions to History of the Anti-Semitic Movement"), and the Soziale Reichsverein, led by the racial and radical anti-Semites Ernst Henrici and Otto Böckel. In 1886, at an anti-Semitic congress held at Kassel, a reunion was effected, but this lasted only three years. In June 1889 the anti-Semitic Christian Socialists under Stöcker again seceded.

During the subsequent ten years the movement became more and more discredited. Financial and other scandals covered the party with the very obloquy which it had attempted to attach to the Jews. At the same time, the Christian Socialists who had remained with the Conservative party also suffered. After the elections of 1893 Stöcker was dismissed from his post of court preacher. The following year the emperor publicly condemned Christian socialism and the "political pastors." Another blow to anti-Semitism came from the Roman Catholics. They had become alarmed by the unbridled violence of the demagogues, and in 1894 the ultramontane *Germania* publicly washed its hands of the Jew-baiters. Thus gradually German anti-Semitism became stripped of every adventitious alliance. At the general election of 1903 it managed to return only nine members to the *Reichstag*. Although in those years (1899) appeared Houston Stewart Chamberlain's *Die Grundlagen des neunzehnten Jahrhunderts* (*Foundations of the 19th Century*), which subsequently became a classic of racial anti-Semitism (*see* CHAMBERLAIN, HOUSTON STEWART), the fury of anti-Jewish agitation had spent itself without producing a single legislative enactment against the Jews, and that at a time when the second *Reich* was readily promulgating special legislation against Socialists, Catholics and Poles.

Austria-Hungary.—Understandably, the German-speaking areas in the neighbouring Habsburg empire were most immediately affected. Austrian anti-Semitism found influential spokesmen particularly among the pan-German nationalists and the Christian Socialists. Among the former it was the maverick deputy Georg von Schönerer who declared anti-Semitism as "the mainstay of our national ideology" and an integral part of the program of the newly formed German National party (beginning with the parliamentary elections of 1885). Stressing above all the racial issue, a member of that party, Josef Herzog, presented in parliament a bill amending the constitution of 1867 by withdrawing the equality of rights from "all members of the Jewish race, irrespective of their religion, whose descent from a Jew or Jewess could be proved either from the paternal or maternal side in the first, second, or third generation" (May 1, 1903).

By broadening its attacks to include also the Roman Catholic Church and the Habsburg monarchy, however, this vocal and much-publicized movement antagonized the masses of the Austrian Germans, who preferred the more moderate brand of anti-Semitism as preached by the Christian Socialist party. Aided by the debate on the *Talmudjude*, published by the Prague theologian August Rohling in 1874, the clerical Jew-baiters concentrated their assaults on the Jewish religion and way of life. Supported by the clerical paper the *Vaterland*, the Christian Socialist party celebrated many electoral victories. In 1895 its leader, Karl Lueger, a gifted demagogue, was elected mayor of Vienna, over the emperor's opposition. The party subsequently became the largest in the Austrian parliament. Although it thus became the first political party to achieve power with the aid of an avowedly anti-Semitic program, the Christian Socialist faction greatly moderated its policies with respect to both legislation and administrative practice. Its inconsistencies were well illustrated by Lueger's reputed declaration: "I decide who is or is not a Jew."

Russia.—The practical effects of the German anti-Semitic teachings on the political and social life of Russia were more serious. Medieval anti-Semitism was still an integral part of the polity of the Russian empire. The Jews were confined to one huge ghetto in the western provinces (*see* PALE). Their activity or exploitation, as it was called, was exaggerated and resented by the landowners who had been hurt by the emancipation of the serfs. A nationalist and reactionary agitation emanated particularly from the Slavophil party, which, under N. P. Ignatiev and K. P. Pobêdonostsev, became paramount in the government, with a policy based on absolutism, orthodoxy and the racial unity of the Russian people. The blood accusation also made sporadic appearances and even found an eloquent defender in the priest Hippolyte Liutostansky. This was the situation on the eve of Easter 1881. The hardening nationalism above, the increasing discontent below, Jewish economic activity and echoes of anti-Semitism from over the western border were combining for an explosion.

A scuffle in a tavern at Yelisavetgrad (Kirovograd) sufficed to ignite this combustible material. Within a few weeks the whole of western Russia from the Black sea to the Baltic was smoking with the ruins of Jewish homes. Murderous riots and incendiary outrages took place in no fewer than 167 towns and villages, including Warsaw, Odessa and Kiev. Instead of curbing these outbreaks, the police often disarmed Jews trying to organize in self-defense, while the courts later meted out light sentences to the ringleaders. The tsar's ministers, ardent Slavophils, were not slow to recognize in the outbreak an endorsement of the nationalist teaching of which they were the apostles, and, while condemning the acts of violence, came to the conclusion that the most reasonable solution was to aggravate the legal disabilities of the persecuted "heretics."

To this view the tsar was won over, partly by the clamorous indignation of western Europe, which had wounded his national *amour propre*, and partly by the strongly partisan report of a commission appointed to inquire into the exploitation alleged against the Jews. Its report resulted in the drafting of a "temporary order concerning the Jews" by the minister of the interior, which received the assent of the tsar on May 3, 1882. This order had the effect of creating a number of fresh ghettos within the pale of Jewish settlement. The Jews were driven into the towns and their rural holdings arbitrarily confiscated, with the result that their activities were completely paralyzed, and they fell into a condition of unparalleled misery. By stimulating Jewish emigration into the western countries, moreover, the new legislation played into the hands of anti-Semitic agitators there, who effectively exploited the xenophobic sentiments among the masses.

The Russian May laws were the most conspicuous legislative monument achieved by the new anti-Semitism up to that time. Their immediate result was, however, a commercial depression which was felt all over the empire and which profoundly affected the national credit. Negotiations for a large loan had been entered upon with the house of Rothschild, and a preliminary contract had been signed, when the finance minister was informed that unless the persecution of the Jews was stopped the great banking house would be compelled to withdraw from the operation. Deeply mortified by this attempt to deal with him *de puissance à puissance*, the tsar peremptorily broke off the negotiations and ordered that overtures be made to a non-Jewish French syndicate. In this way anti-Semitism, which had already profoundly influenced the domestic politics of Europe, set its mark on the international relations of the powers, for it was the urgent need of the Russian treasury quite as much as the termination of Bismarck's secret treaty of mutual neutrality which brought about the Franco-Russian alliance.

A new era of conflict dawned with the great constitutional struggle toward the end of the 19th century. By confining the Jews to the towns at the very moment when Count S. Y. Witte's policy of protection was creating an enormous industrial proletariat, the May laws placed at the disposal of the disaffected masses an ally powerful in numbers and intelligence. As early as 1885 Jewish workmen, assisted by Jewish university students, led the way in the formation of trade unions. They also became the colporteurs of western European socialism, and they played an important part in the organization of the Russian Social Democratic federation which their Arbeiter Bund joined in 1897. The latter ultimately counted 30,000 members. The Jewish element in the new democratic movement excited the resentment of the government, and the persecuting laws were once more rigorously en-

forced. They were not abolished until the Revolution of 1917.

Other Countries.—The only other country in Europe in which there had been legalized anti-Semitism was Rumania, where the struggle against Ottoman domination assumed the form of a crusade against Islam. Rumanian politicians preached a nationalism limited exclusively to indigenous Christians. Thus, although the Jews had been settled in the land for many centuries, they were by law declared aliens. This was done in defiance of the treaty of Paris of 1856 and the convention of 1858, which declared all Rumanians to be equal before the law, and also in violation of the treaty of Berlin of 1878 under which Rumania agreed to abolish religious disabilities. Despite reiterated interventions of the western powers, including Britain and the United States, it was not until 1919 that these violations were finally swept away.

The last country in Europe to make use of the teachings of German anti-Semitism in party politics was France. The movement became serious in 1882 when the failure of a prominent financial enterprise was blamed on Jews. In 1886 violent expression was given to that feeling in a book, *La France juive devant l'opinion*, by Édouard Drumont, which appeared in a hundred editions within a year and was speedily translated into English, Spanish, German and Polish. Before long all disaffected elements, especially in the army, joined the Boulangist movement, led by Gen. Georges Boulanger (*q.v.*).

In 1894 a prominent Jewish officer, Capt. Alfred Dreyfus (*q.v.*), was arrested on a charge of treason, and though the case against Dreyfus was proved false, public agitation continued long after his vindication, leaving permanent scars on French public life.

1901 THROUGH WORLD WAR II

At the turn of the century anti-Semitism increasingly assumed international aspects. Stöcker and his associates had tried in the 1880s to organize international congresses of the various Jew-baiting groups. These efforts were facilitated by the problems created by the Jewish mass migrations from eastern to western Europe and America, which reached a peak in 1890–1914. In the debates which preceded the enactment of the Anti-Alien laws in England (1903) and those accompanying the numerous hearings in the U.S. congress from 1891 on, the Jewish issue arose. At the same time the United States government insisted upon equal treatment of its Jewish and non-Jewish citizens in foreign countries. As a result of a long drawn-out controversy with the Russian regime, which discriminated against foreign Jews as it did against its own, Pres. William Howard Taft abrogated in 1912 the 80-year-old commercial treaty with Russia.

More generally, however, the ever-strengthening imperialist tensions which ultimately led to World War I helped the anti-Semites. Nationalist agitators in many countries increasingly attacked Jewish "internationalism" and the alleged alliance between the Jews and the internationally minded Freemasons. In 1906 Count Lamsdorf, the Russian foreign minister, actually suggested an alliance between the tsar, the German emperor and the pope to combat the Jewish "foe of the Christian and monarchical order in Europe." German nationalists, on the other hand, often viewed Christianity itself as a serious impediment to the realization of their imperialistic dreams.

In the meantime conditions in eastern Europe went from bad to worse. The regime of Nicholas II (1895–1917) not only intensified Russian legislative and administrative measures against the Jews but also actively promoted the spread of anti-Semitic propaganda. The tsar spent large sums from his personal funds to subsidize anti-Semitic publications, thus, ironically, indirectly inciting the populace to breaches of order. The militant League of the Russian People, formed in 1904 and popularly called the Black Hundreds, enjoyed the full backing of the government. The latter did nothing to prevent the recurrent violent outbreaks against Jews, culminating in the Kishinev massacre of 1903 and numerous pogroms in reprisal for the Jewish share in the revolution of 1905. Riots in Bialystok, Congress Poland, in 1906 simultaneously attested the effectiveness of the tsarist policies to divide its opponents. The growing tension between the nationalistic Poles and the Jews reached a peak in 1912, when the former proclaimed a sharp economic boycott on their Jewish compatriots.

All this was but a prelude, however, to World War I, which brought with it a series of political and economic changes that were bound to have their effect upon the attitude of the peoples of Europe toward the Jew. The war had marked the breakup of two great empires, tsarist Russia and Austria-Hungary. It was in this area that the largest number of Jews was concentrated, and there more than anywhere else that they maintained their distinctive Jewish way of life. Mob violence, arising from economic rivalry and religious bigotry, thus found in these areas an unprotected minority upon which to expend itself. There also were outbreaks against Jews during the postwar period in Algiers, Syria, Iraq and other Muslim areas.

One of the first phases of postwar anti-Semitism developed out of the Communist Revolution in Russia in 1917 and its aftermath in central Europe. The presence among Communist leaders of persons of Jewish extraction—such as Trotski, L. B. Kamenev, Grigori Zinoviev, Karl Radek and others in Russia, Kurt Eisner in Bavaria and Béla Kun in Hungary—provided anti-Jewish groups throughout the world with a new basis for their anti-Semitism. This was first made apparent in the civil wars between the Communists and the various White Russian armies that sought to overthrow the Red dictatorship. Wherever the White armies penetrated a wave of violence against Jews followed. The most serious excesses occurred in the Ukraine and White Russia, where the number of Jewish victims in 1918–19 far exceeded that of all the earlier pogroms since 1881. Reactionary forces in Europe and the United States, apprehensive of the spread of communist ideas from Russia, likewise identified communism with the Jews. This charge of "Jewish bolshevism" was later to be taken up by the German Nazis and made the cornerstone of their international propaganda. It mattered little that not only the vast Jewish middle class but also the Jewish-Socialist *Bund* sharply opposed communism. For every Jewish Communist leader could be counted several prominent Jewish Socialists who suffered imprisonment and exile as Russian "counter-revolutionaries." In fact, many Communist agitators were appealing to the working classes and lower middle classes by identifying Jews with capitalism and plutocracy.

Manifestations of anti-Semitism spread to the Anglo-Saxon countries. Books such as Lothrop Stoddard's *The Rising Tide of Color Against White World-Supremacy* (1920) and *Racial Realities in Europe* (1924) and Madison Grant's *The Passing of the Great Race* (1916) revived and popularized Nordic racial theories. The charges made against Jews by anti-Semitic writers and agitators revolved around three main points: (1) the claim that Jews were a disintegrating force in the political, moral and cultural life of the countries in which they resided; (2) charges of Jewish economic domination and monopoly; and (3) a claim of Jewish world conspiracy. (Paradoxically, the Nazis later sought to liquidate Jews because of Judaism's spiritual values and its vision of the universal relatedness of all human beings.)

Anti-Semitic writers concocted weird fantasies concerning the alleged Jewish world conspiracy. The most notorious of these fabrications is known as the *Protocols of the Learned Elders of Zion*, which purports to be a report of a series of 24 (in other versions, 27) meetings held at Basel, Switz., in 1897, at the time of the first Zionist congress. There plans were said to have been worked out whereby Jews, together with Freemasons, were to disrupt the entire Christian civilization, and on the ruins of Christendom erect a world state ruled over by Jews and Freemasons. The *Protocols* were first printed in Russia in abbreviated form in 1903 in the newspaper *Znamia* ("the Banner"), and subsequently in book form in 1905. They were translated into German, French, English and other languages of the western world and soon came to be the sacred book of anti-Semitic literature.

The spurious character of the *Protocols* was first revealed in 1921 by Philip Graves, Constantinople correspondent of the *Times* (London), who showed their obvious resemblance to a satire by Maurice Joly on Napoleon III published in 1864 and entitled *Dialogues aux enfers entre Machiavel et Montesquieu*. Subsequent investigation, particularly by Vladimir Burtseff, the historian of the Russian revolutionary movement, revealed that these *Proto-*

cols were forgeries, compounded by officials of the Russian secret police out of the satire of Joly, a fantastic novel *Biarritz* by Hermann Goedsche (1868), and other sources. John S. Curtiss, supported by a committee of prominent U.S. historians, published *An Appraisal of the Protocols of Zion* (1942) in which the documents are subjected to a thorough and critical analysis and pronounced to have no claim to authenticity.

National Socialism.—The storm of anti-Semitic violence let loose by the triumph of Adolf Hitler in 1933 not only reached a terrifying degree in Germany but inspired a world-wide anti-Jewish movement unequaled in modern history. Anti-Semitism ceased to be merely a local and internal problem; it became an instrument of German foreign policy and thus a problem of international concern.

The German revolution of 1918 had eliminated all forms of legal anti-Semitism under which the 500,000 Jews of Germany had lived in the second *Reich*. It was not until the rise of the Nationalsozialistische Deutsche Arbeiterpartei (NSDAP), led by Hitler, that anti-Semitism was made a major national issue by a political party. (*See* also NATIONAL SOCIALISM.) The novelty of this brand of anti-Semitism was that it appealed both to the underprivileged masses and to the élite of aristocrats, former army officers and bureaucrats displaced by the revolution. By stressing the pseudoscientific race theories of Count J. A. de Gobineau, Chamberlain, Dühring and Paul de Lagarde, it painted the "eternal" Jew as the permanent devilish enemy of the German nation. It combined these doctrines with elements in the philosophy of Nietzsche directed against the ethical and moral teachings of ancient Judaism and Christianity and with the neopaganism of Richard Wagner and others. The anthropological bases for these theories were developed by Ludwig Woltman, Ludwig Schemann and above all by the Nazi race theorist H. F. K. von Günther.

The political and cultural applications found their supreme expression in Hitler's *Mein Kampf* and in Alfred Rosenberg's *The Myth of the 20th Century*. A crude and pornographic form of anti-Semitic propaganda was carried on by Julius Streicher, through his *Der Stürmer* (founded in 1922), whose vulgar cartoons and illustrations incited its readers to violent actions against Jews and their non-Jewish friends. The maintenance of "Aryan" racial purity was asserted to be the main function of the state, since this was the only truly creative race in history and interbreeding tended to lead to its corruption. Of this Aryan race the Germans were said to be the purest examples, although scientists pointed out that "Aryan" refers to a family of languages used by many peoples and that there is no such thing as an Aryan race.

Anti-Semitism in Germany also derived from other sources. The Communist Revolution brought German free corps soldiers fighting side by side with the White armies, and a great deal of anti-Semitism filtered into Germany by this route. Hitler's views, too, were coloured by his contact with anti-Semitic currents in Vienna before World War I. Finally, the pacifist activities of such German Jews as Kurt Eisner infuriated the German nationalists and enabled them to identify Judaism with pacifism.

With the coming to power of the Nazis, a flood of anti-Semitic propaganda was loosed. A boycott of Jewish shops was organized on April 1, 1933, and carried out chiefly by the SA (*Sturmabteilungen*). This was to serve as the symbol of popular pressure for legal action against Jews. A decree of April 7, 1933, forbade non-Aryans to occupy public posts, except those who had been in office before Aug. 1, 1914, or who had served in World War I. These exceptions were revoked in 1935. A non-Aryan was defined as a person having at least one Jewish grandparent. This Aryan paragraph was soon applied to the fields of culture and the liberal professions. Jews were dismissed from their posts in universities and technical schools; Jewish artists, musicians, actors and screen and radio stars (with special exceptions) were banned from appearances before German audiences, and Jews were eliminated from the field of journalism.

The denial to Jews of German citizenship was accomplished by the Nürnberg laws on citizenship and race of Sept. 15, 1935, art. ii declaring: "A citizen of the reich is only that subject who is of German or kindred blood and who, through his conduct, shows that he is both desirous and fit to serve faithfully the German people and the reich." In the first supplementary decree of Nov. 14, 1935, this was made specific by defining who was a Jew and by declaring explicitly that "a Jew cannot be a citizen of the reich. He cannot exercise the right to vote; he cannot occupy public office." Together with this law came another designed to complete the process of Jewish segregation. Marriages and extramarital relations between Jews and "Aryans" were prohibited. Jews were also forbidden "to employ in domestic service female subjects of German or kindred blood who are under the age of 45 years." Before long Jewish passports were stamped with a red "J" (*Jude*), and Jews were compelled to adopt Jewish names. Jewish communities were deprived of their legal status by the decree of March 28, 1938, and steps were taken to exclude Jews completely from the practice of medicine.

A high point in Nazi anti-Semitic activity in Germany was reached in the pogroms of Nov. 1938. On Nov. 7 a 17-year-old Polish Jewish boy, Herschel Grynszpan, assassinated one of the junior counsellors to the German embassy in Paris, Ernst vom Rath. This act set off, on the night of Nov. 9, a systematic series of violent reprisal actions by the Nazis. Jewish homes and shops in Germany were plundered. More than 30,000 arrests were made and thousands of Jews sent to concentration camps. Synagogues in Germany and Austria (about 600) were methodically set on fire and the holy scrolls desecrated. Jewish orphanages, homes for the aged and hospitals were not spared. These acts were carried out by the SA, SS (*Schutzstaffel*), Hitler Youth and the gestapo (*Geheime Staatspolizei*) without the participation or sympathy of the general populace. The decrees of Nov. 12 and Nov. 23, 1938, completed the total elimination of Jews from German economic life, while imposing upon them the enormous fine of 1,000,000,000 marks ($400,000,000).

The triumph of national socialism in Germany and the adoption of anti-Semitism as the official government policy brought about a tragic deterioration of the position of Jews far beyond the German frontiers. The main centres for the international dissemination of anti-Semitism, utilizing all the varied arts of propaganda, were Fichte-Bund in Hamburg, Reich Institute for the Study of the Jewish Question and, above all, Welt-Dienst in Erfurt.

The dumping of many German and Austrian refugees into the western countries, which had just begun to recuperate from the great depression of the early 1930s, and the deportation of thousands of Polish Jews to Poland in 1939 likewise helped to increase anti-Jewish feelings. A foreign office circular sent to all German legations and consulates on Jan. 23, 1939, emphasized that "the poorer and therefore the more burdensome the immigrant Jews are to the country absorbing them, the stronger that country will react and the more favourable will the effect be in the interest of German propaganda." In 1933 the Nazi regime also began sponsoring international congresses of anti-Semites (Copenhagen in 1933, Budapest in 1934 and Erfurt in 1937). Most significantly, anti-Semitism became an integral part of German foreign policy. Anti-Semitic propaganda, by increasing domestic unrest and partisan strife, weakened the powers of resistance of Germany's neighbours and prepared them for Nazi conquest.

The Nürnberg war crimes trials and many publications issued after 1945 recalled the appalling extent of anti-Semitic activities during World War II. By 1943 Hitler's *Festung Europa* was dotted with concentration and labour camps, and mass deportations to these centres were being carried out from all the occupied countries (*see* CONCENTRATION CAMPS). Wherever there was any sizable Jewish population, the entry of the Nazis was marked by mass pogroms and organized murder on a scale previously unheard of. Lwow (Lvov), Pol., for example, had 160,000 Jewish residents when it was captured on June 29, 1941; only about 827 came out of hiding after the Russians returned three years later. Of the 3,300,000 Jews in Poland at the outbreak of the war, not more than 10% were alive in 1944, including the refugees to the Soviet Union and other countries.

Despite the enormous number of documents available, it is difficult to fix exactly the date of the Nazi decision to speed the process of population extermination. Gas vans, gas chambers and lethal injections were already in wide use in Europe at the end

of 1941, when the Nazi administration built its large death installations at Auschwitz (Oswiecim; *q.v.*), Chelm, Belzec, Bergen-Belsen, Buchenwald, Dachau (*q.v.*), Maidanek and Treblinka. A major decision using veiled language was taken in the Gross-Wannsee conference of Jan. 20, 1942. In March 1943 the first crematorium was opened at Maidanek. At several death centres, notably Auschwitz and Buchenwald, finely equipped hospital laboratories were maintained in which medical experiments were conducted upon living men and women. The record of German atrocities in France, compiled by the supreme Allied headquarters' psychological warfare section, filled 13 volumes.

Perhaps six out of every seven European Jews found in the occupied areas were killed by the Nazis. This figure must be viewed in the context of the wholesale extermination of "undesirable" ethnic, national and religious groups. It is estimated that from 18,000,000 to 26,000,000 persons—prisoners of war, political prisoners, men, women, children of all ages and all nationalities—were "put to death by the Germans through hunger, cold, pestilence, torture, medical experimentation, and other means of extermination in all the camps of Germany and the occupied territories" (***Documents pour servir à l'histoire de la guerre***, vol. iv, "Camps de concentration," Office Français d'Edition, Paris, 1945).

Not all opposition to Nazi anti-Jewish excesses was crushed, however. Even in Germany, many Jews owed their lives to their Christian neighbours, who sheltered them or their children. Some Protestants and Roman Catholics in Germany consistently opposed Nazism, and such opposition was stronger in the occupied countries. In the spring of 1943, for example, the *Bratislava Gardista* grumbled that "anti-Jewish action in Slovakia is not meeting with the expected success," and the *Grenzbote* accused Slovaks of widespread collusion with the Jews. Louis d'Arquier de Pellepoix, French commissar for Jewish affairs, admitted that resistance to anti-Semitic measures in France continued strong despite threats of punishment. Because thousands of Jewish children were being hidden by non-Jews that spring, the gestapo was extending its raids into the homes of peasants in French areas formerly unoccupied. In Denmark, eight bishops protested against anti-Semitic propaganda to Minister of Justice Thune Jacobsen, and clergymen everywhere, though forbidden to refer to the political aspects of the "Jewish problem," were outspokenly denouncing anti-Semitism. In Greece 600 priests were sent to concentration camps for refusing to preach anti-Jewish sermons and for urging their congregations to help Jews. Thirty-four Budapest residents were sent to prison for sheltering Jews, and some Christian Hungarian women openly wore yellow badges in contempt of the regime's anti-Jewish decrees. The Protestant and Catholic churches of the Netherlands protested the persecution of Jews and the deportation of Dutch citizens. Swedish condemnation of Hitler's "barbaric and systematic extermination of the Jews" continued, and the director of the Swedish Red Cross resigned in protest against the refusal of the Nazis to allow the organization to send aid to Jewish women and children in Poland or to permit the emigration to Sweden of Norwegian Jewish families whose men had been deported.

Among the Jewish victims themselves, resistance was sporadic, desperate and futile. There were many tragic gestures of heroic defiance, notably the uprising in the Warsaw ghetto. At its most crowded stage this ghetto, a slum area of Warsaw which had originally housed about 50,000, contained more than 450,000 Jews from all parts of conquered Europe. By April 1943 their numbers had been reduced to 35,000 by mass executions, pestilence, starvation and deportation to the death camps. On April 18, the eve of Passover, armed with a few rifles, hand grenades and machine guns obtained from the Polish underground, the Jews of the Warsaw ghetto gave battle to the German army, and 25,000 perished.

United States.—After the colonial period, religious freedom, reflecting the need for unity among the various groups in the population, became a dominant principle of American public life. Jews were accorded the same dignity and rights as persons of other religions. To be sure, events in Europe awoke echoes: the Dreyfus case caused talk; the faked *Protocols of the Learned Elders of Zion* were published in Henry Ford's *Dearborn Independent* and elsewhere; and the Ku Klux Klan in the 1920s included anti-Jewish with its stronger anti-Roman Catholic and anti-Negro phobias. But anti-Semitism was not virulent in the United States before Hitler's triumph in Germany, when Nazi propaganda found a depression-born climate of opinion favourable to intergroup hostilities.

The German-American Bunds, directed from Germany, although their total membership amounted to only 8,300 in 1939, possessed more than 80 active cells, including 22 youth camps located near important military centres. The Nazis embraced other organizers who appealed for membership with an anti-Semitic line: William Dudley Pelley started the Silver Shirts in North Carolina in the early 1930s; the Reverend Gerald B. Winrod began operations for Defenders of the Christian Faith in Kansas about the same time, with anti-Semitism as the core; George Deatherage brought the Knights of the White Camellia into action; the Black legion, the Sentinels of the Republic, the American Vigilant Intelligence federation and the Christian Front were other units carrying the Nazi philosophy. The last organization centred around Father C. E. Coughlin of Royal Oak, Mich., and his publication *Social Justice;* in radio talks he used familiar anti-Semitic phrases.

A new element, however, served as a check to anti-Semitism—the National Conference of Christians and Jews, founded in 1928 by Charles Evans Hughes, Newton D. Baker, S. Parkes Cadman, Roger W. Straus and Carlton J. H. Hayes. More importantly, apart from being shocked by the Nazi atrocities, American public opinion increasingly resented Hitler's expansionist policies. Ultimately the United States was drawn into the anti-axis alliance, which made pro-Nazi propaganda of any kind extremely suspect.

Canada.—In Canada, too, organized anti-Semitism began to flourish only after Hitler's seizure of power. More than 20 anti-Semitic organizations sprang up between 1933 and 1935. In Quebec the Parti National Social Chrétien, modeled after the German NSDAP, was organized by Adrien Arcand, the *führer* of Canadian fascism. There also were Blue Shirts, White Shirts and other Jew-baiting groups. Anti-Semitism was frequently condemned by powerful voluntary organizations, however, and anti-Jewish manifestations were relatively quiescent during World War II.

Great Britain.—In England Sir Oswald Mosley's British Union of Fascists carried on a wide variety of anti-Jewish activities, from demonstrations in the Jewish districts of London to the dissemination of the *Protocols* and other pamphlets and leaflets. Even more extreme was the National Socialist league, formed by John Becket and William Joyce (the notorious Lord Haw-Haw of the German broadcasts during World War II), and the Imperial Fascist league, headed by Arnold Leese. These activities met with strong opposition, however, from government spokesmen and leaders of British public opinion.

Western Europe.—Italy, although totalitarian before Germany, was practically free from anti-Semitism until it became enmeshed in German foreign policy. The first legal measures against Jews were initiated in Sept. 1938, and the basic anti-Jewish legislation was incorporated in the racial laws, patterned on the Nürnberg laws, of Nov. 17, 1938. These measures found little support among the Italian people and, aided by Christian neighbours, three-quarters of Italian Jewry survived the Nazi ordeal.

In France the coming to power of a popular front government headed by a Jew, Léon Blum, was utilized by the anti-Semitic groups to raise a cry of Jewish domination and Jewish communism. With the heightening of the international crisis, particularly after the pact of Munich in 1938, anti-Semitic agitation in France became closely identified with a pro-Nazi orientation of French foreign policy and came to be considered a serious menace to the safety of the state. After the German conquest the formal distinction existing up to Nov. 1942 between the occupied and unoccupied zones was reflected in the attitude toward the Jews. In the occupied zone confiscations and "Aryanization" of Jewish property, anti-Jewish legislation and physical assault upon Jews followed the regular pattern of Nazi Germany proper. In the unoccupied zone the status of the Jews depended largely on the degree of Franco-German collaboration. As the Vichy regime became more and more committed to a policy of collaboration, the

severity of the measures against the Jews increased, and were extended to the colonial empire. In all the territories adhering to Gen. Charles de Gaulle and the Fighting French and, after the Anglo-U.S. occupation, also in north Africa, these anti-Semitic measures, together with all Vichy legislation, were declared null and void. This administrative division helped some two-thirds of the Jews of metropolitan France to survive, whereas neighbouring Belgium lost more than half and the Netherlands more than three-quarters of their Jewish inhabitants.

In Norway the clergy of the state church, under the leadership of the courageous Bishop Eivind Berggrav, opposed the Nazi propaganda, and a pastoral letter was read in many churches denouncing the racial legislation. From its office in London, the Norwegian government in exile opposed the agitation against Jews in Norway. In Denmark the adamant stand of King Christian succeeded in preventing special anti-Jewish measures demanded by the Nazis during the occupation. Many Danish Jews fled to Sweden, assisted by Christian Danes. In Sweden the activities of the anti-Semitic editor Einar Aberg were of minor importance.

In Switzerland, too, there were many expressions of disapproval of Hitler's anti-Jewish policy throughout the whole Nazi era, although there appeared numerous publications which attempted to justify the Nazi party line.

Eastern Europe.—In sharp contrast with the policies of the other states of eastern and central Europe was the original public stand against anti-Semitism taken by the Soviet Union. Lenin and his associates included the Soviet Jews among the national minorities to which the law of Nov. 1917 promised full governmental support in the preservation of their cultural autonomy; they also outlawed anti-Semitism and declared it to be a counter-revolutionary crime (July 1918). To reinforce this prohibition Lenin himself broadcast to the Soviet peoples a major message explaining that anyone urging discrimination against Jews unwittingly promoted the restoration of the tsarist regime. This policy was more or less strictly adhered to, although the simultaneous prohibition of Zionism, the elimination of public instruction in Hebrew and the agitation against Jewish religion were sapping the vitality of the Russian Jewish community, which became increasingly isolated from the rest of world Jewry. Moreover, Stalin constantly reiterated his view that the recognition of national minority rights was intended only for the period of transition from the capitalist to the truly communist society. In the 1930s, owing to the rising wave of Russian nationalism and imperialism, this friendly attitude toward the Jewish community underwent a change. It reached its nadir after the conclusion of the German-Soviet treaty of nonaggression in 1939, followed by the incorporation of some 2,500,000 Jews in the newly occupied territories of Poland and the Baltic states. However, after the German invasion of Russia the Soviet regime again professed its friendliness toward the Jewish people and through the Anti-Fascist league tried to collaborate with the Jews of other countries.

In Poland, after World War I, the lead in the anti-Semitic movement was taken by the old National Democratic party (known as Endeks). The economic crisis helped to create a favourable environment for anti-Semitism, which took the form of physical attacks upon Jews and student riots in the universities, and above all in the economic boycott of Jewish business enterprises and Jewish professionals. The period of violent assaults upon Jews came to an end in 1926 with the coup d'état of Marshal Jozef Pilsudski, and until his death in 1935 Pilsudski's dictatorial regime protected the Jews from mob violence. The economic strangulation continued, however, and increased nationalization of the Polish economy resulted in the elimination of thousands of Jewish workers from industry. The death of Marshal Pilsudski opened the way for a new wave of anti-Semitism. The worsening economic conditions, the coming to power of the clique of Polish colonels, and the flirtation of Foreign Minister Jozef Beck with Nazi Germany all helped to aggravate the situation. Extremist parties, such as the National Democrats and the Nara (National Radicals), began to emulate Nazi policies toward the Jews. Jewish ritual slaughtering was outlawed in 1936. Universities practised an informal *numerus clausus;* many established special "ghetto benches" for Jewish students. Violence once more became widespread, the economic boycott was extended and there was agitation for the emigration of "superfluous" Jews. Elimination of Jews from the economic and professional life of Poland continued. Within a few weeks after Hitler's armies had moved into Poland, ghettos were established and large numbers of Jews were deported or sent into forced labour and concentration camps. Terrorism became the official policy.

Before World War I, Hungary was relatively free of radical anti-Semitism, and for the most part the Jews were accepted as loyal citizens of the realm. The economic dislocation of the postwar period, however, and also the fact that the Hungarian Communist revolution of 1919 was led by Béla Kun, who was born a Jew, resulted in the growth of animosity which, ushered in by the White Terror and propagated by the Awakening Magyars, placed Hungary with Poland and Rumania as the three countries in which anti-Semitism was widespread before the advent of Nazism. Acts of violence were committed, a silent effective boycott was instituted against all Jews, particularly in the smaller towns and villages, and Hungary was the first country in postwar Europe to pass a *numerus clausus* law, restricting the number of Jewish students in the universities to 5% (1920). This law was in violation of Hungary's obligation assumed in the postwar treaties, and aroused considerable opposition in international circles, but it was not modified until 1928. Hitler's triumph in Germany led to the rapid spread of Nazi agitation in Hungary, and only the fact that occupation of Hungary by German troops was delayed enabled about half the Jewish population (in the 1937 boundaries) to escape the Nazi extermination squads.

In Rumania anti-Semitism was widespread during the period 1918–35. There were practically no Jews in the civil service, and they were discouraged from entering the professions. Both the National Christian party and the Liberal party were anti-Semitic, and the National Peasant party, coming into power in 1928 after a record of disavowal of anti-Semitism, did nothing to change the situation. As Rumania came into the political orbit of Nazi Germany the condition of the Jews worsened, and Nazi officials established close connections with the native anti-Semitic groups, especially the Iron Guard. Nevertheless, because of greater laxity in execution, more than half of Rumanian Jewry either survived the war in the homeland or returned there from the concentration camps in Transnistria. (K. S. P.; E. R. Cy.; B. Y. L.; S. W. B.)

AFTER WORLD WAR II

After the Nazi defeat in World War II the anti-Semitic movement lost ground in western Europe and America, but as a result of international developments it assumed new significance in the Soviet Union, eastern Europe and the middle east. Its new manifestations were partly the aftermath of the Nazi regime and partly the result of the new enmities generated by the rise of the state of Israel.

Germany and Western Europe.—In the first years after the war the Jewish issue was kept alive in Germany and throughout formerly Nazi-occupied Europe by the recurrent war crimes trials, the denazification procedures, property restitution problems and the attempts at rehabilitating the survivors of the Nazi concentration camps. The International Military tribunal at Nürnberg in 1945–46 tried 22 "major war criminals." By dealing with such leading Nazis as Hermann Göring and Joachim von Ribbentrop, by defining the nature of crimes against humanity as well as war crimes and crimes against peace, and by accumulating an enormous mass of written and oral testimony, it established a standard for similar trials by other tribunals, both national and international. By its detailed account of the persecution of the Jews and its finding that half the defendants were guilty of crimes against humanity for participating in these atrocities, it brought to public attention the enormity of the mass murder of Jews committed during the war. When the United Nations War Crimes commission came to an end in 1948, jurisdiction over these offenses was transferred to the individual countries, where public opinion veered toward increasing leniency. (*See* WAR CRIMES.)

The denazification proceedings aimed at removing confirmed

Nazis from administrative and teaching posts in Germany faced the difficulty of distinguishing ideological from prudential Nazis and of conducting administration without the services of many of the latter class. By 1955 most denazification courts had altogether suspended their activities. The problem of former Nazis in political and administrative offices became, indeed, one of the outstanding issues in West German public life in the 1950s and 1960s. As an indication of the number of these, by Sept. 1962, 149 of West Germany's 11,500 judges and prosecutors had taken advantage of a law of June 1961 permitting early retirement for those who had been in office during the Nazi period. Various attempts to re-establish formal neo-Nazi parties in West Germany failed, in part because of their outlawry by the courts and in part because of lack of popular support. Certain crypto-Nazi groups and parties could claim some members, but they were politically negligible.

In East Germany many former Nazis became Communists. In Nov. 1951 some 900 former Nazis in East Berlin were allowed to establish the People's Freedom party.

The rehabilitation of the survivors of the concentration camps and efforts at restitution of confiscated Jewish property were attacked by neo-Nazi agitators in the West German republic. Many Germans who had acquired from the Nazis confiscated Jewish houses, factories and other businesses were reluctant to return them to their rightful owners, and formed protective associations to resist restitution. Within a decade after the war, however, all the camps for displaced persons had been emptied of their Jewish inmates by emigration to Israel, the United States and other countries. The last camp, at Föhrenbach, was closed in 1956. Restitution and reparation proceedings likewise proceeded with respect to individual claimants as well as to the vast property to which there were no heirs. They culminated in the Luxembourg agreement of Sept. 10, 1952, between Germany, on the one hand, and the state of Israel and the Conference on Jewish Material Claims Against Germany, representing the leading Jewish organizations in the free world, on the other hand, whereby Germany promised to deliver to Israel in the course of 12 to 14 years goods valued at $822,000,000 (of which $107,000,000 was to be used for the indemnification of Jewish victims residing outside Israel). This agreement as well as internationally supported attempts at restoring Jewish property in other formerly Nazi-occupied countries were cited by anti-Semitic agitators as proofs of Jewish world machinations. Incidents affecting Jewish war orphans served to embitter relations between Jews and their neighbours. Foster parents who had saved Jewish children whose parents had been deported, and raised them in the Christian faith, on several occasions defied court orders to restore the children to their Jewish relatives. All through these years anti-Semitic propaganda continued.

The most persistent Jew-baiting French periodicals, the weekly *Aspects de France*, *Rivarol* and *La Nation française*, in the early 1960s had a combined circulation of only 105,000. The monthly *Défense de l'Occident* and *Europe Action* (the latter launched in Jan. 1963) had much smaller circulations. Politically, anti-Semitism was ineffective in France after World War II, in spite of the possibilities opened up by the powerful right-wing surge during the Algerian war and by the brief prominence of Pierre Poujade's tax-protest movement (he won 12.1% of the vote in the parliamentary elections of Jan. 1956).

Apart from local anti-Semitic publications there was a considerable interterritorial exchange of Jew-baiting literature. The Swedish pro-Nazi Einar Aberg attracted particular attention in Europe and America, although his influence in the Scandinavian countries was negligible, particularly after he was condemned to prison in June 1954. A Russian *émigré* group in Munich, the St. George's Brotherhood for National and Patriotic Enlightenment (RONDD), likewise had an extensive mailing list in many countries. The international congress of anti-Semites meeting in Malmö, Swed., in 1951, attracted more notice because of its disavowal of Nazi affiliations than because of its representative character.

Behind the "Iron Curtain."—A sharp turn toward anti-Semitism occurred in the Soviet Union and its European satellites beginning in 1948. With the progressive deterioration of inter-Allied relations and the outbreak of the Korean War, the Soviet Union began to view the Jewish population as a potentially subversive group. Journalistic spokesmen for the regime, including the Jew Ilya Ehrenburg, began attacking the Jews for their "cosmopolitanism" and their connections with western co-religionists. Although in Nov. 1947 the Soviet Union joined the United States and other powers in voting at the United Nations for the partition of Palestine and the establishment of the state of Israel (Soviet main interest being to remove British influence from the middle east), the U.S.S.R. distrusted Russian Jewry's "nationalistic" attachment to the new state. These accusations were followed by the deportation of thousands of Jews, including most Yiddish writers and other intellectuals, to Siberian labour camps. All organs of Jewish opinion and almost all Jewish cultural institutions were closed. In 1952 Jews were withdrawn from the Soviet army of occupation in East Germany, and the *Big Soviet Encyclopaedia* dropped the names of Jewish scientists, writers and artists listed in the 1947 edition. Finally, a number of leading Jewish doctors in Moscow were accused of plotting to poison Stalin and other leaders. The evidently intended large-scale persecution of Jews was interrupted, however, by Stalin's death (1953). The new regime thereupon declared the doctors to have been victims of charges falsified by L. P. Beria, head of the secret police. The ensuing relaxation of anti-Jewish agitation, however, was neither all-embracing nor enduring.

Though the Soviet government has been consistently hostile to all religions, it seemed clear during the late 1950s and 1960s that a policy to obliterate not only the practice of Judaism but also Jewish culture was in operation. Jewish congregations were not permitted to form regional or national associations; necessary religious articles could not be manufactured; facilities for rabbinical training were practically eliminated; and the Hebrew language, essential for understanding and participating in religious services, could not be taught (as it had not been since 1917). Participation by Jews in public life likewise was being curtailed. In May 1961 the death penalty was extended to "economic crimes"; by March 1963, 58 trials had been held for such crimes, more than half of them involving Jews. Newspaper reports of the trials made a point of emphasizing defendants' Jewishness by dwelling on Jewish-sounding names, etc.

Among the satellite countries, Poland and Rumania maintained their deep-rooted anti-Semitic heritage. Although the Jewish population of Poland had dwindled to some 90,000 (in the new geographic boundaries) in 1945, the animosities, strengthened by resentment of claims for restitution of property made by the few Jews who returned from the Soviet Union, led to numerous riots, culminating in the Kielce pogrom of July 1946. More than 800 Jews lost their lives in the first two years after the liberation. The government, in which the Communists played an increasingly dominant role, at first opposed anti-Semitism and supported the newly formed League to Combat Racism. But this very attitude, combined with the presence of a number of Jews in the highest echelons of the Polish Communist party, intensified the anti-Jewish agitation among rightist groups. By 1948, however, when the Communists secured full control, the Soviet attitude was fully adopted, leading to persecution of Zionists and suppression of most Jewish cultural activities. Jewish "nationalism" was now equated with "anti-gentilism." This policy of suppression was moderated slightly upon the return of Wladyslaw Gomulka to power in 1956 and the adoption of a somewhat more independent policy toward the Soviet regime, although this upheaval had also resulted in the demotion of several influential Jewish Stalinists. The 20th anniversary of the uprising of the Warsaw ghetto was celebrated solemnly throughout Poland in 1963, with the government participating.

In Rumania, too, the progressive seizure of power by the Communists was accompanied by the persecution of "Zionists" and the suppression of all Jewish cultural activity. The early rush of Jewish *émigrés* to Israel was checked, and thousands of Zionist leaders were condemned to long prison terms. Ultimately, leading

Jewish Communists, among them the foreign minister, Ana Pauker, were removed from office. But in Rumania, too, the death of Stalin led to some moderation of the anti-Jewish policies.

Equally reflective of the changing Soviet policies were those pursued by Czechoslovakia and Hungary. In Slovakia the heritage of the Tiso regime led to many assaults on Jews in Bratislava and elsewhere in the first postwar years. In Bohemia and Moravia, on the other hand, the Jews were often accused of having been agents of Germanization. The restitution of Jewish property was opposed not only by the new owners but also by labour unions and the bureaucracy, which wished to maintain state ownership of expropriated holdings. Under the influence of the Soviet policies, finally the numerous Jews serving in the Communist party leadership, diplomatic posts, etc., lost their positions, and some even their lives. The trial and execution in Nov. 1952 of Rudolf Slánsky, the former secretary of the party, and several of his Jewish associates had overtly anti-Semitic aspects.

In Hungary similar developments were aggravated by numerous deportations of citizens from Budapest and provincial cities to labour camps in the Soviet Union in 1951–52. These exiles included a disproportionate number of Jews (in Dec. 1951 the Vatican radio estimated that there had been 14,000 Jews among the 38,000 deportees from Budapest alone). Jews also comprised a very large proportion of victims of the successive Communist purges and of the repression of the Hungarian revolt of 1956, although many thousands succeeded in escaping. A similar exodus had taken place from East Germany, especially the eastern sector of Berlin, in 1953, when anti-Jewish purges had revealed that that country, too, had subscribed to policies of the U.S.S.R.

Middle East.—Since the Arabs regard themselves as Semites, Arab hostility to Israel is primarily political, a result of the territorial and refugee problems, and not racial. It resulted, however, not only in a world-wide anti-Zionist propaganda but also in many anti-Jewish measures because of the assumption that Jews generally support Zionism. Under the guise of suppressing illegal Zionism the Iraqi and Syrian governments instituted a persecution of all Jews. As a result of the ensuing mass migrations, the Jewish population in Iraq dwindled from 130,000 to 6,000 and that of Syria from 25,000 to 3,000 in the first four years after the rise of the new state. In Egypt, where even the revolutionary regime of Gamal Abd-al-Nasser professed to distinguish sharply between Jews and Zionists, all restraints were removed during the Sinai campaign in the autumn of 1956. Confiscations of Jewish property and more or less enforced emigration further reduced the number of Jewish inhabitants, which had already dwindled from 75,000 in 1946 to 35,000 in 1953; by 1963 Jews in Egypt were estimated to number no more than 4,000.

At the same time the various propaganda services of the Arab league in the western countries often indulged in accusations against Jews and Judaism generally and in many cases worked with local anti-Semites. Some Arab nationalists felt that by thus undermining the power and influence of the local Jewish communities they might weaken the support extended to Israel by the western powers. The member states of the Arab league also proclaimed an economic boycott of Israel and even boycotted firms trading with the new state.

South Africa.—In South Africa the Jewish population was menaced, many leaders of the dominant Nationalist party having made anti-Jewish and pro-Nazi statements before and during the war. However, the government of Daniel Malan, soon after coming to power (1948), reassured the Jewish citizens that it intended to adhere scrupulously to the principle of constitutional equality. An official list of 2,300 prohibited publications issued in July 1956 included the *Protocols* and several other anti-Semitic tracts. The government's growing friendship with Israel, since both countries felt threatened by the African and pan-Arab propaganda emanating from Egypt, also benefited the local Jewish population. But in 1961 Israel joined the Afro-Asian states and the Soviet bloc in a UN General Assembly motion to censure South Africa for its *apartheid* policy, and thereafter relations between the two countries deteriorated. Though the South African government made a firm distinction between the country's Jewish community and the state of Israel, and made pronouncements against anti-Semitism that were generally supported, anti-Semitic groups increased their activities, especially through circulation of Einar Aberg pamphlets.

Western Hemisphere and British Commonwealth.—In the United States anti-Semitic agitation by what Pres. Franklin D. Roosevelt had called the "lunatic fringe" greatly diminished after the war. William Dudley Pelley was sentenced to a prison term of 15 years. The German Bund disintegrated, although there were still a few attempts to revive its Nazi program. However, there was a fairly steady flow of anti-Jewish periodicals and pamphlets, most persistently those of Gerald L. K. Smith and Conde McGinley, leader of the *Common Sense* group of Union, N.J., both of whom supplied hate literature to other organizations.

The intensification of the movement for Negro civil rights in the late 1950s and 1960s created tensions and disturbances that provided good ground for a resurgence of anti-Semitic activity. Especially prominent was the American Nazi party, whose anti-Semitic publications were numerous and virulent. But U.S. anti-Semitism more typically expressed itself under guises of patriotism or religiosity, or both, and these were seen in the activities of the Ku Klux Klan; the National States Rights party, with its monthly *Thunderbolt* and reprints of such classical anti-Semitic literature as Arnold Leese's *Jewish Ritual Murder* and the *Protocols of the Learned Elders of Zion;* and the National Renaissance party, headed by James H. Madole, with its bimonthly *National Renaissance Bulletin.*

Native Argentinian anti-Semitism received a new impetus from the immigration of numerous Nazis, for whom the country became a major haven of refuge and who propagated their violent brand of anti-Semitism in a periodical, *Der Weg.* They found a few listeners. However, even the Perón administration refrained from enacting any discriminatory legislation against Jews, and the later more liberal regimes adhered to the principle of Jewish equality. In the 1960s, however, a strong wave of anti-Semitism swept Argentina, the result of several factors chief of which was undoubtedly the kidnapping of Adolf Eichmann by Israeli authorities, in violation of Argentinian territorial integrity. This created resentment, and a number of anti-Semitic outrages followed. In the week after Eichmann's execution (May 31, 1962) ten serious incidents occurred. Most of these could be traced to adolescent members of two neo-Fascist organizations, Tacuara and Guardia Restauradora Nacionalista, which in May 1963 were banned.

Elsewhere in Latin America, anti-Semitism has never been prominent, even in such countries as Uruguay, Brazil and Mexico, which have sizable Jewish populations. The 1962 incidents in Argentina touched off a few minor outrages in Brazil and Uruguay against which measures were promptly taken.

The Jewish populations of the British Commonwealth suffered relatively little from anti-Semitism, despite tension in regard to the Palestine situation in 1946–48. Occasional outrages, such as damage to several synagogues in and around London on the night of the Day of Atonement, 1948, were generally condemned by public opinion. In the summer of 1962 disorders took place in Trafalgar square, London, during meetings of Colin Jordan's National Socialist movement, Sir Oswald Mosley's Union movement and Andrew Fountaine's British National party, the three main fascist organizations in Britain. As a result of a police raid on the National Socialist movement headquarters thereafter, Jordan and three supporters were convicted of violating the Public Order act and sentenced to prison terms. The conviction, on appeal, was sustained by the High court in March 1963, the Lord Chief Justice, Lord Parker, declaring that guarantees of free speech do not include the right to "threaten, be abusive or insult [others] in the sense of hitting them by words." His decision led to debate over the desirability of further legislation to curb hate groups.

In Canada, notwithstanding the dissemination of much anti-Jewish literature, both native and imported, several provincial legislatures passed laws prohibiting discrimination in employment, and generously responded to appeals for immigration of Hungarian refugees, including Jews. In Australia the earlier opposition to Jewish immigration gave way to a friendly attitude that found

expression in the rejection by the vast majority of the occasional anti-Jewish publications, chief among which were those of Eric Butler's Social Credit movement and the *New Times* magazine.

See also references under "Anti-Semitism" in the Index.

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ANTISEPTICS. Antiseptics are a group of widely differing chemical compounds possessing the property of either killing bacteria (bactericidal) or of preventing their multiplication (bacteriostatic). They are employed in medical practice with the object of preventing or combating bacterial infection of superficial tissues, and in the sterilization of instruments and infected material. A distinction is drawn in modern usage between antiseptics and chemotherapeutic agents, such as the antibiotics, sulfonamides and organic arsenical drugs, which are administered by mouth or by injection for the treatment of deep-seated or generalized infections but may also be applied locally in the treatment or prevention of superficial infections.

The first rational use of a chemical substance to prevent or control infection in the human body occurred when Joseph Lister (later Lord Lister), following the demonstrations by Louis Pasteur that fermentation and putrefaction were caused by living bacteria or yeasts, conceived the idea of interposing an antiseptic barrier between injured tissues and the germs that might gain access from an outside source. Lister employed carbolic acid in various forms both to control infection of intentional or accidental wounds and to sterilize surgical instruments. He thereby greatly reduced the risks and deaths from hospital sepsis. In hospital practice this principle of antisepsis was modified in favour of asepsis, in which potentially dangerous germs are denied access to susceptible tissues by the sterilization, usually by heat, of all instruments and dressings, the wearing of sterile gowns, masks and rubber gloves, and the disinfecting by chemical antiseptics of the skin around the site of operation.

Properties of Antiseptics.—A very large number of chemical compounds possess the power of killing bacteria, but many of them also exhibit properties that may profoundly affect or entirely prohibit their practical use. Most antiseptics are general protoplasmic poisons and if used in sufficient concentration are harmful to the body's cells and tissues as well as to bacteria. Thus an antiseptic is most valuable in the disinfection of contaminated wounds or skin surfaces when there is a wide margin between its bactericidal and toxic concentrations. When, however, an antiseptic is to be used to disinfect contaminated articles or excreta, its toxic properties are not important, and so chemical substances (usually called disinfectants) may be used for this latter purpose that cannot be applied to living tissues.

Again, the activity of antiseptics, with the possible exception of the acridine dyes, is adversely affected by the presence of organic matter such as blood or serum. The degree of inactivation varies with different compounds and with the quantity of such material that is present. It is perhaps the most important factor contributing to the difficulty of controlling wound infection by the application of antiseptics.

Another difficulty is that different species of bacteria show great variation in their sensitivity to antiseptics in general or to any particular antiseptic; among the more resistant are the tubercle bacillus, bacterial spores and the blue pus bacillus, *Pseudomonas pyocyanea*, which prove very troublesome in superficial wounds and burns.

Evaluation and Comparison of Antiseptics.—The efficiency of an antiseptic must be measured in relation to three main factors: concentration, time and temperature. It is desirable to know the minimum concentration at which an antiseptic will be effective. Some antiseptics like phenol lose their activity sharply beyond a certain dilution, whereas mercurial preparations are still inhibitory to bacterial growth at very high dilutions. The time that an antiseptic takes to act will depend to some extent on its concentration, but the speed at which antiseptics kill bacteria varies considerably; thus the halogens (*e.g.*, iodine and chlorine salts) act quickly while the mercurials, the compounds of heavy metals and the antiseptic dyes are slowly acting antiseptics. Most antiseptics act more quickly with increase of temperature; *e.g.*, the activity of the coal tar derivatives is doubled by a rise in temperature from that of a cool room to body heat. Hypochlorites, on the other hand, are best used cold since they become more unstable at higher temperatures.

Many attempts have been made to produce a satisfactory standard method of comparison of antiseptics. None of these is entirely satisfactory owing to the impossibility of selecting a single yardstick by which the performance of an antiseptic under widely differing conditions may be judged. The best-known comparative tests are the classical methods developed by S. Rideal and J. T. A. Walker (1903) and the modified test introduced by H. Chick and C. J. Martin (1908; see *Bibliography*). The principle employed in the Rideal-Walker method is the determination of the concentration of antiseptic that will kill a suspension of the typhoid bacillus in a given time, compared with the killing efficiency of phenol under similar conditions. The bactericidal activity of the antiseptic under test may then be expressed as a figure of 2,5,10, etc. (the phenol coefficient), relative to the

efficiency of phenol, which is represented as unity. The Chick-Martin test employs a similar technique but is modified by the addition of known quantities of organic material. The inherent disadvantage of any such tests is that efficiency is only measured against one organism under a single set of conditions. Results show considerable variation if these conditions are altered and the test gives little guidance about how an antiseptic may be expected to act under practical conditions.

The more modern approach to the problem makes use of *in vivo* tests, in addition to test-tube methods, and thus tries to imitate the natural conditions that may be met in practice. For example, several antiseptics may be compared for their efficiency as skin disinfectants by tests on the skin of volunteers for such qualities as lethal effect against a wide range of organisms, speed and reliability of action and the absence of irritant effects on the skin.

Use and Choice of Antiseptics.—If the antiseptic is to be used to disinfect instruments or infected material its toxicity is of minor importance and high concentrations may be used. Speed and efficiency of action and cost are the main considerations.

On the other hand, for the disinfecting of skin and in the treatment or prophylaxis of wound infection, the degree of inactivation by organic material, the duration of effective action, the powers of penetration, and activity against a wide range of bacteria are of major importance. Certain antiseptics, for example, 2% iodine and 70% ethyl alcohol, are particularly useful for the rapid and effective disinfection of the intact skin surfaces before operation or injection; the antiseptic dyes such as the flavines may be used effectively in surgical wounds and minor injuries to prevent the establishing of infection. Once infection has occurred in an open wound antiseptics are much less effective, for though they may produce a fall in the number of bacteria, they usually lack the ability to penetrate into the depths of the wound where bacterial growth is taking place. Besides, by inactivating the phagocytes and young tissue cells, antiseptics may interfere with the body's natural defenses and repair processes.

It is because they have the properties of diffusion and lack of toxicity to living tissues and are not inactivated by organic matter that penicillin and sulfonamide preparations have yielded such excellent results when applied directly in the prevention and treatment of wound infection.

Types of Antiseptics.—Antiseptics in common use fall into nine main classes.

Acids and alkalis are of little practical importance because they are either too caustic to tissues or are relatively inefficient bactericides. Acetic acid (vinegar), used for many centuries for dressing wounds, is a possible exception.

Soaps and Detergents.—The soaps possess both a bactericidal and cleansing action and are of considerable value when used to prevent superficial infection, since thorough washing of the skin results in a great diminution of the bacterial flora. Certain antiseptics, *e.g.*, hexachlorophene, may be incorporated in soaps.

Detergents are of three types, the anionic, cationic and nonionic. The cationic detergents exhibit powerful antiseptic properties and are active against most types of bacteria, particularly the pyogenic cocci. They are relatively nontoxic when applied superficially, but a minority of people develop skin sensitivity to them. These cationic detergents combine cleansing with bactericidal activity but have the disadvantage that they are inactivated by soap and are partially inactivated by organic material.

Oxidizing Agents.—This group, of which the more important members are potassium permanganate and hydrogen peroxide, owe their activity to the liberation of oxygen. Their chief disadvantage is the high degree of inactivation by organic material. Because of this and its instability in weak solution, hydrogen peroxide is a relatively poor antiseptic.

The halogens, chlorine and iodine, are both extremely effective agents and may be used in high dilution in the absence of organic material. The hypochlorites, which are marketed in many proprietary preparations, owe their activity to the liberation of chlorine, which acts as an oxidizing agent; they are quickly inactivated by organic matter. Iodine, though toxic to living tissue, provides the most efficient form of skin disinfection, particularly when combined with 70% ethyl alcohol. Iodoform has been used for wound disinfection but is ineffective.

The Heavy Metals.—The salts of mercury, silver, copper and zinc have been used as antiseptics. The simple salts of mercury are unsuitable for use in wound prophylaxis or therapy because they are toxic if used in bactericidal concentration and are only bacteriostatic in lower concentrations.

Complex organic mercury salts are more effective bactericides than the simple salts, are less affected by organic material, are less toxic and may have some prophylactic value when applied to wounds.

Ethyl alcohol is an excellent skin antiseptic, used in a 70% concentration with water. Industrial methylated spirit is 90%–95% alcohol and should therefore be diluted to 70% for most effective use; its use as an antiseptic for the storage of insulin or other hypodermic syringes is not recommended, since sterilization cannot be guaranteed.

The Coal Tar Derivatives.—This group contains a large number of common antiseptics and disinfectants varying considerably in toxicity and efficiency. Phenol, or carbolic acid, is the least efficient and is highly toxic to tissues. The cresols, which are various forms of methylated phenol, are poorly soluble in water but are dissolved in soap; they are somewhat stronger bactericides than phenol but only slightly less toxic. The black and white fluids are cresols, dissolved respectively in oils or gums, and are used mostly for the disinfection of excreta or contaminated materials. Xylenol, especially when combined with chlorine, is an effective general bactericide and is relatively nontoxic but is considerably affected by organic matter.

The Dyes.—The aniline dyes (*e.g.*, brilliant green, gentian and crystal violet) are slow-acting antiseptics with considerable penetrative power but are rather selective in their activity and are toxic to tissues.

The acridine dyes (*e.g.*, the flavines) also act slowly but they are practically nontoxic and are inactivated very slightly by organic material. They have been proved effective against infection of experimental wounds and have enjoyed considerable popularity in the control of wound infection.

Formalin (40% formaldehyde), sulfur dioxide and chlorine are employed in gaseous form for the fumigation of sick rooms, the so-called terminal disinfection. Formalin vapour is a very efficient surface disinfectant for bedding, books and other articles and materials that may be deleteriously affected by heat sterilization. Care must be taken to maintain a sufficient concentration of the gas for a sufficient length of time by sealing all air outlets in the room or chamber where the materials or articles are being disinfected. A moist atmosphere and higher temperatures enhance its disinfectant action.

Sulfur dioxide is less effective, and chlorine may tarnish or bleach.

Disinfection of polluted air by the administration in gaseous form of certain chemical substances (*e.g.*, hypochlorite, resorcinol or hexyl-resorcinol, glycols, lactic acid and its analogues) has not proved to be a practical proposition.

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(R. Cx.; C. R. K.)

Germicidal and Fungicidal Lamps.—The most suitable electromagnetic radiation for use in germicidal and fungicidal lamps is ultraviolet in the region of 2650 Å. The most practical sources are low-pressure mercury vapour lamps, made of glasses capable of transmitting ultraviolet, which have a peak emission (about 95%) in the 2537 Å wave band. Quartz glass may also be used but requires screening with other types of glass or a jacket of acetic acid solution to prevent the emission of ozone-producing wavelengths shorter than 2000 Å.

Hot cathode lamps are of a construction similar to standard fluorescent lamps and require the same electrical circuits for their operation. Their life is dependent on the life of the electrodes and the transparency of the glass. Cold cathode lamps require high voltages for starting and operating and, as the electrodes do not require heating, their life is long. High intensity lamps combine the characteristics of the other two, requiring high voltages for starting and subsequently operating with hot cathodes. Their principal advantage is their high ultraviolet output per rated lamp watt, which is almost double that of the hot cathode tube; however, they share the same tendency to deteriorate.

Clinical Application.—The germicidal properties of ultraviolet lamps help to control cross-infection by the sterilization of air, the aim being to administer a lethal dose of radiation to the maximum number of air-borne organisms without endangering human skin or eyes. This cannot be achieved satisfactorily by total irradiation of a room or part of a room, but some success has been obtained by placing high-intensity ultraviolet sources at points of maximum air movement. The most popular application is the "ultraviolet curtain" across passages and doors, while organisms within the room are affected by the rapid recirculation of the room air past a shielded ultraviolet source.

See also references under "Antiseptics" in the Index.

(H. M. D.)

ANTISTHENES (d. *c.* 365 B.C. at an advanced age), Greek philosopher, of Athens, seems to have been converted from the study of rhetoric to that of philosophy by the influence of his friend Socrates. Tradition affirmed that Antisthenes taught in an exercise place called Cynosarges, being debarred as the son of a Thracian mother from other Athenian gymnasiums; and that for this reason his philosophy was called Cynicism (*see* CYNICS). The real inventor of the Cynic way of life was Diogenes, but he acknowledged an indebtedness to Antisthenes, whose views on morality he presumably learned from his numerous writings. Antisthenes was a true Socratic in maintaining the supreme value of virtue and that it could be taught, but he was more individual in welcoming his own poverty as giving freedom and in condemning all pleasure but the satisfaction of hard work.

That he held up Hercules and Cyrus as models is an example of his custom of turning mythology to edification, some of which found its way into the commentaries on Homer. As a Socratic, he became interested in the nature of definition and, more widely, in the possibility of significant predication. The grounds for his extreme views ("it is not possible to contradict") can only be guessed at; modern writers have called in aid various passages in Plato which they suppose to allude to him. (F. H. SH.)

ANTISTROPHE. The ancient Greek choral ode (*q.v.*), which has been imitated in modern European languages, is composed of one or more sets of three "stanzas" named strophe, antistrophe and epode. The strophe and antistrophe are of identical metrical structure.

ANTITOXIN, a substance present in the bloodstream which combats and neutralizes the toxins (poisons) produced by microorganisms. The inoculation of man, and a variety of experimental animals, with toxin or toxoid (a toxin in which toxicity has been destroyed but which still retains its antigenic properties) results in the appearance, three to five weeks later, of a capacity of the blood serum specifically to neutralize the toxin (*q.v.*). This capacity is demonstrable in the living animal as an immunity to the effects of an amount of toxin lethal to the normal animal; it is also demonstrable by mixing a lethal dose of toxin with immune serum in a test tube and then inoculating an animal with the mixture to show that it is no longer toxic (*see* IMMUNITY AND IMMUNIZATION).

The ability of the serum to neutralize toxin is attributable to the presence of a new substance, antitoxin. Antitoxin, like other antibodies, is usually associated with the gamma globulin fraction of serum protein and is produced in response to the antigenic stimulus provided by the inoculation of toxin or toxoid. This stimulus alters the normal processes of synthesis of globulin; the globulin is modified in such a way that it combines specifically with the toxin to give a complex that precipitates in the test tube (toxin-antitoxin flocculation) and is no longer toxic. This modified serum globulin is antitoxin. The presence of the appropriate antitoxin in the blood and other body tissues results in an effective immunity to the toxemias caused by bacteria, especially diphtheria and tetanus (*qq.v.*).

Man may form his own antitoxin in response to inoculation with toxoid (active immunity), or he may be made temporarily passively immune by inoculation with antitoxic serum taken from an immunized animal.

See IMMUNITY AND IMMUNIZATION; SERUM THERAPY; TOXIN; VACCINATION; VACCINE THERAPY; VENOM; *see* also references under "Antitoxin" in the Index.

ANTIUM: *see* ANZIO.

ANTLER, the name given to the solid bony outgrowths on the heads of deer, which are shed and renewed each year. For details *see* DEER.

ANT LION, the name given to insects (order Neuroptera) of the family Myrmeleonidae, with relatively short and clubbed antennae and four narrow, densely net-veined wings which are usually marked with brown or black. The adult insects are mostly nocturnal and are believed to be carnivorous. In the United States, where the ant lion is locally known as doodlebug, about 65 species occur. The best-known species, *Myrmeleon formicarius*, which matures in the late summer, occurs in many European countries, though like the rest of this group it does not occur in England.

Strictly speaking, however, the term "ant lion" applies to the larval form because of its peculiar and forbidding appearance and its skilful and unique manner of trapping prey by means of a pitfall. The sandy-gray abdomen is oval and covered with warts and bristles; the prothorax forms a mobile neck for the large square head, which carries a pair of long and powerful toothed mandibles.

The ant lion lays its trap in dry and sandy soil. Having marked out the chosen site by a circular groove, it starts to crawl backward, using its abdomen as a plow to shovel up the soil. By the aid of one front leg it places consecutive heaps of loosened particles upon its head, then with a smart jerk throws each little pile clear of the scene of operations. Proceeding thus, it gradually works its way from the circumference toward the centre. When this is reached and the pit completed, the larva settles down at the bottom, buried in the soil with only the jaws projecting above the surface. Since the sides of the pit consist of loose sand they afford an insecure foothold to any small insect that ventures over the edge. Slipping to the bottom, the prey is immediately seized by the lurking ant lion; or if it gains a hold and attempts to scramble up the treacherous walls of the pit, it is speedily checked in its efforts and brought down by showers of loose sand which are tossed at it from below by the larva. By means of similar head jerks the skins of insects sucked dry of their contents are thrown out of the pit. A full-grown larva digs a pit about two inches deep and three inches wide at the edge.

The larva makes a globular case of sand stuck together with fine silk, spun, it is said, from a slender spinneret at the posterior end of the body. It remains in this cocoon until the completion of the transformation into the sexually mature insect, which then

BY COURTESY OF NEW YORK ZOOLOGICAL SOCIETY

ANT LION (MYRMELEON FORMICARIUS) IN TWO STAGES OF ITS DEVELOPMENT: (LEFT) THE LARVAL STAGE; (RIGHT) THE PUPAL STAGE DURING WHICH THE PUPA MATURES WITHIN A BALL OF SAND OF ITS OWN MAKING

emerges from the case, leaving the pupal skin behind.

In certain species of Myrmeleonidae, such as *Dendroleon panthernis*, the larva, although resembling that of *Myrmeleon* structurally, makes no pitfall, but seizes passing prey from any nook or crevice in which it shelters.

ANTOFAGASTA, a province in the desert of northern Chile. Area: 48,381 sq.mi. It was occupied in 1879 by Chilean forces at the outset of the War of the Pacific, ceded by Bolivia in 1884 and created a Chilean province four years later. Present boundaries were fixed in 1938. Pop. (1960) 215,376 with about a third concentrated in the capital city of Antofagasta. Lesser administrative and urban centres are Tocopilla (pop. [1960] 21,580), Calama (26,166) and Taltal (5,291). The province leads Chile in mining, production in the early 1960s being valued at about 35% of national output. Copper from Chuquicamata (*q.v.*) and nitrates and iodine from María Elena and Pedro de Valdivia represent major portions of Chilean production, as does the production of sulfur, guano, gold and silver.

The Inter-American highway, air service and railways link the province with the rest of Chile. Railways also enter Bolivia and Argentina.

See also ATACAMA DESERT. (J. T.)

ANTOFAGASTA, capital of the northern province and department of the same name, and a major Pacific port. Pop. (1960) 87,860. Prior to 1879 it was in Bolivian territory. The city occupies a terrace at the base of bleak coastal mountains. Early growth resulted from the nitrate boom that began in 1868 and from the Caracoles silver strike of 1870, the year in which Antofagasta's name became official. Supplying the mines and embarking copper and sulfur continue to be major functions of the city. Besides foundries and shops, ore concentrating and sulfuric acid manufacturing facilities, the city's industry is concerned with food and beverage processing and fish-meal production. Rail communications with the mines date from 1873. Extension of the service to Oruro, Bol., occurred in 1879. In 1910 the railway was linked to the main Chilean system; in 1948 a line was opened into the Argentinian northwest with the hope of drawing food supplies and transit freight to the port city. One of Antofagasta's best-known institutions is the school of mines, founded in 1918. A turf club, modern hotel, municipal beach and various public gardens are tourist attractions. (J. T.)

ANTOINE, ANDRÉ (1858–1943), French actor, manager and critic, was born at Limoges and in his early years was a clerk. But he was an enthusiastic amateur actor, and in 1887 he founded in Paris the Théâtre Libre ("free theatre") in order to realize his ideas as to the proper development of dramatic art. In this undertaking he had the support of Emile Zola, who championed Antoine's efforts for the replacement on the Parisian stage of the "well-made play" by something nearer the actualities of life. Many other writers backed the campaign, and Antoine began to produce the great series of naturalistic plays by Eugène Brieux, François de Curel, Georges de Porto-Riche and Ibsen that made his theatre famous.

Great as was the Théâtre Libre's importance in Paris and in France, it was perhaps still greater in other countries. The Freie Bühne of Berlin, the Independent theatre in London and other such institutions descended from it. For an account of his work *see* DRAMA: *Modern Drama: Ibsen: The Play of Ideas.*

In 1894 Antoine gave up the direction of the Théâtre Libre to become connected with the Gymnase. Later, after a season (1896) with the Odéon, he opened his own theatre, the Théâtre Antoine, in 1897. He again became associated with the Odéon in 1906, but in 1913 resigned to become a drama critic. He died in Brestin, Brittany, Oct. 21, 1943.

See S. M. Waxman, *Antoine and the Théâtre Libre* (1926).

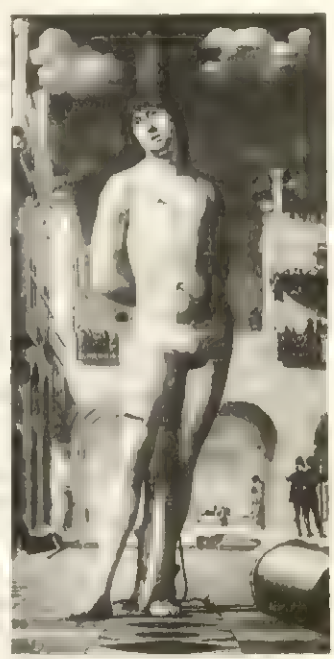
ANTONELLI, GIACOMO (1806–1876), Italian cardinal, secretary of state to Pope Pius IX (*q.v.*), was born at Sonnino on April 2, 1806. He entered public affairs and held various offices in the papal states. Though never ordained priest, he was created cardinal by Pius IX in 1847, and became in 1848 premier of the papal states, which were then for the first time governed by a democratic constitution. After his own and succeeding governments had fallen and the revolutionary situation at Rome had led to the assassination of Pellegrino Rossi in 1848, he showed much courage in remaining with Pius IX at the Quirinal and in planning the pope's flight to Gaeta, where Antonelli was made acting secretary of state.

After the pope's return to Rome in 1850, Antonelli was appointed officially to the post of secretary of state, which he retained until his death. He remained in general control of the government of the papal states until their elimination in 1870, and he was in charge of the pope's relations with other governments until 1876. His policy was to avoid further attempts to introduce constitutional government into the papal states, because it was impossible either to distinguish the pope's spiritual from his temporal power or to subject the former to a lay assembly. As an able diplomatic opportunist Antonelli knew that his only hope of preserving the pope's temporal sovereignty over central Italy during the growing movement for Italian unity was to retain the good will of the French government of Napoleon III, which had retained a garrison in Rome after 1850. He was therefore opposed to the raising of a papal army which took place in 1860, and to all quarrels, even of a religious character, with Paris. When the Piedmontese forces entered Rome in Sept. 1870 he requested them to extend their occupation to the "Leonine city" around the Vatican, to preserve order, and the papal army was disbanded.

He died in the Vatican on Nov. 6, 1876. Though he served the pope with great loyalty for nearly 30 years, and foreign diplomats paid tribute to his courtesy and good sense, Antonelli was little mourned by the better men at Rome. The pope himself had come to dislike him because of the frequent reports of the impurity of his life, while the wealth which he had accumulated, especially in his collection of precious stones, had caused offense to many. (E. E. Y. H.)

ANTONELLO DA MESSINA (*c.* 1430–1479), Italian painter, who greatly influenced the Venetian school of the early Renaissance, partly by his use of Flemish technique, was born probably about 1430 in Messina, Sicily. He received his training in Naples from Colantonio, whose art was based on Flemish and Provençal models, and studied Flemish works (notably of Jan van Eyck), of whose presence in Naples at that time there is documentary evidence; the influence of Jean Fouquet, Piero della Francesca and Spanish painting may also be assumed. On the other hand, the Netherlands visit affirmed by G. Vasari and the suggested encounter with Petrus Christus in Milan in 1456 may be ruled out. The earliest known works, a "Crucifixion" (Sibiu) and "St. Jerome in His Study" (National gallery, London), already show Antonello's characteristic combination of Flemish technique and realism with clarity and simplicity of spatial arrangement and modeling in the Italian manner.

From 1457 to 1474 Antonello is known to have been in Messina. In his earliest dated and signed work, the "Salvator Mundi" of 1465 (National gallery, London), his style is fully developed. A number of renderings of "Ecce Homo," the "Madonna and Child" in Washington, D.C., the "Virgin of the Annunciation" in Munich and in Palermo and several vigorous male portraits date from between 1470 and 1474. The chief works of this period are the polyptych of 1473 for S. Gregorio (Messina) and the "Annunciation" of 1474 (Syracuse). Of two "Crucifixions," both with landscape backgrounds, dated



ALINARI

"ST. SEBASTIAN" BY ANTONELLO DA MESSINA. IN THE GEMÄLDEGALERIE, DRESDEN, GERMANY

1475, the one in the National gallery, London, was probably painted in Sicily and that in the Antwerp museum, in Venice.

From 1475 to 1476 Antonello was in Venice and Milan. His altarpiece for S. Cassiano in Venice, fragments of which are in the Vienna museum, clearly influenced Venetian painters. The "Dead Christ With Angels" (Venice), some portraits and the full-length "St. Sebastian" (Dresden) were done in Venice. In the "St. Sebastian," his most mature work, Antonello achieved a synthesis of clearly defined space, monumental, plastic form and luminous colour, which was one of the most decisive influences on the evolution of Venetian painting down to Giorgione's day. In 1477 he was again in Messina, where he died between Feb. 14 and 25, 1479.

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ANTONESCU, ION (1882–1946), Rumanian army officer and statesman, head of the pro-German government during World War II, was born at Pitesti on June 15, 1882. After service in World War I, he was military attaché in Paris and later in London. He returned to Rumania in 1930 and for a year (1934) was chief of the general staff. His nationalist and anti-Communist sentiments led him to sympathy with the anti-Semitic National Christian party of Octavian Goga and even with the Iron Guard of C. Zelea Codreanu. Appointed minister of defense in the Goga cabinet in Dec. 1937, he retained the post in Miron Cristea's government (Feb. 1938), but was dropped a month later because of his Guardist leanings. The territorial losses imposed on Rumania in 1940 by the U.S.S.R., Germany and Italy, before Rumania's entry into World War II, led to disorders and undermined the position of King Carol, who appointed Antonescu prime minister on Sept. 4, 1940, as a known patriot who was yet acceptable to the Germans. Antonescu agreed on condition that Carol abdicate in favour of his son Michael, and Antonescu became *conducator* of Rumania. At first he worked with the Guardists, but their excesses roused indignation, and in Jan. 1941 he crushed them (with the help of the German troops that he had allowed into Rumania as "instructors"). Having signed the Tripartite pact in Nov. 1940, he declared war on the U.S.S.R. as Germany's ally in June 1941, becoming himself generalissimo. The country supported his campaign for the recovery of Bessarabia, but there was opposition to his creation of a Rumanian province (Transnistria) on Ukrainian territory. In Aug. 1941 he was made marshal. With the success of the Soviet counter offensive in 1944, Rumanian circles opposed to Antonescu started secret negotiations with the Allies. King Michael had him arrested during his *coup d'état* of Aug. 23, 1944. Sentenced to death as a war criminal by the Rumanian Communist people's court, Antonescu was executed near Ft. Jilava on June 1, 1946. (B. BR.)

ANTONINE WALL, a Roman frontier barrier in Britain, extending for 36½ mi. across Scotland from Bridgeness on the Firth of Forth to Old Kilpatrick on the river Clyde, was built in A.D. 142 for the emperor Antoninus Pius by Lollius Urbicus, governor of Britain. Built of coursed turfwork on a kerbed rubble bottoming, it was 14–16 ft. wide and probably 10 ft. high, exclusive of any timber crenelation. A ditch 40 ft. wide and over 12 ft. deep ran 20 ft. or more in front, and about 50 yd. to the rear was a military road.

The wall was controlled from a series of 19 forts placed at intervals of roughly two miles; also from fortlets, four of which are now known. Two pairs of stances for fire signals faced north toward Stirling, one pair south toward mid-Clydesdale. The flanks of the wall were guarded by forts at Cramond and Inveresk on the Forth, and at Bishopton, north of Paisley, on the Clyde, while at Lurg moor, south of Gourock, there was a signal station. A road ran northward as far as Perth equipped with signal stations and forts; the wall was thus the base of a line of penetration which secured Fife and watched Strathmore.

The wall was built by the 2nd, 6th and 20th legions. It was garrisoned by auxiliary units, sometimes part mounted and sometimes subdivided among the smaller forts, from which combined sallies could trap attackers against the barrier. Occupation was interrupted during the northern revolt of 155–158; and the wall said by Dio Cassius (*Historia Romana*, lxxii, 8) to have been broken by enemy attack in 184 was probably this one. It was systematically evacuated not later than 196. Archaeologists have found evidence of one complete reconstruction, and occasional signs of a second; but historical correlation has yet been achieved only at Mumrills, linking the first reconstruction with the events of 155–158.

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ANTONINUS, SAINT (ANTONIO PIEROZZI or DE' FORCIGLIONI) (1389–1459), archbishop of Florence, theologian and economist, is regarded as one of the founders of modern moral theology and Christian social ethics. Born in Florence, he there joined the Dominican order (1405), in which he became a leader of the Observant movement, especially at Fiesole. As vicar of the Observants he founded the convent of San Marco, Florence, in 1436 and was prior (1439–44) while Fra Angelico painted. He attended the Council of Florence (1439–45) and became archbishop in 1446. He died at Montughi, Florence, on May 2, 1459, much beloved for his charity. His principal work is the *Summa moralis*. He was canonized in 1523, and his feast day is May 10.

See the standard biography, R. Morçay, *S. Antonin* (1914); B. Jarrett, *St. Antonino and Mediaeval Economics* (1914). (S. BH.)

ANTONINUS PIUS (TITUS AURELIUS FULVUS BOIONIUS ARRIUS ANTONINUS) (A.D. 86–161), Roman emperor A.D. 138–161, was born on Sept. 19, A.D. 86. He was grandson on the father's side of Aurelius Fulvus (twice consul, and urban prefect), on the mother's side of Arrius Antoninus (also twice consul); his wife was a daughter of Annius Verus (three times consul). By further ties he was linked to most of the new governing class of Rome, the nobility who had been brought to the fore by the Flavian emperors. Antoninus had a distinguished public career: he was consul in 120, and later one of the former consuls charged by Hadrian with judicial administration in Italy; he governed the province of Asia, and after his governorship he was a frequent adviser of the emperor. In view of this it is surprising that he was not Hadrian's first choice as successor to the principate. Only in 138, *faute de mieux*, was he adopted by Hadrian and indicated as successor, and then only as a place-warmer for the youths Annius Verus and Ceionius Commodus (the future emperors Marcus Aurelius and Lucius Verus respectively), whom he in his turn adopted. Shortly afterward Hadrian died and Antoninus became emperor. He persuaded a reluctant senate to offer the usual divine honours to his predecessor, though it is probably not solely for this dutiful act that he received the name Pius.

Though the literary authorities for Antoninus' principate are exceptionally scanty, it need not be doubted that few striking events happened. Tendencies of a general kind were at work, especially the growth of bureaucracy and the decline of local initiative in the provinces. In the first decade of Antoninus' reign there was a major rebellion in north Britain. Hadrian's wall had proved inadequate, and in 141 the situation was serious. The revolt was overcome by Lollius Urbicus, the governor, who then built the turf wall known as the Antonine wall (*q.v.*) between the Firths of Clyde and Forth. In the second decade there was more trouble in Mauretania, Germany, Dacia and Egypt; but the barbarian invasions had not yet begun, and the standing army was still adequate to its tasks. Parthia was kept at peace by negotiation, as in Hadrian's time. When Antoninus' wife Faustina died in 140, she received divine honours, and an institution for bringing up the daughters of poor citizens, the *puellae Faustinianae*, was founded to her memory.

Unlike Hadrian, Antoninus did not travel. He stayed in Rome and governed with the advice of those best qualified to give it. His personal contribution to Rome's development was not negligible—it consisted of a wide-ranging program of legislation, not original in conception but covering the whole field of law, softening its harshness and removing its anomalies. Antoninus was a careful financial administrator and left the treasury in a sound

condition in spite of lavish largesses to the Roman plebs. In 143 or 144 the orator Aelius Aristides delivered his panegyric on Rome, a notable tribute to the blessings of the Roman peace, and in 147 Rome celebrated the 900th anniversary of its traditional foundation. Antoninus died peacefully on March 7, 161, at Lorium just outside Rome, after giving to the tribune of the watch for the day the password *aequanimitas* ("peace of mind"). He was later accorded divine honours.

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ANTONIO, DOM (1531–1595), generally known as the PRIOR OF CRATO, claimant of the throne of Portugal, was the illegitimate son of Luis, duke of Beja, brother of John III of Portugal. He became head of the Order of St. John in Portugal and was endowed with the wealthy priory of Crato (1555). He accompanied John III's grandson and successor Sebastian to North Africa, where in the battle of the Three Kings near Alcazarquivir (1578) Sebastian was killed and Antonio captured. On his return to Portugal, his claim to be heir presumptive was not supported by Sebastian's successor Henry, the last surviving brother of John III (*see* PORTUGAL: *History*), nor by the council which governed Portugal for some months after Henry's death (Jan. 1580). Antonio was acclaimed king by his supporters in June 1580, but his possession of the crown was contested by Philip II of Spain whose army, under the duque de Alba, defeated Antonio outside Lisbon in August.

Antonio then went to Paris. With French help he sent naval expeditions to the Azores, where he was still recognized as king, in 1582 and 1583, but they were defeated by Spanish squadrons. He next went to England where he enlisted the help of Elizabeth I. An English fleet effected a landing near Lisbon in support of Antonio in 1589, but the expedition proved a costly failure. Impoverished and in ill-health, Antonio returned to Paris, where he continued to make plans for further expeditions until his death on Aug. 26, 1595. (DA. A. P.)

ANTONIO, NICOLÁS (1617–1684), bibliographer and first systematic historian of Spanish literature, was born in Seville on July 28 or 31, 1617, and died in Madrid on April 13, 1684. His *Bibliotheca Hispana*, in two parts (*Nova*, 1672; *Vetus*, 1696), a vast Latin bibliographical index of Peninsular and Spanish colonial writers after 1500, with critical evaluations, followed by a history of Peninsular literature from the reign of Augustus to 1500, marks the emergence of modern bibliography and the transformation of literary history from a branch of belles-lettres into a scholarly discipline. The division of the work at 1500 anticipates the establishment of the *terminus ad quem* for incunabula (*q.v.*). A second edition (1788; vol. i of the *Nova* wrongly dated 1783), with important additions from Antonio's manuscripts, is regularly consulted by scholars. The manuscript of the unpublished *Bibliotheca Hispano-rabbinica* is in the National library in Madrid. In his *Censura de historias fabulosas* (1742), Antonio applied his special skills to discrediting certain celebrated historical forgeries. (F. S. R.)

ANTONIUS, the name of an old plebeian family in ancient Rome.

MARCUS ANTONIUS (143–87 B.C.), a great orator, vividly portrayed as a speaker in Cicero's *De Oratore*. None of his speeches survives. Consul in 99 and censor in 97, he was a confirmed member of the *optimates* (families owing their prestige to wealth and repeated tenure of office in successive generations) and perished in the reign of terror that followed the capture of Rome by Marius and Cinna in 87.

MARCUS ANTONIUS, derisively surnamed CRETICUS (d. *c.* 72 B.C.), elder son of the first-mentioned Marcus Antonius. Praetor in 74 B.C. and an inept naval commander, he was defeated in battle by the Cretan pirates in 72 and died soon after.

GAIUS ANTONIUS, derisively surnamed HYBRIDA (d. after 42 B.C.), younger son of the first-mentioned. Though expelled from the senate by the censors of 70 B.C., he was elected with Cicero to be consul in 63 and commanded an army in Etruria against Catiline, with whom he was thought by Cicero to be not unsympathetic. On his return to Rome after governing Macedonia he was prosecuted for extortion in 59, defended by Cicero, but condemned. He was later recalled from exile by Caesar, and was censor in 42.

GAIUS ANTONIUS (d. 42 B.C.), second son of Marcus Antonius Creticus, was *legatus* of Caesar in 49. In 43 he was captured in Apollonia by M. Junius Brutus, who had him executed in 42.

LUCIUS ANTONIUS (d. after 40 B.C.), third son of Marcus Antonius Creticus, quaestor in Asia 50 B.C., tribune in 44 and consul in 41. He was defeated by Octavian in the Perusine War (41–40 B.C.).

MARCUS ANTONIUS (*c.* 82–30 B.C.), Mark Antony, eldest son of Marcus Antonius Creticus, was, with Cleopatra, the queen of Egypt, defeated by Octavian (later the emperor Augustus) in 31 B.C. in the last of the civil wars that destroyed the Roman republic. Much that is unfavourable in the historical tradition about him must be discounted as based on intemperate abuse by Cicero (*q.v.*) and on Octavian's propaganda during the war and his patronage of historical writing after it.

Antony was on Caesar's staff in Gaul from 54 (in 52, as quaestor) and in 50 was elected augur and tribune for 49. He was one of the two obstructive tribunes who, after warning from the consuls, fled to Caesar on Jan. 7, 49. Left in charge of Italy as propraetor in 49, he brought troops across to Caesar in Illyricum that winter and commanded the left wing at Pharsalus in 48. He was master of the horse to Caesar as dictator in 48/47 but not after 46, when he and Caesar quarreled. In 44, when they were joint consuls, they were again at variance.

He was detained at the door of the senate house when Caesar was murdered on March 15, 44, and Cicero never tired of saying that he should have been murdered too. In the hours and days that followed he controlled events with brilliant skill, securing Caesar's papers from his widow, taking possession of the treasure left by Caesar, preventing M. Aemilius Lepidus from bringing in his troops to attack Caesar's assassins on the capitol and, as presiding consul, engineering the compromise by which on March 17 the senate granted an amnesty to the assassins and at the same time confirmed Caesar's acts. His funeral oration over Caesar's body, probably on March 20, following the publication of Caesar's will, won him immense popularity with the Roman populace, and he acquired a dangerous power when the senate made him sole judge of the authenticity of alleged "acts" of Caesar.

The return to Italy at the age of 18 of young Octavian, Caesar's great-nephew, whom he had adopted in his will and named as heir to his property, was a warning, for Octavian inherited the loyalty of Caesar's troops and astutely ingratiated himself with the senate. On June 2 by a popular bill Antony secured the government of Cisalpine and Transalpine Gaul for five years, with the legions then in Macedonia. With two of the four legions brought across to Brundisium that were loyal to him, he moved north to evict Decimus Junius Brutus, one of the assassins, from Cisalpine Gaul. On April 14, 43, he was defeated at the battle of Forum Gallorum by a Roman army that had come to Brutus' relief, commanded by the two consuls, with Octavian in subordinate command. Antony escaped across the Alps, where the three proconsuls Gaius Asinius Pollio, Lepidus and Lucius Munatius Plancus, with their armies, joined him, and in late October Octavian, then consul, met him at Bononia (Bologna) and the triumvirate of Antony, Lepidus and Octavian was formed. It was later regularized by a law (the *lex Titia*) at Rome.

The triumvirs were granted military command and provinces for five years. The proscriptions, of which Cicero was a victim, followed, as did in 42 the defeat of Brutus and Cassius (*qq.v.*) at Philippi, the whole credit for the victory resting with Antony. Octavian returned to Italy to supervise the demobilization of troops; to fight an army commanded by Antony's third wife, Fulvia, daughter of M. Fulvius Bambalio and his brother Lucius

(the Perusine War); and to face a corn shortage at Rome occasioned by the piracy of Sextus Pompeius. Antony remained to settle problems in the east, summoned Cleopatra to Tarsus in 41, fell in love with her and lived with her through the winter in Alexandria. The Parthians then invaded Roman territory.

Threatening rifts were closed when Antony returned to Italy and met Octavian in 40 at Brundisium, where he received command of the eastern provinces of the empire and, Fulvia having died, married Octavian's sister Octavia; in 39 at Misenum, where a short-lived agreement was made with Sextus Pompeius; and in 37 at Tarentum, where the triumvirate was renewed to the end of 33, and Antony promised Octavian 130 ships for use against Sextus Pompeius in exchange for four legions (which were never sent) for the Parthian war. Antony's treatment of Octavia could not easily be tolerated by Octavian, for in late 37 or early 36 Antony married Cleopatra (though, as she was not a Roman, it was not valid in Roman law) and in 35 he severed relations with Octavia. Antony's campaign against Parthia in 36 ended in disaster, though he conquered Armenia in 34 and celebrated a Roman triumph in Alexandria, which was the occasion of extravagant honours and territorial gifts to Cleopatra and her children. Reports of his unrestrained assumption in public of the character of a Hellenistic divine king were seized on avidly by Octavian for skilful propaganda in Italy. None the less, Antony was joined in 32 by the two consuls and by numerous senators from Rome. In Rome Octavian secured and published, whether it was genuine or forged, Antony's will, in favour of Cleopatra and his children by her.

Antony's mobilization of a fleet started in winter 33–32. He was now financed and politically impelled by Cleopatra, yet aware that his Roman officers and troops wanted him to break with her. After his defeat at Actium (*q.v.*) in 31 by Octavian he fled with Cleopatra to Alexandria and there, after Octavian's arrival, on the false news of Cleopatra's death he committed suicide on Aug. 1, 30 B.C. (*See* also AUGUSTUS.)

Antony was personally attractive, a good soldier, capable of brilliant political improvisation, but incapable of the cold far-sighted scheming by which Octavian outmaneuvered him. Before his marriage to Fulvia he was married first to Fadia and second to Antonia, daughter of Gaius Antonius Hybrida. His elder son by Fulvia, Marcus Antonius Antyllus, was put to death by Octavian in 30; his younger son by Fulvia, Iullus Antonius, married to Octavian's niece and consul in 10 B.C., was forced to suicide in 2 B.C.; through his two daughters by Octavia, Antonia *maior* and Antonia *minor*, married to Lucius Domitius Ahenobarbus and Nero Claudius Drusus (*qq.v.*) respectively, the emperors Gaius, Claudius and Nero were his descendants. By Cleopatra he had two sons and a daughter. His love for her inspired Shakespeare's *Antony and Cleopatra* and Dryden's *All for Love.*

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ANTONOMASIA, in rhetoric the Greek term for a substitution of any epithet or phrase for a proper name, such as the "Maiden Queen" for Queen Elizabeth I, and in sports, the "Great Bambino" for Babe Ruth, "Galloping Ghost" for Red Grange; or a proper name to describe a typical characteristic, such as "Solomon" for any wise man. *See* FIGURES OF SPEECH: *Figures of Relationship.* (G. W. A.)

ANTONY, MARK: *see* ANTONIUS.

ANTRIM, RANDAL MacDONNELL, 1ST MARQUESS OF (1609–1683), Irish royalist, played a minor part in politics during the English Civil War and is remembered chiefly for abandoning the king's cause in 1647. He was born on June 9, 1609, the son of the 1st earl of Antrim, and educated as a Roman Catholic. In 1635 he married Katherine, widow of George Villiers, 1st duke of Buckingham. On the outbreak of the Bishops' Wars in 1639, he planned an attack on Argyll in Scotland, which came to nothing. From that time onward he was engaged in various schemes for the assistance of Charles I against parliament—all of them abortive. He was at various times arrested as a suspect. The papers found on him at his capture in 1643 informed the parliamentary leaders of a plan for a rising by the earl of Montrose in Scotland to be supported from Ireland. On Jan. 26, 1644, MacDonnell was created a marquess on Montrose's recommendation. He was employed on various missions in Ireland and on the continent until 1647, when he ceased to support the king's cause. Annoyed when the marquess of Ormonde was reappointed lord lieutenant, he entered into communication (1649) with Cromwell, for whom he performed various services, though there appears no authority to support the story that Antrim was the author of a forged agreement for the betrayal of the king's army by Lord Inchiquin. Subsequently he joined Henry Ireton and was present at the siege of Carlow. He returned to England in Dec. 1650, and in lieu of his confiscated estate received a pension of £500, later increased to £800, together with lands in Mayo. At the Restoration, Antrim was excluded from the Act of Oblivion because of his religion and, on presenting himself at court, was imprisoned in the Tower of London, subsequently being called before the lords justices in Ireland. In 1663 through the influence of the queen mother he obtained a pardon, his estates being restored to him by a proviso in the Irish Act of Explanation in 1665. Antrim died at Ballymagarry, County Antrim, on Feb. 3, 1683. He is described by Clarendon as of handsome appearance but "of excessive pride and vanity and of a marvellous weak and narrow understanding."

ANTRIM, a county of Northern Ireland, occupies the northeastern corner of Ireland, being separated from the Mull of Kintyre in Scotland, less than 13 mi. away, by the North channel. It is bounded north and east by the Atlantic ocean and the Irish sea, south by Belfast lough and the river Lagan, dividing it from the counties of Down and Armagh, and west by Lough Neagh and the lower river Bann, separating it from the counties of Tyrone and Londonderry. The land area is 1,098 sq.mi.

Physical Features.—The northern and eastern part of the county is occupied by a Tertiary basalt plateau which is cut by deep glens. Glens and hills follow the same trend, northeast-southwest, as the mountains of Scotland. The Antrim plateau ends at its northeastern corner in Fair head (626 ft.), a perpendicular cliff. Much of the plateau consists of rolling moorlands and peat bogs. The collapse of the basalt at its southwestern corner caused the depression which is occupied by Lough Neagh (*q.v.*), the largest inland lake in the British Isles. There are also some outstanding peaks of older or of intrusive rock. Mountains include Trostan (1,817 ft.), Knocklayd (1,687 ft.), Slieveanorra (1,676 ft.) and Slemish (1,437 ft.). Of the Belfast hills, south of the main Antrim plateau, the highest is Divis (1,560 ft.).

The basalt reaches the sea along the north coast in steep cliffs. At the Giant's Causeway (*q.v.*) it makes a curious formation of perpendicular columns, mostly six-sided. A narrow zone of Jurassic, Triassic and Cretaceous rocks separates the basalt from the east coast. Triassic and Cretaceous rocks also bound the basalt on the southeast, and Triassic sandstone is extensive in the Lagan valley. (HU. S.)

History.—It seems that man first came to Ireland through Antrim from Scotland. There are many traces of early life, particularly in the Lough Neagh district where quantities of flint implements have been discovered, thought to date from about 6000 B.C. The county abounds in cromlechs and other monuments and there are also remains of ancient man in the form of kitchen midden deposits in the sand dunes of White Park bay.

St. Patrick is depicted as a swineherd in the county coat of arms, for it was on the western slopes of the mountain of Slemish, near Ballymena, that the national saint is reputed to have tended swine when brought as a boy prisoner to Ireland following an Irish raid on the coast of Great Britain. There have been many invasions and counterinvasions between Antrim and Scotland. The original "Scots" came from Ulster. Early in the 6th century there was a migration of Scots from the Ulster kingdom of Dal-

riada (*q.v.*) in northeastern Antrim over to Scotland, so that Dalriada came to lie on both sides of the North channel, its eastern portion, known as Argyll, developing later into the nucleus of the kingdom of Scotland.

Scandinavian invaders came up the Bann into Lough Neagh, but made no permanent settlements. Antrim was partially penetrated by Anglo-Norman adventurers from the 12th century and formed part of the earldom of Ulster. The disorders of the later middle ages and the invasion of Edward Bruce from Scotland in 1315 brought about the decline of the English power, and the only settlement which remained in Tudor times was the town and fortress of Carrickfergus. During Tudor times a number of adventurers attempted with varying success to colonize Antrim and many Scots settled there. Among towns founded then was Belfast. Although Antrim was not part of the territory involved in the scheme for the plantation of Ulster, it continued to attract many immigrants from Britain.

The Presbyterian Church predominates in the county. In 1861 Presbyterians represented 53% of the total population and the figure was still as high as 45% in 1951. It was no doubt because of this strong Presbyterian influence that Antrim men played such a leading part in the rebellion of 1798. The hill country from Cavehill to the ancient town of Antrim was a training ground for the rebels, whose leader Henry Joy McCracken was tried and publicly executed in Belfast. In an earlier campaign, carried out by William III against James II, County Antrim had also had its place, for William landed at Carrickfergus and traveled from there to the battle of the Boyne (1690).

Population and Administration.—In 1961 the population of the county was 273,905. At one time Carrickfergus was the county town but with the Industrial Revolution the small town of Belfast began to expand rapidly and in 1847 a new county courthouse was built in Belfast and the grand jury moved from Carrickfergus. However, Belfast became a county borough in 1898 and, while the county courthouse remains legally in County Antrim, the county lacks a county town.

House building round the northern boundaries of Belfast increased rapidly after World War II and one result of this was the establishment in 1958 of a new urban district, Newtownabbey (*q.v.*). The population of Newtownabbey (37,448) makes it by far the largest town in the county. The next in order of size are Lisburn (17,700), Larne (16,350), Ballymena (14,734) and Carrickfergus (10,211) (*qq.v.*).

County Antrim returns seven members to the parliament of Northern Ireland and two members to the United Kingdom parliament.

Agriculture, Industry and Communications.—Agriculturally Antrim is a rich county. Oats, potatoes and seed hay are the chief crops. There is extensive beef production together with sheep farming, poultry and pig rearing. The land in the valley of the Six-Mile-Water, particularly around Ballyclare, is probably among the richest in Northern Ireland, and other important agricultural districts are centred around Ballymena and Ballymoney. There is considerable salmon fishing off the north coast and the eel fisheries on the river Bann are of some importance.

The county is not particularly rich in minerals, but coal is still mined in small quantities around Ballycastle. There were at one time bauxite mines in the Parkmore district and salt used to be mined on a considerable scale at Carrickfergus.

The government is building factories at Newtownabbey, but the main industrial town is Larne which has a large turbine factory, a radio factory and a sizable port. Nearby, cement is produced on a large scale at Magheramorne. Ballymena has a fair-sized linen industry as well as some light engineering works, while Carrickfergus has a large textile factory. Lisburn is noted for its furniture and linen industries, the latter having been established by Huguenot refugees from France in the 17th century.

With its long coastline and excellent beaches County Antrim has an extensive tourist trade. Two fine beaches at White Park bay on the north coast and Cushendun on the east coast are owned by the National Trust, while the county council is carrying out tourist development schemes at several places to preserve the natural beauty. The towns of Portrush, Ballycastle (*qq.v.*) and Whitehead and the villages of Portballintrae, Cushendun and Cushendall are noted holiday resorts, all on or near the coast.

There is a direct passenger-steamer service between Larne and Stranraer, Scot., while Belfast airport at Nutts Corner in County Antrim is the civil airport for Northern Ireland. The main railway line from Belfast to Londonderry runs through the length of County Antrim and the main line from Belfast to Dublin runs through its southern part. Several branch lines of former importance were closed, but there are adequate bus services throughout. Two motorway approaches to Belfast were constructed in the early 1960s, one from the north and the other from the south. There is also one of the finest systems of trunk and other roads to be found in Ireland. It was the building of the coast road in the first half of the 19th century which opened up the glens in the northeastern corner of the county; before that time they were relatively inaccessible and backward. In the 1960s Irish was still spoken in some parts. (W. J. Jo.)

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ANTRIM, a town of County Antrim, N. Ire., lies in the valley of the Six-Mile-Water rivulet at the northeastern corner of Lough Neagh, 17 mi. N.W. of Belfast by road. Pop. (1961) 1,448. Area 0.3 sq.mi. Antrim is an important road junction and much traffic passes through it between Belfast and the towns of northern and northwestern Ulster. As a market town it serves a populous countryside and it is the site of several small industries, including sawmilling and the production of linen and woolen goods. There are naval and air force establishments in the district. Less than 1 mi. N. of the town is one of the most perfect of the round towers of Ireland. Dating from the 10th century or earlier, it is 93 ft. high and about 17 ft. in diameter at the base. Antrim castle, built in the 17th century, also testifies to the strategic advantage which the site had in earlier times. In 1798 the town was the scene of a battle in which several thousand insurgents, led by Henry Joy McCracken, were defeated by the military. (Hu. S.)

ANTRUSTION, the general name for a member of the personal guard of the Merovingian sovereigns in France. The free man who wished to enter the royal guard presented himself, armed, before the king, swore the *trustis* (a special oath of fealty) to him and engaged himself to defend him. In return he enjoyed the king's special protection, could only be tried in a royal tribunal and had a wergild ("man-price" paid for homicide) three times that of the ordinary Frank. The king employed him on confidential missions and might reward him with grants of land to be held outright. The antrustions formed a body whose members had mutual obligations; they were not able to give evidence against one another, and litigation between them was governed by intricate formalities. They seem to have been the only permanent military force under the Merovingians.

The antrustions were the successors of the body of "companions" of the Germanic chieftains described by Tacitus—an institution appropriated to himself by the Merovingian king in the 6th century. They were of great importance under Clovis, but with the accelerating decay of royal power in the 7th and 8th centuries they declined. At the beginning of the reign of Charlemagne they were of no importance and they disappeared entirely on the rise of a new institution, vassalage.

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ANT THRUSH, the name given to a large group of small and medium-sized passerine birds comprising the family Formicariidae and occurring in the American tropics. The name is in reference to their habit of accompanying ant armies to prey on insects flushed by the ants. Most of the 222 recognized species have loose-webbed plumage that is predominantly black, gray or brown. The colours may be solid, barred or streaked; the sexes

usually differ in colour. Many species are crested, and in most the feathers of the lower back are notably long and dense, with a concealed white or rufous patch. The bill is strong and hooked. Ant thrushes, which also are known as ant birds, ant shrikes and bush birds, inhabit forests or brushlands and may be either arboreal or essentially terrestrial. They are weak fliers and do not migrate. They utter harsh calls, whistling notes and occasionally melodious songs. (E. R. BE.)

ANTUNG (AN-TUNG), a Chinese city near the mouth of the Yalu river in the southeastern part of Liaoning province (39° 59′ N., 124° 30′ E.). Pop. 360,000 (1953). It was opened as a treaty port in 1907 and developed into an important centre of trade between China and Korea. The harbour accommodates ships with a draft of about 9 ft. Its staple export items include soybean oil, soybeans, timber, and light industrial products such as matches, flour and wild cocoon silk. The port is icebound four months in a year.

Antung increased its importance after the construction of a railway in 1907 linking Mukden (Shen-yang) with Korea; the railway spans a half-mile-long bridge over the Yalu between Antung and the Korean city of Hsinyichou (Sinuiju). A number of modern industries have sprung up at Antung. These include a chemical fibre plant, completed in April 1958, with an annual capacity of 400 tons; flour and soybean mills; an aluminum plant; and paper factories. Power is supplied by the Shuifeng hydroelectric station, upstream on the Yalu river, which has a total capacity of over 600,000 kw. Antung also has an airport on the Dairen-Antung-Mukden air route.

Between 1932 and 1945, Manchuria was divided under the puppet Manchoukuo regime into many provinces of which Antung was one. The census of Oct. 1, 1940, described Antung province as consisting of six counties and one municipality with a total population of 1,170,787 (including 182,283 for Antung city). (KN. C.)

ANTWERP (Flem. ANTWERPEN; Fr. ANVERS), the most northerly of the nine provinces of Belgium, adjoins the Dutch frontier. After the French occupation of 1795, it was made part of the French *département* of Deux-Nèthes, and in 1815 its present boundaries were established, though subsequently modified in detail. The province is divided into three *arrondissements* (Antwerp, Malines and Turnhout), subdivided into 19 cantons and 151 communes. Area 1,104 sq.mi. Pop. (1961) 1,443,355.

Most of the area is covered with Pliocene sands and gravels, with a smaller extent of Miocene and Oligocene deposits in the southwest. Superficial sheets of sand overlie much of the centre and east, forming part of the Kempen heathlands. Much of this exceeds 75 ft. in altitude forming a tongue of low plateau projecting westward, from which rise gently swelling eminences (*bergen*) to about 115 ft. In the southwest, near Herentals, an outcrop of soft Lower Pliocene (*Diestian*) sandstone forms a more diversified relief than the sands and gravels, because of its resistance to erosion; a line of hills, culminating in the Langenberg (131 ft.), extends from northeast to southwest near the valley of the Kleine-Nethe. Other hills occur farther south; Heist-op-den-Berg rises from an eminence at 148 ft. The land slopes away gently northward into the Netherlands and westward into the clay-covered polderlands of the Scheldt estuary. Numerous streams (notably the Mark) flow northward to the Maas (Meuse); to the south drainage is by the many headstreams of the Nethe; the watershed is very indeterminate.

The heathland is characterized by areas of sand dunes, with marshy depressions containing small lakes, areas of ling and broom, and poor pasture. There are extensive blocks of coniferous plantations. The landscape changes gradually westward toward the Scheldt; there is progressively less heathland, more market gardening and dairy farming and more numerous villages and small towns. Much of the polderland along the Scheldt is intensively farmed to supply the demands of the city of Antwerp.

Apart from Antwerp (*q.v.*), the chief town is Malines (in Flemish Mechelen; *q.v.*), situated on the banks of the tidal Dyle. It is a market centre for the surrounding agricultural land and has a wide range of industries: furniture, textiles, clothing, lace, paper, leather and food processing. Turnhout (*q.v.*) is a prosperous market, industrial and administrative town in the north of the province, and a centre of road, rail and canal communications. Its industries are varied: the making of paper, stationery, playing cards, sacking and canvas, cigars, pottery, leather and lace. Around the canal basin in the northwest are timber yards, sawmills, cement works and flour mills, and 29 brickyards are along the canal banks. Mol is on the railway from Antwerp, and makes cigars, leather, pottery, textiles, clothing and blankets. Herentals has similar small-scale industries, including also the manufacture of copper and bronze articles, and a large factory makes industrial explosives and cartridges. Several large factories are located in the heathlands; including the Mol-Gompel glass works, two zinc refineries, and a huge refinery at Oolen (2 mi. E. of Herentals) which produces radium, uranium, cobalt, copper and arsenic. Baarle-Hertog (Fr. Baerle-Duc) is a small Belgian enclave in the Netherlands, the Dutch part being called Baarle-Nassau. The frontier is so confusing that neighbouring houses, or even parts of the same house, may find themselves on different sides of it. Apart from the towns, the heathlands are thinly inhabited. Villages are situated at road junctions, at rail-canal intersections, and on low eminences away from the marshes.

The heathlands were for long poorly served with communications. A mainline railway runs from Brussels via Mechelen and Antwerp into the Netherlands; another line runs southeast from Antwerp via Lier and Hasselt; and a third east from Lier across the centre of the heathland via Herentals-Geel-Mol into the Netherlands. A north-south line from the Netherlands passes through Turnhout and Herentals. There is a considerable mileage of light railway (tramway) serving the small towns and villages; six lines focus upon Oostmalle to the northeast of Antwerp and five lines upon Turnhout. A small waterway (Desschel-Turnhout-Schoten canal) curves around the northern part of the province, but much more important is the Albert canal which crosses the southern part on its way from Antwerp to Liège. (F. J. M.)

ANTWERP (Flem. ANTWERPEN; Fr. ANVERS), capital of the province of the same name, the second largest town in Belgium and chief port and commercial centre of the country, lies on the Scheldt (*q.v.*) (Flem. Schelde) in the centre of a vast alluvial plain about 55 mi. from the North sea.

Pop. (1961) 253,295.

Antwerp is situated on both banks of the river, the city proper being on the east bank. There are no bridges, but after 1933 the banks were connected by tunnels—one for pedestrians and one for vehicles. The oldest part of the city extends from the river to a line of broad avenues, which were laid out on the site of the 16th-century ramparts when these were demolished in 1859. The walls built around the city in the 13th century have completely disappeared. The town was extended, chiefly toward the north, and large public gardens were laid out. The most striking building is the Cathedral of the Holy Virgin, begun in the 14th century and not completed until nearly 200 years later; a thorough restoration was carried out in the 19th and 20th centuries. It is the biggest church and one of the finest Gothic buildings in the country, and has a tower more than 400 ft. high; a second tower, begun in the 15th century, was never finished. The cathedral contains, among other paintings, three of Rubens' masterpieces, "The Descent from the Cross," "The Elevation of the Cross," and "The Assumption" (above the high altar). St. James's church, in flamboyant Gothic style, was founded in 1491 but not finished until 1656. The Rubens chapel contains the tomb of the artist whose "Virgin and Child With Saints" is the altarpiece. St. Paul's, a 16th-century Dominican church (with a bell tower dating from the 17th century), and St. Augustine's both possess works by Rubens, Van Dyck, Jordaens, P. Verbruggen and other artists. The former Jesuit church of St. Charles Borromeo, originally dating from 1615–21 but partly rebuilt in the 18th and 19th centuries after destruction by fire, has a splendid baroque façade and contains a small museum of old lace.

The early medieval town grew up around a fortress called the Steen which lies on the river bank. The present castle, whose stone foundations are of the 9th century, dates largely from 1520 but

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CATHEDRAL OF THE HOLY VIRGIN, ANTWERP: BEGUN IN 14TH CENTURY

was greatly restored in 1889 and now houses the national maritime museum. Nearby is the *stadhuis* or townhall (1561–65), a Renaissance structure combining both northern and Italianate elements in its architecture and with frescoes by H. Leys, a native artist. It stands in the Grote Markt (market square) which also contains the Brabo fountain and typical Renaissance buildings. The Meir, a short wide road running west-east, is now the centre of the city, with big shops, banks and offices, and also the royal palace. In the Rubens Straat, off the Meir, is the house which the famous painter built and in which he lived from 1615 until his death in 1640. Once almost demolished, it has now been carefully restored. The Bourse or Exchange (1531) was destroyed by fire in 1858 and rebuilt in 1872. Fire has also destroyed several other old buildings in the city, notably in 1891 the house of the Hanseatic league near the northern quays.

Of several museums the Plantin-Moretus and the Fine Arts museum are the most important. The former, to the southwest of the cathedral, is the old Plantin house, the home of the great 16th-century printer (*see* PLANTIN, CHRISTOPHE) and of his successors, the Moretus family. In it, the pressroom, foundry, proofreaders' room and bookshop are still in their original state. The house also contains an exceptional collection of manuscripts, books, woodblocks, copper plates, etc., as well as paintings by Rubens and others, tapestries and furniture. The Royal Museum of Fine Arts (1880–90), to the south, has a superb collection of paintings by the great masters of the Flemish and Dutch schools, and also 15th-century Flemish primitives and many modern European works. In 1950 the Museum Knight Smidt van Gelder was opened; it is a richly furnished 18th-century patrician's house. The old Butchers hall (*c.* 1500) is a museum of arts and crafts, archaeology and history. The Mayer van den Bergh museum possesses masterpieces of the Flemish school, old embroidery, lace, sculptures and ivories. There are a Royal Opera house and a Royal theatre. Antwerp has several large parks, a botanical garden and a well-known zoological garden, with a natural history museum and aquarium, near the central station. In the grounds of the former château of Middelheim adjacent to Nachtegalen park is an open air museum where, in odd-numbered years, a biennial international exhibition of sculpture is held.

Antwerp's educational institutes include schools of engineering, navigation and diamond working, commercial and colonial universities, a music academy, institutes of fine arts and of architecture and a university foundation for tropical medicine.

Commerce.—Antwerp has three railway stations and is connected directly by rail to Paris, Amsterdam, Brussels and Basel. There is an international airport at Deurne, 3 mi. S.E. of the city. The Albert canal links Antwerp with Liège. The port began its rapid growth after 1863 when Dutch rights to levy toll were redeemed by purchase. It is the greatest Belgian port and one of the four biggest European ports. It consists of two parts: a roadstead, or outer harbour, facing the city, and an inner harbour with extensive installations, lying to the north of the city. There are 19 maritime docks, 10 municipal dry docks and 6 private dry docks. The harbour is connected with the Scheldt by means of six locks, the most recent and largest being the Baudouin lock with a length of 1,180 ft., a width of 147 ft. and a depth at average high tide of more than 50 ft. Because of a vast expansion program, a large territory, including three rural villages north of the city, was in the late 1950s incorporated in the port's area, increasing the total area from 3,460 ac. to 13,200 ac., including the water area of 1,325 ac. which reached more than 2,000 ac. by the 1960s. The total berthage space was increased to 50 mi. More than 16,000 seagoing ships of above 34,000,000 net register tons enter Antwerp yearly, discharging an average 20,000,000 tons of cargo and loading about 15,000,000 tons. Antwerp is not merely of importance for Belgian imports and exports but also has a considerable transit traffic, chiefly to and from the German Federal Republic, especially the Ruhr area. Established in the harbour area are shipyards, sawmills, scrap-iron plants, assembly plants for U.S. automobiles, and oil refineries. Other industries in Antwerp include food and chemical industries. Rubber, ivory and radium are imported from the Congo and marketed at Antwerp. The most important local industry, established in the 16th century, is diamond cutting.

History.—Legend has it that the name Antwerp was derived from *hand werpen* ("to throw the hand"), based on the mythological Roman giant, Druon Antigonus, who supposedly cut off the hands of those mariners who sailed past his castle without paying tolls and threw them in the Scheldt. Another derivation is from the name given to the first settlement *Aen de Werpen* ("at the wharfs"). In the 11th century, when the city was first walled, Antwerp was a marquisate, for some years under the famous Godfrey of Bouillon (*q.v.*). It was the headquarters of Edward III during his early negotiations with Jacob van Artevelde, and his son Lionel, duke of Clarence, was born there in 1338. After the death of Duke John III (1355), Antwerp, which had been under the authority of the dukes of Brabant since the 13th century, came under the domination of the count of Flanders and later of the dukes of Burgundy. Toward the end of the 15th century, with the silting up of the Zwyn and the consequent decline of Bruges, and the enlargement of the western Scheldt by floods, the foreign trading guilds and banks (the first real *bourse* in Europe was founded in Antwerp in 1460) were transferred from Bruges to Antwerp, and the latter became the chief port and commercial centre of the Netherlands and of western Europe. At the beginning of the 16th century there were at least 1,000 foreign business houses established in the city and by 1560, the highest point of its prosperity, Antwerp had superseded Venice in its first place in European commerce.

It was not only in trade that Antwerp had become great, but also in the arts. It had taken the place of Bruges as the centre of Flemish art and its school of painting, of which Quentin Massys (*q.v.*) was a founder, exercised a far-reaching influence. Van Dyck, David Teniers, A. Brouwer, F. Snyders and J. Jordaens were all natives or citizens of Antwerp and members of its guild of painting, and Rubens lived and died there. Pieter Bruegel was another great member of the Antwerp school.

The religious troubles that marked the second half of the 16th century broke out in Antwerp as in every other part of what is now Belgium excepting Liège. In 1576, following upon disturbances, the Spanish garrison plundered the town during what was called "the Spanish Fury," and thousands of citizens were massacred and many houses destroyed. In the following year,

having thrown off the Spanish oppressors, the people destroyed the citadel, and Antwerp came under Calvinist rule. In 1585, after a long siege, Antwerp was recaptured by the Spanish and its Protestant citizens sent into exile. Under Albert and Isabella, who made their state entry into Antwerp in 1599, the city experienced a period of peace and splendour. The recognition of the independence of the United Provinces by the treaty of Münster in 1648 carried with it a severe blow for Antwerp, for it stipulated that the Scheldt should be closed to navigation. The city's prosperity had already begun to decline, and its port was now ruined. In 1795, under French rule, the provisions of the treaty were relaxed, and the Scheldt was reopened to shipping. The port began to develop again rapidly when Napoleon built docks and a naval arsenal in order to make Antwerp the chief military harbour in his empire. In 1830 the city was captured by the Belgian insurgents, but the citadel continued to be held by a Dutch garrison under Gen. David Chassé. For a time this officer subjected the town to a periodical bombardment which inflicted much damage, and at the end of 1832 the citadel itself was besieged by a French army under Maréchal Etienne Gérard until, after a gallant defense, Chassé made an honourable surrender.

At the end of the 19th century Antwerp was converted from a fortress to a fortified city by the construction of an outer line of forts 5 mi. to 11 mi. from the city. After the beginning of World War I the Belgian government left Brussels for Antwerp on Aug. 18, 1914; and three days later the Belgian army took up a position behind the fortified lines. The siege of Antwerp began on Sept. 28, and after an intensive bombardment the city surrendered on Oct. 9, most of the population having already fled into Holland. On May 18, 1940, during World War II, the Germans again occupied Antwerp in their drive toward the channel ports. The fall of the city endangered the whole Belgian army, which surrendered ten days later after a heroic battle on the banks of the river Lys. Antwerp was later subjected to several severe bombardments, the worst taking place after its liberation by British troops in Sept. 1944. The harbour installations did not suffer severe damage. *See* also Index references under "Antwerp" in the Index volume. (E. F. B.; L. C. V.)

ANU (AN), a Babylonian deity, who, as the first figure in the triad Anu, Enlil (*see* BEL) and Ea (*q.v.*), came to be regarded as the father and king of the gods. Anu is prominently associated with the city of Erech in southern Babylonia, but the cult was transferred there in prehistoric times from Der east of the Tigris. At Erech he was closely associated with the worship of his daughter, the heaven goddess Inanna-Ishtar. The name signifies the "high one" and he was probably a god of the atmospheric region above the earth—perhaps a storm god like Adad (*q.v.*). In the period before Hammurabi, Anu was regarded as the god of the heavens and his name became in fact synonymous with the heavens, so that in some cases it is doubtful whether, under the term, the god or the heavens is meant. To Anu was assigned the control of the heavens, to Enlil the earth and to Ea the waters. The summing up of divine powers manifested in the universe in a threefold division represents an outcome of speculation in the schools attached to the temples of Babylonia, but the selection of Anu, Enlil and Ea for the three representatives of the three spheres recognized shows that each of the three must have been regarded in his centre as the most important member in a larger or smaller group, so that their union in a triad marks also the combination of the three pantheons into a harmonious whole.

In the astral theology of Babylonia and Assyria, Anu, Enlil and Ea became the three zones of the ecliptic, the northern, middle and southern zones, respectively. The purely theoretical character of Anu is thus still further emphasized, and in the annals and votive inscriptions as well as in the incantations and hymns he is rarely introduced as an active force to whom a personal appeal can be made. His name becomes little more than a synonym for the heavens in general, and even his title as king or father of the gods has little of the personal element in it. A consort, Antum (or as some scholars prefer to read, Anatum), is assigned to him, on the theory that every deity must have a female associate, but Antum is a purely artificial product and is really a title of Ishtar as queen of heaven. Anatum became the special name of Ishtar as "lady of battle." She was identified with the western Asian Ashratum. Anu and A-an-tum occur in the Hittite treaties of the 16th–14th centuries, but it is not certain that the Syrian-Canaanite war goddess Anat was borrowed from Babylonian Antum or Anatum. The Egyptian war goddess Anat is an Asian importation. *See* BABYLONIA AND ASSYRIA: *Religion: Herding Regions.*

ANUBIS, an ancient Egyptian god of the dead, represented in art by the figure of a man with the head of a jackal (or dog). In the early dynasties of the Old Kingdom he enjoyed a pre-eminent (though not exclusive) position as lord of the dead, but was later overshadowed by Osiris.

His particular concern was with the funeral cult and the care of the dead: hence he was reputed to be the inventor of embalming, an art he first employed on the corpse of Osiris. In his later role as the "conductor of souls," the Greco-Roman world sometimes identified him with the Greek Hermes, naming the composite divinity Hermanubis. (F. R. WN.)

ANURADHAPURA, a town of Ceylon and the administrative capital of the North Central province and the name of a district. Pop. (1953) town, 18,390; district, 229,282. The town is on the main railway from Colombo to the north. Nearby are two huge tanks, the ancient irrigation reservoirs of Tissa Wewa and Nuwara Wewa. Anuradhapura was established in the 5th century B.C. and became the second and most famous capital of the ancient Sinhalese kings. It was the seat of government at the time of the conversion of its king and his people to Buddhism by Mahinda, a son of Asoka. It suffered much during the earlier Tamil invasions, and was evacuated by the Sinhalese in A.D. 760 in favour of Polonnaruwa. Of its archaeological remains the most remarkable are its huge pyramidal *dagobas* (Buddhist relic shrines or stupas), constructed of small sun-dried bricks; its *pokunas*, or bathing pools; and the foundations of monastic buildings and palaces. Many of these monuments have histories going back at least to the time of King Dutthagamini (*c.* 100 B.C.). The city contains the famous Bo tree (pipal), believed to be originally a branch of the sacred tree at Buddh Gaya (*q.v.*) under the shade of which Gautama attained to Buddhahood, miraculously transported from India in 245 B.C. It is the oldest tree in existence of which there is any historical record. The city was completely abandoned to the jungle until it was rediscovered and opened up by the British in the middle of the 19th century; it has become the resort of many Buddhist pilgrims. It was decided in the mid-20th century to move the commercial, residential and administrative buildings of the town to a new position near the railway station, so that the site of the ancient capital could be turned into an archaeological park and place of pilgrimage. At Mihintale, 8 mi. E., there are many other important monuments.
(B. H. F.)

ANUS, the terminal aperture of the gastrointestinal tract. In man it is encircled by muscle fibres, the anal sphincter, which control the evacuation of feces. When contracted they throw the skin and mucous membrane into folds, giving a wrinkled appearance. Hemorrhoids or piles are due to dilated veins which project from the anus and often bleed.

See GASTROINTESTINAL TRACT; *see* also Index references under "Anus" in the Index volume.

ANVARI (AUHAD AL-DIN ALI) (d. *c.* 1190), Persian poet, accounted among the greatest panegyrists, was born in Abivard to the west of Merv early in the 12th century, studied at Tus and became the court poet of the Seljuk sultan Sanjar whom he attended constantly in Merv (the capital) and in the field of battle. When Sanjar died in 1157, Anvari fell out of favour and was hard put to it to find a patron. A prolific writer, his poems, which run to 770 pages in the Lucknow edition (1880), are marked by great technical skill and varied erudition, so that the Persian critic Daulatshah said of his verses that "they are difficult and require a commentary." His virtuosity is fully displayed in his formal odes. His lyrics, which are comparatively simple, exhibit tenderness and charm. He passed his last years in scholarly retirement, and died about 1190, probably at Balkh. His longest piece, a lament on the devastation wrought in northeastern Persia by in-

vading Ghuzz tribesmen, was translated into English in 1785 by William Kirkpatrick under the title *The Tears of Khorassan.* Another version was published in 1877 by E. H. Palmer in his *Song of the Reed;* he also translated Anvari's "Palinodia," a bitter satire of disillusioned old age.

See E. G. Browne, *A Literary History of Persia,* vol. ii, 365 ff. (1906; reprinted 1928); A. J. Arberry, *Classical Persian Literature,* pp. 113–119 (1958). (A. J. Ay.)

ANVIL, a mass of iron on which material is placed while being shaped under the hammer. The blacksmith's common anvil is made of wrought iron, often in the U.S. of cast iron, with a smooth working face of hardened steel. At one end is a projecting conical beak or bick for use in hammering curved pieces of metal; occasionally the other end is also provided with a bick, which is then partly rectangular in section. There is also a square hole in the face, into which tools, such as the anvil cutter or chisel, can be dropped, cutting edge uppermost. For power hammers the anvil proper is supported on an anvil block of great massiveness, and the block in turn rests on a strong foundation of timber and masonry or concrete. *See* FORGING.

ANVILLE, JEAN BAPTISTE BOURGUIGNON D' (1697–1782), distinguished French geographer and cartographer, was born in Paris on July 11, 1697. From an early age he continued, with greater effect, the reformation of cartography begun by G. Delisle, but he was also a classical scholar of repute and many of his memoirs and maps relate to ancient and medieval geography. He displayed exceptional judgment in the choice and use of his authorities and a detailed knowledge of measures of length, and he adjusted the results where possible to astronomically determined positions. His first important map was that of China, prepared from the surveys of the Jesuits. First issued with Du Halde's *Description de l'empire de la Chine* in 1735, it later appeared as the *Nouvel atlas de la Chine* in 1737. His map of Italy (1743) revealed numerous errors in the accepted maps of that country. Other important maps were of Africa (1749), Asia (1751), India (1752) and the world in hemispheres (1761). From the contemporary map of Africa, D'Anville removed many of the conventional and largely fictitious features of the interior, and his representation stood until the great explorations of the 19th century. His *Atlas général,* first published in 1743, was frequently revised. As well as being more accurate than those of earlier cartographers, the maps produced in his office were distinguished by their clarity and good lettering, while some were accompanied by valuable memoirs on the sources employed. His pre-eminence was recognized by his appointment as *premier géographe du Roi* in 1773. His published memoirs amounted to 78 and his maps to 211. Shortly before his death in Jan. 1782, his extensive geographical collection was acquired by the government and is in the Bibliothèque Nationale.

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AN-YANG (or CHANG-TE), important archaeological site in northern Honan province where the Peking-Canton railway crosses the Huan river (36° 05′ N., 114° 20′ E.). Long known as the capital of the legendary Shang dynasty, both the site and the dynasty emerged into historical fact with the excavations by Chinese archaeologists of the Academia Sinica working from 1928 to 1937 under the leadership of Li Chi. Hsiao-t'un, about 10 mi. W. of present An-yang, was the actual palace site of the Yin or later Shang dynasty, *c.* 1401–*c.* 1123 B.C. A royal burial ground nearby has yielded many Shang bronzes, chariots, inscribed oracle bones, pottery and evidence of human and animal sacrifice. After 1950 further digging in this and other sections of north China enlarged the map of Shang influence and led to answers about the origins and development of the early Shangs and relations with their predecessors. Chinese scholars working in the area interpret the Shang as a period of urban growth with large workshops indicating occupational specialization, of use of imported materials like ivory and tin, and of slavery or human servitude in some form. An-yang declined when the succeeding Chou capital arose at Lo-yang. *See* also CHINA: *History.* (TE. H.)

ANYTE (early 3rd century B.C.), a poet of Tegea in the Peloponnesus, was so highly esteemed in antiquity that in the famous "Garland" composed by Meleager (early 1st century B.C.) the "lilies of Anyte" are the first poems to be entwined in the "wreath of poets." Her fame persisted, and Antipater of Thessalonica, writing during the reign of Augustus (27 B.C.–A.D. 14), places Anyte, whom he calls "a woman Homer," in a list of nine lyric poetesses. Of 24 extant epigrams assigned to her 20 are believed to be genuine. In her dedicatory epigrams her verse is akin to that of Theocritus and Leonidas, her contemporaries. Her dedications for fountains and to the nymphs of the springs show the Greek feeling for a quiet landscape that is so often illustrated in the Greek Anthology. She wrote epitaphs, perhaps literary rather than for actual use, on various animals. Unlike her contemporary, Nossis, she gives no suggestion of herself in her poems and never has love for a theme. Her love of nature and interest in animals mark her as thoroughly typical of the early years of the Hellenistic period.

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ANZENGRUBER, LUDWIG (1839–89), Austrian playwright and novelist, most of whose works deal realistically with peasant life, was born in Vienna, Nov. 29, 1839. In 1870 his anticlerical play, *Der Pfarrer von Kirchfeld,* was widely acclaimed. Anzengruber won his greatest successes with plays of Austrian peasant life. *Der Meineidbauer* (1872) presents a gloomy picture, but *Die Kreuzelschreiber* (1872), *Der G'wissenswurm* (1874) and *Doppelselbstmord* (1876) are gay and witty comedies. *Das vierte Gebot* (1878) is a problem play which has affinities with Ibsen's *A Doll House.* Anzengruber also wrote a novel, *Der Schandfleck* (1877; revised 1884) and various other tales of village life. He died in Vienna on Dec. 10, 1889.

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ANZHERO-SUDZHENSK, a town of Kemerovo *oblast* (province) of the Russian Soviet Federated Socialist Republic, U.S.S.R., lies on the Trans-Siberian railway at the northern limit of the Kuznetsk basin coal-mining area. Pop. (1959) 115,628. The urban districts of Anzherka and Sudzhenka were amalgamated in 1928, became in 1931 the town of Anzhero-Sudzhensk and grew with the development of the coal field which includes the mining of the high-quality sapropelite type of coal. Apart from mining, there are chemical industries using coal by-products for pharmaceutical manufactures, and factories for mining machinery. In the vicinity, quartzites and limestone, used in the Kuzbass metallurgical plants, and marble are also quarried. (R. A. F.)

ANZIKA, a former kingdom of central Africa, situated to the northeast of the kingdom of the Congo, whose province of Nsundi it adjoined. Portuguese travelers of the 15th and 16th centuries called its people *Anguicos* (*Anziques*). The name referred either to the Bateke people of the area ruled by the paramount chief Makoko, within the limits of the present Congo republic (former French territory) and Stanley pool as a whole, or to one of the tributary chiefdoms of the Makoko or, more generally, to the pagan cannibals north of the Congo river and the Christianized Congo kingdom. Anzika is said to have had a despotic king to whom many chiefs were subject. It was never subordinate to the Congo kingdom, being larger and more powerful according to Confalonieri, who based his descriptions on those of D. Lopez, F. Pigafetta and early Portuguese missionaries. Between 1568 and 1587 the Congo kingdom, under Alvare I, was defeated by hordes of Yaga and Anzika invaders.

The Anzika traded with the people of the Loango chiefdom, a vassal of the Congo kings. The country was famous for its copper

and red sandalwood and Anzika copper was sold to the earliest European traders by the Bavili tribe of Loango. The Anzika also exchanged slaves for cloth, ivory, salt and cowries. They used small arrows and bows covered with snakeskin and practised tattooing and circumcision.

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ANZILOTTI, DIONISIO (1867–1950), Italian jurist, cofounder with Heinrich Triepel of the so-called positive school of international law, was born at Pescia, on Feb. 20, 1867. Professor of law at the universities of Palermo, Bologna, and finally Rome, 1911–37, he was appointed in 1921 a judge of the Permanent Court of International Justice of The Hague, where he presided from 1928 to 1930. In 1906 he founded in Rome with Ricci Busatti the *Rivista di diritto internazionale* ("International Law Review").

Anzilotti was one of the foremost representatives of modern international jurisprudence and, with Triepel, advocated a strictly legal approach to international law, based on a sharp distinction between the legal and the political and moral aspects of international relations. He died at Pescia on Aug. 23, 1950. (A. P. SI.)

ANZIO, a town of central Italy in the region of Lazio and province of Rome, lies on a peninsula jutting into the Tyrrhenian sea 38 mi. by road south of Rome. Pop. (1961) 17,453 (comm.) Anzio is a seaside resort with long sandy beaches and a small port for yachts and fishing boats. The Casino, known as the "Paradise on the Sea," was built in 1924. The Villa Spigarelli was reconstructed from a Roman villa and has frescoes, mosaic floors, statues and a grotto known as Coriolanus' tomb. Opposite is a Roman theatre and nearby a Volscian defense wall. At the end of the western beach are the ruins of the Roman port (A.D. 59) and Nero's magnificent villa. The medieval castle overlooks the port. The resorts of Nettuno and Lavinio are close by. Anzio and Nettuno are on the end of a branch line from Campoleone on the main Rome-Naples railway. In the summer months boats ply to the Ponza islands. Fishing is the chief industry; there is also a large soap and detergent factory and a sardine-canning plant. There is a thriving tourist trade.

The origins of Anzio are uncertain, legend declaring that it was founded by Antias, son of Odysseus and Circe. Known as Antium, it was the Volscian capital and traded with the near east. It was older than Rome, which conquered it in 341 B.C. It became an all-season resort, most wealthy Romans having villas there. Augustus was proclaimed "father of the Roman nation" while there; Caligula and Nero were born in Anzio. There are extensive Roman remains, and valuable works of art, including the famous statue of Apollo Belvedere, were found. After the fall of the western Roman empire, Anzio passed in turn under Gothic, Frankish, and papal rule, becoming part of the Italian kingdom in 1870. In World War II Allied forces landed at Anzio on Jan. 22, 1944, and formed a bridgehead, which, because of German resistance, did not link up with the main front until May 25, 1944. (EN. S.; F. FE.)

ANZOÁTEGUI, a state in northeastern Venezuela between the Caribbean sea and the Orinoco river, a typical llanos plains state containing, however, a few outliers of the northeastern highlands. Area 16,718 sq.mi.; pop. (1961) 382,002. Anzoátegui contains some of Venezuela's oldest settlements. Essentially a cattle-raising state, it also has important oil fields. Particularly outstanding among the latter is the Great Oficina area, composed of El Tigre, San Tomé, Campo Oficina and Campo La Leona fields and notable for light oils. Other fields in the state are Campo El Roble, Campo Santa Rosa, Campo San Joaquín and Campo El Guarico. Important pipelines connect these fields, along with small fields in the states of Monagas and Guárico, with Puerto La Cruz which exports crude oil and refines petroleum. There is coal at Naricual. Barcelona (*q.v.*) is the principal city and state capital. Important ports are Guanta and Puerto La Cruz. (L. WE.)

AOMORI, northernmost prefecture (*ken*) of Honshu, Japan. Area 3,711 sq.mi. Pop. (1960) 1,426,606. Aomori has a relatively poor, unstable agricultural economy that is handicapped by long, cold, snowy winters and poor drainage. Low-yielding rice fields and Japan's largest apple-producing area are features of western Aomori, while its eastern part specializes in dry grains and horses. Large-scale manufacturing is found only in Hachinohe, which produces chemical fertilizer and pig iron. In the mountainous interior are some of Japan's finest timber stands, mostly in national forests. Coastal and deep-sea fishing operations centre on Hachinohe, the leading fishing port, and Aomori.

The city of Aomori, located on Aomori bay, is the capital and largest city of Aomori prefecture. Pop. (1960) 202,211. One of Japan's most important transportation centres, it is the terminal for both northern Honshu rail lines and railroad ferry services across Tsugaru straits to Hakodate in Hokkaido. Although founded in the late 16th century, Aomori remained a local port until the opening of the Hokkaido ferry service (60 nautical miles long) in 1908. Strong winter winds make extensive breakwaters necessary in its artificial harbour. Its port is noted for shipments of lumber and fish and its coastal trade, mostly with Hokkaido. (J. D. EE.)

AORTA AND AORTIC VALVES. The aorta is the main systemic artery arising from the left ventricle of the heart. The blood passes through it to all parts of the body though the capillary and venous systems intervene between the systemic and pulmonic circulations. Its orifice is guarded by three semicircular pocket-shaped valves with their convexities toward the heart. The back pressure of the blood distends the pockets and closes the valves thus preventing regurgitation of blood into the left ventricle. The valve leaflets may become distorted by inflammation and permit leakage. Rheumatic fever may cause such valvular disease.

See ARTERIES; BLOOD VESSELS, SURGERY OF; CIRCULATION OF BLOOD; CIRCULATORY SYSTEM; HEART, ANATOMY OF. (F. L. A.)

AOSTA: *see* VALLE D'AOSTA.

APACHE, the general term used to denote six culturally related, Athapaskan-speaking Indian tribes of southwestern North America. Their ancestors probably entered the area from the north about A.D. 1100 as a unit, and tribal and linguistic differentiation occurred after arrival. The tribes encountered at the time of the first white contact were the Western Apache, the Chiricahua, the Mescalero, the Jicarilla, the Lipan and the Kiowa Apache. The process of differentiation was apparently still continuing at the time of first contact, for the Western Apache were found to be divided into five groups that were something less than separate tribes, yet more autonomous than bands. The Navaho (*q.v.*) have differentiated sufficiently to be considered a separate tribe. At the time of the North American occupation by the white man, the Apache ranged over what is now east-central and southeastern Arizona, southeastern Colorado, southwestern and eastern New Mexico, western Texas and northern Mexico. In physical type the Apache tends to be short, stocky, roundheaded and broadfaced.

The social organization of the Apache has a common core, but there are some interesting tribal variations. The family is uniformly a strong social and economic unit. At marriage the man and wife make their home at the encampment of the wife's relatives, and the husband is expected to work for them and show them deference in speech and behaviour. The Western Apache, doubtless influenced by their Navaho and Pueblo neighbours, are divided into a large number of named clans. A child automatically belongs to the clan of his mother. The Jicarilla tribe is divided into two bands or sections which have some reciprocal ceremonial functions. This moiety arrangement probably was stimulated by the example of nearby eastern Pueblo peoples.

The Apache were basically hunters and gatherers. Those on the western edge of the central plains hunted buffaloes. The reintroduction of the horse into the new world by the Spaniards and the rapid multiplication of this animal gave mobility to the Apache for the chase and for raiding. When first encountered, the Western Apache and the Jicarilla were supplementing their food supply of game and wild plants by cultivating corn and other vegetables on a modest scale. The Kiowa Apache, perhaps because of small numbers and military reverses threw in their lot with the Kiowa In-

dians of the plains, moving and camping with them. The Jicarilla, though they retained their separate territory, formed an alliance with the Southern Ute to counterbalance the Navaho threat.

After the American Civil War a determined attempt was made to limit the territories and movements of the Apache. Efforts, which failed miserably, were made to concentrate the Mescalero with the Navaho at Bosque Redondo on the Pecos river. Then there was an attempt, which also had to be abandoned, to station the Jicarilla with the Mescalero on a reservation farther to the south. Serious troubles arose when the Chiricahua were forced to relinquish their territories and were housed with the Western Apache. Groups of Chiricahua repeatedly left the reserve in fright or protest and were promptly pursued by army units. The last Indian war of this kind ended in 1886 with the surrender of Geronimo and his few remaining followers. This time the entire Chiricahua tribe was evacuated from the west and held as prisoners of war successively in Florida, Alabama, and at Fort Sill, Oklahoma, for a total of 27 years. In 1913 the members of the tribe were allowed to choose between taking allotments of land in Oklahoma or returning to the west to live in New Mexico on the Mescalero reservation. Approximately one-third chose the former course and two-thirds, the latter.

The Apache population totaled about 11,000 (1960s). The Western Apache live on the Fort Apache and San Carlos reservations in east-central Arizona. The Chiricahua, except those still living near Apache, Oklahoma, the Mescalero, and the Lipan live on the Mescalero reservation in southern New Mexico. The Jicarilla have a reservation in north-central New Mexico. The Kiowa Apache live on allotments of land in southwestern Oklahoma.

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APALACHEE, an extinct tribe of American Indians belonging to the Muskogean linguistic stock. They have been known since the 16th century, and formerly ranged the country around Apalachee bay, Fla. The name is apparently Choctaw, meaning "people on the other side." About 1600 the Spanish Franciscans founded a successful mission among them, but early in the 18th century the tribe suffered defeat at the hands of the British; the mission churches were burned, the priests killed, and the tribe practically annihilated, more than 1,000 of them being sold as slaves. *See* Muskogean Indians.

See F. W. Hodge (ed.), *Handbook of American Indians North of Mexico* (1959).

APAMEA (Apameia), the ancient name of several towns in western Asia:

1. Apamea Cibotus (Apamea ad Maeandrum) was a city of Hellenistic Phrygia, the site of it being partly occupied by the modern Dinar, south of Afyonkarahisar in Turkey. Founded by Antiochus I Soter in the 3rd century B.C. and named after his mother, it superseded the ancient Celaenae, which stood at the source of the Marsyas. Apamea held a commanding position at the point where the great east-west trade route of the Seleucid empire left the Maeander valley for the Anatolian plateau. The name Cibotus (Gr. *kibotos*, "coffer," "ark") may have referred to its wealth or to some feature of its topography. It is possible that this name gave rise to the early Christian legend that the ark of Noah rested on the hill above the town. Having passed from Seleucid to Attalid and thence, in the 2nd century A.D., to Roman rule, it became a great centre for Italian and Jewish traders; it long claimed primacy among Phrygian cities. Disorganization in the 3rd century A.D. and the diversion of trade to Constantinople led to its decline. It was captured by the Turks in 1070 and finally destroyed by an earthquake. The older sections of Dinar are largely constructed from the remains of Apamea.

2. Apamea ad Orontem (in the valley of the middle Orontes in western Syria) was a treasure city and stud depot of the Seleucid kings, founded by Seleucus I Nicator. It was destroyed by Khosrau II of Persia in the 7th century A.D. and again by an earthquake in 1152. At the time of the crusades the site was known under the corrupted name of Famia. Extensive remains of streets and buildings may still be traced.

3. Apamea Zeugma (the modern Birecik in southeastern Turkey) was a town refounded by Seleucus Nicator on the site of the Til-Barsip mentioned in Assyrian inscriptions. On the high left bank of the Euphrates, it was approached by a bridge of boats (*zeugma*).

4. Apamea Myrlea (the modern Turkish Mudanya on the sea of Marmara) was so named when Prusias I of Bithynia rebuilt the earlier city of Myrlea.

5. Apamea in Babylonia is mentioned by Stephanus Byzantinus and by Pliny as having stood near the Tigris in the district of Mesene, but the identification of the site is uncertain.

6. Apamea Rhagiana was a Greek city in western Parthia, near Rhagae (the modern Rai or Rayy, in Iran). (Wm. C. B.)

APARRI, a municipality of the province of Cagayan, Luzon, Phil., on the east bank of the Cagayan River near its mouth, about 55 mi. N of Tuguegarao. Pop. (1960) 33,424. It was visited in 1572 by Gov. Guido de Lavezares and somewhat later by Luis Pérez Dasmariñas. In 1898 Filipino insurgents under Col. Daniel Tirona landed at the port; but in 1901 civil government under the U.S. was established. Aparri is the northernmost of the larger Philippine municipalities and is the port for much of northeastern Luzon. Ocean vessels cannot cross the bar at the mouth of the river, but interisland ships anchor in the river opposite Aparri. Principal products shipped are palay (rice), corn, copra, logs, and fish products. Both fishing and cattle raising are significant industries. The Christian inhabitants are mainly Ilocanos and Ibanags. Aparri was invaded by the Japanese on Dec. 10, 1941. U.S. forces occupied it in June 1945. (An. C.)

APARTHEID, an Afrikaans word meaning "apartness," the state of being separate or segregated. It is the name given by the Afrikaner Nationalist Party, in office in South Africa after 1948, to the policies that govern relations between the country's 3,000,000 white inhabitants and its 12,000,000 nonwhite, mainly African, inhabitants. It is also used to describe the long-term objective of the territorial separation of races that is advocated by Afrikaner church and intellectual circles.

The basic tenet of South African policy has always been the complete domination of state and society by the white population, and the two major parliamentary parties have vied with each other on how best to maintain white power. In practice, there have been few major changes since the Union of South Africa came into being in 1910 although terminology and idiom have changed considerably. Separation, segregation, and trusteeship are some of the terms that have passed in and out of use, and the word apartheid, which first gained wide currency during the 1948 election, is only the most recent.

Frontiersmen with attitudes born of exclusiveness and fear, white trade unionists determined to exclude unorganized and cheap nonwhite labour, industrialists equally determined to keep that labour unorganized and cheap—all these contributed to the establishment of a framework of segregation. Both before and after 1948 this framework was substantially strengthened. A vast range of industrial and service occupations was reserved exclusively for white workers and statutory powers were created to extend this policy in time of recession.

Ownership of land by Africans was limited to designated Native Reserves comprising only 13% of the land surface. Sexual relations and marriage between whites and nonwhites were made illegal. The right to vote was denied to nonwhite men, and all Africans were required to obtain permission before they could enter and remain in urban areas.

The advocates of apartheid declared that this legislation was necessary because they regarded Africans living in urban areas and on white-owned farms as aliens, temporarily residing in white society. Only in the Native Reserves, officially known as Bantu Homelands, could Africans hope to obtain political and economic freedom. After their 19th century conquest, a modified system of traditional authority was retained in the Reserves, together with

communal land ownership and the recognition of African family law. The Reserves have long been overcrowded rural slums and the adult males, because of poverty and taxation, are forced to spend their working lives as migrant labourers.

In the Transkei, the largest of the Homelands, the form, if not the substance, of political power is to be found. A prime minister and cabinet sit in a legislative assembly made up of 65 nominated members and 45 elected members, but its authority is limited and the South African president retains the right of veto. Critics who doubt that sovereignty will ever be transferred to the Transkei are even more skeptical about the application of this policy to the remaining Homelands which, like the Transkei, are not economically viable and have much smaller populations and territories. The policy of separate development is widely held to be an illusory one, and is regarded as a rationalization for maintaining racial discrimination.

Criticism of the apartheid policy by other member nations of the British Commonwealth led to South Africa's withdrawing from the Commonwealth in 1961. (S. Tr.)

APARTMENT HOUSE. In the United States an apartment house is a building containing more than one dwelling unit, each designed for housekeeping. In Great Britain a similar type of building is known as a block of flats, and each unit therein is called a flat. These units may be grouped in many ways and vary in size, appointments and facilities, providing a wide variety of living accommodations capable of satisfying the requirements of many different types of families. In the United States there was a steady increase in apartment building during the first quarter of the 20th century.

Communal dwellings and apartment buildings have existed for centuries. Among the North American Indians the most noted were the long houses of the Iroquois. These buildings ranged in depth from about 18 to 20 ft. and in length from 60 to 100 ft. They were divided into separate bays, one for each family.

The primitive buildings in the American southwest consisted of one-room houses built to form one continuous structure. Because of their locations on heights or in narrow river gorges, for ease of defense, the only possibility of expansion was upward. New houses would rise above the old, tier on tier, until heights of several stories were reached, each story of dwellings stepped back to give a terrace at each floor.

In the great cities of the Roman empire, because of urban congestion, the individual house had given way in early imperial times to the communal dwelling or apartment house, except for the residences of the very wealthy. Four stories were common, and six-, seven- or eight-story buildings were occasionally used.

Later, tall apartment buildings were erected in walled cities such as Paris and Edinburgh to hold increasing populations within inflexible boundaries; some of these buildings still standing in modern times in Edinburgh date from the end of the 16th century. In England houses were often converted from upper-middle-class residences to boardinghouses and finally to small flats. The only dwellings in England similar to the tall buildings in Edinburgh and on the continent were the chambers in the Inns of Court and the universities, until, in 1804, York house (the Albany), Piccadilly, was converted and extended to form bachelor apartments. There was no real development of the apartment building in England until the 1850s.

Early in the 19th century the Industrial Revolution enormously increased the populations of all the great industrial centres of the world. Populations doubled, tripled and quintupled in approximately 100 years. The result of this increase was a tremendous overcrowding, unaccompanied as yet by new conceptions of city planning or of dwelling design. People were simply crowded more and more closely into rooms, houses or blocks of tenements.

In the middle of the 19th century a new building type arose—the slum dwelling conceived and built as such, erected under municipal codes and accepted as standard practice. The typical New York "old-law" tenement, for instance—a type which started in the 1830s and consisted of apartments popularly known as railroad flats, the rooms placed in a row like railroad cars—probably holds a record for intensive use of space in the worst possible way. It is perhaps significant that sections of the cities that contained apartments for the rich were almost as densely covered and as poorly planned as those in the sections characterized by poverty. Much so-called model housing of this period was only slightly better. The Peabody foundation built five- and six-story tenements in London in 1864. In Paris a seven-story walk-up group which consisted of three buildings erected one behind the other on an interior lot received first prize in a competition in 1901. In Berlin Huber's society built an apartment building five stories high with its toilets in the yard. Few low-cost apartment buildings erected anywhere before 1918 show any signs of good design according to 20th-century standards.

In many continental cities, however, the second half of the 19th century witnessed great progress in the design of apartments for the upper-middle class and the rich. Particularly in Paris and Vienna this period produced a flood of apartment buildings which were excellently arranged for their purpose despite their cramped and difficult sites, although their standards of light, air and sanitation were still primitive.

From 1919 to about 1934 many large housing projects were constructed in Europe, a majority of them built either by the government or by public-utility societies with government aid. These projects included about 4,500,000 dwellings and showed tremendous advances in planning. In the United States a subsidized public housing program was started under the United States Housing act of 1937, by which the federal government made loans and subsidy grants to cities and other local governments to provide housing for low-income families. Much of this housing was in apartment buildings.

From about 1930 to the beginning of World War II many well-designed apartment buildings were erected, all over the world, and though these form only a small fraction of the total of apartment buildings existing, they established new standards, developed new methods and techniques and gave form to new and creative ideas.

The demand for rental housing after World War II was greater than ever before as the result of increased building costs, shifts in population and other causes. It was met in part by a vast amount of construction of multistory buildings in urban areas and by enormous developments of houses and apartments in suburban areas. The construction of apartment buildings in suburbs was almost entirely a 20th-century development, a result primarily of lack of adequate urban sites at economically feasible prices. Because of the availability of large tracts of comparatively inexpensive ground, suburban sites made possible the provision of many amenities not possible in costly urban centres, such as large open areas, providing views and privacy, outdoor sitting and play spaces and adequate parking facilities. These benefits, however, frequently were offset by longer travel time to and from work places and shopping districts.

See also City Planning; Housing; Residential Architecture.

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APATITE is the name applied to a group of closely related phosphate-bearing minerals that are widely distributed in nature. Economically, the most important is the carbonate-bearing apatite of rock phosphate deposits, such as those of Florida, the Rocky mountain region, North Africa, the Ukraine and certain oceanic islands (*see* Mineral Phosphates). Low-grade phosphate rocks are of interest because of their content of uranium and vanadium.

Apatite is the hardness standard 5 in Mohs' scale. Its crystalline symmetry is limited to a sixfold axis and a plane perpendicular to it. The specific gravity is about 3.2, depending upon the chemical composition. The crystals may be brown, yellow, green, blue,

violet, white, or colourless.

Chemically, apatites are calcium phosphates having the type formula $Ca_{10}X_2(PO_4)_6$, where X is fluorine, chlorine or hydroxyl. Strontium and manganese may substitute for calcium within the crystal structure, thus giving rise to additional varieties. Carbonate-containing apatites related to fluorapatite and hydroxyapatite are known as francolite and dahllite, respectively. The indefinite term collophane is applied to seemingly noncrystalline substances with similar compositions. A rare, silicate-sulfate mineral, ellestadite, has essentially the same crystal structure, as does a mineral of intermediate composition, wilkeite.


B. M. SHAUB

BLACK APATITE CRYSTAL, SHOWING HEXAGONAL STRUCTURE, FROM ONTARIO, CAN. (ABOUT NATURAL SIZE)

Fluorapatite occurs as an accessory mineral throughout the compositional range in igneous rocks, frequently as small or microscopic crystals with hexagonal cross sections. Fluorapatite or hydroxyapatite occurs in many varieties of metamorphic rocks. Dark coloured crystals, sometimes exceeding a foot in length, occur in a matrix of coloured calcite in eastern Canada, for example. Though rarer, chlorapatite may be locally abundant, as it is in southern Norway.

The hard substance of vertebrate teeth and bones is chemically similar to carbonate hydroxyapatite and produces a similar X-ray diffraction pattern. During the process of fossilization the fluorine content tends to increase. (D. McC.)

APATURIA, an ancient Greek festival that was held annually by nearly all the Ionian towns. At Athens it took place in the month of Pyanopsion (Oct.–Nov.) and lasted three days, on which occasion the various phratries (clans) of Attica met to discuss their affairs. The name probably means the festival of "common relationship."

On the first day, called Dorpia, banquets were held toward evening at the meeting place of the phratries or in the private houses of members. On the second day, Anarrhysis, a sacrifice of oxen was offered at the public cost to Zeus Phratrios and Athena. On the third day, Koureotis, children born since the last festival were presented by their fathers or guardians to the assembled phrators, and, after an oath had been taken as to their legitimacy, their names were inscribed in the register.

APAYAO: *see* ISNEG.

APE, the general term for primates of the family Pongidae. The term anthropoid ape is generally used for those that most closely resemble man in appearance, anatomical features and probably genetic functions.

The apes include the gorilla, chimpanzee, orangutan and gibbon (*qq.v.*). The first three are sometimes referred to as great apes and are frequently classified together as the subfamily Ponginae. The gibbons and the closely related but much larger siamangs are placed in the subfamily Hylobatinae. The implied relationship of anthropoid apes to man and his ancestors leads to their inclusion together in the superfamily Hominoidea. (*See* PRIMATES: *Manlike Primates* [*Anthropoidea*]: *Apes and Men.*)

In addition to the living apes, numerous fossil forms have been discovered. Many of these remains are extremely fragmentary, the majority being represented by little more than teeth. The earliest date from the Oligocene. A number show affinities with the gibbons; the majority of the others are placed in the extinct subfamily Dryopithecinae. Of these, one group shows possible affinities with human ancestors and may eventually be grouped with the subfamily Australopithecinae of the family Hominidae. These man-apes have been traced back to the early Pliocene, indicating that the separation of the human line of descent from that of living anthropoid apes goes back at least 12,000,000 years. (*See* ANTHROPOLOGY: *Evolution and Racial Variation in Man.*)

Apes are similar both to men and old world monkeys in basic structure of the head and neck; to men only in the shoulder girdle and arms and in the lack of a tail. Their hip structure does not allow the characteristic human bipedal locomotion on the ground, although all apes can walk upright briefly. The apes are tropical forest dwellers of the eastern hemisphere. Gibbons and orangutans are arboreal brachiators, *i.e.,* they move through trees by swinging from branches by their arms. Chimpanzees and gorillas stay on the ground much of the time, and perhaps consequently have feet more similar to man. *See* MAN, EVOLUTION OF: *Comparative Anatomy.*

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APELDOORN, a town in the province of Gelderland, Neth., is situated east of the sand hills of the Veluwe where they level off into the flat IJssel valley, 39 mi. by road east of Utrecht. Pop. (1960) 78,961. The town, with its brightly painted red brick houses, is mainly residential and industrial and has few buildings of historic interest. Het Loo, a royal palace built as a hunting lodge in 1686 by Jacob Roman for William III, is 1½ mi. N. It is surrounded by fine gardens. Apeldoorn is a tourist centre for exploring the Veluwe, a 15-mi.-wide area of heath and sand dune running southward for 25 mi. from the southeastern part of the IJsselmeer. The town is also a centre of road and rail communications and the canal from Dieren to Hattem runs through it. The chief industry is paper making, but the town is being developed as a general industrial centre. In World War II Apeldoorn was occupied by the Germans from May 1940 to May 1945.

APELLES (4th century B.C.), probably the greatest painter of antiquity. He lived in the time of Philip of Macedon and his son Alexander. He was of Ionian origin but became a student at the celebrated school of Sicyon, where he worked under Pamphilus. He thus combined the Dorian thoroughness with the Ionic grace. He became the recognized court painter of Macedon, and his picture of Alexander holding a thunderbolt ranked with the Alexander with the spear of the sculptor Lysippus. Other works of Apelles had a great reputation, among them the portraits of the Macedonians Clitus, Archelaus and Antigonus, the procession of the high priest of Artemis at Ephesus, Artemis amid a chorus of maidens, a great allegorical picture representing Calumny and the painting representing Aphrodite rising out of the sea. Of these works no copies survive, unless a painting of Alexander as Zeus in the house of the Vettii at Pompeii be considered as a reminiscence of his work. It is said that he attached great value to the drawing of outlines, practising every day. The tale is well known of his visit to Protogenes, and the rivalry of the two masters as to which could draw the finest and steadiest line. The power of drawing such lines is conspicuous in the decoration of the red-figured vases of Athens. Apelles allowed the superiority of some of his contemporaries in particular matters: according to Pliny he admired the way Melanthius spaced his figures, and Asclepiodorus' mastery of symmetry and proportion. He probably used only a small variety of colours and avoided elaborate perspective. Simplicity of design, beauty of line and charm of expression were his chief merits.

When the naturalism of some of his works is praised—for example, the hand of his Alexander is said to have stood out from the picture—it must be remembered that this is the merit always ascribed by untutored critics to works which they admire. In fact the age of Alexander was one of notable idealism, and probably Apelles succeeded in a marked degree in imparting to his figures a beauty beyond nature. Apelles was also noted for improvements which he introduced in technique. He had a dark glaze, called by Pliny *atramentum,* which served both to preserve his paintings and to soften their colour. There is little doubt that he was one of the most bold and progressive of artists.

APELLICON (d. *c.* 84 B.C.), a wealthy Greek book collector, was born at Teos and later became an Athenian citizen. During the First Mithridatic War, when Athens in revolt set up the peripatetic philosopher Athenion as tyrant, Apellicon supported him

and was disastrously defeated by a Roman commander when in charge of a force in Delos. He had previously bought from the descendants of Neleus of Scepsis in the Troad the libraries of Aristotle and Theophrastus which were in a damaged condition and may have contained the only copies of the Aristotelian treatises to survive, although this is uncertain. Apellicon was said to have published them with corrections and supplements. After his death, when Sulla captured Athens, the books were carried off to Rome where eventually they formed the basis of the famous edition by Andronicus of Rhodes. A keen bibliographer, who had once been found surreptitiously removing the originals of ancient decrees from the archive-depository in the Metroon at Athens, he owned a copy of the *Iliad* with the first line differing from that in the present text.

See I. Düring, *Aristotle in the Ancient Biographical Tradition*, pp. 382–395 (1957), for sources and references. (G. B. Kd.)

APENNINES (Appennino), a series of mountain ranges traversing peninsular Italy and forming the "backbone" of the country. The name probably derives from Celtic *pen*, a mountain top; it originally denoted only the northern section, from the Maritime Alps to Ancona. Polybius (*q.v.*) probably first applied it to the whole chain, extending the name as far as Marseilles. The total length is about 838 mi. and the width 25 to 80 mi.

Divisions.—The Apennines may be divided into three parts, northern, central and southern.

1. The Northern Apennines or Appennino Settentrionale extend from the western end of the Maritime Alps. The first section is called the Ligurian Apennines (Appennino Ligure), bordering the coast of the Gulf of Genoa. The rocks consist of limestones and Flysch (sandstones, marls, clays). The highest point is Monte Bue (5,840 ft.). The southern slopes rise steeply from the sea, their lower parts terraced for the cultivation of vines, olives, fruit and vegetables. The rugged coast has numerous resorts (*see* Riviera). The ranges are crossed by several passes, one of which (the Giovi) carries the main road and railway between Genoa and Milan. Numerous hydroelectric plants have been built, linked into the Italian grid-system.

The ranges then trend in a southeasterly direction as the Tuscan Apennines (Appennino Tosco-Emiliano). They culminate in Monte Cimone (7,103 ft.). The ranges are dissected by valleys draining to the Po and the Mediterranean, and are in places thickly forested with pine woods and on the lower slopes with sweet chestnut. The rocks are of limestone, sandstone and clay, and in places marble occurs, as at Massa-Carrara. The clays give rise to landslides during the winter rains, which can do much damage to roads and villages. Tuscany, however, is taken up by lower hills, divided from the Apennines by the Arno, Chiana and Paglia rivers. The Tuscan hills are rich in minerals and chemicals toward the west, which are not found in the Apennines proper. Railways cross from Pistoia to Bologna, from Florence to Faenza, and from Prato to Bologna through a long tunnel.

The Umbrian Apennines (Appennino Umbro) extend south to the Scheggia pass. They are lower, rising to 5,007 ft. in Monte Nerone, and are much dissected by the headstreams of the Tiber. A railway from Terni and Foligno crosses the mountains to Ancona on the east coast.

2. The central Apennines or Appennino Centrale extend southward as far as the valley of the Sangro as a series of broadly parallel ranges comprising the Roman Apennines (Appennino Umbro Marchigiano) and the Abruzzi Apennines (Appennino Abruzzese). The main summits are in the east, the Gran Sasso d'Italia (*q.v.*), culminating in Monte Corno (9,560 ft.), the highest point in the Apennines. There are extensive limestone plateaus, rugged and deeply dissected. From the easterly ranges, short rivers flow directly to the Adriatic. Between the parallel ridges lie long narrow valleys, mainly draining to the Tiber. The western margins of the central Apennines show signs of volcanic activity, with peaks such as Monte Amiato and the Alban hills (*q.v.*), and numerous crater-lakes; *e.g.*, Lake Bolsena. Near Lardarello a large geothermic power station utilizes steam produced by volcanic activity. The ranges are not easily crossed by railways, which follow the longitudinal valleys, but one line pursues a circuitous course from Rome via Avezzano to Pescara.

3. The southern Apennines or Appennino Meridionale extend southward as the Neapolitan Apennines (Appennino Napoletano) from the Sangro valley in a series of isolated blocks separated by broad depressions, rather than continuous chains. Most consist of rugged limestone, with bare rock where the winter torrents have gashed the hillsides. In the north the Montagna del Matese culminate in Monte Miletto (6,726 ft.); farther south are the Lucanian Apennines or Appennino Lucano (Monte Pollino, 7,375 ft.). Beyond the isthmus between the Tyrrhenian sea and the Gulf of Taranto are the Calabrian Apennines (Appennino Calabrese), made chiefly of granite, and the La Sila mountains which project into the "toe" of Italy toward the Straits of Messina. Numerous reservoirs have been constructed in the high valleys for irrigation and hydroelectricity. Volcanic activity is again evident around the Bay of Naples, notably Vesuvius (*q.v.*) and the Campi Flegrei. Further south this activity is represented in the Lipari Islands, with Stromboli and Vulcano. Numerous short rivers flow to the southern coasts. Several railways link the west and east coasts.

Character.—Many parts of the Apennines are snow-covered in winter, which is cold and bleak, though in summer the landscape is parched and arid. Winter torrents degenerate into strings of pools or dry courses in summer. Much was once thickly forested with pine, oak and beech, but a large proportion has been cleared during past centuries, so that the slopes, deprived of their protective tree cover, have been denuded of soil. Large areas are covered with poor evergreen scrub (macchie), and the higher parts, particularly in the central Apennines, carry summer pastures for sheep and goats. In recent years hillsides were terraced, pastures improved, and plantations of sweet chestnuts established on the lower slopes and of pines higher up. The eastern slopes overlooking the Adriatic sea are more gentle and fertile, but their disadvantage is the lack of water, since they are on the leeward side of the peninsula and receive less rain than the west. For the most part the Apennines are thinly populated. Settlements consist of villages of tall stone houses, either huddled in the valleys and depressions or perched on the hilltops. The people practise a poor type of agriculture. After World War II, the Italian government carried out several land-improvement schemes, particularly in the south of the peninsula, to create farms for landless peasantry. (F. J. M.)

Geology.—The Apennines form a part of the Alpine-Himalayan group of mountains (*see* Alps). They consist almost entirely of Triassic, Jurassic, Cretaceous, Eocene and Miocene beds, like the outer zones of the Alps. Remnants of older rocks may be seen in the Calabrian peninsula, Capo Circeo and the Island of Zannone, in the Apuane Alps, in the islands off the Tuscan coast and in the Colline Metallifere.

In the south the deposits from the Trias to middle Eocene consist mainly of limestones and were laid down, with a few interruptions, upon a quietly subsiding sea floor. Toward the end of the Eocene, the folding which gave rise to the existing chain became marked. The sea grew shallow; the deposits became conglomeratic and shaly; and volcanic eruptions began. Folding and elevation went on until the close of the Miocene period, when a considerable subsidence took place and the Pliocene sea overspread the lower portions of the range. Subsequent elevation, without folding, has raised the Pliocene beds in some cases to more than 3,000 ft., and they now lie almost undisturbed upon the older folded beds.

The last elevation led to the formation of numerous lakes, now filled by Pleistocene deposits. Both volcanic eruptions and movements of elevation continue to the present day around the shores of the Tyrrhenian sea. In the northern Apennines the elevation appears to have begun earlier, for there the Upper Cretaceous consists largely of sandstones and conglomerates. In Calabria the chain consists chiefly of crystalline and schistose rocks; it is the Mesozoic and Tertiary zone which has been sunk beneath the sea. Similar rocks are found beneath the Trias farther north in some of the valleys of the Basilicata. Glaciers no longer exist in the Apennines, but post-Pliocene moraines have

been observed in Basilicata. (J. I. P.)

Vegetation.—The Apennines are not generally rich in flora and have few endemic species by comparison with the Balkan or Iberian peninsulas. The greater part of the area is geologically Recent and, the range being cut off in Tertiary times by the sea on the east and west, plant immigration in more recent times must have taken place from the north either over the Alps or along their southern fringes. The low-lying areas have a Mediterranean type of vegetation and often form the boundary zones between eastern and western European types. The middle slopes carry types of vegetation ranging from Mediterranean to central European strongly influenced by Alpine conditions. Only in the south are there similarities to the true Mediterranean high mountain flora.

The Apennines are naturally wooded but the middle and lower slopes have for the most part been cleared of forests. Up to 1,000 ft. and, in favourable situations where the slopes are dry and sunny and there is chalk in the soil, even higher up, the dominant types of tree are the holm oak (*Quercus ilex*) and Mediterranean pine. Where deforestation took place the trees were often replaced by *maquis* and *garigue*. Olives, vines and vegetables are cultivated. Between 1,000 and 4,000 ft. there are deciduous oaks (*Quercus pubescens*, *Q. cerris*, *Q. petraea* and *Q. farnetto* in the south) and many other deciduous trees especially hop hornbeam (*Ostrya carpinifolia*), manna ash (*Fraxinus ornus*) and sweet chestnut (*Castanea sativa*). The sweet chestnut is cultivated over extensive areas. The dominant plant cover of the uninhabited subalpine zone (4,000–7,000 ft.) is beech with woods of beech and silver fir in the damper parts. Wide areas are covered with brushwood and pastures. Between the last two zones coniferous woods of black pine (*Pinus nigra*) occur especially in the southern part of the peninsula. At the highest level, such as the peaks of the Abruzzi and other peaks to the north and south, there is treeless alpine pasture. (We. L.)

Animal Life.—The mammals are similar to those in other mountainous areas of Europe. They include red deer, red fox, wildcat, otters in the rivers and mountain hares. There are also wild pigs and wolves except in the north. The brown bear is found in the Abruzzi National park, chamois in the central Apennines and the common porcupine in the south. Birds of prey include the golden eagle and, only in the south, Bonnelli's eagle. (Ma. Bu.)

APEX, SOLAR, the point of the heavens toward which the sun's motion relative to the mean of the stars is directed. Its position was indicated approximately by Sir William Herschel in 1783.

It is near right ascension 18^h, declination $+30°$, not far from Vega, but the position varies considerably according to the class of stars that has been chosen for reference. The speed of the sun's motion is approximately 12.4 mi. (20 km.) per second.

APHANITE, a name given to certain igneous rocks which are so fine-grained that their component minerals are not detected by the unaided eye. Although a few authorities still recognize the aphanites as a distinct class, most systematic petrologists have now discarded it and regard these rocks as merely fine-grained examples of other species.

Any compact, crystalline and fine-grained rock is frequently said to be aphanitic.

APHASIA: *see* Speech Disorders: *Aphasia* (*Dysphasia*).

APHELION, in astronomy, the point in the orbit of a planet or comet most distant from the sun. When the earth is at its aphelion in early July, it is about 3,000,000 mi. farther from the sun than when at its perihelion (*q.v.*) in early January. Corresponding terms for describing the most distant orbital point of bodies moving around centres of force other than the sun include apogee, apocenter and aposaturnium. The apogee of the earth's moon, for instance, is about 31,250 mi. more distant from the earth than its closest orbital point. *See* Moon: *Constants of Moon's Size and Motion.*

APHID, a plant louse, any of the minute insects belonging to the family Aphidae (formerly Aphididae) of the suborder Homoptera (order Hemiptera). They are among the most common insect pests of plants throughout the growing season, and there is hardly a species of plant, cultivated or wild, that escapes aphid infestation. Aphids (sometimes aphides) are soft-bodied insects measuring usually from one-sixteenth to not much more than one-eighth of an inch, although a few species may reach a quarter of an inch or slightly more. Because of their small size and coloration, resembling foliage, they are often difficult to detect and usually pass unnoticed. Many of them are beautifully coloured, ranging from white and creamy-gray through delicate shades of green, yellow and pink to deep red, various hues of brown and even jet black; they are variously marked and speckled with other colors and sometimes with white tufts or powdery wax. These tiny insects can do a tremendous amount of damage to heavily infested plants by constantly sucking up the plant sap needed for the vital functions and growth of plants. Instances are known in which beds of ornamental plants or large areas of field and truck crops were entirely ruined by aphids in a few weeks or even days.

FRAN HALL FROM NATIONAL AUDUBON SOCIETY

PLANT APHIDS (MACROSIPHUM AMBROSIAE) FEEDING ON STEM OF RAGWEED

Description.—Aphids are characterized by a pear-shaped body that is divided into a head, thorax and abdomen. Winged (alatae) and wingless (apterae) adults occur. The head in the winged forms is provided with three simple eyes (ocelli) and a pair of compound eyes. Aphids have two slender antennae, consisting of three to usually six segments. The last segment ends in a narrow process, the length of which, along with the number, shape, size and distribution of special sense organs (sensoria or rhinaria) over the antennal segments, is very useful in classification. The rostrum, or beak, is usually four-jointed, ensheathing four hairlike mouth parts that are capable of piercing plant tissue and penetrating intercellularly the food conducting channels (phloem) of vascular plants. The beak itself does not penetrate the plant tissue. In feeding, aphids inject a poisonous saliva into the plants, thereby producing various types of discoloration and malformations. Certain species (*Pemphigus* and *Eriosoma*) are notorious for a specific gall formation on poplars, elms and other plants. Several species act as vectors of different virus diseases of plants; moreover, all species provide avenues for bacterial infection via their feeding punctures.

The thorax consists of three segments. The winged aphids are provided with two pairs of delicate transparent wings, the hind ones much reduced, attached to the thorax. The wings are usually held in a gable rooflike position when the insect is at rest; however, some species keep them flat over the body. The thorax also has three pairs of jointed legs; each leg has a two-jointed end process (tarsus) fitted with paired claws. In the egg-laying (oviparous) females the long hind leg segment farthest from the body (the tibia) is usually swollen and studded with circular sensory porelike organs.

The abdomen is clearly eight-segmented (a ninth rudimentary segment is often concealed) and terminates in a tail-like cauda and an anal plate of significance in taxonomy. Each of the first seven abdominal segments has a pair of breathing pores (spiracles), one on either side. The abdomen may have dorsal and lateral tubercles of various shapes and sizes. The sixth abdominal segment, on its dorso-lateral margins, usually has a pair of special tubelike organs, possessed by no other insects; these organs, known as cornicles or siphunculi, emit gasses or sometimes a waxlike material. The cornicles were formerly often called honey-tubes because it was believed that the sticky, sweetish fluid known as honeydew of aphids was secreted through these tubes. Actually honeydew is a by-product of digestion, containing modified plant sap and sugars in excess of the aphid's needs, that is eliminated through the anus.

Natural History.—Aphid honeydew is fed upon by bees, wasps and flies and is eagerly sought by several species of ants. Certain ants care for flocks of aphids for the sake of this sweet fluid and will protect the aphids against predators and parasites. Some species of ants may build covering shelters from bits of plant material to safeguard the aphid colonies from rain and enemies, may transfer aphids from wilted plants to healthy ones to perpetuate colonies, and may chew off the wings of aphids to keep them from flying away.

Some species of aphid, for example, the corn-root aphid (*Anuraphis maidi-radicis*), are actually overwintered in ant nests; the cornfield ants (*Lasius americanus*) store eggs of the corn-root aphid and care for them throughout the winter. In the spring the young aphids hatch and are carried by the ants to the roots of weeds, where the aphids feed; later in the season, when corn is planted, the ants transfer their charges to the roots of corn. There are other interesting relations between aphids and ants, and the very existence of some species of aphids with incomplete life cycles, as in *Paracletus*, depends on protection by ants.

Ant-aphid relationships are set up only with aphids secreting the honeydew; those producing only a waxy secretion are ignored by ants.

In their biology, life cycles, method of reproduction, polymorphism (variation in form among members of a species) and instinctive heteroecy (migration to alternate hosts) aphids have no equals in the insect world. The life span of an aphid is rather short, two to four weeks, but amazingly complex in the seasonal life cycle of certain species. Aphids are known for a remarkable cyclic reproduction known as heterogamy, characterized by an alternation of several parthenogenetic generations, produced without mating during the growing season, with true sexual generation in the fall.

Life Cycle.—The life cycle typically begins with the fertilized eggs. They are laid singly or in small clusters late in fall about the bases of dormant buds and in crotches and crevices of plants, on primary hosts or egg-overwintering plants on which life history begins in the spring. The minute eggs (less than $\frac{1}{25}$ in. in length) are yellowish or greenish when freshly laid but soon become black.

Early in spring young aphids hatch from overwintered eggs, feed, grow by molting four times and reach maturity on the primary host in two or three weeks, depending on temperature. These forms, known as stem-mothers, are considered to be the first generation (fundatrix). Usually they are wingless, but stem-mothers of certain species of the subfamily Panaphinae are winged. The stem-mothers and the following generations reproduce parthenogenetically and ovoviviparously (eggs hatch in the parent's body and young are born live) until fall. Each female may give birth to three to seven living young nymphs daily for three or more weeks. Twelve to 20 generations may occur through the plant growing season, thus giving rise to enormous populations. The progeny feed either singly, in scattered groups or in dense colonies on stems, foliage or roots, depending on the species.

The second generation may be of winged or wingless forms. The winged forms of nonmigratory species in this and successive generations may disperse to plants of the same or related species for further propagation. In the case of the migratory species spring migrants (exules) are produced; these forms undertake with precise regularity a migration from the original primary host to oftentimes botanically strikingly different alternate or secondary hosts, usually annual plants or herbaceous perennials. (It is of interest to note that the primary hosts are perennial and evolutionarily older plants.) There may be from a few to usually ten or more wingless generations on secondary hosts.

In late summer or early fall, with the advent of cooler temperatures and shorter days, a special generation of winged individuals is produced on the secondary host. These aphids, known as fall migrants, disperse in search of primary hosts, where they may establish colonies. The progeny of the fall migrants may be wingless sexual oviparous females; these wingless females are joined by winged males that are produced on the secondary host. After mating, the sexual females lay their fertilized eggs, thus starting a new cycle. The foregoing account is the typical life cycle for the green peach aphid, *Myzus persicae* and for the potato aphid (*Macrosiphum solanifolii*). In other cases the fall migrants on primary hosts give birth to a wingless generation of parthenogenetic females known as sexuparae, as in the foxglove aphid (*Myzus solani*). These sexuparae in turn produce sexual males and females for further continuation of the life cycle.

The oviparous females in the majority of cases are wingless, though in some species (*e.g., Tamalia*) winged oviparous females are known. Most of the oviparous species lay several eggs, but in the subfamily Eriosomatinae only a single egg is laid by a beakless, nonfeeding female.

Males are small and may be winged or wingless. In some instances both kinds of males may occur in the same species, as in *Cepegillettea betulifoliae* and others.

A few species have anolocyclic reproduction in which the sexual part of the cycle is absent. Definite sexes may be lacking in their life history presumably because of some geoclimatic changes that occurred in the history of the earth and perhaps destroyed the primary hosts of these species. Also, when aphid species are newly introduced into a country not having the species of plant necessary for sexual reproduction of the particular aphids, an anolocyclic reproduction may develop. Such a case is that of the woolly apple aphid (*Eriosoma lanigerum*); this North American species after introduction into Europe began propagating only parthenogenetically on apples in the absence of its original primary host, the American elm.

Instinctive migration with the heteroeceous habit of feeding is distinctly advantageous to aphids in utilizing the more suitable plant sap of herbaceous plants during the summer, at a time when feeding conditions on primary hosts become unfavourable. Migration also provides a means of escape from predators and parasites. Continuous parthenogenetic reproduction without sexual forms is common in the tropics and is known to occur without interruption for several years in greenhouses, where uniform environmental conditions favour such reproduction.

Classification and Distribution.—The family Aphidae, divided into several subfamilies, belongs to the superfamily Aphidoidea, which also includes the family Phylloxeridae (*see* PHYLLOXERA). The Aphidae is represented by about 1,750 known species, and new ones are added to this number annually.

The relative abundance and diversity of aphids in the temperate zone of the northern hemisphere and the absence or very poor representation of native species in tropics and in the southern hemisphere indicate that aphids probably originated in the northern zoogeographic zones, the Nearctic and Palaearctic. North America, Europe and eastern Asia are rich in aphid fauna.

Phylogenetic (race history) studies suggest that the most ancient aphids inhabited evergreen trees, feeding on bark, young shoots and needles. Later they established themselves on broadleaf plants—mainly willows, poplars, birches, oaks, hickories and others—and eventually adapted themselves to perennials and annuals, infesting stems, leaves and roots. During this evolution aphids developed their marvelous adaptations, habits and complicated life cycle.

The past and present distribution of aphids is mainly governed by the parallel evolutionary development of plants and aphids, the presence or absence of suitable hosts and the complexity of ecological conditions, especially temperature and humidity, to which most of the aphid species are very sensitive. The majority of aphids depend on plants that grow in a moderate climate; a considerable fauna of specialized aphids, however, does exist in arid plant communities.

Economic Importance.—Aphids usually do not kill their host plants, but they frequently do reduce plant vigour, distort leaves and cause other malformations. These insects, in many stages of development, can often be found clustered in large numbers on new plant growth, on buds and on the undersides of leaves.

Damage wrought to crop plants by aphids is considerable: annual losses charged to the pea aphid (*Macrosiphum pisi*) run to about $4,000,000, and to the potato aphid (*M. solanifolii*) about $66,500,000. Heavy infestations often occur on many ornamental plants, among them roses, asters and many flowering bulbs.

Among other common economic species of aphids are: corn-leaf aphid (*Rhopalosiphum maidis*), spotted alfalfa aphid (*Therioaphis maculata*), green peach aphid (*Myzus persicae*), apple aphid (*Aphis pomi*), melon aphid (*Aphis gossypii*), woolly apple aphid (*Eriosoma lanigerum*), cabbage aphid (*Brevicorine brassicae*) and green bug (*Toxoptera graminum*).

Control.—Among the most efficient natural controls of aphids are the insect-eating species of ladybird beetles (Coccinellidae) that in their larval and adult stages may completely destroy large aphid colonies. Next in importance are the larvae (aphid lions) and adults of green lacewings (Chrysopidae), brown lacewings (Hemerobiidae) and the larvae of flower flies (Syrphidae). Parasites of aphids are found among small wasps of the families Braconidae, Chalcidae and Ichneumonidae. A fungus, *Entomophthora aphidis*, at the right combination of temperature and humidity may wipe out enormous populations of the pea aphid and other species in two or three days' time.

Aphids can also be controlled by chemical methods; insecticides such as Malathion, Rotenone, DDT and others, either as dusts or sprays, are effective. In many countries more detailed information on control may be obtained from governmental departments of agriculture and from local experimental stations.

See also Index references under "Aphid" in the Index volume.

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(A. A. G.)

APHONIA, or loss of voice, not due to a brain lesion, is a symptom of disease of the larynx or interference with the mechanism which controls its muscles. Of causes in the larynx itself, the commonest is acute catarrhal laryngitis, in the course of a cold, or after overuse of the voice. More serious diseases of the larynx are diphtheria, tuberculosis, syphilis, and cancer, each of which may produce hoarseness or loss of voice when it attacks the vocal cords. Causes outside the larynx are masses pressing on the laryngeal nerves, such as tumours of the thyroid gland and aneurysms of the aorta, and brain disorders giving rise to spasm or paralysis of the laryngeal muscles. Aphonia may be a manifestation of hysteria. *See* also LARYNGITIS; THROAT, DISEASES OF.

APHORISM, a principle expressed tersely in a few telling words or any general truth conveyed in a short and pithy sentence, in such a way that when once heard it is unlikely to pass from the memory. The name was first used in the *Aphorisms* of Hippocrates, a long series of propositions concerning the symptoms and diagnosis of disease and the art of healing and medicine. The term came to be applied later to other sententious statements of physical science, and later still to statements of all kinds of principles.

Aphorisms have been especially used in dealing with subjects to which no methodical or scientific treatment was applied till late, such as art, agriculture, medicine, jurisprudence and politics. The *Aphorisms* of Hippocrates form far the most celebrated as well as the earliest collection of the kind. The first aphorism, perhaps the best known of all, which serves as a kind of introduction to the book, runs as follows: "Life is short, art is long, opportunity fugitive, experimenting dangerous, reasoning difficult: it is necessary not only to do oneself what is right, but also to be seconded by the patient, by those who attend him, by external circumstances."

Another famous collection of aphorisms is that of the school of Salerno in Latin verse, in which Joannes de Meditano, one of the most celebrated doctors of the school of medicine of Salerno, summed up the precepts of this school. The book was dedicated to a king of England. It is a disputed point as to which king, some authorities dating the publication at 1066, others assigning a later date. Another collection of aphorisms, also medical and also in Latin, is that of the Dutchman Hermann Boerhaave, published at Leyden in the year 1709; it gives a terse summary of the medical knowledge prevailing at the time and is of great interest to the student of the history of medicine.

APHRAATES (Syriac AFRAHAT; Persian FARHAD) (fl. in the 2nd quarter of the 4th century), commonly known as the Persian Sage, was a Syriac homilist and one of the earliest fathers of the Syriac church. The few certain facts about his life are gleaned from his Homilies. A convert from paganism, he became a monk, probably also a bishop, for he speaks of the laying on of his hands, and he had a seat at the council of Seleucia and Ctesiphon (344), where he drew up the encyclical letter (Homily 14). A marginal note in a 14th-century manuscript in the British museum, London, calls him bishop or head of the convent of Mar Matthew near Mosul. Probably at some ecclesiastical advancement, he seems to have adopted the name Jacob, which as early as 496 led Gennadius of Marseilles to attribute the Homilies to Jacob of Nisibis (d. 338), and explains the attribution to the latter of the Armenian version published by Antonelli (1756). Aphraates lived during the persecutions of Shapur II (*q.v.*), which are alluded to in the Homilies. There are 23 Homilies, each beginning with a successive letter of the Syriac alphabet. Ten were produced in 337, 12 in 344, and as appendix a Homily, beginning with the first Syriac letter, was added in 345. They are treatises on the Faith, an ordered exposition furnished to an enquirer, orthodox as later Jacobites and Nestorians attested, but free from Greek theological influence. "To him Christianity was the revelation of a Divine Spirit dwelling in man and fighting against moral evil, not first and foremost a tissue of philosophical speculation about the nature of the Divinity in itself." (F. C. Burkitt, *Early Eastern Christianity*, John Murray Publishers Ltd [1904].) Several Homilies are directed against the Jews and show knowledge of Jewish exegesis. His works are important for the light they throw on 4th-century Christianity in Persia; even their obscurities may reflect the need for caution amid persecution. His practice of full biblical quotation affords valuable evidence for the form of text used then. Burkitt held that Aphraates quoted from the *Diatessaron*, but A. Vööbus, *Studies in the History of the Gospel Text in Syriac* (1951) indicates that it was from a *tetraevangelion* (four Gospels) of the Old Syriac type.

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(W. D. McH.)

APHRODISIAC, any of various forms of stimulation used chiefly to arouse sexual excitement. Aphrodisiacs may be classified in two principal groups: (1) psychophysiological (visual, tactile, olfactory, aural); and (2) internal (foods, alcoholic drinks, drugs, love potions, medical preparations).

By far the more important is the second group, as the preparation of erotic dishes has played a tremendous role in the sexual history of man. In spite of their vast popularity, almost no scientific studies have been written about them; most writings on the subject are little more than unscientific compilations of traditional material. Of the various foods to which aphrodisiac powers are traditionally attributed, fish, vegetables and spices have been the most popular throughout history. None of these foods, however, contains any chemical agents that could effect a direct physiological reaction upon the genitourinary tract, and it must be concluded that the reputation of various supposedly erotic foods is based not upon fact but upon folklore.

Since food cannot produce sexual desire biochemically, the question at once arises of how it has happened that man has, for centuries, in all parts of the world, attributed such powers to foods. It should be remembered that a large number of the plants, vegetables, spices, etc., that are supposed to be aphrodisiacs acquired their reputation many centuries ago, when there was no scientific information available. In those early times the guiding principle that determined the attributes of plants and other foods was the doctrine of signatures. This refers to an ancient belief in the therapeutic efficacy of resemblances. Thus if a plant resembled the genitalia, it possessed, so it was reasoned, sexual characteristics

and powers. The best example of this visual identification is the name of vanilla, which originally meant vagina (from the Spanish *vainila*, the diminutive form of *vaina*, "pod," "sheath," "vagina," from the Latin *vagina*, "sheath," "vagina").

One of the subtlest aspects of the question of foods as aphrodisiacs, which has been practically ignored by all writers on the subject except the German nutritionist H. Balzli, is the psychophysiological reaction that a well-prepared meal of subtly seasoned foods can have upon the human organism. The combination of various sensuous reactions—the visual satisfaction of the sight of appetizing food, the olfactory stimulation of their pleasing smells and the tactile gratification afforded the oral mechanism by rich, savoury dishes—tend to bring on a state of general euphoria conducive to sexual expression. In this connection might be cited the famous French *cabinets particuliers*—luxurious private dining room-boudoir suites featured by many Parisian restaurants of the 19th century.

With the exception of alcoholic drinks and certain narcotics such as marijuana, which may lead to sexual excitation through depression of inhibitory centres, modern medical science recognizes a very limited number of aphrodisiacs. These are, principally, cantharides and yohimbine. Yohimbine is a crystalline alkaloid substance derived from the bark of the yohimbé tree (*Corynanthe yohimbe*) found in central Africa, where it has been used for centuries by Africans to increase sexual powers. Although it has been promoted as an aphrodisiac, most investigators feel that any clinical change in sexual powers after its use is probably due to suggestion, since stimulatory effects are elicited only with toxic doses.

BIBLIOGRAPHY.—By far the most authoritative survey is M. Hirschfeld and R. Linsert, *Liebesmittel* (1930), a unique discussion of the question from a modern medical viewpoint. Informative studies, not treating the subject from the all-important physiological viewpoint, are: H. S. Denninger, "A History of Substances Known as Aphrodisiacs," *Annals of Medical History*, vol. ii, pp. 383–393 (1930); A. Costler and R. Willy, *Encyclopaedia of Sexual Knowledge*, ed. by Norman Haire, pp. 355–386 (1936); H. Ellis, *Studies in the Psychology of Sex*, vol. iii (1936); G. R. Scott, *Encyclopedia of Sex*, pp. 22–23 (1939); A. F. Niemoeller, *Aphrodisiacs and Anti-Aphrodisiacs* (1945). Important studies for various regions are: R. Schmidt, *Beiträge zur indischen Erotik*, pp. 833–855 (1902); E. Malone, *The Plays of William Shakespeare*, vol. viii, T. Hopfner, *Das Sexualleben der Griechen und Römer* (1938); H. Licht, *Sexual Life in Ancient Greece* (1934); B. Stern, *Medizin, Aberglaube und Geschlechtsleben in der Türkei*, vol. 2 (1903). *See* also H. Balzli, *Gastrosophie: Ein Brevier für Gaumen und Geist* (1931), an extraordinarily sensitive evaluation of the subtle yet profound relationship between food and sex; and C. F. Heartmann, *Cuisine de l'amour* (1942). (D. Md.; F. O. K.)

APHRODITE, best known as the Greek goddess of sexual love and beauty, identified by the Romans with Venus (*q.v.*). The familiar picture of the goddess who "overcomes all mortal men and immortal gods with desire" occurs first in book 14 of the *Iliad* and provides the archetype for most later Greek poetry. To her sphere of influence Hesiod assigns "girlish dalliance, smiles, deceits; sweet pleasure, love, and gentleness" (*Theogony*, 205–206). The Homeric Hymn to Aphrodite extends her power to all living things save three virgin goddesses. Among the early lyric poets she came to stand for a cultural ideal, the life devoted to youthful beauty and love: Sappho, ardent and sensitive, honours her above all others, while Mimnermus asks, "What is life without golden Aphrodite?" From the very first her own person was the paradigm of female beauty; Achilles in book 9 of the *Iliad* says that he would not marry Agamemnon's daughter, "even if she rivaled golden Aphrodite in beauty." The statue of Aphrodite at Cnidos, considered by Pliny the Elder the finest statue ever made, is Praxiteles' attempt to capture this vision in marble. The Venus de Milo continues the tradition; in fact, most of Aphrodite's sculptural types are devoted to one or another aspect, lofty or sensual, of her beauty. As goddess of beauty Aphrodite was associated with the Charites (usually translated Graces); in the eighth book of the *Odyssey* they bathe, dress and anoint her. Hesiod and later epic poets connected Aphrodite with the Horae (Seasons), suggesting her power over natural as well as human beauty.

Homer and Hesiod, according to Herodotus, fixed for the Greeks the nature and duties of their gods; they must have exerted considerable influence over the mind of the average worshiper. In very few cult shrines, however, is there found evidence that Aphrodite was primarily the love goddess in the Homeric sense. This suggests that some of her cults may reflect conceptions that antedate Homer—that Homer made her the love goddess. Certain forms she took have nothing to do with love: she is sometimes the protectress of sailors, sometimes armed, occasionally bearded. Of most of her local cults little is known directly, but what evidence there is indicates that her sphere was the act of love rather than the passion. We should expect the function of such a goddess to be the promotion of human, perhaps vegetative, fertility, and we are not entirely disappointed. In Hymettus, near a temple of Aphrodite, there was a spring where women drank who wished to conceive or who wanted an easy childbirth. In Hermione, women sacrificed to her before marriage, perhaps for satisfactory sexual relations but more reasonably for their own fecundity. Spartan mothers upon the betrothal of their daughters sacrificed to Aphrodite Hera—a fusion of Aphrodite with the marriage goddess—doubtless for similar reasons. In Attica, Aphrodite was associated with the Moirai (Fates) and the Genetyllides, goddesses who presided over birth. Phallic symbols, appropriate to fertility worship, have been found dedicated to her. In Corinth, Cyprus and Eryx in Sicily, she was worshiped by religious prostitution: either all women gave themselves once to a stranger before marriage, or certain women devoted themselves continually to her service. Aphrodite's religious prostitutes were probably intended to promote fertility, as they were in other ancient cults; in Eryx the goddess probably presided over vegetative growth.

Clearly the gulf between sexual desire and human fertility is not vast, and it may be supposed that worshipers at Aphrodite's shrines in later days felt little conflict between Homer's conception and their own. But to early poets, probably voicing courtly opinion, the cult seems to have had a somewhat different appearance. In mythology Aphrodite is often found associated not with human love in general but with its darker side: rape (in the myths of Paris and Helen, of Theseus and Ariadne), adultery (in Aphrodite's own affair with Ares while married to Hephaestus) and incest (in the myths of Hippolytus and Phaedra, of Cinyras and Myrrha); the list could be considerably extended. Only one mortal couple in Homer knows Aphrodite's favour, Paris and Helen; she has no influence over Achilles and Briseis, Hector and Andromache or Odysseus and Penelope. In most of the *Iliad* she is the goddess of seduction and rape. It may be reasonably supposed that Homer inherited, along with the obviously pre-Homeric myth of Helen's rape, this concept of Aphrodite, and that in book 14, modifying tradition, he made her the goddess of love. Even here she aids in Hera's deceit and seduction of Zeus, but her sphere of influence is extended and the nature of that influence treated far less harshly than elsewhere. In one line of book 5 Homer even associates her with marriage. The pre-Homeric goddess of rape, toward whom we sense much antagonism in the *Iliad*, may well represent the Greek nobility's estimate of the cult goddess of sexual intercourse. Ritual prostitution, for instance, is not likely to have aroused much enthusiasm among those who professed heroic values.

It is not from Greek cult and myth alone that scholars have sought clues as to the early nature of Aphrodite. Most are inclined to think that her worship came from the east after the Greeks had made their home on the peninsula to which they later gave their name. The cult of Aphrodite in the Cyprian town of Paphos was of considerable prominence in pre-Homeric times, since the *Odyssey* speaks of Paphos as if it were her native city. In Hesiod's *Theogony*, though literally born from the sea, she comes to land first on Cyprus. She was called Cypris (Lady of Cyprus) and Cyprogeneia (Cyprus-born) very early. The Greeks probably first met her there during their penetration of the eastern Mediterranean in the latter half of the 2nd millennium B.C. As her worship was carried westward she may have absorbed features of deities already established. This seems certainly to have occurred on Mt. Ida in the Troad (the northwest corner of Asia Minor, flanking the Hellespont), for the goddess there bears many resemblances to the Great Mother of Asia Minor, best known under the name Cybele.

If we attempt to venture beyond the Cyprian cult in the search

for origins the path becomes much darker. It was formerly felt that Aphrodite was only another form of a mother goddess common to the Semitic near east generally but worshiped under varying names in different places: Ishtar in Mesopotamia, Astarte and Asherah (Ashtoreth) in Syria, and so forth. The Phoenicians were said to have brought this goddess to Cyprus, Cythera (where there was an ancient cult of Aphrodite) and Corinth. This theory cannot be right, though it must not be rejected entirely. Aphrodite's presence on Cyprus almost certainly antedates the Phoenician colonization, and many features of her cult there may have received Anatolian rather than Semitic influence. Her Paphian worship was carried on by Cinyradae, whose ancestor Cinyras was said to have founded the cult there. Later myths make Cinyras a Syrian and father of Adonis, a Syrian vegetation god; these myths have been used as evidence for Aphrodite's Syrian origin. But the only reliable tradition assigns Cinyras' provenience to Cilicia in southern Anatolia. Adonis and Aphrodite were indeed often associated, but Adonis may be a late Phoenician replacement for earlier native Cyprian deities; the evidence is slight, moreover, for Adonis' worship at Paphos. The Paphians themselves were said by Herodotus to have derived their temple type from Ascalon in Phoenicia. The type was known in the Minoan-Mycenaean culture, long before the Phoenicians were active; but the Mycenaeans may well have derived this type from Syria. The fact that Aphrodite's "statue" at Paphos was a stone in the shape of a pointless cone has been adduced to show Semitic influence, but actually the aniconic representation, rare among the Greeks, who of course preferred anthropomorphic forms, was common all over the pre-Greek Aegean.

Certain of Aphrodite's features must be considered Semitic. Her unusual epithet Urania (heavenly, daughter of Uranus) points to the Semitic goddess of the heavens, actually called Urania by Herodotus. The maritime Aphrodite, protectress of sailors, may derive this function from the Syrian Asherah, called Asherah "of the sea." Some scholars derive Aphrodite's name from Asherah, the Greeks assimilating the foreign word to a Greek root *aphro-* ("foam") and later calling her the foam-born goddess. Aphrodite's familiar symbol, the dove, seems near eastern in origin.

In the town of Amathus, near Paphos, a bisexual form of Aphrodite was worshiped. A terra-cotta figurine dating from the early 7th century and showing the bearded goddess rising from what seem to be testicles was found near Corinth. Hesiod tells a myth clearly related to this figurine. Cronus, having castrated his father Uranus, cast the genitals into the sea, and from the foam that flowed from and surrounded them Aphrodite was born. When she first stepped ashore on Cyprus grass sprang up under her feet, suggesting that she possessed power over the life of vegetation. Though Hesiod's concept of Aphrodite's character is Homeric, his myth is not; in Homer Zeus and Dione, rather than Uranus and the sea, are Aphrodite's parents. Hesiod's birth story appears invented for the fertility goddess. There are many indications that the Amathusian bisexual deity represented by the terra-cotta figurine was a vegetation deity: it is the role played by most other ancient eastern bisexual divinities; the vegetation god Adonis was worshiped at Amathus; an inscription refers to sacrifices to Aphrodite to secure the fertility of the crops. There was a grove of Aphrodite Ariadne there, Ariadne (*q.v.*) being originally an Aegean vegetation goddess; the cults appear to have fused at an early date, before Ariadne became a mere mortal. In honour of Aphrodite Ariadne, a young man dressed in women's clothes and imitated the cries of a woman in childbirth; though the exact significance of this rite is unknown, it surely points to a fertility cult. Aphrodite's tomb was shown at Amathus, and a dying deity is almost always a vegetation god.

The time of Aphrodite's movement westward is uncertain. Her name has not yet been read on the Mycenaean tablets. A naked dove-goddess found on ornaments at Mycenae has been called Aphrodite, and her nudity points to eastern influence, but it is not known whether or not the ornaments had cult significance.

Aphrodite probably preserved her function as a fertility goddess when she came to Mt. Ida in the Troad, for such was the Great Mother whose worship she there absorbed. The Homeric Hymn, with its rich sensuousness, its vision of the goddess' great splendour, and especially the train of wild animals accompanying her, draws heavily upon Aphrodite's predecessor. A much-disputed point is whether Aphrodite preserved her function as a vegetation goddess when she came to the Greek mainland. Her bearded form and ritual prostitutes occur at or near Corinth, where also there was a cult of Aphrodite the Dark, an earth goddess who was probably associated with vegetation. But these may be ritual survivals from the eastern cult; her domain may be no more than human fertility. Simonides praised certain Corinthian women, probably Pindar's "hospitable young ladies," the ritual prostitutes, for their efforts during the Persian invasion. Aphrodite seems thus to have had a wide range of duties there, and in fact her statue on Acrocorinth showed the goddess armed. This attribute is recorded for the early cult on Cythera, and may be an oriental feature; the fact that Aphrodite was called Urania at Corinth also points eastward. Aphrodite was worshiped together with Eros (the Roman Cupid) on the north slope of the Athenian acropolis, with the designation, quite inappropriate to the spot, of "in the gardens." This title and the presence of phallic symbols have suggested that Aphrodite here retained her vegetative character. Eros seems to be the god of divine procreation in the *Theogony*, but his Hesiodic associations are not with vegetation, and in Athens above all we must be conscious of poetic influence. The title "in the gardens" may merely stress Aphrodite's sway over natural beauty; the phallic symbols may indicate human fertility. This is apparently the significance of the myth that Aegeus founded the Athenian cult of Aphrodite Urania in the belief that she was responsible for his childlessness. The Athenians also had a temple of Aphrodite Pandemos ("of all the people"), whose temple was purified by the sacrifice of a dove. The dove attribute is probably eastern, but we may well wonder whether anything more than the symbol has here migrated to Greece.

The imagination discernible in the Cyprian cult apparently failed to persist in Aphrodite's cults in Greece, which are generally uninteresting. But poetry and art were not bound to the ritual tradition; Plato could use the terms Pandemos and Urania to distinguish between common and heavenly love in utter despite of their cult significance. Aphrodite was very seldom a cult goddess of beauty; Greek poets and sculptors made her the ideal feminine type. Eastern features, though modified, do not always disappear: the bisexual fertility deity becomes Hesiod's foam-born goddess, then the artistic type of Aphrodite Anadyomene ("rising from the waves"), while traces of the vegetation goddess may persist in such symbols as the apple in the hand of the Venus Genetrix (Mother) in the Louvre. To Euripides, Aphrodite represented human passion, overwhelming in intensity and potential destructiveness, yet was also "she who from the streams of Cephissus breathes fragrant breezes over Attica," who sends "the loves that are seated by the throne of wisdom, fellow workers in all virtue" (*Medea*). Aeschylus calls her part-cause of the love between heaven and earth, the universal power of procreation, and such she remains in the poem of Lucretius, "sole ruler of all the world," without whom "no thing can win to the shores of light, to joy and love."

See articles on the related figures ASTARTE; ATARGATIS; GREAT MOTHER OF THE GODS; ISHTAR; VENUS; *see* also references under "Aphrodite" in the Index.

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APHTHOUS FEVER: *see* FOOT-AND-MOUTH DISEASE.

APHTHOUS STOMATITIS: *see* THRUSH (disease).

APICULTURE: *see* BEEKEEPING.

APION (fl. 1st century A.D.), Greek grammarian and commentator on Homer, who was born at Oasis in Libya, is the original source for the story of Androcles and the lion. This was taken by Aulus Gellius from his *Aiguptiaka*. He was head of the school at Alexandria and led a deputation sent to Caligula (in A.D. 38) by Alexandrians to complain of the Jews. References to this deputation are to be found in the *Legatio ad Gaium* of Philo who led a Jewish deputation to Rome in A.D. 39–40. The charges he

brought in his books against the Jews were answered by Josephus in his *Contra Apionem.* Later he settled at Rome and taught rhetoric.

For fragments of his *Glossai Homerikai, see* F. G. Sturz (ed.), *Etymologicum Gudianum* (1818).

APIS, the classical Greek form of *Hape* or *Hapi,* the sacred Egyptian bull deity worshiped at Memphis. His cult was of early origin: the festival of the "running forth of Apis" was celebrated in the Archaic period, probably by the time of the first kings. Like other bull deities in Egypt, Apis must at first have been a fertility god, concerned with the propagation of flocks and herds, but he became associated with Ptah (*q.v.*), the paramount deity of the Memphite locality, and also with Osiris (*q.v.*) and Sokaris, gods of the dead and of the underworld. As "the living soul of Osiris" he was frequently known as User-Hapi (Osiris-Apis). As Apis-Atum he was associated with the solar cult and is often shown on monuments and in figurines with the sun-disk between his horns.

Much of what is known about Apis comes from Greco-Roman writers. He was black and white and distinguished by special markings. Some said that he was begotten by a ray of light from heaven, others that he was sired by an Apis bull. When a sacred bull died, the calf which was to be his successor was sought and installed in the Apieion at Memphis with great rejoicing, in a stable near the temple of Ptah; his mother was housed nearby. In the court adjoining he was daily let out to exercise, and here he could be glimpsed by visitors. His priests drew omens from his behaviour, and his oracle had a wide reputation. The cult of the Apis bull was particularly favoured by the Saite kings.

When an Apis bull died, it was buried with great pomp in the necropolis at Saqqarah, in underground galleries known in the classical world as the Serapeum. In chambers opening off a central corridor, the mummified bulls were laid in huge sarcophagi of limestone or granite of many tons' weight.

It was probably at the Memphite Serapeum, to which pilgrims flocked, that the worship of Sarapis (*q.v.*) arose in late times. Transplanted to Alexandria by Ptolemy I Soter, it spread among the Greeks and Romans to become one of the most universally popular oriental cults; but the bearded, Zeuslike figure of Sarapis the Healer had more in common with the syncretistic deities of the Hellenistic world than with the ancient bull gods of Egypt.

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APOCALYPSE OF ST. JOHN THE APOSTLE: *see* REVELATION, BOOK OF.

APOCALYPTIC LITERATURE. The word "apocalypse" is Greek in origin and means "unveiling" or "uncovering." It was first used to describe a vision (*cf.* Dan. viii, 1) and was then applied to books relating it. The type of literature called apocalyptic professes a secret knowledge of future events, in particular of the time and manner of the End, and is able to disclose these secrets by superhuman means. The Jewish apocalyptic literature is of considerable significance both for Judaism and for Christianity. It gives interesting insights into that section of Judaism that lay outside the rabbinical schools and it also casts light on a number of important developments in religious beliefs that took place during the intertestamental period and that are reflected in the New Testament Scriptures. Apocalyptic is exemplified in the Bible by the Book of Daniel (*q.v.*) and also by the Book of Revelation (*q.v.*) (Gr. *Apokalypsis*), which, though Christian, reflects the pattern of Jewish apocalyptic writings.

NATURE AND FORM OF APOCALYPTIC

There is no agreed list of Jewish apocalyptic books, but those generally accepted as belonging to the group, or as having apocalyptic elements in them, are as follows:

1. The biblical Book of Daniel; 165 B.C.
2. I Enoch, 1–36, 37–71, 72–82, 83–90, 91–108; *c.* 164–80 B.C. (*see* ENOCH, BOOKS OF).
3. The Book of Jubilees; *c.* 150 B.C. (*see* JUBILEES, BOOK OF).
4. The Sibylline Oracles, book iii; from *c.* 150 B.C. onward (*see* SIBYLLINE ORACLES).
5. The Testaments of the Twelve Patriarchs; second half of the 2nd century B.C. but with extensive Christian redaction (*see* TWELVE PATRIARCHS, TESTAMENTS OF THE).
6. The Psalms of Solomon; *c.* 50 B.C. (*see* SOLOMON, PSALMS OF).
7. The Assumption of Moses; 4 B.C. (or perhaps A.D. 7)–A.D. 30 (*see* MOSES, ASSUMPTION OF).
8. The Martyrdom of Isaiah; A.D. 1–50 (*see* ISAIAH, ASCENSION OF).
9. II Enoch (the Book of the Secrets of Enoch); 1st century A.D. (*see* ENOCH, BOOKS OF).
10. The Life of Adam and Eve (the Apocalypse of Moses); shortly before A.D. 70.
11. The Testament of Abraham; 1st century A.D.
12. The Apocalypse of Abraham, 9–32; *c.* A.D. 70–100.
13. The Sibylline Oracles, book iv; *c.* A.D. 80.
14. II Esdras, 3–14; *c.* A.D. 90 (*see* ESDRAS, SECOND BOOK OF).
15. II Baruch (the Syriac Apocalypse of Baruch); A.D. 100–130 (*see* BARUCH APOCALYPSES).
16. The Sibylline Oracles, book v; after A.D. 100.

Apart from II Enoch and the several Sibylline Oracles, which reflect a Hellenistic background, these books probably originated in Palestine.

There has been much controversy among scholars concerning the authorship of these books, which have been ascribed to each of the main Jewish sects in turn. It is very doubtful, however, whether they belonged exclusively to any one particular party. The Judaism of the period before A.D. 70 embraced many parties and sects, among which there was much interchange of ideas and beliefs. It seems likely that there were some in all these parties, and outside them, who shared in the apocalyptic tradition. The apocalyptists do not form a sect; they represent a certain mood or temper of religious belief.

Popular Literature.—Although only one of these writings, the Book of Daniel, gained canonical authority, many others must have acquired a measure of sanctity and were highly valued. It is uncertain to what extent they may have been used in the synagogues and schools, but the indications are that they enjoyed a considerable popularity particularly in certain circles within Judaism. The ideas contained in this literature would be more widespread than the books themselves and would have a strong appeal to the Jewish people as a whole. There are indications that as late as the 3rd century A.D., in some parts of the Diaspora at any rate, apocalyptic was still highly esteemed. In the synagogue at Doura-Europus (A.D. 245) on the Euphrates there appear, prominently displayed, the figures not only of Moses and Joshua but also of Enoch and Ezra, representing the apocalyptic tradition. It is of interest to note that many fragments of an apocalyptic character were found among the writings of the Qumran covenanters, with whom, it seems certain, this kind of literature was very popular. It may well be, indeed, that some of the apocalyptic books were actually written there. The Book of Jubilees, I Enoch and certain sources of the Testaments of the Twelve Patriarchs are represented among these discoveries (*see* DEAD SEA SCROLLS).

When, in course of time, the apocalyptic books fell out of favour in Palestine they had already been translated into Greek by the Jews of the Diaspora and enjoyed an even greater popularity there. The Christians in their turn took over this literature and popularized it still more by adapting it to their own use.

Background of Persecution.—The first and greatest of the apocalyptic writings, the Book of Daniel, was written in a time of national crisis when the Jews suffered grievous persecution under Antiochus IV Epiphanes (175–163 B.C.). Those that followed continued through the troubled times of the Hasmonaeans, the Herodians, the Roman procurators and the Zealot fanatics. Not only did they reflect the unrest of the time but their teaching did much to fan the flames of revolt, particularly in the war of A.D. 66–70 and the revolt of Bar-Cochba in A.D. 132–135. Their message has rightly been called "a gospel for bad times." It did much to

encourage the faithful to continue their struggle against evil powers and to hope for the miraculous intervention of God.

Character: Esoteric.—The apocalyptic writers believed that certain divine secrets had been revealed to them which they were to record in their "hidden" books and which would enable the righteous to discern the signs of the coming End. The secrets thus disclosed are recorded in "heavenly tablets" which contain an account of "all the deeds of mankind . . . to the remotest generations" (I Enoch lxxxi, 2) and foretell the evil which is to come upon the earth (cvi, 19).

Authorship: Pseudonymous.—The pattern of this disclosure is roughly the same in all the books. They record revelations of divine secrets made known by God to certain elect individuals, ranging from Adam to Ezra, who purport to be the authors of the books. Apocalyptic is thus almost invariably pseudonymous. These revelations generally consist of an account of world history culminating in the End. For generations they have been kept secret; this disclosure now makes clear that the End is at hand.

Form: Visionary.—The form taken by this divine disclosure is usually that of dreams, visions, trances, auditions or translations in which the seer is permitted to visit heaven or hell. There the divine mysteries—past, present and future—are revealed to him, often by an angelic attendant. This literary device is common in Greek literature, but probably the apocalyptists were influenced even more by the Old Testament idea of a heavenly council presided over by God and attended by angels and sometimes by men (*cf.* I Kings xxii, 19 ff.; Job i, 6 ff.; etc.).

Language: Symbolic.—Symbolism is the language of apocalyptic. Some is derived from the Old Testament, whose metaphors and figures are adapted to a new purpose; much, however, derives from ancient mythology and from foreign sources. The pattern of presentation is largely stereotyped. Animal figures of many kinds represent men and nations; angels symbolize men; stars indicate fallen angels. Numerology too plays its part, symbolic significance being given to certain numbers which feature also in the Old Testament and in Babylonian and Persian sources.

RELATION OF APOCALYPTIC TO PROPHECY

The transition from prophecy to apocalyptic is not marked by a sudden break, and Daniel does not represent an entirely new type of literature. Apocalyptic had its beginnings in the Old Testament in such passages as Ezek. xxxviii–xxxix, Zech. xii–xiv, Joel and Isa. xxiv–xxvii. In these writings the ground was prepared and the seed sown; but in the time of Antiochus Epiphanes conditions were right for spectacular growth and in Daniel the seed came to full flower.

Apocalyptic as Fulfillment of Prophecy.—During the intertestamental period the belief was held that prophecy had ceased soon after the Babylonian exile (*cf.* I Macc. iv, 46; ix, 27; xiv, 41). The apocalyptists, however, believed that they stood in the true prophetic tradition and sought to interpret human life and destiny in the light of the prophetic revelation. As T. W. Manson pointed out, apocalyptic was really an attempt to rationalize and systematize the predictive side of prophecy. In particular, the apocalyptists proceeded to interpret and reinterpret unfulfilled prophecies in the light of their own day and of the approaching End. An example of this is Jeremiah's prediction that the captivity would last 70 years (xxv, 11; xxix, 10), which is reinterpreted by Daniel as 70 weeks of years (ix, 24) and by I Enoch as the 70 reigns of the 70 "shepherds" or angels who would shepherd Israel (lxxxix, 59 ff.). Somewhat the same method is adopted in the Book of Revelation, where the Antichrist's rule of 42 months (xi, 2; xiii, 5) is a reinterpretation of the three and a half years of persecution referred to in Daniel ("a time, two times, and half a time"; vii, 25, xii, 7).

Divine Compulsion.—Much of this literature no doubt follows a stereotyped, conventional literary pattern and has an air of artificiality about it. It would be less than fair, however, to think of the apocalyptists as mere plagiarists, woodenly reproducing what the prophets and other apocalyptists had written. They were deeply religious men with a message for their time who wrote under a sense of divine compulsion as the prophets had done before them. Behind the literary convention may be traced, in some cases at any rate, genuine experiences of inspiration (through actual dreams, visions and the like) that lie midway between the inspiration of the prophets and that of a more modern literary kind.

Literary, Not Oral.—Both prophet and apocalyptist were given a message to proclaim. But their methods were different. The prophet, for the most part, declared his message by word of mouth, which might subsequently be recorded in writing. The apocalyptist, on the other hand, remained completely hidden behind his message, which he wrote down for the faithful to read. God's command to the prophet was, "You shall speak to them this word" (Jer. xiii, 12); His command to the apocalyptist was, "Write what you see in a book" (Rev. i, 11).

Pseudonymity.—The prophets spoke in their own name a message for their own day; the apocalyptists wrote in the name of some notable man of the past a message for the time of the End. Many explanations have been given of this strange phenomenon. R. H. Charles maintained that, from the time of Ezra onward, when prophecy was believed to have ceased, the all-sufficiency of the Law made impossible the reception of fresh revelations of faith and truth unless the books containing them came under the aegis of certain great names in the past. It is doubtful, however, whether the Law was in fact regarded as all-sufficient at that time, for the prophetic canon was certainly not closed by the time of Ezra, and it is more than doubtful that pseudonymity can be explained in terms of such open deception. This charge was removed by H. H. Rowley, who suggested that the author of the Daniel stories, in the first part of that book, later wrote an account of his visions under the guise of Daniel, not with the intention of deceiving his readers but in order to reveal his identity with the author of the Daniel stories, and concludes that pseudonymity only became artificial when it was woodenly copied by imitators.

This may well be a true explanation of the origin of apocalyptic pseudonymity, but, as has been indicated above, in the case of some of these writers at least the evidence seems to suggest more than simply the following of a literary convention, indeed a genuine experience of inspiration. Not only did they want their readers to believe their revelations; they actually believed them themselves. If this is so, it would indicate that they had a deep sense of kinship with those in whose name they wrote and were convinced that they were saying the kind of thing the ancient seer would have said were he alive at that time. For the purpose of revealing the divine secrets they were essentially the same people. In support of this, F. C. Burkitt suggested that the choice of a name was not arbitrary but showed more or less the problems occupying the writer's mind. This explanation would have even greater credence if, as has been suggested, the writers were using ancient traditions long associated with those in whose names they wrote. In this case the apocalyptist would see himself as the interpreter and not simply as the author of his book.

Deterministic View of History.—The apocalyptists inherited the idea of the unity of history from the prophets (*cf.* Amos and Deutero-Isaiah) and developed it along two lines, no doubt under the influence of Zoroastrianism. First, they divided history systematically into well-defined periods—into 85 Jubilees (Assumption of Moses) or 10 "weeks" (Apocalypse of Weeks in I Enoch) or 7 parts (Testament of Abraham) or 12 parts (Apocalypse of Abraham, etc.). Second, they taught that history, thus divided, had been predetermined by God, Who recorded on the heavenly tablets its fixed orders: "What is determined shall be done" (Dan. xi, 36). The course of history from the beginning and the predetermined time of the End God had revealed to His servants, who recorded them in their books. By calculating the times and seasons and by identifying events in the scheme they could discover at what point in time they stood; almost invariably this was in the last days just before the End.

Concern With Eschatology.—The future and the world to come are the prevailing interest of apocalyptic. In some writings the prophetic idea of the Kingdom of God established on this earth persists. But generally speaking these writers despaired of the present and of this world and looked to the future and to the world to come for the fulfillment of their hopes. Already there had been

growing up in Judaism, largely under the influence of Persian thought, an eschatology described by S. Mowinckel as at once dualistic, cosmic, universalistic, transcendental and individualistic. The old idea of a kingdom on earth gives place to a supernatural kingdom in a new heaven and a new earth (I Enoch 37–71) or a spiritual kingdom in heaven (II Enoch) or a temporary earthly kingdom followed by an eternity in heaven (II Esdras and II Baruch; *cf.* Rev. xx for a similar millennial idea) in which the righteous will share through resurrection.

An important aspect of this eschatology is the Day of Final Judgment, which might be described as a development and specialization of the prophetic Day of the Lord. In the prophets judgment falls upon the living and takes the form of a great crisis in history when destruction overtakes the nations; in the apocalyptists it includes the dead and assumes a forensic character in which individual men receive their just reward. (*See* also ESCHATOLOGY; LAST JUDGMENT.)

MESSAGE OF APOCALYPTIC

Purpose and Goal of History.—Like the prophets before them, the apocalyptists saw in the working out of history a purpose and a goal. The evil in the world might lead men to despair, but the unfolding of the plan of the ages (*see* above) showed clearly the predetermined purpose of God which could not be frustrated. Nor would this purpose end with the climax of history, for "the Most High has made not one world but two" (II Esdras vii, 50). The future age of righteousness would replace the present age of ungodliness and God's purpose would at last be fulfilled. This literature, then, is a mixture of pessimism—times would become worse and worse and God would destroy this present evil world—and of optimism—out of travail and confusion God would bring in His kingdom, the goal of history.

Angels and Demons.—Persian influence is to be traced in the remarkable growth during this period of the belief in angels and demons. Angels act as God's intermediaries, are arranged in ascending orders of rank and acquire names and personalities of their own. Of particular interest is the idea that each nation has a guardian angel upon whose power and authority depend the fortunes of the peoples on earth. (A variation of this is to be found in the Book of Revelation in the angels of the churches, who, as representatives of these churches, are answerable for them to God.) The evils perpetrated against Israel by the nations are ascribed to the angels who, in the End, share the punishment of evil earthly rulers.

An early apocalyptic tradition traces this association of the angels with evil to the story recorded in Genesis vi, 1–4 which tells how the angels, later called "watchers," lust after the daughters of men (*cf.* I Enoch, Jubilees, Testaments of the Twelve Patriarchs, II Enoch). From this illicit union a brood of giants is born from whose bodies evil spirits come forth (I Enoch xv, 8 ff.) who continue their work of inciting to sin until the final judgment. This developed doctrine of angels and demons, and the notion that the present world is in the power of the prince of demons, is familiar to readers of the New Testament. (*See* also ANGEL.)

Advent of the Messiah.—The figure of the Messiah does not occupy a central place in these writings, but certain developments within this idea are of the utmost importance, especially for an understanding of the New Testament. In several apocalyptic books (Daniel; I Enoch 1–36, 91–104; Jubilees; Assumption of Moses; II Enoch) no mention is made of a Messiah. In others the traditional Davidic Messiah is presented (*e.g.*, Psalms of Solomon). In at least one writing (Testaments of the Twelve Patriarchs) hope is expressed in the coming of two Messiahs, one priestly and the other kingly; this belief seems to have been shared by the covenanters of Qumran.

But most important of all is the emergence of a transcendent type of Messiah, closely associated with a mysterious "Son of Man," who plays a significant role in certain of these writings. Of particular interest in this connection are the Similitudes of Enoch (I Enoch 37–71), in which the Son of Man is described as a pre-existent, heavenly being who stands at the head of "the elect ones," and by whom the righteous will one day be exalted to share in God's kingdom. In II Esdras this transcendent Son of Man is presented as the Messiah.

Resurrection and Life Beyond.—With the exception of two passages there is no clearly expressed belief in life after death indicated in the Old Testament. It is of considerable significance that both these passages are to be found in an apocalyptic setting and that both express this belief in terms of resurrection. The first is Isa. xxvi, 10, possibly dating from the 3rd or 4th century B.C., in which most scholars see a reference to the resurrection of the body; the second is Dan. xii, 2–3, dating from 165 B.C. This concept undergoes considerable development in the extracanonical apocalyptists and supplies a bewildering number of variations. The conviction that the righteous must be raised to share in the glories of the coming kingdom (as in Isa. xxvi, 10) was accompanied by the belief that the wicked also must be raised to receive due punishment for their sins (as in Dan. xii, 2–3). In this literature, then, for the very first time in Jewish thought, moral distinctions are made in the realm of the departed. Here, too, for the first time the departed are called "souls" or "spirits," although in the two biblical apocalypses the typical Old Testament picture of Sheol as the abode of "shades" is retained. In subsequent writings the concept of Sheol undergoes a radical change. No longer is it the eternal abode of all the departed; it has become a waiting place from which the souls of men are taken in resurrection to receive reward or punishment. Two separate compartments appear, one for the righteous and one for the wicked. These are subdivided still further to provide paradise, heaven, hell and Gehenna in addition to Sheol itself where the souls of men suffer punishment, even before the resurrection, or else await the coming judgment. The influence of these ideas on the New Testament conception of the last things is obvious, in particular on the Book of Revelation.

RELATION OF APOCALYPTIC TO JUDAISM AND CHRISTIANITY

Judaism.—It has been argued by some scholars that Jewish apocalyptic lay outside the main stream of Judaism and that, indeed, it represents a rather stagnant backwater. This contention is difficult to substantiate. It is true that it does not represent what G. F. Moore calls the "normative" Judaism of the rabbinical writings; but the indications are that during the intertestamental period at any rate it was part of the accepted Jewish tradition and represented one important aspect of its life and belief.

A comparison of the apocalyptic literature with the writings of the Qumran covenanters, for example, gives an indication of the prevalence of apocalyptic ideas during this period. Apart from the fact that several apocalyptic books are represented among the Qumran texts, the two bodies of literature are closely related not only in the beliefs expressed but even in actual words and phrases used. In particular there is a close connection in expression of messianic hopes, in belief in good and evil spirits and in ideas concerning the End—the final apocalyptic battle, the judgment to come, the reward of the righteous and the punishment of the wicked in the life beyond. Whatever their exact relationship may be, it is certain that they shared a common spiritual tradition.

This, too, can be said of the relationship between apocalyptic and orthodox Pharisaic Judaism. To both alike the Torah, for example, was central and commanded reverence as the revelation of God. Moreover, that deep ethical concern so often expressed by the rabbis is found frequently in the writings of the apocalyptists, while in such beliefs as the resurrection of the body and the advent of the Messiah there is no small measure of agreement. The influence of apocalyptic thought and even phraseology can be traced in the writings of the rabbis themselves and in the later liturgy of the synagogue.

Some time after A.D. 70, however, the apocalyptic literature became unpopular with official rabbinical Judaism and met with antipathy on the part of the rabbis. At least two reasons probably lie behind its ultimate rejection by Judaism. One is the dangerous part played by this literature, with its often belligerent messianic hopes, in rousing the people in open rebellion against Rome, which led to the downfall of Jerusalem in A.D. 70. The other was the interest now being taken in it by the Christians, who had begun

to adopt it for their own use.

Christianity.—It is not at all surprising that, almost from the beginning, the Jewish apocalyptic writings were popular with the Christians who had themselves been brought up in the Jewish faith. The teaching contained in them covering such matters as the resurrection of the dead, the Kingdom of God and the imminent return of the Messiah was very much in keeping with the church's hopes and expectations. As Greek rather than Aramaic became increasingly the language of the Christian community, these books, already popular in Greek translations among the Jews, became even more widespread, and when at last they were relinquished by Judaism they remained the secure possession of Christianity. Thus, with the exception of the canonical Book of Daniel, the tradition of apocalyptic is Christian, not Jewish. This entire body of literature, then, owes its survival to the Christian church, which has preserved the several books, in whole or in part, in many languages.

Not content with taking over the Jewish apocalypses, however, Christian writers set about interpolating them with specifically Christian teaching (as, for example, in the Sibylline Oracles) or adding to them entire new sections with a Christian content (as in the Ascension of Isaiah or the Christian additions to II Esdras). In this way they were able to claim the support of ancient traditions for their new faith.

Within the New Testament canon itself the pattern of Jewish apocalyptic is evident. This is particularly the case with the Book of Revelation (*q.v.*), by far the most significant of all the Christian apocalypses. Though a Christian writing, it draws freely on Jewish apocalyptic tradition and follows in a true line of descent from the earlier writings. Many of the marks of Jewish apocalyptic are to be found in it—fantastic imagery, symbolic language, angelic powers, the overthrow of evil, the resurrection of the dead, the final judgment, the messianic kingdom, the world to come. The chief difference lies in the person of the Messiah and the Christian interpretation given to him as the meaning and end of human history.

Quite apart from this canonical book, many other apocalypses were written in the course of the following centuries, usually in imitation of earlier Jewish works. A number of these were attributed to New Testament characters such as Peter, Paul, Thomas, John, Stephen, James, James the Less, Philip and the Virgin Mary. Not a few of the apocalyptic writings from these centuries are known to us only by name or in fragments preserved by the Church Fathers.

Three apocalypses, dating from the 2nd century A.D., may be singled out for special mention. These are the Epistle of the Apostles, the Shepherd of Hermas (*see* APOSTOLIC FATHERS) and the Apocalypse of Peter. The first is in the form of a revelation from the risen Lord and purports to be based on his speeches. The Shepherd of Hermas narrates certain allegories in the form of visions; it has a deep interest in eschatology and points to the last judgment. The Apocalypse of Peter, like the Shepherd, was widely read in Christian circles for a time and is the most important of all those named after apostles. In it the Lord, at the request of his disciples, gives signs of his second advent and of the End. Reference to the last judgment is followed by a gruesome picture of hell and the punishment of sinners according to their deeds. Visions of heaven are also given and the glories of the saints in paradise revealed. The stress in this book on the fate and future condition of individual souls had a considerable influence on later writings and especially on medieval theology.

Generally speaking, when in course of time Christian expectations of an early return of Christ faded, the apocalyptic books, both Jewish and Christian, tended to fall out of favour. The hope, however, remained, and again and again the Christian church has turned to this kind of literature for inspiration and encouragement in times of crisis and persecution.

BIBLIOGRAPHY.—Most of the Jewish apocalyptic books are to be found translated in *The Apocrypha and Pseudepigrapha of the Old Testament*, vol. ii (1913), ed. by R. H. Charles, and in several volumes of *Translations of Early Documents*, ed. by W. O. E. Oesterley and G. H. Box. R. H. Charles has published a number of larger commentaries on individual apocalypses. A convenient list of Christian apocalyptic writings is given by M. R. James in *The Apocryphal New Testament* (1924) and in *The Lost Apocrypha of the Old Testament* (1920). Informative articles by R. H. Charles appear in J. Hastings *et al.* (eds.), *Dictionary of the Bible*, vol. i, pp. 109–110 (1900) and in T. K. Cheyne and E. S. Black (eds.), *Encyclopaedia Biblica*, vol. i, col. 213–250 (1899); by H. T. Andrews in A. S. Peake (ed.), *Commentary on the Bible*, pp. 431–436 (1920); and by J. B. Frey in L. Pirot (ed.), *Supplément au dictionnaire de la Bible*, vol. i, col. 326–354 (1928).

Other books of a more general character are: Joshua Bloch, *On the Apocalyptic in Judaism* (1952); F. C. Burkitt, *Jewish and Christian Apocalypses*, Schweich lectures for 1913 (1914); R. H. Charles, *A Critical History of the Doctrine of a Future Life*, 2nd ed. (1913); R. T. Herford, *Talmud and Apocrypha* (1933); R. H. Pfeiffer, *History of New Testament Times* (1949); F. C. Porter, *The Messages of the Apocalyptical Writers* (1905); H. H. Rowley, *The Relevance of Apocalyptic* (1944); D. S. Russell, *Between the Testaments* (1960) and *The Method and Message of Jewish Apocalyptic* (1964); C. C. Torrey, *The Apocryphal Literature* (1945). (D. S. R.)

APOCRYPHA, NEW TESTAMENT, early Christian or semi-Christian writings that in form resemble the books included in the New Testament but were not admitted to the canonical collection. These are not analogous to the Old Testament Apocrypha, for most of the New Testament apocryphal literature never was regarded as acceptable by orthodox Christians; it was produced by and for schismatic or heretical groups, especially by Gnostics (*see* GNOSTICISM).

In the past the writings of the Apostolic Fathers (*q.v.*) sometimes were included among the New Testament Apocrypha, but such a classification is purely arbitrary.

Early Christian writers classified some of the apocrypha as "spurious" (Christian but noncanonical); they treated other documents as plainly heretical. In general, however, there was little dispute; the apocryphal writings were simply rejected. Among them is sometimes placed the *Testamentum Domini* ("Testament of the Lord"), but this is a 5th-century expansion of the *Apostolic Tradition* of Hippolytus (*q.v.*).

In addition to complete books or fragments of books, there are isolated sayings recorded (supposedly from oral tradition) by later writers. These sayings, whether "authentic" or not, can add nothing to our knowledge of Jesus because the canonical writings provide the only norm by means of which they can be tested.

Most of the apocryphal literature consists of (1) gospels; (2) acts or preachings or teachings of the apostles; and (3) epistles. For the Apocalypses *see* APOCALYPTIC LITERATURE.

GOSPELS

Traditions of the deeds and sayings of Jesus were circulated, both orally and in writing, along with the four gospels that came to be accepted universally. Apparently it was in the first half of the 2nd century that attempts were made to create gospels in which these materials were utilized and interpreted; usually materials from the canonical gospels also were employed. The authors of the apocryphal gospels often tried to give the impression that their works were historically and theologically reliable; in some instances they pretended that they were conveying secret doctrines that Jesus had set forth to only a few of his disciples. Under such circumstances they naturally reproduced some materials from the canonical gospels (so that Jesus would be recognizable as Jesus) and some materials from their own—often Gnostic—theology (so that Jesus would be recognizable as the revealer of their teaching). The church recognized these purposes and rejected the works.

Papyrus Fragments of Unknown Gospels.—These include:

1. Oxyrhynchus Papyrus 840 (4th–5th century), a discussion of ritual purity between Jesus and a Pharisee who is high priest. (The Oxyrhynchus papyri are a collection found at the site of the 4th-century town of Oxyrhynchus in Egypt, beginning in 1897. *See* OXYRHYNCHUS; PAPYROLOGY.)

2. Egerton Papyrus 2 (2nd century), sayings of Jesus based on the four gospels.

3. Oxyrhynchus Papyri 1, 654 and 655 (3rd century), all of which come from the Gospel of Thomas.

4. A Coptic papyrus fragment (Strasbourg 5–6) of the 5th–6th century, containing a prayer of Jesus and a discussion with the apostles.

Gospels Not Ascribed to Authors.—Among these are:

1. The "gospel" created by Marcion (*q.v.*) by removing so-called interpolations from the Gospel of Luke.

2. The Gospel of Perfection, a Gnostic work quoted once by Epiphanius (4th century).

3. The Gospel of Truth, used, according to Irenaeus (*c.* 185), by Valentinian Gnostics. This is probably the work which, found among the Coptic Gnostic writings from Nag-Hammadi, Egy., was published in 1956 by M. Malinine, H. C. Peuch and G. Quispel under the title *Evangelium Veritatis;* several pages missing in their edition were published by P. Labib in *Coptic Gnostic Papyri From the Coptic Museum in Old Cairo* (1956); *cf.* also K. Grobel, *The Gospel of Truth* (1960). The work is a mystical-homiletical treatise based not on secret traditions but on a mixture of Christian doctrine with a kind of Gnosticism that is Jewish in origin.

Gnostic Books in the Name of Jesus.—These writings are not, strictly speaking, gospels, but their content resembles that of gospels. Among them are:

1. The Coptic treatise (two versions extant) called the Sophia (Wisdom?) of Jesus Christ, a postresurrection dialogue with the disciples (a 3rd–4th century Greek fragment in Oxyrhynchus Papyrus 1081).

2. Two Books of Jeû containing secret mysteries revealed by "Jesus the Living."

3. Pistis Sophia, a 3rd–4th-century revelation of the same sort.

4. The Dialogue of the Savior, a similar document found at Nag-Hammadi.

Gospels Ascribed to Biblical Personages.—These writings include works ascribed to "the apostles," such as:

1. The Epistle of the Apostles (not really an epistle), from the middle of the 2nd century, an apocalyptic, antiheretical discourse supposedly given by Jesus after the resurrection.

2. The Gospel of the Twelve, now completely lost but mentioned by Origen.

3. Perhaps the Gospel of the Seventy.

More often, apocryphal gospels were ascribed to individual apostles. These works include books ascribed to:

4. James, especially the 2nd-century "protevangelium of James," which in a 3rd-century papyrus (Papyrus Bodmer V, edited by M. Testuz, 1958) is entitled "Genesis [birth? bringing forth?] of Mary—Revelation of James"; this work was valued by many Church Fathers because it set forth the perpetual virginity of Mary.

There is also an Apocryphon (secret book) of James from Nag-Hammadi.

5. John, especially the 2nd-century Apocryphon of John, known in one form to Irenaeus and in others to those who produced various Coptic versions of Jesus' Gnostic teaching after the resurrection.

6. Judas (Iscariot), in whose name there was a gospel that, according to Irenaeus, was used by the Gnostic Cainites (*see* CAIN).

7. Matthias, whose "traditions" were known to Clement of Alexandria.

8. Peter, supposedly author of a gospel that was rejected about 190 by Serapion, bishop of Antioch; an 8th–9th-century fragment was found at Akhmim, Egy., in 1886.

9. Philip, supposedly author of a gospel from Nag-Hammadi that contains Gnostic teaching (chiefly Valentinian).

10. Thomas (the work found at Nag-Hammadi is called the Gospel of Thomas; there is another Nag-Hammadi book called the Book of Thomas the Athlete; in addition there is an "infancy gospel" ascribed to Thomas).

Several apocryphal gospels were assigned to women. Among them were:

11. The Gospel of Eve, quoted by Epiphanius.

12. The Major and Minor Questions of Mary (Magdalene), also discussed by Epiphanius.

13. The Gospel of Mary (Magdalene), partly preserved both in Greek (Rylands Papyrus 463, early 3rd century) and in Coptic (Berlin Papyrus 8502, 5th century).

Epiphanius also describes a Gnostic parody of the Genesis of Mary (*see* number 4 above).

Gospels Ascribed to Sectarian Leaders or to Groups that Used the Books.—The existence of such gospels as those ascribed to Apelles, Bardesanes, Basilides and Cerinthus is questionable; on the other hand, Marcion and Mani certainly composed works of this kind. Among relatively early gospels used by special groups are three that reflect Jewish Christianity as it gradually came to be more sectarian:

1. The Gospel according to the Hebrews, probably written in Egypt in the 2nd century and known chiefly from quotations given by Clement of Alexandria and Jerome.

2. The gospel used by the Ebionites (*q.v.*).

3. The gospel used by the Nazarenes (*q.v.*).

The interrelations of these three gospels (if there really were three of them) have not been established. In addition, there was a gospel according to the Egyptians, now known only from fragments, that reflects its author's tendency toward Gnosticism. This work may have been used by the author of II Clement (*see* CLEMENTINE LITERATURE).

ACTS

The apocryphal Acts of the Apostles are rather different from the New Testament book of Acts (*see* ACTS OF THE APOSTLES). While the latter is concerned with the work of the Holy Spirit as the guide of the apostles in their work of proclaiming the gospel and establishing the church (though some biographical interest is not absent), the apocryphal Acts deal primarily with the miraculous and piquant adventures of individuals, and the doctrine set forth by most of them is a popular form of 2nd-century Christianity that often verges on Encratism (*i.e.*, asceticism carried to the point of heresy). Both in form and in content these Acts are close to the contemporary Hellenistic romances (*see* ROMANCE), and details in many of them seem to be borrowed from such writings. The authors of such works tried to make the story of Christian origins dramatic; usually they made it merely melodramatic. Tertullian (early 3rd century) relates that the author of the Acts of Paul was known to be a presbyter of Asia Minor; he claimed that he had written from "love of Paul," but he was deposed. Even so, these Acts were still used as an authority by Hippolytus and Origen, and it was not until the early 4th century that clear evidence shows that they were almost universally rejected.

Andrew.—Acts of Andrew were rejected by Eusebius and, according to Epiphanius, used by Gnostics. Such acts are extant in various forms, including several versions of martyrdoms of Andrew, Acts of Andrew and Matthias among the Cannibals, and Acts of Peter and Andrew.

Barnabas.—Journeys and Martyrdom of Barnabas, 5th-century acts, were written to glorify Cyprus, where Barnabas was believed to be buried, in its struggle with Antioch. The author supposedly was John Mark, described as formerly a servant of a certain Cyril, high priest of Zeus. They are partly based on the canonical book of Acts.

Bartholomew.—This Martyrdom describes the adventures and death of the apostle in India.

John.—The Acts of John (Oxyrhynchus Papyrus 850, 4th century), very close to the Hellenistic romance, probably came from Asia Minor in the 2nd century. They contain occasional semi-Gnostic touches. (*See* also JOHN, GOSPEL ACCORDING TO AND EPISTLES OF SAINT: *Literary History: Apocryphal Acts of John.*)

Matthew.—The Martyrdom of Matthew describes miracles and death of Matthew in "the land of the cannibals"; evidently Matthew is confused with Matthias (see *Andrew* above).

Paul.—These include the Acts of Paul, Acts of Paul and Thecla, and Acts and Martyrdom of Peter and Paul. The most popular of all the apocryphal Acts, those of Paul and Thecla (or of Paul alone, according to varying titles), describe the apostle's activities in Asia Minor and tell of an encounter with a lion he had previously baptized (*cf.* the story of Androcles and the lion).

Peter.—These include Acts, Martyrdom (= Acts of Peter with Simon) and Peter and Paul (see *Paul* above) (Oxyrhynchus Papyrus 849, 4th century). Close in popularity to the Acts of Paul, these were probably modeled after them. Striking parallels exist

between some of the sayings of Jesus in the Martyrdom of Peter and those in the Gospel of Thomas. This work, composed *c.* 190, contains Peter's question, "Domine, quo vadis?" and the reply of the risen Lord that he goes to Rome to be crucified (again). Acts of Peter and the Twelve have been found at Nag-Hammadi.

Philip.—The Acts of Philip relate deeds, especially miracles, of Philip in Greece, Parthia and the land of the Ophians (apparently Naassene Gnostics), and his martyrdom.

Thaddaeus.—The Acts of Thaddaeus include the story of how Thaddaeus converted Abgar, king of Edessa, and others.

Thomas.—The Acts of Thomas is a semi-Gnostic account of the oriental adventures and death of the apostle; the book includes the Gnostic "hymn of the pearl." It was used by Gnostics and Manichaeans.

EPISTLES

No fewer than five of the 49 Gnostic works found at Nag-Hammadi are in epistolary form (including an epistle of Peter to Philip), and this form was popular among authors of apocryphal books (*cf.* the Epistle of the Apostles, above). Below are considered only the letters written in the name of the apostle Paul but not admitted to the New Testament canon in the west.

Achaeans.—Such a letter, mentioned in the correspondence of Seneca with Paul (*see* below), probably never existed.

Alexandrians.—According to the Muratorian list, such a letter was forged by Marcionites. No trace of it exists.

III Corinthians.—An antiheretical letter, probably of the late 2nd century, composed largely out of the genuine epistles, along with a letter from the Corinthians to Paul.

Laodiceans.—This is found in Latin biblical manuscripts from the 6th century and later; there is also an Arabic translation from the Latin. It is intended to supply the lack of a letter from Laodicea mentioned in Col. iv, 16. (According to Marcion, the letter known as Ephesians was properly entitled Laodiceans.)

Macedonians.—This title is mentioned by Clement of Alexandria but probably refers to Philippians (Philippi is in Macedonia), from which he quotes.

Seneca.—A collection of letters, probably from the 4th century, supposed to have been exchanged by Paul and his contemporary, the philosopher-politician Seneca; first mentioned by Jerome.

In addition, there are several apocryphal letters among the writings of the Apostolic Fathers (*q.v.*) and in the Clementine literature (*q.v.*); a famous forgery is the Letter of Jesus to Abgar (*q.v.*). *See* also APOCRYPHA, OLD TESTAMENT.

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Acts: B. Pick, *The Apocryphal Acts of Paul, Peter, John, Andrew and Thomas* (1909); R. Söder, *Die apokryphen Apostelgeschichten und die romanhafte Literatur der Antike* (1932); B. Altaner, *Patrologie*, 2nd ed. (1950); J. Quasten, *Patrology*, vol. i, pp. 128–143 (1950). For Greek texts, *see* R. A. Lipsius and M. Bonnet, *Acta Apostolorum Apocryphe.* A Greek papyrus (late 3rd century) of the Acts of Paul was edited by C. Schmidt in *Praxeis Paulou* (1936); he notes other papyrus fragments, and still others are noted by H. A. Sanders (*Harvard Theological Review*, 31:73 ff.), G. D. Kilpatrick and C. H. Roberts (*Journal of Theological Studies*, 47:196 ff.) and W. D. McHardy (*Expository Times*, 58:279).

Epistles: The Seneca letters were edited by C. W. Barlow, *Epistolae Senecae ad Paulum et Pauli ad Senecam (quae vocantur)* (1938); a 3rd-century Greek text of the Corinthian letters was published by M. Testuz, *Papyrus Bodmer X–XII* (1959).

See also M. R. James, *The Apocryphal New Testament* (1924).

(R. McQ. G.)

APOCRYPHA, OLD TESTAMENT.

The term apocrypha, the plural of the Greek neuter adjective *apocryphon* ("hidden away"), is used to designate certain religious books highly regarded by the Jews of ancient times but never included in the Hebrew canon of Scripture. In the narrowest sense it refers to a section in the King James version of the Bible (and other versions related to it) that contains those books found in the Greek and Latin translations of the Old Testament but not in the original Hebrew. In a broader sense it is used to cover not only these books but also certain other noncanonical writings from Hebrew antiquity, such as those more commonly called pseudepigrapha—books "written under a false name," most of them of an apocalyptic character.

The use of the term apocrypha is merely arbitrary and conventional, since the books ordinarily designated by it were never "hidden away," either in the sense of being literally concealed from the public or of containing esoteric teaching. The origin of the term is still a matter of dispute, but the most probable view derives it from the legend preserved in II Esdras (IV Esdras of the Vulgate), ch. xiv, which relates that when Ezra was commissioned to republish the Law in the days following the Babylonian Exile he was told that Moses on Mt. Sinai had been instructed to "hide" many of the words he received (verse 6) and that he himself was to issue publicly only a portion of the books that were dictated to him, the others to be delivered "in secret to the wise" (verses 26, 46). From this tradition of a store of books deliberately "hidden away" from public use there arose quite naturally an imprecise use of the word apocrypha to denote any books outside the familiar canon. It was in this sense that the word was introduced into Christian usage by Cyril and Jerome as a convenient name for those books they found in the Greek Old Testament (the Septuagint) but not in the Hebrew. Although these books were, for the most part, ultimately included in the Latin Vulgate, Jerome himself proposed to call them apocrypha with the connotation "uncanonical"; in later Roman Catholic usage they are called deuterocanonical but without any implication of inferior worth or authority. Jerome's usage subsequently was revived by the reformers Andreas Karlstadt and Martin Luther. Luther segregated the surplus books of the Latin canon in a separate section, which he called Apocrypha, a custom that was then imitated in the authorized versions of the reformed Church of England. The Apocrypha is an integral part of the King James version of the Bible and was always printed with it until 1827, when the British and Foreign Bible society, followed by the American Bible society and other publishers, decided to omit it in their editions.

STANDARD APOCRYPHA

The standard Apocrypha of the King James, Revised and Revised Standard versions of the English Bible consists of the following books:

1. I Esdras, a Greek translation of the canonical Book of Ezra with some important additions and variations, preceded and followed by brief portions of II Chronicles and Nehemiah (*see* ESDRAS, FIRST BOOK OF).

2. II Esdras, an apocalyptic work of the 1st century A.D. (neither of these books was included in the Septuagint or in Luther's Bible, and both appear in the Vulgate only as part of an appendix attached to the New Testament) (*see* ESDRAS, SECOND BOOK OF).

3. Tobit, a pleasant romantic story that gives interesting insight into Jewish beliefs and customs in the late pre-Christian era (*see* TOBIT, BOOK OF).

4. Judith, a nationalistic and unhistorical account of the deliverance of the people of Bethulia by the heroic conduct of a noble widow Judith (meaning "Jewess") (*see* JUDITH, BOOK OF).

5. The Rest of Esther; *i.e.*, those portions of the Book of Esther, characterized by a religious spirit missing in the Hebrew, that are found only in the Greek (*see* ESTHER, BOOK OF: *Rest of Esther*).

6. The Wisdom of Solomon, the most valuable of the apocryphal books, a philosophical work that evidences the growing *rapprochement* in Alexandria between Judaism and Hellenistic philosophy (*see* WISDOM, BOOK OF).

7. Ecclesiasticus, or The Wisdom of Jesus ben Sirach, another wisdom book which, however, remains firmly anchored in the main stream of the older Hebrew wisdom literature (the prologue makes it plain that it was composed in Hebrew; portions of the Hebrew original have been found in modern times in the Genizah at Cairo and the Dead sea caves) (*see* ECCLESIASTICUS).

8. Baruch, a pseudepigraphic work, somewhat difficult to characterize, which contains a letter purporting to have been written by Baruch in Babylon to the people of Jerusalem (i, 1–iii, 8), a hymn in praise of wisdom (iii, 9–iv, 4), and a song of comfort addressed to the people of Israel (iv, 5–v, 9); to which is appended

as a sixth chapter (in the King James, Revised and Douai versions) another pseudepigraph, the Epistle of Jeremy, a brief polemical essay on the folly of idolatry (printed as a separate book in the Revised Standard version) (*see* BARUCH, BOOK OF; JEREMY, EPISTLE OF).

9. The Song of the Three Children, Susanna and the Elders, and Bel and the Dragon, the additional items that appear in the Septuagint version of Daniel, the first being a liturgical composition placed upon the lips of the three young Hebrews who were thrown into the fiery furnace, while the other two are independent stories loosely connected with the Book of Daniel by the fact of having a common hero (*see* DANIEL, BOOK OF).

10. The Prayer of Manasses, a brief devotional composition that was never part of the Septuagint and is found in the standard Apocrypha only because the Vulgate includes it, like the two Books of Esdras, in an appendix attached to the New Testament (*see* MANASSES, PRAYER OF).

11. I Maccabees, a sober historical work describing the course of the Maccabean revolt from the time of Antiochus IV Epiphanes to the accession of John I Hyrcanus.

12. II Maccabees, a more romantic account of the same revolt from the days of Seleucus IV to Judas' victory over Nicanor (*see* MACCABEES, BOOKS OF).

These books may be classified as follows: (1) Hellenistic works, composed in Greek, presumably in Alexandria (Wisdom of Solomon and II Maccabees); (2) Palestinian works, composed in Hebrew (I Esdras, Ecclesiasticus, Baruch, Prayer of Manasses and I Maccabees); (3) Palestinian works, probably composed in Aramaic (Tobit, Rest of Esther and, possibly, II Esdras and the Additions to Daniel).

It is sometimes assumed that these works, which (with the exception of I–II Esdras and the Prayer of Manasses) are found in the Septuagint, are evidence of the existence of an Alexandrian as opposed to a Palestinian canon of Scripture. Since, however, the manuscripts of the Septuagint exhibit considerable differences among themselves and sometimes contain other books (such as III and IV Maccabees and the Psalms of Solomon), it is rather to be inferred that the distinction between canonical and noncanonical books was more fluid in Alexandria than in Jerusalem. The Palestinian canon, created by a conservative, not to say reactionary, type of Judaism, was rigidly limited to books that were unimpeachably ancient, or that were at least not patently of recent date—a standard that automatically excluded such works of indubitably Hebrew origin as Ecclesiasticus (the date and authorship of which were well known) and I Maccabees, which dealt with events of the recent past. In the freer atmosphere of Alexandria, on the other hand, while the hard core of the Hebrew canon was left inviolate, greater tolerance was shown toward other religiously valuable works, regardless of date and authorship.

OTHER APOCRYPHAL WORKS: PSEUDEPIGRAPHA

If the Hebrew canon may be regarded as the hard nucleus of Scripture and the standard Apocrypha as a surrounding layer closely attached to it, the other works, including the so-called Pseudepigrapha, may be thought of as a still further layer, centred in Scripture but much more loosely attached. None of these books ever received general recognition as part of the Bible, even though three of them are alluded to in the New Testament—Jannes and Jambres in II Tim. iii, 8, the Assumption of Moses in Jude 9, and Enoch in Jude 14 ff. No doubt many of them were highly regarded in certain more or less eccentric Jewish groups, such as the Qumran community, in whose library a number of them have appeared along with some other works previously unknown.

Certain of the additional apocrypha are known today only by name. Such, for example, are the Chronicles of John Hyrcanus mentioned in I Macc. xvi, 23 ff.; the Five Books of Jason of Cyrene, of which II Maccabees is professedly only an abridgement (II Macc. ii, 23); and the Book of Jannes and Jambres alluded to above. Others have been preserved only as selected portions of them were incorporated in other, still extant works. In this category may be mentioned the Martyrdom of Isaiah, an account of the prophet's death, preserved in the Ascension of Isaiah (*see* ISAIAH, ASCENSION OF); the Salathiel Apocalypse, included in II Esdras 3–13; and, possibly, a Book of Noah, now part of Enoch. In the general class of apocrypha are frequently listed certain quasi-historical works, such as III and IV Maccabees and the Letter of Aristeas, which are still extant.

The largest group of pseudepigrapha are apocalyptic writings such as the books of Enoch (and the Slavonic Enoch), II Baruch, the Testaments of the Twelve Patriarchs, the Psalms of Solomon, the Assumption of Moses and the Sibylline Oracles. Several fragmentary manuscripts of Enoch (though not including the important section called the Similitudes) have been found in the Dead sea caves, as have fragments of Testaments of Levi (in Aramaic) and Naphtali (in Hebrew), these latter perhaps to be accounted as sources for the Testaments of the Twelve Patriarchs rather than as parts of the completed book. (*See* APOCALYPTIC LITERATURE; BARUCH APOCALYPSES; ENOCH, BOOKS OF; MOSES, ASSUMPTION OF; SIBYLLINE ORACLES; SOLOMON, PSALMS OF; TWELVE PATRIARCHS, TESTAMENTS OF THE.)

A number of works that are legendary rather than apocalyptic also may be included among the Old Testament apocrypha: First in importance is the Book of Jubilees, a midrash on Gen. i, 1 to Ex. xiv, 31, preserved in its entirety only in Ethiopic. It was probably composed in the late 2nd century B.C. Its theme is that normative Judaism existed from the beginning of human history, and it is characterized by a division of history into jubilees, cycles of seven times seven years (*see* JUBILEES, BOOK OF). This was one of the most popular books in the community of the Dead sea scrolls, as is shown by the fact that fragments of some ten manuscripts have come to light. The popularity of the work is due in part to the peculiar, solar calendar which it (in common with I Enoch) advocates, the observance of which was evidently one of the important points of controversy between the Qumran Covenanters and the Pharisees. Since all the Dead sea fragments are in Hebrew, the view that the book was written in Aramaic becomes increasingly improbable.

Other works sometimes counted among the legendary apocrypha are a series of writings in Latin, Greek or one of the oriental church languages, apparently based on Jewish sources, that deal with the life of Adam and Eve; several late Christian versions of what seems to be an older Jewish work dealing with the story of Joseph and Asenath (in which Asenath is represented as really the daughter of Shechem and Dinah and only the foster daughter of Potipherah); and Pseudo-Philo's *Liber Antiquitatum Biblicarum*, a haggadic revision of biblical history from Adam to the death of Saul. To these should be added the *Lives of the Prophets*, a work perhaps originally written in Hebrew as early as the first century A.D., but surviving only in Greek, Latin, Syriac and Ethiopic. It purports to supplement the information given in the Bible about the more important Hebrew prophets.

APOCRYPHAL WORKS FROM QUMRAN

The discovery, beginning in 1947, in the caves near Khirbet Qumran at the northwest corner of the Dead sea, of great quantities of manuscripts and manuscript fragments that once belonged to the library of a community of Covenanters (probably to be identified with the Essenes, who are known to have lived in this vicinity) brought to light portions of Tobit (in Hebrew and Aramaic) and the Hebrew Ecclesiasticus (in a form that agrees closely with medieval Hebrew texts found by Solomon Schechter in the Cairo Genizah). As noted above, Jubilees and some form of the Testaments of the Twelve Patriarchs also are represented there.

Of greater interest, however, is the discovery of some fragments of the Damascus, or Zadokite, Document. This book, unknown until it was found in the Cairo Genizah by Schechter in 1910, was included by R. H. Charles in his edition of the Apocrypha and Pseudepigrapha and was widely studied by scholars, although its original provenance and historical significance were uncertain. The fact that fragments of it have been found in the Dead sea caves and that other Qumran literature shows marked affinity with it makes it apparent that this document was a product either

of the Qumran community or of some closely affiliated group. The document that is closest to it is the so-called Manual of Discipline, an almost complete scroll containing the rule of life by which the Qumran community was governed and upon which knowledge of its distinctive beliefs and practices is largely based. In this connection must also be mentioned a briefer document that sets forth the Rule of the Congregation "at the End of Days," when the ideal of the community was to be more perfectly realized.

A special class of literature, which scarcely falls into the category of apocrypha but should be mentioned here for the sake of completeness, is represented by the various fragments of commentaries on parts of the Old Testament—Genesis, Isaiah, Habakkuk, Micah, Nahum and Psalm 37. More strictly "apocryphal" in character are several documents for which no precise parallels are known: the War of the Sons of Light With the Sons of Darkness, the Genesis Apocryphon, the Copper scroll and the Thanksgiving Psalms (the names in all cases being modern inventions used merely for convenience of reference). The War scroll gives the plan of campaign for the last great battle of world history when the conflict between the forces of good and evil reaches its decisive climax. The idea of such a final battle appears in the Old Testament and later became one of the stock elements in Hebrew apocalyptic literature. The scroll published under the title of *A Genesis Apocryphon* (edited by N. Avigad and Y. Yadin) remained unrolled for several years because of the poor condition in which it was found and was then commonly supposed to be a lost "Book of Lamech," since the patriarch's name could be seen in the opening lines. When read, however, it turned out to be an Aramaic midrashic paraphrase of some of the early stories of Genesis. The Copper scroll acquired its name from the unusual material on which it was inscribed. Like the Genesis Apocryphon, it remained unopened for several years, but when the problem of unrolling it was finally solved by the drastic procedure of cutting it into strips, it proved to contain a list of sites in Palestine where large treasures are supposedly buried. The Thanksgiving Psalms (Hebrew, *hodayoth*) are a collection of religious lyrics, highly personal in character, which praise God for His merciful dealings with the poet, who is thought by some to be the Teacher of Righteousness, the founder of the Qumran sect. *See* also APOCRYPHA, NEW TESTAMENT; DEAD SEA SCROLLS.

BIBLIOGRAPHY.—The texts of the Qumran manuscripts (apart from the Genesis Apocryphon and the Copper scroll) are to be found in M. Burrows *et al.* (eds.), *The Dead Sea Scrolls of St. Mark's Monastery* (1950); E. L. Sukenik (ed.), *The Dead Sea Scrolls of the Hebrew University* (1955); and D. Barthélemy and J. T. Milik, *Discoveries in the Judaean Desert*, vol. i (1955). Translations of the more important of them are included in M. Burrows, *The Dead Sea Scrolls* (1955) and *More Light on the Dead Sea Scrolls* (1958), and T. H. Gaster (ed. and trans.), *The Dead Sea Scriptures in English Translation* (1956).

Introduction, translation and text for the more important standard and traditional apocrypha will be found in R. H. Charles (ed.), *The Apocrypha and Pseudepigrapha of the Old Testament in English*, 2 vol. (1913) and in the series, edited by S. Zeitlin, called *Jewish Apocryphal Literature* (1950–). *See* also C. C. Torrey, *The Apocryphal Literature* (1945). (R. C. DE.)

APOCYNACEAE, the dogbane family, a numerous group of dicotyledonous plants composed chiefly of tropical twining shrubs but including also various trees and perennial herbs, all with a milky, often poisonous juice. There are about 130 genera and 1,000–1,100 species, comparatively few of which are found in cool temperate regions. Of the species representing the family in North America, only about 6 are found as far north as New York and adjacent Canada. The best known of these are the American dogbane (*Apocynum androsaemifolium*) and the Indian hemp (*A. cannabinum*). In the British Isles the family is represented by the greater and the lesser periwinkle (*Vinca major* and *V. minor*), the latter of which has run wild in the eastern United States. Several tropical genera yield rubber (*Landlophia, Cardopinus, Funtumia, Urceola, Willoughbya,* etc.); others are sources of drugs (*Aspidosperma, Strophanthus, Alstonia, Allamanda,* etc.). Some are exceedingly poisonous, notably the ordeal tree (*Tanghinia*) of Madagascar, the manghas tree (*Cerbera*) of tropical Asia and the Bushman's poison (*Acocanthera*) of South Africa. Other widely known plants of this family are the oleander (*Nerium oleander*), the temple tree or frangipani (*Plumeria acuminata*), the crape jasmine (*Tabernaemontana coronaria*), the star jasmine (*Trachelospermum jasminoides*) and the Chilean jasmine (*Mandevilla suaveolens*). The Natal plum (*Carissa grandiflora*) and several other species produce edible fruits and many are showy ornamental plants. (*See* DOGBANE; INDIAN HEMP; OLEANDER; PERIWINKLE.)

The leaves are simple, entire and usually opposite; the flowers are regular, sympetalous, with the parts in fours or fives, and are borne either singly or clustered in cymes or panicles.

APODICTIC, a logical and philosophical term, approximately the same in meaning as "necessary" or "a priori." Aristotle used the word occasionally in the sense of "demonstratively certain" (*i.e.,* inferred from premisses that are certain). Kant classified judgments according to the kind of assertion made: in *assertoric* judgments something is asserted to be true; in *problematic* judgments something is held to be possible; while in *apodictic* judgments something is held to be necessary. On this traditional view, an apodictic judgment would take the form *A is necessarily B.* The word is now used (though somewhat rarely) in the more general and vaguer sense indicated above. (M. BK.)

APOGEE, in astronomy, that point in the orbit of a satellite, natural or artificial, which is farthest from the earth. In the case of the moon, the distance at apogee is approximately 253,000 mi.

APOLDA, a town of Germany which after the partition of the nation following World War II was located in the Erfurt district of the German Democratic Republic, is about 6 mi. N.E. of Weimar. Pop. (1959 est.) 29,621. For centuries it has been noted for bell casting and the nationally owned Apolda bell-casting works export a large part of their output. In the bell museum is an extensive collection of bells and chimes. Apolda is on the railway line from Leipzig to Weimar. Its industries include leather and knitted goods, and dye and chemical works.

Apolda, named in 1119, became a town in the 13th century. Until 1666 it belonged to the bishopric of Mainz.

APOLLINAIRE, GUILLAUME (real name WILHELM APOLLINARIS DE KOSTROWITZKI) (1880–1918), French poet who in his short life took part in all the avant-garde movements which flourished in French literary and artistic circles at the beginning of the 20th century, and who helped to direct poetry into unexplored channels.

He was born in Rome, Aug. 26, 1880, the son of a Polish *émigrée* and an Italian officer; but his origins were long kept secret, and his father did nothing for him. Left more or less to himself, he went at the age of 20 to Paris, where he led a bohemian life. Several months spent in Germany in 1901 had a profound effect on him and helped to awaken him to his poetic vocation. He fell under the spell of the Rhineland, and later recaptured the beauty of its forests and its legends in his poetry. More important, he fell in love with a young Englishwoman, Annie Playden, whom he pursued, unsuccessfully, as far as London; his romantic disappointment inspired him to write his famous "Chanson du Mal-Aimé."

After his return to Paris, Apollinaire became well known as a writer and a habitué of the cafés patronized by literary men. He met Paul Fort and Jean Moréas, became friendly with André Salmon, André Billy, Paul Jean Toulet and Léon Paul Fargue and in 1903 attempted to run an avant-garde review, *Le Festin d'Ésope.* He also made friends with some young painters who were to become famous—Maurice de Vlaminck, André Derain, Raoul Dufy and Pablo Picasso; he introduced his contemporaries to Douanier Rousseau's naïve paintings and to Negro sculpture; with Picasso, he applied himself to the task of defining the principles of a cubist aesthetic in literature as well as painting.

His first volume, *L'Enchanteur pourrissant* (1909), is a strange dialogue in poetic prose between the magician Merlin and the nymph Viviane. In the following year a collection of vivid stories, some whimsical and some wildly fantastic, appeared under the title *L'Hérésiarque et Cie* (1910). Then came *Le Bestiaire* (1911), in mannered quatrains. But his poetic masterpiece was *Alcools* (1913); in these poems he relives all his experiences and expresses them sometimes in alexandrines and regular stanzas, sometimes in

short unrhymed lines and always without punctuation.

In 1914, Apollinaire enlisted. He became a second lieutenant in the infantry, and received a head wound in 1916. Discharged, he returned to Paris and published a symbolic story, *Le Poète assassiné* (1916), and more significantly, a new collection of poems, *Calligrammes* (1918), which is dominated by images of war and his obsession with a new love affair. But on Nov. 9, 1918, two days before the Armistice, he died of Spanish influenza.

In his poetry Apollinaire made daring, even outrageous, technical experiments; his *calligrammes,* thanks to an ingenious typographical arrangement, are designs as well as poems. More generally, Apollinaire set out to create an effect of surprise or even astonishment by means of unusual verbal associations and, because of this, could be called the herald of surrealism. Yet he sometimes forgot all his modernistic principles and poured out his sufferings and his nostalgia in sincere and melodious lyrics of haunting beauty.

BIBLIOGRAPHY.—*Oeuvres poétiques,* ed. by M. Adéma and M. Décaudin, with a preface by A. Billy (1956). *See* E. Aegerter and B. Labracherie, *G. Apollinaire* (1943); A. Billy, *G. Apollinaire* (1947), an anthology with an introductory essay. (P.-G. CA.)

APOLLINARIS (APOLLINARIUS), THE YOUNGER (*c.* 310–*c.* 390), bishop of Laodicea in Syria, collaborated with his father, Apollinaris the Elder, in reproducing the Old Testament in the form of Homeric and Pindaric poetry, and the New Testament after the fashion of Platonic dialogues, when the emperor Julian had forbidden Christians to teach the classics. In his eagerness to combat Arianism, Apollinaris went so far as to deny the existence of a rational human soul in Christ's human nature, this being replaced in Him by a prevailing principle of holiness, the Logos.

It was held that the system of Apollinaris was really Docetism and the position was condemned by several synods and in particular by that of Constantinople (A.D. 381). Apollinaris had a considerable following which after his death divided into two sects, the more conservative taking its name (Vitalians) from Vitalis, bishop of Antioch, the other (Polemeans) adding the further assertion that the two natures were so blended that even the body of Christ was a fit object of adoration. The Apollinarian type of thought persisted in what was later the Monophysite school (*see* MONOPHYSITES).

Although Apollinaris was a prolific writer, scarcely anything has survived under his own name. But a number of his writings are concealed under the names of orthodox Fathers, long ascribed to Gregory Thaumaturgus. These were collected and edited by Hans Lietzmann, under the title *Apollinaris von Laodicea und seine Schule* (1905).

Apollinaris must be distinguished from the bishop of Hierapolis who bore the same name and who wrote one of the early Christian "apologies" (*c.* 170).

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APOLLO, a god of manifold function who occupied the loftiest place, next to Zeus, in the Greek pantheon. Though his original nature is obscure, to Greeks of the historical period he was above all the averter of evil, presiding over religious law and expiation, who communicated to man through prophets and oracles his knowledge of the future and the will of his father Zeus. No god save his father awoke such dread and awe as he, and no god was handled with more respect by poets and mythmakers. Homer considers him the deadliest of the gods and compares his coming with the swift onrush of night (*Iliad* i, 47). Beside him the hero Diomedes, who can sneer at Aphrodite and wound Ares, is puny indeed. Homeric Hymn 3 records the fear felt even by the gods when first Apollo came among them, when only his mother Leto and Zeus himself could endure his presence. Hesiod and Pindar humanize him by including in his sphere music and the dance and by telling of his loves with mortal girls, but nowhere in their pages nor in those of the Athenian tragedians does his stature diminish. In humbler circles he was also a god of crops and herds, though his chief concern was seldom with the life of nature as such, but only as in its less regular features—the encroachment of wild animals and disease—it affected the hopes and fears of men.

This most Hellenic of all gods was of foreign origin. Even Delphi, where during the middle of the 1st millennium B.C. his cult was virtually the centre of Greek religion and its nearest approach to a Vatican, remembered him as a newcomer. Archaeological evidence suggests that Apollo came to Delphi long after the Greeks had settled there. The gods who are said to have preceded him have left particularly shadowy traces, but from their names—Ge (Earth) and Themis (Moral Order), which are Greek words, and Poseidon, a god of ancient standing among the Greeks—it seems likely that Apollo ousted Hellenic deities. Less reliable is the evidence that the older gods possessed an oracle; prophesy by inspiration, at any rate, probably came to Delphi with Apollo. In this ritual the prophetess (called Pythia) sat upon a tripod chair and delivered Apollo's message while in or immediately upon release from a state of ecstasy, a condition devoid of violence and hysteria and resembling apparently a mediumistic or visionary trance. Sometimes she spoke a verse of several lines, perhaps previously prepared by other priests, sometimes when a simple choice among answers was sufficient she drew lots. The path by which Apollo and the Pythia came to Delphi is uncertain. He had many other oracles, not only on the Greek mainland but also in Asia Minor and on the islands. One in Lycia (a region in southern Asia Minor) and another on Delos in the Aegean were well known; each claimed to be his birthplace. Homeric Hymn 3 gives Delos the honour, implying that he came thence to Delphi; the latter opinion is probably right, but Apollo can scarcely have been a Delian aboriginally, for many things link his cult there to Asia Minor. (*See* also ORACLE.)

The theory that the Greeks first met Apollo in Lycia was advanced in 1903 by Ulrich von Wilamowitz-Moellendorff and is now, with certain modifications, generally though not universally accepted. Very striking is his epithet Letoides ("son of Leto"); rarely were the Greeks called after their mothers, but the practice is common in Asia Minor and Lycia especially. No other Greek god bears a matronymic epithet (Hermes, for instance, is called "son of Maia," but always with the full descriptive form). Apollo fights against the Greeks in the *Iliad;* in the pre-Homeric tradition he and Paris killed Achilles, the greatest Greek hero. Of the other Trojan champions, Ares and Aphrodite are of foreign origin, while Artemis, who alone has roots on Greek soil, plays a quite unimportant role in the poem and doubtless owes her Trojan allegiance to the fact that she was Apollo's twin sister. The gods who fight for the Greeks, on the other hand, are all from the Greek mainland, and the division seems hardly fortuitous. If Homer depicts Apollo as a full-fledged Olympian, his alien origin was probably known to Homer's remote predecessors. Apollo's mother Leto was from Asia Minor and of little importance elsewhere; her name seems related to the Lycian word *lada* ("woman"). If Apollo was Lycian, his common epithet Lykeios is easily explained, though it can be otherwise derived. Delian hymns honouring divinities subordinate to Apollo and Artemis were attributed to the Lycian poet Olen. It is characteristic of Apollo that at certain annual periods he was not present at his shrine, and many cults believed that he had retired homeward. It is tempting to infer, from the Delians' belief that he spent his winters in Lycia, that Lycia was his original homeland, but the more general inference is safer, that the Greeks first met Apollo somewhere in Asia Minor. Such caution accords with the practice of early writers, often

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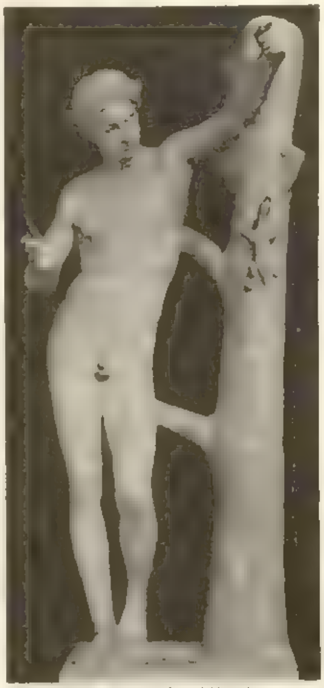
APOLLO BELVEDERE. GREEK SCULPTURE, DISCOVERED IN THE LATTER PART OF THE 15TH CENTURY; A COPY OF A BRONZE ORIGINAL. IN THE VATICAN MUSEUM

imprecise as to Lycia's exact location. Apollo may have had Hittite roots, and certain ritual features—especially the tendency for his festival to fall on the 7th day of the month—seem to derive from Babylonia. Why he and Artemis, different in function as well as geographic origin, became twins is not certainly known. Each carries a bow, and this slim similarity may have induced the Greeks to give Artemis' name to some Asiatic precursor who was Apollo's original sister; they gave her name freely to deities of widely differing natures. Several authorities say that Apollo came from or retired yearly to the land of the Hyperboreans (*q.v.*), a largely if not wholly mythical people whose name most Greeks—though not most moderns—interpreted as meaning "Beyond the North Wind." From their land, said the Delians, came the sacred relics which long ago the Hyperboreans had sent by their own ambassadors but now brought no further than their nearest neighbours, whence they passed from people to people until reaching Delos. The Hyperboreans thus left dark both the early stages of the journey and their own location. Some said that to get there one passed through the land of the one-eyed Arimaspi and the gold-guarding griffins, while Pindar held that the road lay neither on land nor sea. If Pindar is referring to the Milky Way, as has been supposed, it is hard to see how the Hyperboreans can have lived in a fixed spot beyond the north wind. Yet scholars have maintained that Apollo first came to Greece from the north, and there may in fact have been northern influences: his singing swan is a northern bird; amber, often associated with Apollo, is a northern product; some have located the Hyperboreans, and the Apollo-worshipers dwelling on the blessed isle of Helioxia as well, on the Frisian North sea coast and on Helgoland, whence amber was brought to Greece. Helgoland also is reportedly famous for its singing swans. But to give definite geographical location to lands known from myth and legend is dangerous. Apollo, furthermore, was god of music, famous for his lyre, so that a few random appearances of the singing swan in the Mediterranean may have sufficed to make it his bird. Supporters of Apollo's northern origin point to the Stepterion, a Delphic ritual commemorating, among other things, his victory over the serpent Python, whom he slew when taking over the cult; included was a procession to Delphi along a road leading from the vale of Tempe in the north. But even supposing that the procession traced the cult's original progress, it tells us nothing of the direction whence it came to Tempe itself.

Apollo's original nature is shrouded in the darkness covering the early history of his Asian homeland, but among the Greeks he was primarily the averter of evil of various sorts: moral pollution, physical illness and danger threatening herds and crops. Yet the averter may be the sender, and the first appearance of Apollo in the *Iliad* shows him shooting the arrows of the plague upon the Achaeans from his silver bow; placated, he restores health. When in the *Oedipus Rex* Apollo sends sickness to Thebes because it harbours the polluted murderer of Laius, Sophocles in giving the moral illness a physical symbol does no violence to the ordinary conception of the god. For it was Apollo who purified murderers who were morally guiltless or had made restitution; such a man was still polluted in divine eyes. Orestes in Aeschylus' *Oresteia* must go to Delphi for expiation though he killed his mother at Apollo's specific behest. Apollo himself made such restitution for the slaying of the Python.

Apollo was lawgiver to the Greek states, especially in matters requiring religious sanction; he it is, says Plato in the *Republic*, who explains to all men the institution of temples, sacrifices and other services to the deity, besides rites connected with death and the afterlife. Hence he became the symbol for law, order and moral and mental excellence; hence he became too, almost unavoidably, the paradigm of masculine beauty. Yet for all his concern with human morality, he remained essentially remote from man. Aeschylus can bring him on the stage, where he claims to speak for his father, but this is unusual; the fact that he usually confines his revelations to prophets indicates that the ordinary mortal may scarcely dare to approach him.

As a vegetation deity Apollo usually ousted or absorbed an older god, though the reason for such syncretism is not always clear. Often he turned aside the ills which threaten plant life: thus he is called Smintheus (mouse-god), Panopion (ridder of grasshoppers) and Erythibios (rust-god). In the Peloponnesus he absorbed the worship of Hyacinth (*see* HYACINTHUS), a pre-Greek vegetation god who in poetry appears as a beautiful youth beloved of and accidentally slain by Apollo. Apollo was called Hyakinthios, a word also common as a Dorian month name, and in Sparta had a festival, the Hyakinthia, which began with a gloomy sacrifice and ended with a joyous paean to Apollo. Before Apollo's day this ceremony must once have celebrated the death and revival of vegetation (hence Hyacinth's death in the myth); its significance after Apollo's intrusion is elusive. Similarly the festival of the Carneia (*q.v.*), attached to Apollo, probably originally honoured a vegetation god called Karneios or Karnos. In it a man carrying grape clusters was pursued by a group of unmarried youths, and as he ran he cried out for the city's good fortune; if he was caught, all was well. The rite resembles the modern European custom of chasing animal embodiments of the harvest spirit, but ignorance of details forbids pressing the analogy. Apollo's role in the Thargelia is somewhat better understood. Named after the first fruits, or the first bread from new wheat, it included the driving out and occasionally the killing of the *pharmakos*, a man who represented the deity but also acted as scapegoat for community guilt. Since his expulsion aimed at purification, Apollo's connection with the ritual is natural enough. Perhaps thus fortuitously did he acquire the Carneia and Hyakinthia, or a connection between expiation and fertility may through want of evidence be escaping us.



THE MANSELL COLLECTION, LONDON

APOLLO SAUROCTONUS (LIZARD KILLER), A MARBLE COPY IN THE LOUVRE OF A WORK BY PRAXITELES

Scholars have argued that Apollo's tutelary role over the flock was his original function, and have interpreted the epithet Lykeios to mean not "Lycian" but "wolf-god," as indeed it may. Unfortunately this sense of the word was popular among poets but not, apparently, among shepherds. Many other epithets, some derived from cult, support the view that Apollo's pastoral role was widespread, but the simplest course is to regard it as a particular manifestation of the averter of evil.

Through the influence of Nietzsche and Erwin Rohde the world has come to regard as fundamental to Greek religion the distinction between Apollo, the orderly, rational and shining, and Dionysus, the ecstatic, emotional and dark. The distinction is neither absurd nor particularly penetrating. To poets Apollo's epithet Phoebus signified brilliance, and, beginning probably with Aeschylus, Apollo himself stood for the sun. In the *Eumenides* he champions a rationalistic approach to ethics based upon the greater importance of the father than the mother to the well-being of family and society. Sophocles in the *Oedipus Rex* suggests that foreknowledge, Apollo's prerogative, can be acquired by the man who, thoroughly understanding human character, grasps also the moral pattern (called *dike*) whereby pollution, however unintentional, leads to disaster for the polluter, and this too is rationalistic. But to most people foreknowledge seemed to require the seer's vision or the Pythian ecstasy, which if not orgiastic was hardly rational. Rohde, aware of this difficulty, maintained that Apollo borrowed prophetic ecstasy from Dionysus' cult when Dionysus came to Delphi, but this is quite impossible. And Apollo's fundamental connection with purification and release from guilt probably had emotional and not intellectual wellsprings.

Apollo moved westward early; his temple at Cumae, built over the cave of the Sibyl, dates from the 6th century B.C., that in the Flaminian meadows at Rome from 431. The latter was dedicated for the sake of the people's health, and until the second Punic War Apollo was chiefly the warder off of pestilence with the epithet Medicus. In 212, with Hannibal on the city's doorstep, an oracle was discovered ordering the institution of the Ludi Apollinares, religious games accompanied by sacrifices, and promising Apollo's aid against the Carthaginians. Ancient scholars noted that the games, instituted for the sake of victory rather than health, marked an extension of Apollo's sphere; as did the increase in the number of his ministers, from 2, to 10, to 15. These were known finally as the *quindecemviri sacris faciundis* or Committee of Fifteen for performing the rites. Originally their chief duties involved the introduction of foreign cults and the consultation of the Sibylline books, religious documents from which remedies for various catastrophes, and eventually prophesies, were drawn. As this committee became more closely associated with Apollo in particular and bore his Delphic emblems of the laurel and tripod, the god through them approached his Delphic function of peer and religious lawgiver. But not until the Augustan age did Apollo come into his own.

As a young man Augustus had chosen Apollo as his own god, and attributed his victory over Antony and Cleopatra to Apollo's superiority over monstrous Egyptian and oriental deities, whose cults appeared to him lascivious and orgiastic. In commemoration of Actium he built the Palatine Temple of Apollo, including also Diana and Latona, whom the Romans identified with Artemis and Leto. In 17 B.C. he celebrated the Ludi Saeculares, games formerly expiatory but now devoted to the inauguration of a new era, and introduced Apollo and Diana upon equal footing with Jupiter and Juno. Horace's *Carmen Saeculare* expressed for that occasion what must have been Augustus' own vision of Apollo's nature: governor of Roman destiny; master of the sun; archer; augur; averter of pestilence; and giver of sound morals to the young. Signalizing Apollo's importance as seer and corrector of general evils, Augustus in 12 B.C. had the Sibylline books brought from their former place in the temple of Jupiter to Apollo's Palatine temple. The depth and variety of Apollo's functions in this age owed much to Greek influence, and his elevation to such great prominence goes hand in hand with Augustus' determination to Hellenize the age and, by giving it Greek ideals, to make it classic.

For festivals to Apollo *see* DAPHNEPHORIA; DELIA; DELPHINIA; PYANOPSIA. *See* also Index references under "Apollo" in the Index volume.

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(W. M. SE.)

APOLLODORUS (called SKIAGRAPHOS, "the shadow painter"), Athenian painter, active about 430–400 B.C. Ancient sources say that he was a pioneer in the history of painting. He was the first to win fame in easel instead of wall painting. His mixtures of colours and gradation of shades improved on his predecessor Agatharchus and gave his figures the appearance of reality. His manner was called *skiagraphia*, "shadow painting," or *skenographia*, "scene painting," as was that of Agatharchus. Zeuxis is said to have followed Apollodorus toward perspective and illusionistic painting. (ME. BR.)

APOLLODORUS OF ATHENS (born *c.* 180 B.C.), Greek scholar of wide interests, is best known for his *Chronicle* of Greek history. A pupil of the scholar Aristarchus, he left Alexandria about 146 B.C. for Pergamum and eventually settled at Athens. The *Chronicle*, written in the iambic trimeters commonly used in Greek comedy, covers the period from the fall of Troy (1184 B.C.) to 144 B.C. and was later continued to 119 B.C. Apollodorus' other works include a treatise *On the Gods;* one on the Homeric *Catalogue of the Ships*, used by Strabo in his *Geography;* and critical and grammatical writings; *e.g.*, on Sophron, a writer of mimes, Epicharmus, a Sicilian writer of comedy, on etymologies, etc. The compendium to Greek mythology, called *The Library*, extant under his name, is not by him.

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APOLLODORUS OF DAMASCUS (fl. 2nd century A.D.), Greek architect, was a favourite of Trajan, for whom he constructed a stone bridge over the Danube (A.D. 104–105). He also planned a gymnasium, a college, public baths, the Odeum and the Forum Trajanum within the city of Rome, and the triumphal arches at Beneventum and Ancona. The Trajan column in the centre of the Forum is the first triumphal monument of the kind. On the accession of Hadrian, Apollodorus was banished and, shortly afterward, being charged with imaginary crimes, put to death (Dio Cassius, lxix, 4). He wrote a treatise on siege engines, which was dedicated to Hadrian.

APOLLONIA, the name of more than 30 cities of antiquity two of which were especially important.

APOLLONIA BY EPIDAMNUS, on the right bank of the Aous river in Illyria on a site 5 mi. W. of the modern town Fier in the prefecture of Berat in Albania, was founded by the Corinthians and Corcyraeans in the 6th century or earlier. It soon became prosperous as the most convenient link between Brundisium and northern Greece and later as one of the starting points of the Via Egnatia. Toward the close of the Roman republic it was a seat of literature and philosophy. Augustus was being educated there when the death of Caesar called him to Rome. It seems to have declined from the 5th century A.D. and few ruins remain.

APOLLONIA PONTICA OR ANTHEA on the Thracian coast of the Black sea (now Sozopol in the Burgas province of Bulgaria), was colonized by Milesians and Phocaeans at the end of the 7th century B.C.; it became famous for its colossal statue of Apollo by Calamis.

APOLLONIUS (called DYSCOLUS, "the Crabbed") (2nd century A.D.), Greek grammarian, was the founder of scientific grammar. His life was passed at Alexandria during the reigns of the emperors Hadrian and Antoninus Pius. Priscian, the Latin grammarian, styled him *grammaticorum princeps* ("prince of grammarians") and used his work as the basis for his own. Four of his works are extant: *On Syntax*, and three smaller treatises, on *Pronouns*, *Conjunctions* and *Adverbs*.

See R. Schneider and G. Uhlig, *Grammatici Graeci* (1878–1910); A. E. Egger, *Apollonius Dyscole* (1854).

APOLLONIUS OF PERGA (PERGAEUS), Greek geometer of the Alexandrian school, was probably born about 25 years later than Archimedes; *i.e.*, about 261 B.C. He flourished in the reigns of Ptolemy Euergetes and Ptolemy Philopator (247–205 B.C.). His treatise on *Conics* gained him the title of the Great Geometer, and is that by which his fame has been transmitted to modern times. Most of his other treatises were lost, although their titles and a general indication of their contents were passed on by later writers, especially Pappus. After the *Conics* in eight books had been written in a first edition, Apollonius brought out a second edition, considerably revised as regards books i–ii.

The degree of originality of the *Conics* can best be judged from Apollonius' own prefaces. That he made the fullest use of his predecessors' works, such as Euclid's four books on conics, is clear from his allusions to Euclid, Conon and Nicoteles. Books i–iv form an "elementary introduction," *i.e.*, contain the essential principles; the rest are specialized investigations in particular directions. For books i–iv he claimed only that the generation of the curves and their fundamental properties in book i are worked out more fully and generally than they were in earlier treatises, and that a number of theorems in book iii and the greater part of book iv are new. The generality of treatment is indeed remarkable; he gives as the fundamental property of all the conics the equivalent of the Cartesian equation referred to oblique axes (consisting of a diameter and the tangent at its extremity) while the principal axes appear only as a particular case after he has shown that the property of the conic can be expressed in the same form with reference to any new diameter and the tangent at its extremity. On the basis of the form of the fundamental property (expressed in the terminology of the "application of areas")

Apollonius introduced the names parabola, ellipse, hyperbola. Books v–vii are clearly original. Apollonius' genius takes its highest flight in book v, where he treats of normals as minimum and maximum straight lines drawn from given points to the curve (independently of tangent properties), discusses how many normals can be drawn from particular points, finds their feet by construction, and gives propositions determining the centre of curvature at any point and leading at once to the Cartesian equation of the evolute of any conic.

The other six treatises of Apollonius (each in two books) were concerned with cutting off a ratio; cutting off an area; determinate section; tangencies; inclinations; plane loci. An Arabic version of the first was found toward the end of the 17th century in the Bodleian library by Edward Bernard, who began a translation of it; Halley finished it and published it with a restoration of the second (1706). A restoration of the third was given by Robert Simson, *Opera quaedam reliqua* (1776).

Tangencies embraced the following general problem: Given three things (points, straight lines or circles) in position, to describe a circle passing through the given points, and touching the given straight lines or circles. The most difficult case, and the most interesting historically, is when the three given things are circles. This problem, which is sometimes known as the Apollonian problem, was proposed by François Vieta in the 16th century to Adrianus Romanus, who gave a solution by means of a hyperbola. Vieta himself solved it by elementary methods and restored the whole treatise of Apollonius in *Apollonius Gallus* (1600); an interesting account of the problem given by J. W. Camerer in *Apollonii Pergaei de tactionibus quae supersunt, ac maxime Lemmata Pappi in hos Libros, cum Observationibus, etc.* (1795). A restoration of the fifth was given by Samuel Horsley (1770), and one of the sixth by Robert Simson (1749).

Other works of Apollonius referred to by ancient writers included (1) *On the Burning-Mirror*, where the focal properties of the parabola probably found a place; (2) *On the Cylindrical Helix* (mentioned by Proclus); (3) a comparison of the dodecahedron and the icosahedron inscribed in the same sphere; (4) a work in which were included Apollonius' criticisms and suggestions for the improvement of Euclid's *Elements*; (5) a work in which, according to Eutocius, he showed how to find closer limits for the value of π than the $3\frac{1}{7}$ and $3\frac{10}{71}$ of Archimedes; (6) an arithmetical work on a system of expressing large numbers and showing how to multiply such large numbers; (7) extensions of the theory of irrationals expounded in Euclid, book x (*see* PAPPUS OF ALEXANDRIA).

Lastly, from references in Ptolemy's *Almagest* it is known that Appollonius investigated eccentric and epicyclic motion and their equivalence. Of particular interest was his determination of the points where a planet appears stationary.

BIBLIOGRAPHY.—The editions of all the Conics include, besides Edmund Halley's monumental edition of all seven Books (1710), Commandinus' Latin translation (1566), and Barrow's edition (1675) of the first four Books, and J. L. Heiberg's definitive text of the same Books, with Eutocius' commentary, etc. (1891–93); and an edition in modern notation, with introduction, etc., by T. L. Heath (1896). *See* also O. Neugebauer, "Apollonius-Studien," *Quellen u. Studien zur Geschichte der Math.*, ser. B, vol. 2, pp. 215–253 (1932).

(T. L. H.; O. E. N.)

APOLLONIUS OF RHODES (b. *c.* 295 B.C.), Greek poet and grammarian, was the author of the *Argonautica*. A native of Alexandria or possibly Naucratis, he was known as *Rhodius* because of his residence in Rhodes. The two lives contained in the Laurentian manuscript of the *Argonautica* say that Apollonius was a pupil of Callimachus (so too the Suda lexicon); that he gave a recitation of the *Argonautica* at Alexandria; and that when this proved a failure he retired to Rhodes. The first life adds the detail that the poet was still an adolescent when this happened, though it had previously said that he turned late to writing poetry. Both lives say that the *Argonautica* was well received in Rhodes and the second records a report that Apollonius returned to Alexandria and was appointed chief librarian. The Suda lexicon makes him succeed Eratosthenes in this post. But in a list of Alexandrian librarians on a late 2nd-century A.D. papyrus (Oxyrhynchus Papyrus 1241) Apollonius succeeds Zenodotus and precedes Eratosthenes.

If this evidence is accepted it may be conjectured that Apollonius became librarian *c.* 260 and continued as such until *c.* 247, when he fell out of favour under the new king, Ptolemy Euergetes, and retired to Rhodes. The date and place of his death are unknown. He had a famous quarrel with Callimachus, apparently caused by differences about poetic ideals, especially the length and form of a poem, by plagiarism on Apollonius' side and also by Apollonius' being officially Callimachus' superior since the latter was never librarian. Besides the *Argonautica*, an epic in four books on the voyage of the Argonauts, Apollonius wrote epigrams and poems on the foundations (*Ktiseis*) of cities. These are lost except for a few fragments and one epigram, preserved in the Palatine anthology (11.275), attacking Callimachus. As a grammarian, Apollonius is credited with a work "against Zenodotus" and commentaries on several Greek poets.

The *Argonautica* merits more praise than the critics Quintilian and Longinus allow. Apollonius adapted the language of Homer to the needs of a romantic epic with considerable success and in book iii, which recounts Medea's love for Jason, he shows a capacity for sympathetic analysis not found in earlier Greek literature. Virgil in *Aeneid*, iv, owes much to him. As the learned scholia to the poem show, Apollonius had read widely in the literature of the Argonautic legend, and books i, ii and iv are overloaded with erudition, but even here Apollonius often holds the reader by his fresh handling of old episodes, his suggestive similes and his admirable descriptions of nature.

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(E. A. B.)

APOLLONIUS OF TRALLES (in Caria, Asia Minor), a Greek sculptor, who flourished in the 2nd century B.C. With his brother Tauriscus he executed the marble group known as the "Farnese Bull," representing Zethus and Amphion tying the revengeful Dirce to the horns of a wild bull.

APOLLONIUS OF TYANA (1st century A.D.), a Neo-Pythagorean sage whose celebrity is due entirely to the biography of him written by the rhetorician Philostratus (*q.v.*), was born at Tyana in Cappadocia somewhere about the beginning of the Christian era and survived into the reign of the Roman emperor Nerva. The biography by Philostratus, which is the only full account of him, was written *c.* A.D. 200 at the request of the empress Julia Domna, second wife of Septimius Severus, and is a highly romantic and extremely untrustworthy work in which Apollonius appears as a wandering ascetic and wonder-worker; it is impossible to ascertain what facts lie behind the accounts of his wide-ranging journeys (including a visit to India) and miraculous exploits. The memoirs of his disciple Damis, on which Philostratus claimed to base his account, are almost certainly a work of fiction. The work of Philostratus had a great success and led to a certain amount of religious veneration for Apollonius among the devout pagans of the later Roman empire. Caracalla built a shrine to him, and Alexander Severus put a statue of him in his private chapel along with those of Abraham, Orpheus and Christ. The anti-Christian writer Hierocles of Nicomedia paralleled his miracles with those of Christ, and it is possible that Philostratus himself and Julia Domna intended the *Life of Apollonius* as a sort of pagan gospel to counteract the effect of the Christian. If so, the attempt had little success.

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(A. H. AG.)

APOLLONIUS OF TYRE, a Latin prose romance which may be assumed to derive from a Greek original now lost. Be-

sides certain features of vocabulary, the social and topographical context of the story is Greek, while the theme and treatment place it inside the tradition of the Greek romances. Characteristic is the motif of separated lovers and the varied trials which beset them until, faithful throughout, they are reunited in a scene of mutual recognition. The story opens with a preliminary scene in which Apollonius by solving a riddle discloses that the king of Antioch is cohabiting incestuously with his daughter. Apollonius escapes the king's fury by making his way first to Tarsus and then to Cyrene, where he marries the daughter of King Archistrates. On the return journey to Tyre Apollonius' wife supposedly dies in giving birth to a daughter. She is placed in a chest, thrown overboard and washed up at Ephesus. A local doctor revives her and she becomes a priestess in the temple of Diana. Apollonius leaves his daughter in the care of foster parents and retires to Egypt. Years later the foster mother plots to kill the girl and she is saved only by the intervention of pirates, but a worse fate awaits her when she is sold to a brothel in Mytilene. In the meanwhile Apollonius, supposing his daughter as well as his wife is dead, makes a chance visit to Mytilene. To his joy he finds her alive and rescues her, still a virgin despite seemingly inevitable circumstances. His happiness is complete when in response to the promptings of a dream he proceeds to Ephesus and has his wife restored to him.

The introductory episode dealing with the king of Antioch seems to stand outside the main structure of the story and is possibly an interpolation from another source. Such was its impact, however, that the whole romance was later categorized by its character. To Chaucer the story was a tale "horrible . . . for to rede," and Gower chose it as an illustration of the seventh deadly sin in the *Confessio Amantis*.

Other features are indisputable interpolations by the Latin author, notably the inclusion of some of Symphosius' riddles, echoes from Virgil and various Christian touches.

The date of composition may be approximately fixed. The Greek original presumably derives, like the novels of Xenophon of Ephesus and other Greek romancers, from Asia Minor of the 3rd century A.D. The Latin composition must lie somewhere between the date of Symphosius (4th to 5th centuries) and a 6th-century reference to the tale by Venantius Fortunatus (*Miscellanea*, book vi, ch. x, lines 5–6, in J. P. Migne, *Patrologia Latina*, vol. 88, 1850).

Few adventure stories have had such long and widespread popularity in European literature. The survival of numerous Latin manuscripts testifies to its appeal in the middle ages. A metrical version was included in Godfrey of Viterbo's *Pantheon* in the 12th century; the prose version was further popularized by its incorporation into the 14th-century collection of tales, the *Gesta Romanorum;* and vernacular translations were made in the medieval period and continued into modern times. There exist versions in English, German, Dutch, Swedish, Danish, French, Spanish, Italian, Portuguese, Russian, Polish, Hungarian and modern Greek. The history of its treatment in England proves it to be the story with the longest tradition in the English language. An Anglo-Saxon translation (the first vernacular translation) was made in the 10th century. The more noteworthy of the later versions are John Gower's verse narrative, Lawrence Twine's novel *The Patterne of Painefull Adventures* (1576; reprinted 1607) and Shakespeare's *Pericles*, which was entered in the Stationer's Register in 1608. Despite the change in the hero's name, Shakespeare's play preserves the main outline of the story as originally conceived.

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(PE. G.)

APOLLOS, an Alexandrian Jew converted to Christianity at Ephesus in the mid-1st century. According to Acts xviii, 24–28 he was concerned with Old Testament interpretation and perhaps had been a disciple of John the Baptist. After his conversion he delivered mission sermons in the Jewish synagogue, though he "knew only the baptism of John." The account that follows in Acts seems to suggest that Apollos was unaware of the significance of baptism "in the name of the Lord Jesus" and its relation to the gift of the Holy Spirit; though "instructed in the way of the Lord" he only later understood that the Messiah was Jesus. At a later point he went to the Christian church of Corinth, which the apostle Paul had "planted"; Apollos "watered" it, but in such a way as to permit the rise of partisan strife (I Cor. iii, 6; i, 10–12). Later he returned to Ephesus (I Cor. xvi, 12; *cf.* Tit. iii, 13). Apollos is significant as an example of the unclear line between Judaism and Christianity in the minds of some, at least, of the early converts. It is possible though not provable that he wrote the Epistle to the Hebrews. (R. McQ. G.)

APOLOGISTS, EARLY CHRISTIAN, the title conventionally assigned to a group of writers, chiefly in the 2nd century, who attempted to provide, at first in Greek but later in Latin, semiphilosophical defenses of Christianity and criticisms of Greco-Roman culture. Many of their writings were addressed to such Roman emperors as Antoninus Pius (138–161) and Marcus Aurelius (161–180), and it is probable that they were actually sent to government secretaries who were empowered either to accept or to reject them. Under these circumstances, some of the apologies assumed the form of briefs written to defend Christians against the accusations current in the 2nd century, especially the charges that their religion was novel or godless or expressed in immoral cultic practices. The apologists usually tried to prove the antiquity of their religion by treating it as the fulfillment of Old Testament prophecy; they argued that their opponents were really godless, since they worshiped the gods of mythology; and they insisted upon the philosophical nature of their own faith as well as its high ethical teaching. They did not intend to present a complete picture of Christianity, especially since they were arguing largely on grounds chosen by their opponents. From such writings as the *Homily on the Passover* by the apologist Melito of Sardis it can be seen that his Christian faith is not fully expressed in the extant fragments of his apology.

Origin and Nature of the Apologetic Movement.—The apologetic movement began not in Christianity but in Hellenistic Judaism, where Philo of Alexandria not only interpreted Judaism in philosophical terms but also wrote treatises (now lost) explicitly apologetic. Late in the 1st century of the Christian era Flavius Josephus was concerned more with history than with philosophy and tried to correlate biblical history with that recorded by non-Jewish writers. Both kinds of correlation are reflected in Christian apologies, though the first Christian to use Philo's writings was Clement of Alexandria, the first to use Josephus was Theophilus (*q.v.*) of Antioch. In other words, the primary influence of Hellenistic Judaism on the apologists was that of a movement of thought, not of individual writers; the apologists generally took over methods, not conclusions. To such an influence was due the apologists' emphasis on the doctrine of creation, on the importance of the Old Testament and on the work of the Logos in creation and revelation. It should be added that their work was facilitated by the situation of contemporary philosophy, in which previous dogmatic acceptance of traditional schoolteaching was being supplanted by an eclecticism that often venerated ancient oriental wisdom and sought to be justified by it. Platonism and Stoicism tended to be combined, and Skepticism, by undermining older epistemologies, opened the way for acceptance of teaching based on revelation. Finally, within New Testament Christianity itself could be found at least intimations of apologetic. Examples exist in the first two chapters of Paul's letter to the Romans and in the Areopagus address in Acts xvii. The fact that parallels to these passages can be found both in Greek and in Jewish literature shows clearly that bridges were being built between the church and the world.

The most important apologists were those in the 2nd century.

In addition to adopting Hellenistic Jewish methods, they made use of traditional materials provided in Greco-Roman education. The most obvious examples of such materials are to be found in the anthologies of poetry and philosophical opinions used in schools. In these anthologies, theological and ethical doctrines were illustrated by short excerpts from tragic and comic poets, often revealing the discord present in their views; similarly the ideas of various philosophers were briefly stated in relation to various topics. The conclusion, probably intended by the anthologists, was easy to draw: poets and philosophers alike disagreed among themselves. The apologists then proceeded to claim that truth was known only by revelation—the revelation expressed in the Old Testament and fulfilled in Jesus Christ. (The fact that such apologists as Tatian, Theophilus and Minucius Felix do not name Jesus or Christ is due to their desire to argue on their opponents' grounds.)

In addition, the apologists relied upon the doctrine of the Logos, or rational principle governing the world, to explain the existence of a general revelation that had produced some general idea of truth. According to Justin, this Logos was present, though inadequately, in Heraclitus, Socrates and even in Musonius, the Stoic contemporary of St. Paul; it had become incarnate in Jesus Christ. On the negative side, the existence of paganism was due to demons, who in the apologists' view (derived from late Judaism) were fallen angels. Both the doctrine of a universal Logos and that of subordinate supernatural beings were familiar conceptions in 2nd-century thought; the picture of the work of the Logos that Theophilus draws is strikingly parallel to what the rhetorician Aelius Aristides says of the generation and activity of Athena. And several apologists were impressed by the parallel between the life and death of Socrates and the life and death of Jesus, though they did not forget to insist upon the greater significance of the latter.

All of them had read at least some of the works of Plato, especially the *Timaeus,* in which there is a mythological description of the origin of the universe. In their view Plato had been given a partial revelation of the doctrine of creation, but the doctrine of creation was superior to Plato's because it affirmed the transcendence of God in relation to the world. This doctrine occupies an important place in their thought because it is related to the omnipotence of God and supports the doctrine of resurrection, on which they also insisted, usually defending it by analogies from nature.

It has been argued that Justin, at least, developed a "theology of history" to which Celsus replied, but it is at least doubtful that Justin had such a theology in mind, except insofar as the idea of prophecy and fulfillment points toward it. Most of the apologists found the Incarnation difficult to correlate with their apologetic. This does not mean that they failed to believe in the Incarnation (Tatian speaks once of "the God who suffered"); it only means that on the grounds they had accepted from their opponents they found it easier to speak of the generation of the Logos before or at creation.

Early Apologists.—*Quadratus.*—The earliest-known Christian apology exists only in a short fragment preserved by the church historian Eusebius (*Church History,* iv, 3, 1–2). This comes from an apology addressed to the emperor Hadrian about 125 by Quadratus of Athens, perhaps bishop there. Quadratus insists upon the reality of the healing miracles of Jesus in contrast to those ascribed to someone else, perhaps Hadrian himself. The fragment is not extensive enough to determine exactly how its author developed his apology.

Aristides.—A little later comes the apology of Aristides. In its Syriac version (from a manuscript of the 17th century) it begins with a definition of God apparently Stoic in origin and then shows, in a rather naïve way, how various religions have fallen short of it; it ends with a brief statement about the Christian revelation. It appears that much of Aristides' work is based on an earlier Jewish apology; unfortunately, it also appears that at some point in its transmission it has suffered a good deal of interpolation and revision. The Syriac version is rather different from the Greek paraphrase, which is embedded in the medieval romance *Barlaam and Josaphat* (*q.v.*). As a witness to early Christian apologetic, the apology of Aristides cannot be employed with complete confidence.

Justin Martyr.—The most significant of the early apologists was St. Justin Martyr (*q.v.*), who turned from Platonism to Christianity after his complacency was upset by the constancy of Christian martyrs, and his elementary Platonism was shattered by Christian arguments that were ultimately Aristotelian. He could no longer believe in the innate immortality of the soul or in its transmigration. As a Christian teacher he addressed to the emperor Antoninus Pius, about 150, a treatise that included a defense of Christian morality, a proof (largely based on the Old Testament) of the truth of the Christian revelation and a description of Christian worship (to show that it was not immoral). Perhaps a decade later Justin prepared a briefer work that makes more extensive use of philosophical arguments.

It appears that both works were intended for delivery to the imperial secretariat; they are genuine apologies. Politically they had little result, though it must be recalled that there were very few Christian martyrdoms in the reign of Antoninus Pius. Under Antoninus' successor, Marcus Aurelius, Justin was executed at Rome about 165, as we learn from the authentic Acts of his martyrdom. In later times he was remembered as the only Christian "philosopher" of the 2nd century, and writings composed between the 3rd century and the 6th were ascribed to him. These later writings replaced his genuine apologies, which along with his *Dialogue* with the Hellenistic Jew Trypho survive only in a manuscript copied in 1364. It is possible, but not very likely, that the fragments on the resurrection ascribed to him by John of Damascus are actually his; the mode of argument is unlike anything in the apologies or the *Dialogue.*

As for the other writings ascribed to Justin, both the *Oration* to the Greeks and the treatise *On Monarchy* (or "divine unity") contain nothing specifically Christian and seem to come from Hellenistic Judaism; the *Cohortatio* seems to reflect the religious situation of the 3rd century; the epistle *To Diognetus* is certainly not his (*see* APOSTOLIC FATHERS); and other documents set forth the Antiochene theology of the 5th century and later. The *Expositio rectae fidei* was written not by Justin but by Theodoret (*q.v.*).

Tatian.—Justin frequently wrote on the grounds of an eclectic philosophy that combined Platonic with Stoic insights; like other eclectics, he could state that "whatever has been said well by anyone is ours." His pupil Tatian (*q.v.*), trained in rhetoric rather than philosophy, reacted violently from his master's attitude, perhaps because it had resulted only in martyrdom, and probably in 177 produced his militant *Address to the Greeks,* in which he bitterly attacked almost every aspect of Greco-Roman culture, including philosophy, medicine, art and history. By the time he wrote, Tatian had probably already left the church in order to establish his own rigourist school. In the *Address* he referred to his treatise *On Animals,* in which he had explained that apart from the divine spark man was nothing but an animal. This doctrine is characteristic of Gnosticism (*q.v.*).

Apollinaris, Melito and Athenagoras.—Though Tatian's attitude toward culture was later adopted by the Latin apologist and theologian Tertullian (*q.v.*), who also left the church, in his time the other orthodox apologists shared a much more conciliatory viewpoint. The fragments of Apollinaris of Hierapolis and Melito (*q.v.*) of Sardis, about 175–176, are clearly pro-Roman. The former drew the emperor's attention to a miraculous storm that saved a Roman army in 174 and claimed that it was due to the prayers of Christian soldiers. The latter argued that since Christianity had arisen at the same time as the Roman empire and had been persecuted only by tyrannical emperors, it should be recognized as the religion of the state.

The occasion for the writings of both apologists was provided by a revolt against Marcus Aurelius, which, though crushed soon after it took place in 175, led to government efforts to ensure domestic tranquility and to attacks, at least local, upon Christians as potentially subversive. A little later, as persecution developed, Athenagoras (*q.v.*) of Athens produced his *Embassy* (177) in order to deny that Christians were either godless or

immoral. In relation to the Christian worship of God, Athenagoras provided a semiphilosophical account of the doctrine of the Trinity. His loyalist attitude is reflected in the statement that the rule of Marcus Aurelius and his son Commodus is analogous to that of God the Father and his Son. (The treatise *On the Resurrection* later transmitted with the *Embassy* is possibly not by Athenagoras since it seems to be directed against the doctrine of Origen.)

Theophilus.—The last of the early Greek apologists, Theophilus of Antioch (*see* THEOPHILUS, SAINT), stands between anti-Greek and pro-Greek views. Much less conciliatory than Justin or his own immediate predecessors, Theophilus still insists that Christians are loyal to the emperor and, while he vigorously attacks Greek philosophers, poets and historians, he goes no farther than did the Skeptics, whose arguments he used.

Anti-Christian: Celsus.—From the situation of crisis between 175 and 180 there remains one important document, almost entire, which represents the anti-Christian camp. This is the *True Discourse* produced by the Middle Platonist Celsus (*q.v.*) about 178. Known only from quotations provided by Origen in his refutation of 248, the work of Celsus shows how Christianity looked to an intelligent but highly unsympathetic critic. He first assumes the role of a Jew (or, in other words, uses Jewish sources) in order to question the historical reliability and the theological significance of the story of Jesus; then he attacks the principal Christian doctrines on grounds largely philosophical in nature. His work ends with a denunciation of the Christians for their failure to support the Roman emperor and army against barbarism. In it is found an attempt to treat Christianity as a modern version of ancient errors; like the apologist Justin (whose writings he may have known), Celsus claims that whatever is true is his.

Later Apologists.—The apologetic movement did not, of course, come to an end in the 2nd century. The impression that it did is due to the fact that while later theologians wrote apologetic works these were usually less significant than their more strictly theological writings. As examples may be mentioned the *Protrepticus* by Clement of Alexandria (*see* CLEMENT), the important reply to Celsus composed by Origen (*q.v.*), the *Praeparatio evangelica* of Eusebius of Caesarea, and the various answers offered to the anti-Christian Neoplatonists Porphyry and Julian during the 4th century.

In the latter half of the 2nd century Christian apologies were written in Latin, beginning either with the *Octavius*, composed by a certain Marcus Minucius Felix, with much use of Cicero's writings, at an uncertain date, or with Tertullian's *Ad nationes* and *Apologeticus* in 197. Tertullian's work is especially important because, while he often used the writings of his Greek predecessors, he assimilated their materials for his own purpose and created works that possess a literary distinction not found earlier. In addition, two important Latin apologies of the early 4th century exist, the *Adversus nationes* by Arnobius (*q.v.*) and the *Divinae institutiones* by Lactantius Firmianus (*q.v.*). The former is a mordant critique of pagan religion by a half-educated Christian; the latter, an elaborate philosophical analysis of pagan culture by a Christian rhetorician. The Latin apologetic movement culminated in the *City of God* by St. Augustine early in the 5th century.

In later times, under different circumstances, apologetic writings were still produced; mention need be made only of the *Proslogium* of St. Anselm (*q.v.*) and the *Summa contra gentiles* of St. Thomas Aquinas (*q.v.*). In modern times the need to present the Christian religion to a non-Christian world has led to a revival of concern for apologetics and thus to increased interest in the early apologists.

Transmission of Their Works.—After the period in which the apologists wrote, most of their writings were allowed to perish, partly because of the different political situation after the church was recognized by the Roman state and partly because of the different theological situation after the Council of Nicaea. The church realized that the Logos theology of the apologists seemed to favour the thought of the Arians (*see* ARIANISM). The few early manuscripts of their works that have survived owe their existence to Byzantine scholars; for example, in 914 Arethas, bishop of Caesarea in Cappadocia and vigorous student of classical literature, had a collection of early apologies copied for his library. Many of the later manuscripts were copied at the time when the Council of Trent was discussing the nature of tradition. The genuine writings of the apologists were virtually unknown, however, either in the east or in the west until the 16th century. The first apologetic work to be translated into Latin, the treatise *On the Resurrection* ascribed to Athenagoras, was published at Paris in 1498, but his genuine *Embassy to the Greeks* appeared there only in 1557. The genuine apologies of Tatian and Theophilus were published at Zurich in 1546. The first edition of the works of Justin Martyr in Greek (Paris, 1551) consisted largely of works wrongly attributed to him. After the 16th century the only significant discovery in this field was the publication of the apology of Aristides, from a Syriac version, in 1889. A few papyrus fragments have contributed almost nothing new.

Modern Criticism.—In the 19th and early 20th centuries the apologists, and especially Justin, often have been attacked by critics opposed to philosophical theology. Hans Lietzmann, for example, found Justin essentially confused, since on the one hand he maintained "a philosophical religion which clothes Greek ideas and conceptions in a loose Biblical garment, and which in the end issues in man's self-redemption ethically conceived," and on the other, "the unreasoned faith of the church in which words of Jesus, sacramental mysticism, and church life combine to form an active unity" (*The Founding of the Church Universal*, London; [1950] p. 185, Lutterworth Press). The key words here are "philosophical religion" and "unreasoned faith"; none of the apologists would have found this contrast meaningful. The apologists were attempting to create a synthesis; they were not altogether successful, but the ability of a modern historian to take the synthesis apart does not prove either (1) that synthesis is impossible or (2) that theirs was entirely inadequate.

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APOMORPHINE is prepared from morphine by the abstraction of one molecule of water. It lacks the narcotic properties of morphine, its chief action being on the vomiting centre in the brain. As an emetic, it is administered hypodermically. It should not be used indiscriminately since even therapeutic doses may exert a profound depressant effect. *See* also MORPHINE.

APOPHOROMETER. This apparatus is used for the identification of minerals by means of sublimation. It consists of an electrically heated platinum ribbon, on which the substance under examination is spread, enclosed between two watch glasses. The whole may, if necessary, be placed in a vacuum or surrounded by an inert gas, thus avoiding the oxidizing or reducing effects of the flame used in tests with the ordinary blowpipe.

APOPHYLLITE, a hydrous calcium and potassium silcate mineral, always occurs as distinct crystals which belong to the tetragonal system. The form is either a square prism terminated by the basal planes, or an acute pyramid. A prominent feature

of the mineral is its perfect basal cleavage, on which the lustre is markedly pearly, presenting, in white crystals, somewhat the appearance of the eye of a boiled fish; hence the old name fisheye stone, or ichthyophthalmite, for the mineral. On other surfaces the lustre is distinctively vitreous.

Apophyllite is a mineral of secondary origin, commonly occurring in cavities in basalt and other lava rocks. It is often found in association with zeolites, which it resembles, but is not classed with them because it contains no aluminum. Magnificent groups of greenish and colourless tabular crystals of apophyllite, the crystals several inches across, were found with flesh-red stilbite in the Deccan traps of the Western Ghats, near Bombay, during the construction of the Great Indian Peninsular railway.

Groups of crystals of a beautiful pink colour have been found in the silver veins of Andreasberg in the Harz and of Guanajuato, Mex. Crystals also have been found in Iceland and Nova Scotia and in New Jersey, Pennsylvania, Michigan and California.

The formula for apophyllite is $KCa_4FSi_4O_{10}.8H_2O$. Its hardness is 4.5 to 5 on Mohs' scale and its specific gravity is 2.3 to 2.4. (L. J. S.; C. S. H.)

APOPLEXY: *see* Stroke.

A POSTERIORI: *see* A Priori and A Posteriori.

APOSTLE. The term apostle, which means "person sent," is generally understood as applying specifically to the 12 most intimate disciples of Jesus, in fact as synonymous with "the Twelve." In Luke vi, 13 it is stated that Jesus chose 12 from his disciples "whom he named apostles." And in Mark vi, 30 the Twelve are quite casually named apostles when mention is made of their return from the mission of preaching repentance and of healing the sick on which Jesus had sent them. The full list of the Twelve is given with some variation in Mark iii, Matt. x and Luke vi: Peter, James and John the sons of Zebedee, Andrew, Philip, Bartholomew, Matthew, Thomas, James the son of Alphaeus, Thaddaeus or Judas the son of James, Simon the Cananaean (or Cananaian) or the Zealot and Judas Iscariot. For information about the individual apostles, *see* the separate articles on each of them. This article is concerned solely with the status and function of the apostles as a body.

Argument rages among scholars as to whether or not these New Testament references to "apostle" represent the first appearance of the idea in Jewish literature. Whatever may be the date of the emergence of the word *shaliach* (Hebrew equivalent of the Greek *apostolos*), the function of official messenger must often have been employed in Jewish government circles. On important business important emissaries must have been dispatched, some of whom may well have acquired the status of plenipotentiary. That Jesus followed some such precedent is at least likely.

The Twelve Apostles.—Thus, though it would be too much to say that among the Jews of the time of Jesus there was a regular office of apostle, the function at least was recognized: it had its own associated rights and privileges, and it was a simple and natural thing for Jesus to make use of it. The unusual steps that Jesus took were to make the number of his apostles 12, perhaps symbolic of the kingdom of heaven as including all 12 tribes of a restored Israel (*cf.* Matt. xix, 28; Luke xxii, 30; Rev. xxi, 10–14), and to make their function permanent, at least in the sense of giving them pre-eminence among the disciples. Even so it is to be noticed that the name apostle is used of the Twelve only once each by Mark and Matthew in connection with their actual mission, and by Luke three times referring to the mission and on three other occasions. John does not use the term *apostolos* except in xiii, 16, meaning "messenger," but he does use the cognate verb in reference to the mission of Jesus by the Father (xx, 21).

The privileges of the Twelve were to be in continual attendance on their master and to be the recipients of his special teaching and training. Once at least they were sent on a special mission, two by two in what appears to have been "apostolic" fashion, to announce the imminence of the Messianic kingdom (Mark vi; *cf.* Matt. x; Luke ix). Three of them, Peter, James and John, formed an inner circle who alone were permitted to witness such events as the raising of Jairus' daughter (Mark v, 37; Luke viii, 51), the Transfiguration (Mark ix; Matt. xvii; Luke ix) and the agony in the garden of Gethsemane (Mark xiv, 33; Matt. xxvi, 37). One of these, Peter, was recognized as their spokesman and leader and received the special promise of the keys of the kingdom of heaven (Matt. xvi, 19).

Special importance seems to have been attached to the number 12. When a gap had been left by the defection and death of the traitor Judas Iscariot, immediate steps were taken to fill it by the election of Matthias (Acts i). It is to members of this band of 12 that the word apostle is applied 24 times out of the 26 occurrences of it in Acts. Surprisingly, on the other two occasions (xiv, 4, 14) it is applied quite casually and without explanation to Paul and Barnabas.

Other Apostles.—Paul himself provides plenty of evidence that the scope of the title was wide enough to admit far more than the Twelve (*cf.* especially "Then to the twelve . . . then to all the apostles"; I Cor. xv, 5–7). He himself regularly claimed the title of apostle (*e.g.*, "Paul, an apostle of Jesus Christ by the will of God," II Cor. i, 1; Eph. i, 1; Col. i, 1; II Tim. i, 1), apparently on the ground that he had seen the Lord and received a commission directly from him. This appears to agree with the condition in Acts that a newly appointed apostle should be capable of giving eyewitness testimony to the Lord's resurrection (Acts i, 21, 22; *cf.* I Cor. ix, 1). In Rom. xvi, 7 it is at least suggested that Junias and Andronicus were reckoned among the apostles, and in Gal. i, 19 so is James "the Lord's brother."

The bearers of the title were now sufficiently numerous to have invited imitation by some who certainly had no right to it. In II Cor. xi, 13 Paul speaks of "false apostles [*pseudapostoloi*], deceitful workmen, disguising themselves as apostles of Christ." He perhaps speaks the more bitterly as he had experienced some difficulty in establishing his own claim. The passage suggests both that it was still held in high honour and that the distinctive mark of being "sent" by authority was not so clearly distinguishable as it had been in the case of the original Twelve. There appear to have been "signs" by which an apostle might be known, as for instance witness of the resurrection (Acts i, 21, 22), commissions from Christ himself (Luke vi, 13; Gal. i, 1), miracles (Acts ii, 43; *cf.* Heb. ii, 4) and possibly also inspiration (John xvi, 13). But such signs can hardly have been obvious after the first generation.

Tantalizingly little is known about the second grade of "apostles." The most satisfactory explanation is offered by A. Richardson, who draws a sharp distinction between those who had received their commission directly from the Lord, such as the Twelve, and those who were emissaries of the local churches.

Apostolic Office and Function.—It has become customary to speak of "apostolic men," the term being used as a kind of bridge between the Twelve and the later episcopal government of the church. That administration was a function of the apostles seems clear from the position accorded to them in the New Testament after the resurrection of Jesus Christ. It is notoriously difficult in reading the New Testament to distinguish between office and function. It is probable that the lists of ministerial gifts in such passages as I Cor. xii, 28 and Eph. iv, 11 have in view function rather than office; but the fact that the apostles are mentioned first suggests that they are regarded as the highest rank in the church's ministry, or, as some would put it, the rank from which all the ministry flows. Certainly the general picture presented in the New Testament makes the apostles appear as the leaders both in evangelization and in administration. Indeed it would seem almost inevitable that they should exercise authority at least in the churches of their own foundation. It is clear from the epistles of John as well as from those of Paul that that authority sometimes was challenged (*cf.* III John, 9), but the very vehemence of the riposte shows how unnatural the challenge was held to be.

Apostles After the New Testament Period.—That apostles continued to exist even after the period covered by the New Testament is clear from early Christian writers. In the *Didachē*, an enigmatic document of the 2nd century, apostles seem to be coupled with wandering prophets, about whose bona fides one cannot always be certain (*cf.* the doubtful reference in the epistle

to Diognetus, ii, 1; xii, 9). On the other hand Clement of Rome (*c.* A.D. 96), arguing the case for an official succession of ministers in his letter to the Corinthians, distinguishes clearly between the apostles and those "distinguished men" whom they appointed to succeed them and to hand on the succession again to others. Ignatius of Antioch (*c.* A.D. 115) strikes an unusual note by comparing the authority of the bishops to that of the Father and the Son, while the authority of the priesthood is compared with that of the apostles. However, by the middle of the 5th century Theodoret in his commentary on the Pauline Epistles states quite bluntly that "those who are now called bishops were formerly called apostles."

It looks therefore as if the term apostle originally given in Christian circles to the Twelve, and then achieving a wider connotation (much as the pioneer missionary of a country is still called the "apostle" of that country), later became used of the chief administrative ecclesiastical officer of a district before finally reverting to its original significance. (*See* EPISCOPACY and MINISTRY, CHRISTIAN.)

Rudolf Bultmann, however, radically changes the order of development. He holds that the looser application of the term "apostle" to all missionaries came first and was narrowed down to the Twelve in the interests of a desire to establish the theory of apostolic succession. This appears to be an anachronism. The Twelve were in great esteem from the beginning, and the gospels faithfully reflect the situation. There is no need to call in a special motive for the emphasis placed upon them in the gospel record beyond the desire to make it clear that in fact Jesus did treat them so. The recognition that the Twelve were apostles par excellence meant that they were the chosen delegates of Christ but did not preclude the possibility of the use of the term for other people on other occasions. It might be employed (*e.g.*, by Paul) to designate delegates to certain churches or the delegates of local churches to one another. By the end of the 2nd century, as in the writings of Irenaeus, the desire to prove an "apostolic" succession both of office and of doctrine against the Gnostic heresy threw the term into strong relief. But there would have been no value in appealing to apostolic precedent if it had not been firmly rooted in the tradition that the apostles had from the beginning played a leading role in the life of the church.

Legends About the Twelve Apostles.—As Paul had made missionary journeys and brought people far afield into the Christian fold, it was later assumed that the other apostles must have done the same, although there is no mention of it in the Bible. Legends relate that each went to a different territory in which he successfully evangelized the local inhabitants, usually by miraculous means. It was further believed that each apostle was responsible for one of the 12 clauses or articles in the "apostles' creed," which in fact has no direct connection with the apostles (*see* CREED). Nor were the apostles the authors of the "apostolic constitutions" (*see* CONSTITUTIONS, APOSTOLIC). When the 12 apostles are represented in art, the traitor Judas is generally omitted and Paul takes his place.

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APOSTOLIC FATHERS, the title given to a group of Greek Christian writers who belonged to the second or third generation after the Apostles, with whom tradition associated them (Clement and Hermas with Peter and Paul; Barnabas with Paul; Ignatius, Polycarp and Papias with John). At first these writers were called "apostolic men" (Apostolici); the name Apostolic Fathers was first applied to early 2nd-century writers in the 6th century, after the conception of the authority of the Fathers had been developed. It did not pass into common use until the 17th century. Since that time it has been applied not only to the writers mentioned but also to the authors of a diverse group of writings that, as ordinarily printed, includes the *Teaching of the Apostles* or *Didache*, first published in 1883; the 2nd- or 3rd-century apology entitled *To Diognetus;* and the late 2nd-century *Martyrdom of Polycarp*. The group is thus very heterogenous. It included letters (one by Clement of Rome, seven by Ignatius of Antioch, one or two by Polycarp of Smyrna, one from Asiatic churches describing Polycarp's death), an apocalyptic writing with appendices (Hermas), a document dealing with church order (the *Didache*), exegetical treatises (Barnabas, fragments of Papias), a sermon (II Clement) and an apology (*To Diognetus; see* APOLOGISTS, EARLY CHRISTIAN). Not everything in the group comes from the early 2nd century, and not everything in it is equally valuable theologically; but taken as a whole the writings of the Apostolic Fathers are more valuable historically than any other Christian literature outside the New Testament. They provide a bridge between it and the more fully developed Christianity of the late 2nd century.

To a remarkable extent the writings of the Apostolic Fathers have come to light only in relatively recent times. First Clement, discovered in the Codex Alexandrinus of the Greek Bible, was published at Oxford in 1633, but a complete text of it and of II Clement was not found until 1875. The genuine letters of Ignatius, painstakingly restored by use of a medieval Latin translation by Archbishop Ussher in 1644, were first published from a Greek manuscript in 1646 at Amsterdam. The first edition of the *Epistle of Barnabas*, printed by Ussher in 1644, was destroyed by fire, and the first real publication was therefore given by Dom Luc d'Achery at Paris in 1645. Hermas was published in Latin by Lefèvre d'Étaples at Paris in 1513, but in Greek it first appeared in 1857. The letter to Diognetus appeared in 1592, when (as in the manuscript that contained it) it was assigned to the apologist Justin. The *Martyrdom of Polycarp* was first printed in 1689. Before this work of discovery and publication took place, there was a long period in which writings wrongly ascribed to the Apostolic Fathers supplanted their genuine writings. During and after their recovery, scholars tended to value their primitive teaching too highly, but subsequently a more balanced appraisal was made. Their value lies in their reflection of the beginnings of Christian life and thought.

Clement.—The oldest of the Apostolic Fathers is almost certainly Clement, who toward the end of the 1st century wrote in the name of the Roman Church to the Church of Corinth in order to urge its dissident members to return to peace and apostolic order. (*See* CLEMENT: *St. Clement I.*) His letters were regarded as scripture by many Christians of the 3rd and 4th centuries, and by some even later. The principal subjects discussed in I Clement are as follows: (1) the troubles at Corinth explained as due to jealousy and envy, with examples from the Old Testament and from the martyrdoms of Peter and Paul (1–6); (2) the need for repentance, leading to the harmony evident in the creation (7–20); (3) the importance of resurrection (21–32); (4) the necessity of good works in relation to the high priest Jesus Christ, in whose army we serve (33–38); (5) the apostolic succession (30–45); (6) Paul and the need for reconciliation and love (46–50); (7) examples showing the need for humility and obedience (51–58); (8) the need to pray for the elect (59–61); (9) summary on the inspiration of Clement and his messengers to Corinth (62–65). Each of these sections is ended with a doxology. With it, in our manuscripts, was transmitted a homily known as II Clement, probably written at Rome in the period between 125 and 140. Its genuineness, questioned by Eusebius and Jerome, was upheld in the 5th and 6th centuries by Monophysites, who believed that it anticipated their theology when it began with the words, "Brothers, we must think of Jesus Christ as of God."

Ignatius.—Another early Apostolic Father was Ignatius, bishop of Antioch early in the 2nd century, who on his way to martyrdom at Rome wrote seven letters: five to churches in Asia Minor (at Ephesus, Magnesia, Tralles, Philadelphia and Smyrna), one to Polycarp of Smyrna and one to the Roman Church. In these he opposed Judastic and/or Docetic heresy and made a plea for Christian unity, which he based primarily on the unity of the monarchical episcopate. In the 4th century (or perhaps later) his letters suf-

fered interpolation, and six more were added by someone who found Ignatian theology hard to reconcile with the conclusions of the council of Nicaea (or of Chalcedon). The Monophysites, again, found his authentic letters attractive, especially because he was fond of the expression "my God, Jesus Christ," and in this situation neo-Chalcedonians tended to use the inauthentic version instead. It was this version that Lefèvre d'Étaples first published, in Latin, in 1498. Ignatius' vivid Syrian rhetoric and his yearning for martyrdom have sometimes impelled scholars to regard him as somewhat neurotic and to discount the validity of his testimony to the primitive episcopate. His insistence upon its importance has been treated as due to idiosyncrasy. On the other hand, it would appear that, while Ignatius' ideas were not shared by all his Christian contemporaries, his witness for the state of the church should not be discounted too markedly. (*See* also IGNATIUS, SAINT.)

Polycarp.—From Ignatius' younger contemporary Polycarp one letter exists which seems to speak at one point of Ignatius' death as past and, at another, of it as future; the letter also denounces a heresy that may be that of Marcion, later than Ignatius' time. These apparent contradictions have led many scholars to suppose that they are two letters rather than one. It is also possible, though uncertain, that like Ignatius' letters that of Polycarp has undergone later revision. The Monophysites, who were quite careful in citing authorities, provided quotations from Polycarp that do not exactly correspond with the existing text (much of which is available in a late Latin translation). (*See* also POLYCARP, SAINT.)

Hermas.—Either toward the beginning of the 2nd century or somewhat later a certain Hermas, according to later tradition brother of Pius, bishop of Rome, produced a book known as the *Shepherd* (from the guise of the angel who appeared to him). It contains a series of five visions to which Hermas later added 12 moral "commandments" and ten "parables." His basic purpose was to teach that postbaptismal sin was not unforgivable; a certain "day of repentance" would soon come, though sins committed after that time could not be forgiven. Hermas represents a kind of Jewish Christianity (also reflected in II Clement) that seems to have flourished at Rome during the period. His work, regarded as scripture by many writers in the century after his time, gradually lost its influence, though it is contained in the Codex Sinaiticus of the Greek Bible and is found in many Egyptian papyrus fragments of various dates. It was translated into Latin and several oriental languages.

Barnabas.—The so-called *Epistle of Barnabas* is really an exegetical treatise on the use of the Old Testament, which in the author's view cannot be understood by Jews; its significance can be understood only by those who read it and search for "types" or prefigurations of Jesus. Its author is not content with types but often goes into the purest of allegorizations. At the end of his work he sets forth the "two ways" of light and darkness (ch. 18–19). His work, regarded as scriptural at Alexandria, was not so highly regarded elsewhere; and, though it is included in the Codex Sinaiticus, few Christians continued to read it.

Papias.—The fragments of the *Exegeses of the Dominical Oracles*, a work written by Polycarp's contemporary Papias, bishop of Hierapolis in Phrygia, were preserved chiefly by Irenaeus and Eusebius; the latter commented on the Jewish apocalypticism that undoubtedly resulted in the neglect of Papias' work, though he also preserved some rather obscure remarks of Papias about the church's gospels. (*See* also PAPIAS.)

Others.—In the latter decades of the 2nd century the *Martyrdom of Polycarp* was composed; this, along with the roughly contemporary *Martyrdom of Justin*, is the oldest authentic account of an early Christian martyr's death. Unfortunately the form in which it is presented in extant Greek manuscripts (the oldest of which comes from the 10th century) is rather different from that provided by the lengthy extracts found in Eusebius; and it is possible, if not probable, that it has undergone interpolation. In Eusebius' quotations are not found the elaborate comparison of the death of Polycarp with that of Christ which is given in the fuller version.

The epistle *To Diognetus* consists partly (ch. 1–10) of an apology for Christianity not unlike that of Theophilus of Antioch (*q.v.*) and partly of a liturgical sermon (11–12) in the style of Melito of Sardis or Hippolytus of Rome. The association of this document with the Apostolic Fathers must be regarded as simply a mistake.

Finally, the *Didache*, composed either at the end of the 1st century or toward the end of the 2nd, is not the product of an Apostolic Father but reflects the liturgy and order of a church possibly in Egypt but more probably in Syria. Its importance lies in its primitive Jewish-Christian catechetical materials (ch. 1–6; some paralleled in Pseudo-Barnabas), in its rather enigmatic description of baptism and Eucharist (7–10) and in its regulations to govern the conduct of peripatetic apostles and prophets (who are beginning to be supplanted by bishops and deacons; 11–15). The book ends with a picture of the return of Christ (16). The basic problem in regard to the *Didache* is whether it describes a real situation of the 1st century or, consciously or unconsciously, archaizes its picture from the standpoint of some later time. Treated as canonical by a few early writers, its materials were appropriated by the authors of the 3rd-century *Didascalia* and the 4th-century *Apostolic Constitutions* (*see* CONSTITUTIONS, APOSTOLIC), and, except in isolated Egyptian communities, it dropped out of use.

Significance.—The very heterogeneity of the Apostolic Fathers, in the form and the content of their writings, provides a valuable indication of the condition of Christianity immediately after, and to some extent contemporary with, the writing of the New Testament. They show how the Pauline epistles were being interpreted (I Clement, Ignatius, Polycarp); the earlier ones seem to reflect a time when the sayings of Jesus, not written gospels containing them, were regarded as authoritative, though it is not always certain that written gospels were not being used. They reflect the development of ecclesiastical authority. Clement of Rome speaks in the name of the Roman Church and, insisting upon the importance of the apostolic succession of presbyters (not altogether clearly differentiated from bishops), gives instructions to the church at Corinth. Ignatius of Antioch shows the existence of a threefold ministry of bishops, presbyters and deacons in Asia Minor and in Syria. Polycarp of Smyrna gives instructions to the presbyters of the nearby church of Philippi. The *Didache* speaks of the development of the ministry, and Hermas reflects a similar situation. Both Ignatius and the *Didache* clearly present baptism and the Eucharist as central elements of Christian life, while all these writers insist upon the importance of Christian morality.

It has been argued that their writings represent a significant decline from the Christianity of the apostolic age, especially in relation to the Pauline doctrine of grace. In reply to this claim it may be said that (1) they did not necessarily express the full range of their religion in the documents that have been preserved, and (2) the kind of doctrine of grace to be found in the major Pauline epistles is not the only emphasis tenable within Christianity. Under various circumstances various aspects of the doctrine may need to be stressed. According to the tradition of the church, and perhaps already in the letter of Polycarp, the thought of Paul himself is adequately represented not in his major epistles alone but in the Pastoral Epistles (*q.v.*) as well. In relation to apostolic Christianity, the Apostolic Fathers are important because they constitute the earliest witnesses both to New Testament scripture and to tradition. They show the New Testament church alive and flourishing in a new age, though the extent to which all of them fully represent Christian teaching in their times remains open to question; on the basis of the available evidence the question probably cannot be answered. Toward the end of the 2nd century Irenaeus (*q.v.*) made use of Clement, Ignatius, Polycarp, Papias and Hermas; he obviously regarded them as witnesses to the apostolic tradition; as a hearer of Polycarp he may well have been capable of judging whether or not they correctly represented the Christian teaching of their day.

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APOSTOLICI, a name given to various Christian sects that sought to re-establish the life and discipline of the primitive church by a literal observance of the precepts of continence and poverty. The earliest Apostolici (known also as Apotactici and Renuntiatores) appeared in Asia Minor in the 4th and 5th centuries. In their origins, they are probably to be connected with the Encratites. They renounced private property and condemned marriage as impure.

The name of Apostolici also has been given to certain groups of Latin heretics of the 12th century. This movement seems to have arisen from a heretical current that entered Italy and France from the east during the 11th century. Its development was favoured by the wealth and worldliness of the western church at that time. In the course of the 12th century its Neo-Manichaean ideas (*see* MANICHAEISM) were diffused in various centres of southern and northern France, whence it passed into Flanders and the Rhineland. These groups had in common the condemnation of marriage, of the eating of meat and of infant baptism, as well as itinerant preaching, harsh criticism of the church and denial of priestly power.

In the second half of the 13th century appeared in Italy the Apostolic Brethren. This sect, whose origins are to be connected with the penitential and mystic fermentation associated with the ideas of Joachim of Fiore (*q.v.*) and with exalted Franciscanism, was founded about 1260 by Gerard Segarelli, an uncultured workman of Parma, with the idea of restoring what he conceived to be the apostolic way of life. In time he gathered a considerable number of followers who lived as wandering preachers of repentance, without vows but in absolute poverty. Segarelli's increasingly eccentric ways and the diffusion of his followers into several countries led Pope Honorius IV to order them in 1286 to adhere to an already recognized rule. The order refused to submit, and its members were marked as heretics. In 1290 Nicholas IV issued a new bull against them. A time of persecution followed. Four were burned in 1294, and Segarelli, as a relapsed heretic, went to the stake at Parma in 1300.

This persecution embittered their opposition, and under Fra Dolcino, who now took the leadership, the sect became larger, openly antisacerdotal and heterodox. Dolcino was an apocalyptic enthusiast of great gifts and eloquence, who declared in several epistles that the third Joachimite age began with Segarelli and attributed to himself a Messianic role in the establishment of a new and purer church. When a crusade was summoned against him, Dolcino entrenched himself in the mountains around Vercelli, and it was not until 1307 that the sectaries were definitely overcome and Dolcino burned. Traces of the sect remained in northern Italy, France and Spain until the middle of the 14th century.

In later times the doctrines of the various Apostolici were approached most closely by some sects of the Anabaptists (*q.v.*). (C. H. Lo.)

APOSTOLIC SUCCESSION, the doctrine according to which the bishops represent a direct, uninterrupted line of descent from the Apostles, from whom they derive certain special powers; chief among the latter are the power to ordain priests and to teach and rule over the clergy and laity of their diocese. *See* EPISCOPACY; MINISTRY, CHRISTIAN.

APOTHECARY. During the middle ages the application of the term apothecary became restricted to those who prepared and sold drugs, and it is still used in that sense in the United States, Scotland and on the European continent. In England, however, the apothecary became a general medical practitioner. (X.)

United States.—Among the earliest English and continental European colonists in America were apothecaries who had been trained in the old world. They brought with them the practices and customs of their respective countries and endeavoured to practise their art in colonial America.

Uniformity in the practice of pharmacy began to develop as the colonies became more populous and means of communication and travel improved. In addition, many drugs indigenous to America were added to the armamentarium of the apothecary. At the time of the Revolutionary War the activities of the apothecaries were so well established that an office of apothecary general was created for the army by the Continental Congress. The appointee, Andrew Craigie, served on the general staff of the army under Gen. George Washington. The guild of apothecaries organized the first college of pharmacy in Philadelphia in 1821. This school enjoyed continuous operation thereafter. William Procter was appointed to the chair of pharmacy in 1846 and distinguished himself as a teacher, investigator and organizer.

As a medical enterprise the first United States *Pharmacopoeia* was published in 1820. In 1852 the American Pharmaceutical association was organized, and pharmacists soon took an active part in the revisions of the *Pharmacopoeia*. The Food and Drugs act of 1906 made the *Pharmacopoeia* and its companion volume, the *National Formulary* published by the American Pharmaceutical association, the national standards for drugs. The colonial apothecaries guild evolved through the decades into an organized U.S. pharmacy. Nationally it came to be represented by the American Pharmaceutical association, National Association of Retail Druggists, American Association of Colleges of Pharmacy, American Drug Manufacturers association and numerous other associations representing the various facets of the profession. (J. C. K.)

England.—From early records it is apparent that the different branches of the medical profession were not regularly distinguished in England till the 16th century, when separate duties were assigned to them and peculiar privileges were granted to each. In 1518 the physicians of London were incorporated, and the Company of Barber-Surgeons, incorporated originally in 1461 but without disciplinary powers, was reincorporated in 1540 and given these powers. But, independently of the physicians and surgeons, there were a great number of irregular practitioners, who were more or less molested by their legitimate rivals, and it became necessary to pass an act in 1543 for their protection and toleration. As many of these practitioners kept shops for the sale of medicines, the term "apothecary" was used to show their calling.

In 1617 the Society of Apothecaries was founded by James I. The status of apothecaries underwent gradual consolidation and they acquired additional powers until in 1815 the society by act of parliament was given powers of examination and granting of licences to practise medicine. Armed with these powers the society insisted on courses of medical study in candidates for its licence to practise. In common with all other licensing bodies, the curriculum it imposes and the examinations it conducts are subject to scrutiny and approval by the General Medical council.

The Society of Apothecaries is governed by a master, 2 wardens and 21 assistants. The members are divided into three grades, yeomanry or freeman, the livery and the court. The hall of the society, situated in Black Friars lane, London, and covering about

three-quarters of an acre, was acquired in 1632. It was destroyed by the Great Fire, but was rebuilt about ten years later, and enlarged in 1786. This is the only property possessed by the society. In 1673 the society established a botanic and physic garden at Chelsea, and in 1722 Sir Hans Sloane (*q.v.*), who had become the ground owner, gave it to the society on the condition of its presenting annually to the Royal society 50 dried specimens of plants till the number should reach 2,000. This condition was fulfilled in 1774.

Because of the heavy cost of maintenance the "physic garden" was handed over in 1902, with the consent of the Charity commissioners, to a committee of management, to be maintained in the interests of botanical study and research. *See* also PHARMACOLOGY; PHARMACOPOEIA; PHARMACY.

APOTHEOSIS, literally "deification" (Gr. *apotheoun*, "to make a god," "to deify"). The term properly implies a clear polytheistic conception of gods in contrast with men, while it recognizes that some men cross the dividing line. It is characteristic of polytheism to blur that line in several ways. Thus the ancient Greek religion was especially disposed to belief in heroes and demigods. Founders of cities, and even of colonies, received worship; the former are, generally speaking, mythical personages and, in strictness, heroes. But the worship after death of historical persons, such as Brasidas, or worship of the living as true deities, as Lysander and Philip II of Macedonia, occurred sporadically even before the conquests of Alexander the Great brought Greek life into contact with oriental traditions. It was inevitable, too, that ancient monarchies should enlist polytheistic conceptions of divine or half-divine men in support of the dynasties. Whatever part vanity or the flattery of courtiers may have played with others, or with Alexander, it is significant that the dynasties of the Seleucids (*q.v.*) and Ptolemies (*q.v.*), Alexander's successors, claimed divine honours of some sort. Theocritus hails Ptolemy Philadelphus as a demigod and speaks of his father as seated among the gods along with Alexander. Ancestor worship, or reverence for the dead, was another factor, as was also, of course, mere sycophancy.

The Romans, up to the end of the republic, had accepted only one official apotheosis, the god Quirinus, whatever his original meaning, having been identified with Romulus. But the emperor Augustus carried on the tradition of ancient statecraft by having Julius Caesar recognized as a god, the first of a new class of deities proper. The tradition was steadily followed and was extended to some women of the imperial family and even to imperial favourites. Worship of an emperor during his lifetime, except as the worship of his genius, was in general confined to the provinces. Apotheosis, after his death, being in the hands of the senate, did not at once cease, even when Christianity was officially adopted.

The Latin term is *consecratio*, the Greek *apotheosis*, probably a coinage of the Hellenistic epoch, and occasionally used in a weakened sense. The squib of the philosopher Seneca on the memory of Claudius (d. A.D. 54), *apocolocyntosis* ("pumpkinification"), is evidence that, as early as Seneca's lifetime, *apotheosis* was in use for the recognition of a departed emperor as a god.

It also indicates how much contempt might be associated with this pretended worship. The people, says the historian Suetonius, fully believed in the divinity of Julius Caesar, hinting at the same time that this was by no means the case with the majority of the apotheoses subsequently decreed by the senate. Yet Marcus Aurelius was still worshiped as a household divinity in the 4th century and was earlier believed to impart revelations in dreams. Antinous, the favourite of Hadrian, was adored in Egypt a century after his death. The ceremonies attendant on an imperial apotheosis are fully described by Herodianus. The most significant was the liberation of an eagle, which was supposed to bear the emperor's soul to heaven. Sharp-sighted persons had actually beheld the ascension of Augustus and of Drusilla, the sister of Caligula.

Representations of apotheoses occur on several works of art; the most important are the apotheosis of Homer on a relief in the Townley collection of the British museum, that of Titus on the arch of Titus, and that of Augustus on a magnificent cameo in the Louvre. *See* also ANCESTOR WORSHIP.

APPALACHIAN MOUNTAINS, the general name of a mountain system in eastern North America extending from Newfoundland, Gaspé peninsula and New Brunswick in Canada 1,200 mi. southwestward to central Alabama. The whole system may be divided into three regions: the northern from Newfoundland to the Hudson river; the central from the Hudson to the Kanawha river in West Virginia and Virginia; and the southern from the Kanawha river to central Alabama. The northern region includes the Shickshock mountains and Notre Dame range in Quebec, scattered elevations in Maine, the White mountains of New Hampshire and the Green mountains of Vermont. The central region comprises the Ridge and Valley province between the front of the Allegheny plateau and the Great Appalachian valley, the Allegheny plateaus of New York, western Pennsylvania and West Virginia and a large portion of the Blue Ridge.

The southern region consists of a large portion of the Piedmont plateau sloping to the east and bordering on the Atlantic coastal plain, the prolongation of the Blue Ridge, the Great Smoky, Black and Unaka ranges of North Carolina and Tennessee and the Ridge and Valley province adjoining the Cumberland plateau on the west, with some lesser ranges. A remarkable feature of the Appalachian belt is its longitudinal valley, the Great Appalachian valley, which in the southerly regions divides the mountain system into two subequal portions, but in the northern section lies west of the Appalachian ranges of New England and Canada and separates them from the Adirondack group.

The mountain system has no axis of dominating altitudes but in every portion the summits rise to uniform heights and, especially in the central portion, the various ridges and intermontane valleys

APPALACHIAN MOUNTAIN SYSTEM, SHOWING APPROXIMATE DIVISIONS OF ITS THREE REGIONS

have the same trend as the system itself. Mountains of the Long range in Newfoundland reach heights of over 2,500 ft. In the Shickshocks of Quebec the higher summits rise to about 4,000 ft. In Maine 12 peaks exceed 4,000 ft., including Katahdin (5,268 ft.); in the White mountains a number of summits rise above 5,000 ft., including Mt. Washington (6,288 ft.); in the Green mountains the highest point, Mansfield, is 4,393 ft. The Blue Ridge, rising in southern Pennsylvania and known there as South mountain, attains elevations of about 2,100 ft.; southward to the Potomac its altitudes diminish, but in Virginia a maximum is reached at Mt. Rogers (5,720 ft.). In the Ridge and Valley province of Pennsylvania the ridges rise generally to about 2,000 ft., and in Maryland Eagle Rock and Dans Rock are conspicuous points reaching 3,160 ft. and 2,895 ft., respectively. In the southern region of the Blue Ridge is Grandfather mountain (5,939 ft.), with three other summits above 5,000 ft. The Unaka, Black and Smoky mountains have 18 peaks higher than 5,000 ft. In the Black mountains, Mitchell (6,684 ft.), the culminating point of the whole system, is the highest peak in the U.S. east of the Mississippi. In the Smoky mountains, Clingmans Dome (6,642 ft.) is the highest peak.

In the central region the rivers—Delaware, Susquehanna, Potomac—heading in the Allegheny plateau run southeastward into the Atlantic. These rivers cutting across the grain of the Ridge and Valley topography form great gorges called water gaps. South of the Kanawha river the Appalachian ranges are drained westward by the Cumberland and Tennessee rivers, tributaries of the Ohio river. In the northern section the water parting lies on the inland side of the mountainous belt, the main lines of drainage (Hudson, Connecticut, Penobscot rivers) running from north to south into the Atlantic.

Geology.—The rocks of the Appalachian belt fall into two divisions: granites and other massive igneous rocks, and a great succession of Paleozoic sediments. The crystalline igneous rocks are confined to the portion of the belt east of the Great Appalachian valley. The Paleozoic rocks of this area, assuming their greatest areal extent in New England and Canada, are always highly metamorphosed and very generally intruded by granites. The Paleozoic sediments, ranging in age from Cambrian to Permian, occupy the Great Appalachian valley, the Ridge and Valley and the plateaus still farther west. They are rarely metamorphosed to the point of recrystallization, though in eastern Pennsylvania shales are altered to slates, and coals, originally bituminous, are changed to anthracite in northeastern Pennsylvania (*see* PENNSYLVANIA: *Mining*) and to graphite in Rhode Island. The most striking and uniformly characteristic geologic feature of the mountains is their internal structure, consisting of innumerable parallel, long and narrow folds, always closely oppressed in the eastern part (Piedmont plateau to Great Appalachian valley), less so along a central zone (Great Appalachian valley and Ridge and Valley) and increasingly open on the west (Allegheny and Cumberland plateaus).

Folding of the rocks resulted from the operation of great compressive forces. Extensive and deep-seated crumpling was necessarily accompanied by vertical uplift, but once at least since their birth the mountains have been worn down to a lowland, and the mountains of today are the combined product of subsequent uplift and dissection by erosion. The longitudinal valleys were determined by the outcrop of soft shales or limestones, and the parallel ridges upheld by hard sandstones or schists. Parallelism of mountain ridges and intervening valleys is thus attributable to the folding of the rocks. For discussion of geologic processes *see* FOLD; GEOLOGY: *Physical Geology*. For specific occurrences *see* CAMBRIAN SYSTEM; CARBONIFEROUS SYSTEM AND PERIOD; DEVONIAN SYSTEM; SILURIAN SYSTEM.

Forests.—The region is well covered with forests yielding quantities of valuable timber. The most important trees for lumber are spruce, white pine, hemlock, cedar, white birch, ash, maple and basswood. In the central and southern parts of the belt, ash and hickory constitute valuable hardwoods, and certain varieties of the former furnish quantities of tanbark. In the south both white and yellow pine abound.

Influence on History.—From the time of early settlement the Appalachians were a barrier to the westward expansion of the English colonies; the continuity of the system, the tortuous courses and the roughness of its transverse passes, a heavy forest and dense undergrowth all conspired to hold the settlers on the seaward-sloping plateaus and coastal plains. The confinement of the colonies between an ocean and a mountain wall led to the fullest possible occupation of the continent's coastal border under existing economic conditions, conducing to a community of purpose and a political and commercial solidarity, which would not otherwise have developed.

In contrast with this complete industrial occupation, the French territory beyond the mountains was held by a small and very scattered population; its extent and openness added materially to the difficulties of a disputed tenure. Bearing the brunt of the contests against the French as they did, the colonies were undergoing preparation for the subsequent struggle with the home government. In the American Revolution the American armies fought toward the sea with the mountains at their back protecting them against Indians leagued with the British.

See also AMERICAN FRONTIER: *The First Frontier;* MIDDLE WEST.

Appalachian Trail.—Beginning on Mt. Katahdin in Maine, the Appalachian trail for hikers and backpackers stretches southward for more than 2,000 mi. to Springer mountain in northern Georgia, passing through 14 states, eight national forests and two national parks. The trail is maintained by trail and hiking clubs and on public lands co-operatively with government land-managing agencies. Primitive shelters and trailside campsites are provided along the route. At each of these areas, from 7 to 8 mi. apart, the hiker is expected to do all necessary work himself, including replenishing the stock of cut firewood. The co-ordinating organization for the various groups sponsoring trail activities is the Appalachian Trail Conference, Inc., Washington, D.C.

See also references under "Appalachian Mountains" in the Index.

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(E. W. Mı.)

APPEAL, in early common law, was a process of criminal procedure by which an aggrieved party, frequently the relative of a homicide victim, could compel the trial of the alleged felon by resort to one of the early irrational modes of determining guilt or innocence, generally trial by battle. This form of private vindication was available though the accused had been previously tried and found innocent, or found guilty and pardoned. The appeal, in this sense, flourished until the rise of the modern jury trial. It fell into desuetude by the time of the Tudors, but it was not formally abolished until 1819.

The first section of this article deals primarily with appeal in United States law, with only such references to English law as are desirable for historical background. For the English and commonwealth law, *see* the second section below.

In recent times appeal has come to mean the resort to a higher court to review the decision of a lower court or to a court to review the order of an administrative agency. It also has had and continues to have technical meanings which distinguish one form of such review from another, as, for example, in the supreme court of the United States where the term signifies a review as of right as distinguished from review at the discretion of the court, on a petition for certiorari.

The concept of review of one court by a higher court in the Anglo-American legal system was probably derived from the hierarchical system of ecclesiastical courts. Judicial review of this sort has been known almost from the time English judicial courts became separated from the generalized function of the *curia regis*. Thus, the judgments of the local and manorial courts were subject to review by the court of common pleas, which in turn was subject to review by the court of king's bench. Almost from the beginning, too, the right of review has been hedged by a myriad of technicalities which differ greatly from jurisdiction to jurisdiction.

The Judicial Hierarchy.—The concept of appeals requires

the existence of a judicial hierarchy. It is possible for a court to review its own judgments. Thus, the judge at the trial level may be asked to consider whether errors in the trial require correction; this is usually done by a motion of the losing party asking for a new trial or similar relief. Such procedure, however, is not considered an appellate process. Similarly it is possible for one or more judges of a court to have a judgment reviewed by several or all of the judges sitting on the same level of courts. So, too, the entire appellate court might be asked to review its own decisions. Both of these situations are usually termed "rehearings" rather than appeals, although the concept of appeals in criminal cases developed from the notion of a trial court sitting *en banc* to review questions of law raised at a trial before a single judge. Again, by resort to the use of one of the so-called extraordinary or prerogative writs or of habeas corpus it is possible to call for a review of a judgment in civil and criminal cases. Once more, however, this does not take the form of an appeal. The notion of an appeal relates to the overseeing of an action of a lower court by a higher one, and this is predicated on the existence of such a hierarchy.

A typical judicial hierarchy will include: (1) trial courts of limited or special jurisdiction, frequently denominated magistrates courts, justices of the peace, small-claims courts, municipal courts, etc.; (2) trial courts of general jurisdiction which usually carry the name of district court, circuit court or superior court, and occasionally, as in New York, of supreme court; (3) a court of appellate jurisdiction, which may be the ultimate appellate court in the system and, if so, is usually called the supreme court. There may be, however, between the trial court level and the court of ultimate appeal an intermediate appellate court, generally bearing the name of appellate court, appellate division or court of appeals. In most instances, each court in the hierarchy is subject to review only by the court immediately above it. Frequently, however, an intermediate step may be omitted because the importance or immediacy of the problem calls for direct review of the trial court by the highest appellate tribunal.

The Right to Appeal.—Although the right of one appeal is provided in almost every case by statute in all common-law jurisdictions and by the constitutions of some states, it is not uniformly afforded (see *Thompson* v. *Louisville*, 362 U.S. 199 [1960]), and it is not yet considered by the supreme court of the United States to be one of those essential aspects of "ordered liberty" commanded by the due process clauses of the U.S. constitution (see *McKane* v. *Durston*, 153 U.S. 684 [1894]). Indeed, in criminal cases no right of appeal existed in England, with a few exceptions, until 1907, and in the federal courts of the United States, again with a few exceptions, until 1891. The national constitution does require, however, that where appeals are provided, at least in criminal cases, a defendant may not be deprived of his right of appeal because he cannot pay the cost of preparing the necessary documents (*Griffin* v. *U.S.*, 351 U.S. 12 [1956]).

Who May Appeal.—As a practical as well as a legal matter, only the party aggrieved by the order or judgment of a court is entitled to seek review of that order or judgment in the appellate court. Neither an outsider nor the party who has prevailed in securing the order or judgment for which he asked is permitted to secure a review of that order or judgment by a higher court. Where, however, persons not originally parties to the action have been permitted to intervene or have been represented by others, as in class actions, or have subsequently been made parties voluntarily or otherwise, they generally have the same rights of appeal as the original parties. One exception to this rule might be noted. In the federal courts, when the losing party has filed an appeal from the district court in the appropriate U.S. court of appeals, the party who prevailed at the trial court level may seek review by the U.S. supreme court before judgment by the court of appeals. The extraordinary nature of this process is underlined by the very few occasions on which the supreme court has been willing to indulge this form of review. What might also be considered an exception exists in criminal cases. In almost all jurisdictions the prosecution cannot appeal from a judgment entered on a verdict of not guilty. This disqualification, however, is not commanded by the federal constitution (*Palko* v. *Connecticut*, 302 U.S. 319 [1937]), and the states of Vermont and Connecticut do authorize appeals by the state from judgments of acquittal.

Appealable Orders.—Orders and judgments of trial courts may be divided into two categories for purposes of appeal: final and interlocutory. The U.S. supreme court has defined a final judgment as "one which ends the litigation on the merits and leaves nothing for the court to do but execute the judgment" (*Catlin* v. *U.S.*, 324 U.S. 229, 233 [1945]). The problem is, of course, more complicated than that formula would appear to make it (see *Cohen* v. *Beneficial Industrial Loan Corp.*, 337 U.S. 541 [1949]), but the formula will suffice for present purposes. In the course of a trial, a court is required to enter decisions which settle only subsidiary questions or some but not all of the ultimate issues. These decisions are regarded as interlocutory orders. All jurisdictions sanction appeals from final judgments. No jurisdiction authorizes appeals from all interlocutory orders. But the jurisdictions are divided on the question of allowing appeals from important interlocutory orders. New York, for example, is among the jurisdictions which do permit appeals from a wide variety of interlocutory orders. The final-judgment rule jurisdictions, on the other hand, include states like Illinois and until recently the federal court system. Even in jurisdiction of the Illinois type, however, some interlocutory orders are appealable. Thus, appeals are generally allowed from interlocutory injunctions. The federal courts have recently been required to apply a rule somewhere in between. Judgments disposing of some but not all of the ultimate issues are appealable if the trial judge certifies the desirability of such review (*see* Federal Rules of Civil Procedure, rule 54(b), and *Sears, Roebuck Co.* v. *Mackey*, 351 U.S. 427 [1956]), and since 1958 there has been authority to review all interlocutory orders provided (1) that the trial court certifies that the order involves a substantial question of law the resolution of which may expedite the disposition of the case and (2) that leave to appeal is granted by the court of appeals (28 U.S. Code, sec. 1292). The argument in favour of the final-judgment rule is that it prevents delay incident to a series of interlocutory appeals. The argument in favour of the interlocutory-appeal rule is that it provides an opportunity for final resolution of the case before trial in many instances, and in any event provides clear guidance to the trial court for conducting the trial on the basis of rules established by the appellate court. There is merit in both systems, but the 1958 federal compromise of the final-judgment rule may provide a median way which will lead to the best solution.

Form of Presentation of Appeal.—Generally the presentation of the appeal will be by one of two methods or a combination thereof. Frequently where the appeal is taken from a court of minor jurisdiction to a court of general jurisdiction, provision is made for trying the case anew, as though it had originated in the higher court. Though most usual in the appeal from justices of the peace, the *de novo* trial is authorized elsewhere, as, for example, in the review of Interstate Commerce commission orders by a federal district court. The more usual approach calls for the presentation of the appeal on the basis of the record of the trial court proceedings. Generally, in the United States, argument will be presented both in writing, in the form of briefs, and orally in the presence of the court. Oral argument in the United States is usually of severely limited duration, approximately one-half hour for each side in most courts and one hour per side for most cases in the U.S. supreme court.

Scope of Review.—Except where the trier of the facts, *i.e.*, the jury, or the trial court judge in a case tried without a jury, has reached patently erroneous conclusions, the appellate court will not ordinarily reconsider their resolution of the dispute between the parties over the facts to which the law is to be applied. Somewhat more control is exercised by the appellate court where the evidence in the trial court was presented in the form of documents, for then the trial court would have had no advantage over the appellate court in determining the credibility of the evidence adduced. While many jurisdictions provide for review of the facts as well as of the law by appellate courts, and

although the appellate court is almost never wholly restricted to corrections of errors of law, for most purposes it is only errors of law which it is called upon to consider. No longer does the existence of an error in the trial court proceedings require an automatic reversal of the lower judgment. First, the appellate court will not ordinarily even consider the impact of an error to which the counsel did not raise an objection in the trial court. Second, the appellate court will certainly not consider as a basis of reversal any error which was in fact invited by the complaining party. Third, and most important, is the rule that an error which was not likely to have affected the result will not provide a basis for reversal. This so-called "harmless error" doctrine by now has been adopted everywhere. It is perhaps best stated succinctly in rule 61 of the Federal Rules of Civil Procedure, which provides: "No error in either the admission or the exclusion of evidence and no error or defect in any ruling or order or in anything done or omitted by the court or by any of the parties is ground for granting a new trial or for setting aside a verdict or for vacating, modifying, or otherwise disturbing a judgment or order, unless refusal to take such action appears to the court inconsistent with substantial justice. The court at every stage of the proceeding must disregard any error or defect in the proceeding which does not affect the substantial rights of the parties."

The Functions of the Appeal.—Basically the appeal serves two functions. Its first and perhaps primary function is to assure the litigants that justice under the law has been done in the resolution of the specific controversy. Its second function is one which is perhaps peculiar to the Anglo-American system of law: it is the promulgation of rules of decision which will be binding on all lower courts within a judicial system, thus assuring uniformity of treatment and some measure of certainty and guidance to those whose actions bring them within the ambit of the rule.

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GREAT BRITAIN AND THE COMMONWEALTH

Civil and Criminal Appeals.—In the English system of law the right to appeal from one court to another is created, and created exclusively, by statute. Two systems of appeal exist, the one in civil, the other in criminal matters, both having in common that the house of lords is the final court of appeal for each. In civil matters, when a final judgment has been given, appeal lies, without leave, from all three divisions of the high court of justice and, in some cases (see *Appeals From County Courts*, below), from the county courts to the court of appeal; from thence it lies either by leave from the court of appeal or, if that be refused, from the house itself (in practice the appellate committee) to the house of lords. This statement requires qualification when the relevant statute is other than the Judicature act or the County Courts act, since certain statutes confine the jurisdiction of the court of appeal to questions of law, excluding questions of fact, while others limit the right of appeal to the court of appeal, excluding appeals to the house of lords. Appeals from magistrates' courts or from quarter sessions by way of case stated (see *Criminal Appeals*, below) lie to a court of the appropriate division of the high court (*e.g.*, in matrimonial cases, to the probate, divorce and admiralty division) and from thence to the court of appeal only by leave of the divisional court or of the court of appeal.

Criminal Appeals.—In criminal cases appeals lie to the court of criminal appeal on questions of law alone without leave, and on other grounds on application to the court of criminal appeal or on the certificate of the trial judge that the case is fit for appeal, in all trials by indictment—in effect, all cases tried by assize courts or by courts of quarter session in the exercise of their original jurisdiction. The courts-martial appeal court (virtually the court of criminal appeal under another name) hears appeals from courts-martial. From magistrates' courts (except when, as stated above, the appeal is by way of case stated) appeal lies to quarter sessions. Under the Administration of Justice act, 1960, appeal from the court of criminal appeal lies to the house of lords only by leave of the court or of the house and on a question of law of general public importance. (It was formerly only on the fiat of the attorney general.)

Some explanation is here needed of the appeal by way of case stated. A case stated is not necessarily an appeal at all, but rather an action the parties to which, or at least one of them, seek the opinion of the court (rules of the supreme court, order 34, rule 1). In an arbitration, the opinion of the court may be sought in this way and, in this instance, before the court has pronounced upon it. But s. 88 (1) of the Magistrates' Courts act, 1888, provides that: "Any person who was a party to any proceedings before a magistrates' court or is aggrieved by the conviction, order, determination or other proceeding of the court may question the proceeding on the ground that it is wrong in law or in excess of jurisdiction by applying to the justices composing the court to state a case for the opinion of the high court on the question of law or jurisdiction involved." The justices may, if they consider the application frivolous, refuse to state a case, but if they should do so the applicant may request the high court to make an order of mandamus requiring the justices to state a case. At any rate, where the magistrates' courts are concerned the procedure by way of case stated is part of the appellate jurisdiction of the high court. Appeals from determinations of the divisional court lie to the court of appeal only by leave of the divisional court or of the court of appeal.

Appeals From County Courts.—Under the County Courts act, 1959, a party to proceedings in a county court who is "dissatisfied with the determination or direction of the judge in point of law or upon the admission or rejection of any evidence" may appeal to the court of appeal (s. 108). The leave of the judge is required when, broadly speaking, the subject matter of the action does not exceed £20 in value. Section 109 confers a right of appeal on questions of fact subject to the conditions there set out, the most important of which is that, in actions founded on contract or tort or for money recoverable by statute, the subject matter must, generally, exceed £200.

Interlocutory Appeals.—In interlocutory matters there is a right of appeal in the queen's bench division from the masters, and in the probate, divorce and admiralty division from the registrars, to the judge in chambers; the masters and the registrars being subordinate judicial officers with jurisdiction in interlocutory matters and, to a limited extent, power to make final orders also. In the chancery division either party has the right to ask the master to adjourn the matter to the judge in chambers, but the effect is much the same. From the judge in chambers appeal lies from the judge to the court of appeal only by leave of the judge or of that court, and from the court of appeal to the house of lords only by leave of the court or of the house.

Appeals in Habeas Corpus and Contempt Proceedings.—The Administration of Justice act, 1960, referred to above, creates rights of appeal in certain classes of proceeding where none had existed before. In cases of contempt of court, appeals are to go from the court of appeal, the court of criminal appeal and the courts-martial appeal court to the house of lords; from courts to which appeals generally lie to the court of appeal, to that court; and from inferior courts to a divisional court of the high court. Appeals are also provided for in habeas corpus proceedings where the release of a person has been refused. This act also empowers the high court, in cases where a criminal charge has been tried before a magistrates' court or, on appeal, before a court of quarter sessions, to vary a sentence.

Scotland and the Commonwealth.—Appeal procedure operates broadly on the same principles in Scotland and Northern Ireland as in England, and the final court of appeal is for each country the house of lords. For all other countries in the British Commonwealth, where there is any right of appeal to a court outside the country or territory concerned—as there is from Australia and several other self-governing countries as well as from

the colonies—it lies to the judicial committee of the privy council. This committee also has jurisdiction to hear appeals (and, technically, to advise the sovereign) in appeals from ecclesiastical courts in England.

Principles and Procedure.—Appeals are by way of rehearing, but where issues of fact are concerned this generally involves a reading or summarization of the evidence heard in the court below, not oral testimony by witnesses themselves. The court of appeal and the court of criminal appeal both have the right to hear witnesses but this is rarely exercised, and then only in exceptional circumstances, when important new material which could not have been discovered before the trial has been brought to light since. Appeals from magistrates' courts to quarter sessions are, however, conducted quite differently, and the case is presented afresh on behalf of the prosecution, so that the appellant is able to call what evidence he will on his behalf.

On questions of law the appellate courts exercise their own judgment independently, though points not taken below can be admitted before them only if all the relevant facts have been established; but on questions of fact they work within narrower limits. Where the facts permit only one inference, the court may draw it even when the trial has been by jury. When trial has been by a judge alone, the burden of satisfying the court of appeal that the judge was wrong lies on the appellant, and the court should not disturb his judgment unless it is plainly unsound, since he had the advantage of seeing and hearing the witnesses (*Watt and Thomas* v. *Duncan*, 1947, A.C. 484). When an order is within the discretion of the judge, and the crucial question is a matter of discretion and not of law, the appellate court should not interfere unless the judge exercised his discretion on wrong principles.

See COURT; COURT OF APPEAL; CRIMINAL APPEAL, COURT OF; PRACTICE AND PROCEDURE; SUPREME COURT OF THE UNITED STATES, THE; *see* also the Index entries under "Appeal" in the Index volume.

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APPENDICITIS is the inflammation of the vermiform appendix, which is a vestigial wormlike structure attached to the caecum. The caecum is the pouchlike beginning of the large intestine; into the caecum empties the small intestine.

The appendix does not serve any useful purpose as a digestive organ in man. It is essentially a "blind alley" kind of organ with a channel that is two inches or more in length, closed at one end and communicating at the other with the caecum. Intestinal contents may work their way into the appendix and then be expelled by the muscular activity (peristalsis) of the walls of the appendix. Any factors that prevent the appendix from propelling its contents into the caecum may lead to appendicitis, as pointed out by O. H. Wangensteen. Intestinal material in the appendix may be prevented from escaping into the caecum by a failure of peristalsis or by a blocking of the opening into the caecum. The blocking can be caused by fecal concretions (fecaliths), undigested food particles such as seeds or by swelling of the lining of the appendix.

When the appendix is prevented from emptying itself a chain of events develops. Increasing pressure within the appendix leads to edema, swelling and distention of the appendix; the swelling is further increased by mucoid secretions from the lining of the appendix. As the distention increases the blood vessels of the appendix may become closed off, leading to gangrene. Meanwhile, the bacteria normally found in this part of the intestine (colon bacillus especially) proceed to propagate in this closed-off pocket. The combination of increasing tension from within and weakening of the wall by gangrene may lead to a rupture or perforation of the appendix. If this intestinal pus pocket spills into the peritoneal cavity, peritonitis, a very serious and often fatal condition, develops.

Fortunately peritonitis is usually prevented by the protective mechanisms of the body. The omentum, a sheet of fatty tissue, often wraps itself about the inflammed appendix. Exudate that has the clot-forming properties of fibrin normally develops in the areas of inflammation, behaving like paste or glue and sealing off the appendix from the surrounding peritoneal cavity with the help of the omentum. This prevents, in many instances, the direct spread of pus or intestinal contents into the peritoneal cavity. By this localizing process a ruptured appendix may lead to an abscess instead of a generalized peritonitis.

Occurrence and Symptoms.—Appendicitis is most common in the second and third decade of life but may occur in the very young or old. Males are afflicted in somewhat greater numbers than females.

The symptoms of appendicitis are varied. In the so-called typical case the pain may first be noticed all over the abdomen, or only in the upper abdomen, or about the navel. It is often described as a "gas pain." It is usually not as severe as the excruciating colic of gall bladder or kidney stones. After one to six hours or more the pain may become localized to the right lower abdomen. Nausea and vomiting may develop some time after the onset of the pain. Fever is usually present but is seldom high in the early phase of the disease. The leucocytes (white blood cells) are usually increased from a normal count of 5,000–10,000 in an adult to 12,000–20,000. Tenderness develops in the right lower abdomen, and the sudden release of pressure of the palpating hand may cause pain (rebound tenderness).

Diagnosis.—When there is some variation in the anatomical location of the appendix the pain and tenderness may be misleading. If the appendix is lateral to or behind the caecum the tenderness may be in the right flank. If the appendix lies deep in the pelvis one may detect tenderness only on rectal or pelvic examination and even then it may not be easily demonstrated. When the appendix lies on the left side due to transposition of viscera or failure of normal bowel rotation during embryonic life, the symptoms occur on the left. In the youngster and the elderly person the symptoms are more difficult to evaluate.

Appendicitis is one of many causes of abdominal pain. Various diseases produce symptoms that closely resemble appendicitis; these diseases include acute inflammation of the gall bladder, perforating ulcer of the stomach or duodenum, diverticulitis (inflammation of a small pouch) of the sigmoid colon, intestinal obstructions, inflammation of the uterine tubes (salpingitis), rupture of a tubal pregnancy, twisted ovarian cyst, bleeding from a ruptured *corpus luteum* of the ovary and perforating cancer of intestine. In addition, appendicitis-like symptoms may be produced by pneumonia, heart disease, *herpes zoster* (shingles) and kidney infection or stones.

Many abdominal pains are due to digestive disturbances related to food and have no serious significance. Diarrhea is generally a symptom that goes with digestive disturbances, but its presence does not necessarily exclude the possibility of an infected appendix.

Persons who experience abdominal pain that might indicate the early phase of appendicitis or some other perforating disease of the intestine should refrain from eating and should avoid taking cathartics (laxatives). It is very important to avoid cathartics because they increase the muscular activity of the intestine, making it more difficult for the fibrinous exudate to seal off the area of inflammation that may shortly perforate. The cathartic can definitely lead to the development of peritonitis.

If the abdominal pain continues for an hour or more it is wisest to seek medical advice, and appendicitis should be suspected in all patients who have abdominal pain, irrespective of age. Appendicitis is particularly serious in the elderly.

Removal of a Diseased Appendix.—Once a diagnosis of acute appendicitis has been made the appendix should be removed by surgery as soon as the patient's condition permits. In the early phase of the disease, *i.e.* up to 12–20 hours after the onset of symptoms, the mortality and disability rates arising from an appendectomy performed by a qualified surgeon in a well-equipped hospital are extremely low. On the other hand the mortality rate after an abscess has formed may be 3%–5%, and if spreading peritonitis has set in the death rate may be 10%–15% or even higher.

The decision about operation is a matter of surgical judgment in which the probabilities of appendicitis or some other condition

that would also require surgery are weighed against the probabilities of a disease or disorder that produces pain similar to that of appendicitis but does not require surgery. Even if the diagnosis of acute appendicitis cannot be made with reasonable certainty (and experienced surgeons often cannot be sure) it is safer to operate and possibly remove a normal appearing appendix than to wait and observe the symptoms (sometimes they develop overnight) and then find that the appendix has ruptured and peritonitis has set in.

Occasionally the patient is not seen by a physician until several days to a week after the onset of the attack, and an abscess may already be forming. In some cases of this kind the patient may be placed on a regime of nothing by mouth, intravenous fluids and antibiotics with a view toward obtaining better localization of the abscess for drainage purposes. There are times when it is preferable merely to drain the abscess and wait two to three months before operating to remove the appendix.

When appendicitis leads to rupture and produces a generalized peritonitis the patient may go into a state of shock with low blood pressure, weak and rapid pulse, cold and clammy hands and feet, and an ash grey or blue-tinged complexion. This requires the most intensive supportive therapy such as administration of plasma, intravenous saline, dextrose, high concentrations of antibiotics and blood transfusions. If the patient's condition improves, the ruptured appendix may be removed by surgery, but a patient in profound shock may not survive the operation.

Nonsurgical Treatment.—There is evidence that the use of antibacterial drugs instead of surgery for the treatment of appendicitis is hazardous because important symptoms may become masked. The antibacterial drugs are, of course, of tremendous value in postoperative management and in preparing some of the complicated problems for surgery.

Many patients will survive an attack of appendicitis without developing a serious complication, such as abscess or peritonitis. However, it is much safer to have the acute appendix removed early in an attack than to resort to any type of nonsurgical treatment except where medical facilities or personnel are not available or adequate for safe surgical treatment.

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APPENZELL is the name of a town and canton in northeastern Switzerland. The town is the political capital of Inner Rhoden, which comprises half the canton, and lies on the left bank of the Sitter in a hollow formed by the union of mountain torrents from the Säntis. Pop. (1960) 5,082, mostly German-speaking Roman Catholics. The town is full of fantastically gabled and painted houses with much good ironwork. Buildings include a stately modern church with a Late Gothic choir, an ancient chapel of the abbots of St. Gall (12½ mi. N.) whose summer residence was in the village, and two Capuchin convents, one for men (founded in 1588) and one for women (founded in 1613). The two great annual events are the *Landsgemeinde*, or open-air parliament, and the Corpus Christi procession in full local dress. The brass decorations on braces and belts and the gay handkerchiefs worn by the men are of traditional design, while the women's embroidered dresses and high lace headgear is particularly beautiful. Pastoral occupations, embroidery and weaving employ the people.

Weissbad, a cure and holiday resort, is 2½ mi. S.E. of Appenzell.

Appenzell Canton is entirely surrounded by that of St. Gall; both were formed out of the dominions of the prince abbots of St. Gall, whence the name Appenzell (*abbatis cella*). It belongs to the limestone zone on the north side of the main Alpine lines. The culminating point is Säntis (8,209 ft.) in the south of the canton. It is watered mainly by two streams that descend from Säntis, the Sitter and its tributary the Urnäsch.

By the middle of the 11th century the abbots of St. Gall had established their power in the land later called Appenzell, but as early as 1377 this portion of the abbots' domains formed an alliance with the Swabian free imperial cities and adopted a constitution of its own. In 1411 Appenzell was placed under the "protection" of the Swiss confederation, of which it became a member in 1513. Religious differences after the Reformation broke up the land into two half-cantons, each called *Rhoden*, a term said to mean a "clearing." From 1798 to 1803 Appenzell, with the other domains of the abbot of St. Gall, was formed into the canton Säntis of the Helvetic republic, but in 1803, on the creation of the new canton of St. Gall, shrank back within its former boundaries.

The north and west half-canton (or Ausser Rhoden) has a total area of 94 sq.mi., with a population (1960) of 48,920, mainly German-speaking Protestants. Its political capital is Trogen though the largest town is Herisau. Ausser Rhoden is divided into three administrative districts comprising 20 communes and manufactures cotton goods, muslins and embroidery. It sends one member (elected by the *Landsgemeinde*) to the federal *Ständerat* and three to the federal *Nationalrat* (elected by a direct popular vote).

The south or more mountainous half-canton of Appenzell (Inner Rhoden) has a total area of 67 sq.mi., with a population (1960) of 12,943, practically all German-speaking Roman Catholics. It is largely pastoral with numerous summer pastures. Inner Rhoden is extremely conservative and has the reputation of always rejecting any federal referendum. For similar reasons it has preserved many old customs and costumes. It sends one member (named by the *Landsgemeinde*) to the federal *Ständerat*, and one to the federal *Nationalrat*, while it forms but a single administrative district, though divided into six communes.

The canton of Appenzell is perhaps best known by its institution of *Landsgemeinden*, or primitive democratic assemblies held in the open air. This institution is of immemorial antiquity, and the meetings in both portions are always held on the last Sunday in April. The *Landsgemeinde* is the supreme legislative authority. Various old-fashioned ceremonies are observed at the meetings, and each member appears with his girded sword. The existing constitution of Inner Rhoden dates mainly from 1872, and that of Ausser Rhoden from 1876. The meeting for Inner Rhoden is held at Appenzell, that for Ausser Rhoden alternately at Hundwil (near Herisau) and at Trogen.

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APPERCEPTION, a psychological term, refers to the final stage of perception in which something is clearly apprehended and is prominent in awareness. The term also refers to the process by which the apprehended qualities of an object are related to or articulated with already existing knowledge in such a way as to lead to understanding. Apperception is thus a general term for those mental processes in which an experience, sensation or perception is brought into connection with already existent and systematized ideas and is thereby explained, classified or, in a word, understood. The pre-existing knowledge with which the apperceived content is articulated is called the apperceptive mass (J. F. Herbart).

Apperception is defined not in the terms of a modern behaviourism but rather in the language of a psychology of mental content. The latter needed a concept to distinguish between an inattentive, unreflective, even peripheral sort of awareness and an attentive, clearly focused awareness that included that appreciation of context which gives the object identity and meaning. Though the term itself is little used, the doctrine that understanding and learning depend upon discovering relationships between new facts presented and the pupil's already existing knowledge and experience appears prominently, in one way or another, in almost all educational theories. *See* also Perception; Psychological Tests and Measurements. (H. F. Ht.)

APPERT, NICOLAS (also known as François Appert)

(1752–1841), French chef, confectioner, distiller and inventor, known as "The Father of Canning," was born in Châlons-Sur-Marne, Oct. 23, 1752. Publication of his *Art de conserver les substances animales et végétales,* in 1810, set forth the principle of heat-and-hermetic-seal cooking, which, with improved techniques, is still used in commercial canning. Self-educated, he performed his experiments at a time when chemistry was in its infancy and bacteriology nonexistent. Scientists later confirmed his recommendations, Pasteur acknowledging that in proposing what came to be known as "pasteurization" he only made a new application of Appert's method.

With sailors dying of scurvy at sea, soldiers forced to forage on campaigns and malnutrition often fatal to the civilian population, the French *Directoire* in 1795 offered a prize for a method of preserving food for transport. Appert, experienced in cooking, confectioneries, distilleries, breweries and groceries, began a 14-year period of experiment in a workshop at Massy, using apparatus of his own construction. He applied his theory of cooking foods in containers from which air was sealed out, using glass jars and bottles stoppered with corks and reinforced with wire and sealing wax, to about 70 different items (soups, fruits, vegetables, juices, dairy products, marmalades, jellies, syrups). Tests by the French navy were favourable and on Jan. 30, 1810, after investigation and approval by the Consulting Bureau of Arts and Manufactures, the minister of the interior awarded him a prize of 12,000 fr. on condition that he "write an exact and detailed description of these processes."

In his lifetime he supervised four editions of this work and with the prize money established in 1812 the first commercial cannery in the world—the House of Appert, at Massy. The firm remained in business until 1933. Appert also created the bouillon tablet, devised a method for extracting gelatin from bones without the use of acid, perfected a workable autoclave and popularized use of the round container for canned foods. In 1822 the Society for Encouragement of National Industry titled him "Bienfaiteur de l'humanite" for having freed mankind from dependence on local and seasonal harvests. Appert died at Massy on June 3, 1841. *See* CANNING, COMMERCIAL. (N. H. B.)

APPIA, ADOLPHE (1862–1928), Swiss stage designer who, more than any other man except Gordon Craig, was responsible for guiding the visual theatre away from the stronghold of realism. Through his classic sketches and writings he became the prophet of the New Movement in the theatre in both Europe and America. He was born in Geneva, the son of Louis Appia. Although his early training was in music, at the age of 26 he felt impelled to reform the visual theatre and pursued his theatre studies in Dresden and Vienna. Three years later (1891) he propounded his revolutionary theories of theatrical production, illustrated with his settings for Wagner's music dramas. In 1899 his *Die Musik und die Inscenierung* was published in Munich. In this book he established a hierarchy of ideas for achieving his aims: (1) the proper display of the movement of the living actor; (2) a plastic stage that should provide the actor with spatial projection; and (3) the interpretive value of mobile light. He subordinated painting but stressed the significance of colour in light. The combination of these three elements constituted the re-establishment of the space stage. He expanded his theories in a second book, *L'Oeuvre d'art vivant* (1921), published in Geneva.

Appia's theories and philosophy of the visual theatre are recorded in his writings and sketches, and they exerted far more influence on the theatre of the 20th century than did the few productions he actually designed. He collaborated with Jacques Dalcroze in his school at Hellerau on numerous experimental theatre and dance productions. In 1923–24 he designed *Tristan und Isolde* for the Scala opera with Toscanini conducting. The following year he designed both *Das Rheingold* and *Die Walküre* for the Opera house at Basle.

A memorial portfolio of Appia's designs for the theatre was published in Geneva in 1929.

See also STAGE DESIGN; THEATRES (STRUCTURES): *New Theatre Forms.* (D. M. O.)

APPIAN OF ALEXANDRIA (2nd century A.D.), Greek historian of the conquests of Rome, flourished during the reigns of the Roman emperors Trajan, Hadrian and Antoninus Pius. He held public office in Alexandria where he witnessed the Jewish insurrection in A.D. 116. After gaining Roman citizenship he went to Rome where he practised as an advocate. Through his friend Marcus Cornelius Fronto he became a procurator, possibly in an honorary capacity, when already an old man.

Apart from a lost autobiography, he wrote in Greek a *Romaïca* or history of Rome in 24 books, arranged ethnographically according to the peoples (and their rulers) conquered by the Romans. There survive complete Books vi (Spain), vii (Hannibal), viii, part 1 (Carthage), ix, part 2 (Illyria), xi, part 1 (Syria), xii (Mithradates) and xiii–xvii (the civil wars from the Gracchi onward). Extracts from other books survive in Byzantine compilations and elsewhere.

Untouched by Atticism, Appian writes in a Greek which is no longer classical. Not himself an able historian he nevertheless preserves much information of value by his transmission of earlier sources, especially in Book i of the civil wars dealing with the period from Tiberius Gracchus (tribune 133 B.C.) to Sulla (d. 78 B.C.), for which it is a main source.

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(G. B. KD.)

APPIANI, ANDREA (1754–1817), Italian painter, the best fresco painter of his day, was born at Milan on May 23, 1754. He was made pensioned artist to the kingdom of Italy by Napoleon but lost his allowance after the events of 1814 and fell into poverty. His best pieces, which are in the church of Sta. Maria presso San Celso and the royal palace at Milan, almost rival those of his great master, Correggio. He died on Nov. 8, 1817. He is known as "the elder," to distinguish him from his great-nephew Andrea Appiani (1817–65), a historical painter at Rome.

Other painters of the same name were Niccolo Appiani (*c.* 1510) and Francesco Appiani (1704–92).

APPIAN WAY (VIA APPIA), the ancient high road from Rome to Campania and south Italy, was built in 312 B.C. by the censor, Appius Claudius Caecus. It first ran only 132 mi. to ancient Capua (modern Santa Maria Capua Vetere), but was prolonged to Beneventum (Benevento), Venusia (Venosa), Tarentum (Taranto) and Brundisium (Brindisi), probably by 244 B.C. The original road was evidently graveled; in 298 B.C. the footpath was paved in stone (*saxo quadrato*) from the Porta Capena of Rome to the temple of Mars (1 mi.); three years later the full width, which probably averaged at least 20 ft., was paved with lava (*silex*) to Bovillae, a colony of Alba Longa (*q.v.*), and further additions were made in 191 B.C. Elsewhere, the quality of the paving presumably varied. To Tarracina (Terracina) its course was almost straight, with steep gradients in the Alban hills. At Forum Appii it entered the Pontine marshes, which were partly drained to carry it, and in the time of Horace it was the practice to travel by roadside canal from Forum Appii. That this portion (19 mi., hence called Decennovium) belonged to the original scheme is shown by a milestone of about 250 B.C. from Ad Medias (Mesa); an earlier route had skirted the foot of the Volscian mountains and afterward was used as the post road until the 18th century. Under Nerva and Trajan there were extensive repairs, and to avoid the steep climb over the mountain on which Terracina stands, the cliff face was cut away to a depth of 120 ft. Despite further repairs by Theodoric (A.D. 486), this whole stretch became impassable in later times. Beyond Fundi (Fondi) the road struck through mountains to Formiae (Formia) and thence to Minturnae (Minturno) and Sinuessa (near Mondragone), towns of the Aurunci which had been conquered in 314 B.C.

On entering Campania, the road bore inland to Capua. For the traffic seeking the important Campanian harbours, this involved an awkward detour inland, which was eliminated in A.D. 95 by the building of the Via Domitiana along the coast. From Capua through the defile of Caudium (near Montesarchio) to Beneven-

FOTOTECA UNIONE, ROME

SECTION OF THE APPIAN WAY FROM ROME BEYOND ALBANO LAZIALE. THE SO-CALLED TOMB OF THE HORATII AND CURIATII IS ON THE LEFT

tum, the Appian way largely underlies the modern highway, as remains of bridges show. Between Beneventum and Brundisium the ancient road passed through Aeclanum (near Mirabella), Venusia and Tarentum; it was partly restored by Hadrian, but little remains of it. Another shorter but less easy route had run by Aequum Tuticum (either at Ariano or S. Eleuterio), Aecae (Troia), Herdoniae (Ordona), Canusium (Canosa di Puglia), Barium (Bari) and Gnatia (or Egnatia); under Trajan this was converted into the main highway, the Via Traiana, whose course is followed with minor changes by the modern highway. In the journey from Rome to Brundisium described by Horace (*Satires* i, 5) the route followed the Appian way to Aeclanum; thence he turned left to Ausculum (near Ascoli Satriano) by a side road (later called the Via Aurelia Aeclanensis) and joined the line of the Via Traiana at Herdoniae. Another secondary road, the Via Herculia, was built by Diocletian from Aequum Tuticum into Lucania, and intersected the Appian way near Venusia. Finally, the section from Tarentum to Brundisium was restored by Constantine about A.D. 315.

The Appian way was the oldest and most famous of Roman roads; it was celebrated by Horace, and Statius who called it *longarum regina viarum*, "queen of long-distance roads." It was administered under the empire by a curator of praetorian rank. The first few miles outside Rome are flanked by a striking series of tombs and monuments (*see* L. Canina, *La Prima parte della Via Appia . . .*, 1853). There are milestones and other inscriptions about its repair.

For descriptions of the remaining bridges and structures *see* Sir R. Colt Hoare, *Classical Tour through Italy* (1819); T. Ashby and R. Gardner, *Papers of the British School at Rome*, viii, 104 *et seq.* (1916); G. Lugli, *Forma Italiae I* (1926).

See also references under "Appian Way" in the Index.

(M. W. F.)

APPIN, a coastal district of Argyll, Scot., bounded west by Loch Linnhe, south by Loch Creran, east by Benderloch and Lorne districts, and north by Loch Leven and Glencoe (*qq.v.*). It measures 14 mi. N.E.–S.W. by 7 mi. in breadth. The coast is beautiful, and inland the country is rugged and mountainous. The streams Coe and Laroch flow into Loch Leven, Duror and Salachan into Loch Linnhe, and Iola and Creran into Loch Creran. The leading industry is slate and granite quarrying.

Duror, Ballachulish and Appin are the principal villages. The last two are ports of call for steamers, and the Scottish Region railway branch line from Connel Ferry to Ballachulish runs through the coastland. Appin was the country of a branch of the Stewarts.

APPLE. The apple is the domesticated form of *Malus pumila*, Mill (*Pyrus pumila*, Koch), with possible admixtures of other *Malus* species, members of the pomoideae division of the family Rosaceae. It is the most widely cultivated and best-known tree fruit of temperate climates; the world crop, including cider apples, exceeds 700,000,000 bu. in some years. This article treats the subject under the following headings: History; Varieties; Climatic and Site Requirements; Planting, Cultivation and Management; Diseases and Insect Pests; Harvesting, Storage, Use; Production.

The apple is one of the pome (fleshy) fruits in which not only the mature or ripened ovary but the surrounding tissue becomes fleshy and edible. The apple flower of most varieties requires cross-pollination (*i.e.*, by pollen from another variety; the honey bee is especially active in the transfer) to give fertilization and a desirable fruit set by 2% to 4% of the bloom. After the "June drop," at which time the small fruits fall off in large numbers, the remaining fruits increase in volume in fairly uniform fashion. The end product, though varying markedly in size, shape, colour and acidity depending on tree and environmental character, is nevertheless usually roundish, two to four inches in diameter and of some shade of red or yellow.

History.—*Malus pumila*, the species from which cultivated varieties are mainly derived, is native to southeastern Europe and southwestern Asia. Some suggest that it originated in the region immediately south of the Caucasus. These apples were undoubtedly used for food by the earliest inhabitants, and improved selections had been made and varieties were recognized in Europe more than 2,000 years ago. Cato (3rd century B.C.) recognized seven different varieties. Apples were carried by the Romans throughout much of Europe, including Britain, and may in fact have been in many parts even earlier. Hundreds of varieties were recognized in Europe prior to the settlement of the Americas.

The earliest settlers in the new world took with them both seed and propagating wood of the better European varieties. Orchards of considerable size were quickly developed; about 1649 Gov. John Endecott of Plymouth colony exchanged with William Trask 500 apple trees of three years' growth for 200 acres of land. Apples from New England were exported to the West Indies at least as early as 1741 and Albemarle Pippins were sent from Virginia to England as early as 1759. The apple accompanied early traders and settlers from Europe to the southern hemisphere and was carried from Europe or North America to India, China and Japan.

As the wave of settlement moved across North America it was accompanied, if not actually preceded, by the beneficient distribution of seedling apple varieties, perhaps by Indians and trappers, certainly by itinerants who became local legendary figures, the more prominent of which was Johnny Appleseed (Jonathan Chapman) who planted extensively in Ohio and Indiana. Improved varieties were soon added. Plantings were made in California at least by 1853 and in the Yakima valley of Washington state about 1875.

Later plantings were somewhat cyclical; periods of comparatively high prices were followed by increased plantings. The ubiquitous local, farm-home or semicommercial orchard of earlier years practically disappeared in favour of a few larger scale centralized commercial orchards, highly specialized, mechanized and increasingly scientific in management.

Varieties.—Apple varieties do not reproduce true to type from seed and consequently are all vegetatively propagated by budding or grafting. Most varieties originated from chance seedlings possessing superior qualities. During the past 2,000 years, tens of thousands of seedling apples have been propagated and named as varieties throughout the applegrowing countries of the world. More than 7,000 varieties were recorded in the United States alone. Only a few of these stood the test of time and became important in production. Extensive programs of breeding to develop varieties having superior qualities either in fruit, resistance to disease, hardiness of trees or dwarfism for small compact trees were initiated especially in the United States, England, Germany, Sweden and the U.S.S.R.

Initially, the continent made extensive varietal contributions to Great Britain, after which the more acceptable selections and new developments were basic to plantings in North America and the southern hemisphere. During the 20th century the better U.S. varieties have been tested widely, and some met with favour. After World War II several prominent U.S. dessert varieties and

their newer sports (bud variations) were increasingly planted, not only in Canada, but in Latin America, the far east, the U.S.S.R. and even in France. Varieties, thousands in number, fall into three broad but not mutually exclusive classes: (1) Cider varieties, developed mostly on the continent and in England, are of three types: sharps, with more than 0.45% malic acid; the bitter-sweets, with more than 0.2% tannin; and the sweets. Commonly, they are blended for processing. (2) Cooking or culinary varieties have been developed primarily in the United Kingdom and on the continent. Substantial size, at least moderate acidity and firm, dense flesh are characteristic; Bramley's Seedling and Grenadier are among the favourites. (3) Dessert varieties, on which developments primarily focused, differ widely but tend to emphasize colour (particularly brilliant crimson), size, aroma, smoothness and perhaps crispness and tang. Many are relatively high in sugar, only mildly acidic and very low in tannin. Worcester Peramain, Cox's Orange Pippin and Blenheim Orange are English favourites.

Commercial production in the United States, particularly in the Pacific northwest, concentrates rather heavily on the Delicious and some of its red sports. The Delicious accounts for about one-fifth of the U.S. crop, the McIntosh for one-tenth of the total, followed by the Winesap, Jonathan, Rome Beauty and Stayman Winesap. Winter varieties make up fully 80% of the total crop.

Climatic and Site Requirements.—The apple thrives in favourable localities and sites from approximately 30° to 60° latitude both north and south of the equator. It may be grown to a limited extent, but not very successfully, at high elevations closer to the equator than 30° north or south, but since it requires a considerable period of dormancy (generally a total of at least 1,200 hours per year under 45° F. or 7° C.) culture in areas lacking a distinct winter period is unsuccessful. Northward, culture is limited by low winter temperatures and shortness of the growing season.

Temperatures of −40° F. will seriously injure or kill trees of most varieties. A period of approximately 100 days free of killing frost is required for even the hardiest, early-maturing varieties to develop a crop. Sunshine, particularly in the latter part of the summer and early autumn, is important in developing pleasing fruit colour. Water to support tree growth and the sizing of the fruit is normally available in sufficient amounts in the more humid regions; otherwise, irrigation is practised.

Topography is generally of more importance than soil in the selection of sites for apple orchards. Soils must be well drained; fertility can be added if not high enough. Rolling hilltops or the sloping sides of hills are preferred because they provide "air drainage," allowing the colder, heavier air to drain away to the valley below, not only during the winter but more especially during frosty spring nights when blossoms or young fruit would be destroyed by much exposure to freezing.

Location to the south and east of mountain ranges (in the northern hemisphere) gives some protection from extreme cold waves of winter, and location on the leeward side of large bodies of water moderates winter conditions somewhat besides delaying spring development of the apple tree until there is less danger of frost damage.

Planting, Cultivation and Management.—Nursery seedlings of hardy stock are budded to desired varieties or used as piece root grafts when about 18 months of age, then used for orchard planting one or two years later. Spacing depends on varieties, topography, mechanization and intentions as to intercropping and tree removal, but varies from something like 25 by 25 ft. to as much as 45 ft. Rows are commonly planted to a single variety to simplify spraying and harvest; not more than two rows of a single variety are planted adjacent—interspersed rows of other varieties are carefully selected to provide for adequate cross-pollination of the bloom.

Management during the 6 to 8 years prior to appreciable production may consist of little more than protection from competing vegetation and pests. Cultivation and fertilization, even mulching, may be practised. Intercropping is permissible. It is during this early period that most careful attention to pruning is required, especially during the first five years, so that the main scaffold branches will be well distributed along and around the leader trunk and at wide angles thereto so that weak crotches will not develop later to split under heavy fruit loads.

With full bearing, increased attention is given to fertilization. An annual cover crop may be grown if permanent sod is not used. Pruning may be done primarily to allow better sun penetration for even ripening and colouring of the fruit and to lessen tree breakage. A rigorous spraying regime must be followed, not only to protect against insect pests, but possibly to delay spring development, to thin the young fruit set and to hold the autumn drop of ripening fruit to a minimum.

Diseases and Insect Pests.—In all parts of the world, extensive spraying is required to produce high-quality fruits free of blemishes caused by diseases and insect pests.

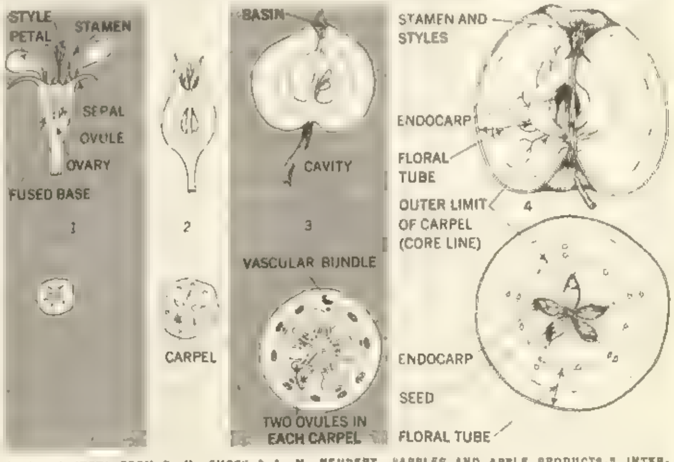
The most serious insect pest in most parts of the world is the codling moth (*Carpocapsa pomonella*), the common apple worm. Spraying with arsenate of lead once or twice in very cool districts or as many as eight to ten times in certain warm, dry districts may be necessary to protect the fruit. Other serious insect pests include San José scale (*Aspidiotus perniciosus*) and several other scale insects, rosy aphis (*Anuraphis roseus*), woolly aphis, species of mites or so-called red spiders and a number of less important insect species.

The most serious and widespread disease is apple scab, caused by a fungus (*Venturia inaequalis*) that attacks the leaves and fruit; it is mainly controlled by spraying with forms of sulfur. Various canker diseases, as well as cedar rust and bitter and brown rots, affect apples in many parts of the world.

Storage troubles include storage scald, soft scald, bitter pit, brown core and internal browning, as well as several sorts of breakdown, spots and mold rots.

Harvesting, Storage, Use.—The proper time of harvest is a matter of technical judgment, related not only to the development of the fruit but also to the time and manner in which it is to be used. Yields per tree will range from small amounts for a young, small tree to 30 bu. or more for the large, mature tree. Each apple is removed by hand, care being exercised not to damage the spur buds, which will provide the bloom for the next year's crop, and not to bruise the fruit. They are perhaps washed and graded and packed in boxes or baskets. Though picking of the fruit has remained a hand job, processing and marketing have been largely mechanized.

Varieties ripening during late summer are generally of poor storage quality and are usually consumed shortly after they mature. Varieties which ripen in late fall may be stored for periods ranging from six weeks to as long as nine months for the best keeping sorts handled by the best methods. For long holding, temperatures only slightly above the freezing point of the fruit (ap-



1, 2 & 3 (TOP) FROM R. M. SMOCK & A. M. NEUBERT, "APPLES AND APPLE PRODUCTS," INTERSCIENCE PUBLISHERS, INC.; 3 (BOTTOM) FROM L. H. MACDANIELS, "THE MORPHOLOGY OF THE APPLE AND OTHER POME FRUITS," CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION MEMOIR 230; 4 FROM W. W. ROBBINS, "BOTANY OF CROP PLANTS," REPRINTED BY PERMISSION OF THE BLAKISTON DIV., MCGRAW-HILL BOOK CO., INC

SUCCESSIVE STAGES IN THE DEVELOPMENT OF APPLE (MALUS PUMILA) FROM FLOWER TO FRUIT

(Top) Longitudinal sections; (bottom) corresponding cross sections

ples freeze at about 28.5° F. or −2° C.) are desirable for fruit from most sections. Fruit from some areas having a cool growing season, as in England, may break down if held near freezing and holds better at 36° to 40° F. Most American apples are stored near 32° F. For home storage, apples should be kept as cool as possible, but above the point of freezing. When held at higher temperatures, they ripen and soften rapidly, ultimately becoming mealy, and soon lose much of their characteristic flavour. Wrapping apples in paper impregnated with mineral oil, or placing such paper in the packages in contact with the fruit, prolongs the holding season for most varieties, as does the use of film box liners. Storage in inert gases is somewhat practised.

Of the United States crop more than four-fifths is normally used as fresh fruit. An apple is not a high-calorie food; the several sugars of a large one provide about 100 calories. Pectin, malic acid, several minerals and vitamin C (ascorbic acid) are also present in considerable amounts. A little less than one-tenth of the total crop is used for vinegar, juice, jelly and apple butter. Nearly one-tenth is canned as pie stock and applesauce. Consumption of commercial apples as food in the United States in the late 1950s was about 22 lb. per capita per year, as compared with 30 lb. as recently as 1940. In Europe a larger fraction of the crop goes for cider, wine and brandy.

Production.—Though the number of apple trees of fruit-bearing age does not change much from year to year, the annual world apple harvest fluctuates rather sharply because of weather, fruiting characteristics of the orchards and economic conditions affecting completeness of harvest. World production before and during World War II averaged nearly 500,000,000 bu. per year, of which about one-fourth was grown for cider. Postwar production was established at a higher level, ranging to more than 700,000,000 bu. France and the United States have each produced an average of 100,000,000 bu. per year.

Europe.—Though Europe produces one-half to three-fifths of the world apple crop, most producing areas do not utilize intensive commercial practices. Central Europe, including France, Germany, Switzerland, northern Italy and the northern Balkan countries, is a region of heavy production. Most of the trees are on land used for livestock pasture. Most of the orchards are unsprayed, and the fruit produced is seriously blemished by insects and diseases. Much of it is used for cider making, particularly in France. For the region as a whole, apples are largely consumed in the area where grown. A few districts, however, have more intensive production practices and pack and ship fruit out of the local area; the most important of these are in Switzerland, northern Italy and in the Danube basin of Yugoslavia, Rumania and Hungary. Extensive apple planting, with good-quality varieties, is also carried on in the Ukraine and north Caucasus regions of the U.S.S.R. In England, Kent is by far the most important apple-producing county. Great Britain before World War II produced less than half the apples it consumed, but young orchards, at levels below 600 ft., were considerably expanded during and after World War II. Belgium and the Netherlands produce some apples for export, although apples are also imported, particularly in late winter.

North America.—The United States produces about one-sixth to one-fifth of the world's apple crop. Individual farm orchards represent a small and declining part of the total. Commercial apple orchards, found in almost every state, are most important in the Pacific northwest, in the areas south and east of the Great Lakes and in the foothills of the Appalachians. Washington is the leading producing state, with an annual crop ranging from 20,000,000 to 35,000,000 bu. of 48 lb. each. A considerable part of the western crop is grown under irrigation and, because of its high colour and careful handling, is important in the eastern and export markets. New York is the second state, with about 20,000,000 bu.; Virginia, Michigan, Pennsylvania and California are among the larger producers. Principal Canadian production is in British Columbia in the west and in Ontario and Nova Scotia in the east.

Asia.—Japan and Korea developed considerable apple production in the 20th century, all being used in those countries. No data were available in the 1950s on production in China and India, though the apple crop in certain areas reaches appreciable proportions.

Southern Hemisphere.—Important apple production occurs in Australia, New Zealand, Argentina and Chile, countries which export considerable quantities to northern markets, particularly Great Britain. The crop is harvested mainly in March and reaches northern markets when local supplies are largely exhausted. The principal centre of production in Australia is in the southeastern provinces of Tasmania and Victoria. In Argentina, production centres in the Rio Negro valley and on delta lands adjacent to Buenos Aires. The main apple production of Chile is near Santiago.

See also Index references under "Apple" in the Index volume.

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APPLEBY, a municipal borough (1885) and the county town of Westmorland, Eng., lies 25 mi. N.E. by road of Kendal, the county's administrative centre. Pop. (1961) 1,755. Appleby is built on a steep hill beside the river Eden, the richly wooded valley being flanked on the northeast by Milburn forest and Dufton and other fells, which rise to more than 2,500 ft. It lies on the main Leeds-Carlisle railway line. A market town whose principal trade is agriculture, Appleby is a centre for dairy produce and there is an ancient annual horse fair in June.

The Roman road between Brough and Brougham passed through Appleby, but the earliest settlers of whom there is evidence were Scandinavians. Before the Norman conquest the area was held by the Scots, and afterward the town rose to importance as the head of the barony of Appleby. This formed part of the province of Carlisle granted by William II to Randulf le Meschin (or de Meschines), who erected Appleby castle. Rebuilt in the 17th century, the castle retains a fine Norman keep, while its double moat recalls its position near the border. The impoverishment caused by Scottish raids, particularly in 1388, led to Appleby's decline and as late as 1515 the greater part of the town lay in ruins. Writers of the 16th and 17th centuries speak of it as a poor and insignificant village. The borough, whose first royal charter was granted by Henry II in 1179, received no charter between 1332 and 1528. The castle was held for the royalists in the Civil War. Two half brothers of George Washington were educated at the grammar school (founded 1574) and there are two old churches, 17th-century almshouses and many Georgian buildings.

APPLETON, SIR EDWARD VICTOR (1892–1965) British physicist who was awarded the Nobel Prize for physics in 1947 for his discovery of the Appleton layer of the atmosphere, was born at Bradford, Yorkshire, on Sept. 6, 1892. Educated at Hanson School, Bradford, and St. John's College, Cambridge, he worked from 1920 at the Cavendish Laboratory in Cambridge until appointed Wheatstone Professor of Physics at King's College, University of London, 1924. There Appleton attained an international reputation with his researches on the propagation of electromagnetic waves and the characteristics of the ionosphere (*q.v.*). He showed that radio waves of sufficiently short wave length to penetrate the Heaviside layer, the ionized region from which long electromagnetic waves are reflected, were reflected by another, upper layer of the atmosphere now known as the Appleton layer. This work was very important for broadcasting and in the development of radar.

In 1936 Appleton returned to Cambridge as Jacksonian Professor of Natural Philosophy, and in 1939 became secretary of the government's Department of Scientific and Industrial Research (DSIR), where during World War II he worked on radar and the atomic bomb. In 1949 he became principal and vice-chancellor of Edinburgh University. Appleton had been made a fellow of the Royal Society in 1927 and was knighted in 1941. He died at Edinburgh on April 21, 1965. (N. Ce.)

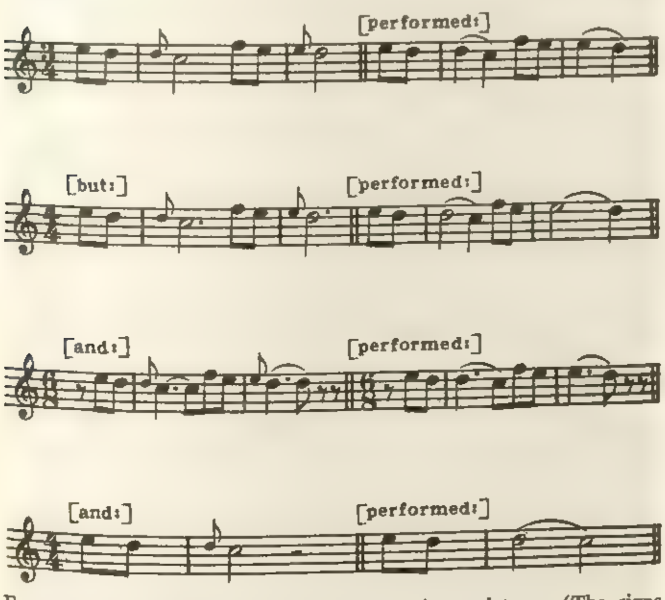
APPLETON, a city of Wisconsin, U.S., and the seat of Outagamie county, on bluffs above the lower Fox river, is about 100 mi. N.W. of Milwaukee. Lawrence college, founded by Amos A. Lawrence of Boston (chartered, 1847; first instruction, 1849), and the abundant water power brought about the first settlement in 1848. The city was incorporated in 1857. Power from the Fox river was first used in sawmills and later in flour and grist mills, which reached their peak about 1880. From the 1890s the chief manufactures included paper mill machinery and equipment, pulp and paper. The world's first commercial hydroelectric power plant went into operation at Appleton in 1882. The Institute of Paper Chemistry, a graduate school affiliated with Lawrence college, has an oustanding library on pulp and paper as well as the Dard Hunter paper museum. For comparative population figures, *see* table in WISCONSIN: *Population.* (W. F. RY.)

APPLIANCES, HOME: *see* HOME EQUIPMENT.

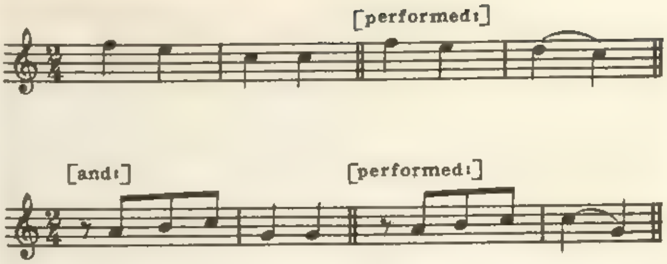
APPOGGIATURA, in music, an ornamental, and frequently unwritten, note of varying duration that temporarily displaces the main, written note, subsequently resolving on to it. The appoggiatura may stand at any interval to its main note but is most commonly adjacent; *i.e.*, at the distance of a tone or semitone, according to the prevailing tonality (unless contradicted by accidentals or the performer's preference).

The renaissance and early baroque appoggiatura was of moderate length, averaging one-third of its subsequent main note, and was more in the nature of a melodic than of a harmonic ornament. By the generation of J. S. Bach appoggiaturas became divided into two distinct species: the short (which takes an inconsiderable length from its subsequent main note and has, therefore, no substantial effect on the harmony) and the long (which takes upward of a half of the length from its subsequent main note and has, therefore, a very substantial effect on the harmony). All true appoggiaturas are taken on the beat (*not* before) and with some degree (often a high degree) either of accentuation or of expressive emphasis; the name, deriving from the Italian *appoggiare,* "to lean," describes this aspect unmistakably: it is necessary to lean on the ornament and subside on to the main note, above all with long appoggiaturas; and appoggiaturas are always slurred to their ensuing main notes.

The commonest baroque signs for the appoggiatura came to be little notes showing the pitch of the ornament, and apparently its duration; but this appearance is misleading and must normally be ignored. The duration is governed by the context, especially the harmonic context. The choice between a short and a long appoggiatura is not always obvious but can usually be made by responding to the natural implications of the music; in a few cases,



Example I: *Characteristic Long Baroque Appoggiaturas* (The signs here shown in the form of little notes are most commonly not present at all.)



Example II: *Characteristic Passages in Recitative Requiring Appoggiaturas (with no sign appearing)*

only one choice is compatible with the written harmony. Long appoggiaturas, however, are by far the most typical and should be given first preference in every suitable context. Certain rules existed for long appoggiaturas: standard lengths were half the duration of undotted notes; two-thirds of the duration of dotted notes; the whole duration of dotted notes in compound time if tied to a further note of the same pitch; and also the whole duration of notes followed by a rest if the main note can be forced forward into the time of that rest. These were described as minimum durations, which might be exceeded if the expression suggested so doing. There are, however, harmonic circumstances in which they must in fact be curtailed; and the decision is one that can ultimately be taken only by good musicianship.

Appoggiaturas are very frequently implied in baroque music without any sign or other written indication appearing in the notation. This is particularly the case in recitative, where to leave out an unwritten but implied appoggiatura is often tantamount to a wrong note.

In the 19th century, the same rules and treatment remained current, but there was an increasing tendency to incorporate the long appoggiatura into the ordinary notated figuration, instead of leaving it to the performer as an ornament shown only by signs or not at all. By the 20th century, this tendency had reached its logical conclusions: all long appoggiaturas, and almost all short ones, were fully and accurately written out as part of the normal text. As a result, the rules and treatment of ornamental appoggiaturas in earlier music had fallen into confusion, and many mistakes are made in performance through ignorance of the relevant conventions; but this ignorance is being increasingly corrected. (R. DO.)

APPOINTMENT, POWER OF, in Anglo-American law, a power given usually by a will or trust instrument by an owner of property to another person to dispose of an interest in the property either for his own benefit or for the benefit of one or more of a group specified by the creator of the power. *See* ESTATES, ADMINISTRATION OF; WILL; TRUST. (A. DM.)

APPOMATTOX, seat of Appomattox county, Va., 25 mi. E. of Lynchburg. The Confederate army of northern Virginia was surrounded there after an engagement with Federal cavalry on April 8, 1865. Three miles to the northeast is the site of the former county seat, known as Appomattox Court House, where Gen. Robert E. Lee surrendered to Gen. Ulysses S. Grant on Palm Sunday, April 9, 1865, thus effectively ending the Civil War. Appomattox Court House, virtually deserted after removal of the county seat to the new town of Appomattox in 1892, was made a national historical monument in 1940 and was restored to its 1865 condition. The Wilmer McLean house, where the surrender took place, was rebuilt and opened to the public. In 1954 the area was designated a historical park (about 968 ac.) (B. DA.)

APPONYI, ALBERT, COUNT (1846–1933), Hungarian statesman whose political philosophy blended the conservative traditions of his background with Hungarian nationalism and Bismarckian state socialism, was born in Vienna on May 29, 1846, of an ancient and famous family; his father, Count György Apponyi (1808–99), had been leader of the Progressive Conservatives and chancellor from 1846 to 1848. Albert Apponyi was educated at the Jesuit seminary at Kalksburg and at the universities of Vienna and Budapest. He then traveled widely. Entering the Hungarian parliament in 1872, he remained a member of it, with one short

interval, until 1918. From 1878 to 1905 he belonged to the "united opposition" in which all parties hostile to the Austro-Hungarian "compromise" (*Ausgleich*) of 1867 were represented. being, from the late '80s, its unquestioned leader. Even during this period he held important public positions and received marks of distinction from the crown. From 1906 to 1910 he was minister of education in the coalition government; the changes introduced by him in school curricula were greatly resented by the non-Magyars of Hungary for their Magyarizing tendencies. After the breakdown of the coalition he returned to the opposition as member of the Party of Independence, of which he became president on Ferenc Kossuth's death (1914). He was minister of education again in 1917–18. Returning to parliament after World War I, he headed the Hungarian peace delegation to Paris and several times represented Hungary at the League of Nations. He died in Geneva on Feb. 7, 1933, as Hungarian delegate to the disarmament conference. A cultivated man and a brilliant linguist and orator, Apponyi was always an imposing figure. It was, perhaps, the artificial atmosphere in which his public life was passed that prevented his being more. His published works include several versions of his memoirs (Eng. trans., 1935) and many studies on Hungarian constitutional problems.

See S. Pethö, *Le Comte Albert Apponyi* (1931). (C. A. M.)

APPORTIONMENT, in government, connotes the division of the burdens or benefits of citizenship (*e.g.*, the awarding to the voters of a certain district of the privilege of electing one legislator). (*See* APPORTIONMENT, LEGISLATIVE.) It also has a special significance in trust administration, indicating how the receipts from trust property, and the expenses of its administration, shall be allocated by the trustee—whether to the income account of the temporary beneficiaries or to the capital account of those who are ultimately to take the principal of the trust. *See* TRUST. (G. G. Bo.)

APPORTIONMENT, LEGISLATIVE. Legislative apportionment refers to the systems or principles according to which units of power are distributed in regular shares among the constituencies of a representative assembly; *i.e.*, on what basis citizens are represented in their legislatures.

The principle of equally shared influence was implicit in primitive assemblies wherein all tribal leaders, warriors, heads of household or nonslave citizens were directly represented by themselves or proxies. About 30,000 citizens were eligible to participate in the assembly of ancient Athens, although attendance never ran this high.

The king's courts and councils of later centuries held the seeds of national legislative institutions. The men who advised the king, helped finance his wars and petitioned him for favours usually fell into one of several classes or "estates": (1) the king's titled feudal tenants, or nobility; (2) heads of religious establishments, or clergy; (3) elected delegates from local corporate bodies (towns, boroughs, shires). The English Model parliament of 1295 consisted of two archbishops, 70 abbots and other clergy, seven earls, 41 barons, many knights of the shires and many burgesses of the boroughs. With the emergence of medieval parliaments in England and on the continent, these estates tended to consult separately, thereby establishing distinct "houses" as the basis for exercising influence in the king's councils; for example, two houses in England, three in France and four in Sweden. The prevalence of two-chamber arrangements in most modern legislatures is an outgrowth of the old estates, usually modified by a federal, nationality or geographical principle of apportionment in one house and a principle of direct popular representation in the other.

With the rise of nation-states, legislative functions of government became differentiated from executive and judicial. The articulation of the "national will" occurred increasingly through representative assemblies. After the British revolution of 1688, for example, English sovereignty rested with the king in parliament rather than with the king alone. Because they constituted influential shares in the nation's sovereignty, seats in parliament became more valuable, literally subject to auction and to contest between the landed aristocracy and the new merchant and industrial classes. As soon as governing power depended upon the successful organization of numbers of votes, the distribution of seats—hence of voting shares in national sovereignty—came under systematic examination among political philosophers and leaders. Principles of legislative apportionment were more methodically and mathematically stated.

More vigorously debated was the problem of how legislative seats could be distributed to reflect most accurately the national will. The growth of democracy, extension of the suffrage and rise of political parties added to the complexity of the problem of delineating constituencies. Practice varies widely, but experience permits the classification of constituencies into five types, as follows: (1) the territorial survey, which creates districts with special boundaries so that inhabitants or voters may be found in relatively equal numbers in each district; (2) the governmental entity, wherein geographically self-contained governing units (such as towns, counties, cities, states, etc.) are represented in legislative bodies at higher levels of government; (3) the official body that acts as a constituency—for example, the state legislatures that chose United States senators before popular election was established by the 17th amendment; (4) functional groupings of the population according to social or economic characteristics, such as the nobility, clergy and commoners of early parliaments, the classes of taxpayers in the Prussian system or the occupational, industrial, professional, nationality and other groupings used as the basis for apportionment in guild socialism and fascist corporate states; (5) groupings according to public opinion or party, usually found where systems of proportional representation are designed to reflect as many facets of voter opinion as possible. (*See* PROPORTIONAL REPRESENTATION; REPRESENTATION.)

Great Britain.—Legislative apportionments in major countries are based on different principles. Before 1832 the British house of commons (from "communes") was primarily a national assembly of representatives from local communities: the shires (later large rural counties) and the incorporated towns (later boroughs). The Reform act of 1832 altered the principle of community representation by imposing in addition a population criterion based on number of houses and a wealth criterion based on assessed taxes, thereby transferring about 143 seats from "rotten boroughs" to more heavily populated industrial towns. ("Rotten boroughs" were those completely under the control of the crown or a patron, some 50 of them having fewer than 50 voters and Old Sarum having only 7.) The Reform act of 1867 regularized the ratio of voters to population within the constituency classes of counties and boroughs. The Reform act of 1885 equalized representation between counties and boroughs on the basis of approximately 50,000 voters per constituency, with 576 of these as single-member constituencies, 18 others (including six university constituencies) returning two representatives each, and one (the Scottish universities) returning three members. The Redistribution act of 1948 permitted only one member from each constituency and made an allocation of seats among England (506 seats), Scotland (71), Wales (36) and Northern Ireland (12). The university seats were abolished, as well as the special parliamentary representation of the City of London (London financial district), in 1948, ending so-called "plural voting." Acts of 1944 and 1949 established constituency boundary commissions which would report every three to seven years regarding the need for boundary changes, the first British approach to periodic reapportionment. Peers and clergy continued to be represented separately in the house of lords.

United States.—Representation is apportioned in the senate according to the principle of equality among the states and in the house of representatives according to the principle of equally proportioned constituencies in the population. Each state in the union is entitled to two seats in the senate and to a number of seats in the house of representatives according to the ratio of its population to that of the nation. Every state is entitled to at least one house member, regardless of how small its population may be. The original constitutional apportionment set a ratio of one representative for each 30,000 inhabitants, counting all

Apportionment in U.S. House of Representatives

Under	Census		Apportionment effective		Whole number of representatives*
	Year	Population	Year	Ratio	
Constitution	..	..	1789	30,000	65
1st census	1790	3,929,214	1793	33,000	105
2nd census	1800	5,308,483	1803	33,000	141
3rd census	1810	7,239,881	1813	35,000	181
4th census	1820	9,633,822	1823	40,000	213
5th census	1830	12,866,020	1833	47,700	240
6th census	1840	17,069,453	1843	70,680	223
7th census	1850	23,191,876	1853	93,423	234
8th census	1860	31,443,321	1863	127,381	241
9th census	1870	38,558,371	1873	131,425	292
10th census	1880	50,155,783	1883	151,911	325
11th census	1890	62,622,250	1893	173,901	356
12th census	1900	75,568,686	1903	194,182	386
13th census	1910	91,972,266	1913	211,877	435
14th census	1920	105,710,620	†	†	435
15th census	1930	122,775,046	1933	279,712	435
16th census	1940	131,669,275	1941	..	435
17th census	1950	150,697,361	1951	..	435
18th census	1960	179,323,175	1961	..	435

*There have been interim changes from time to time between apportionments, owing to admission of new states.

†Despite the constitutional requirements, congress failed to pass a reapportionment act following the 1920 census.

"free persons" but only three-fifths of "all other persons," notably slaves. By 1910 this ratio had become one representative for each 200,000 or more inhabitants. A 1929 act held the total number of house seats at 435, to be reapportioned on a semiautomatic basis according to one of several mathematical formulas subject to congressional choice. In 1941 the formula known as the method of equal proportions was established as the one to be used automatically. This method requires that a state receive an additional representative when its population, divided by the geometric mean of its present assignment of representatives and of its next higher assignment, is greater than the population of any other state divided by the geometric mean of the assignment of such other state and its next higher assignment. In order to compute the relative claims of each state, a priority list is prepared. In this way the difference between the representation of any two states is the smallest possible when measured both by the relative difference in the average population per district and also by the relative difference in the individual share in a representative.

The constitution provides for the apportionment of representatives among states, but is silent as to whether the representatives shall be elected by districts or by the state at large. By 1842, 22 states were electing representatives by districts and only 6 states were electing at large. At the same time the general ticket system was being widely accepted for presidential elections. The Apportionment act of 1842 provided that representatives under that apportionment be elected by districts composed of "contiguous territory equal in number to the representatives to which said state may be entitled, no one district electing more than one representative." Thereafter the practice of electing by districts became universal. Exceptions occurred according to the following principles: (1) If there is no change in the quota of a state, the existing districts continue until new ones are created. (2) If the quota is increased and there is no redistricting, the existing districts remain the same and the additional members are elected at large. (3) If the quota is reduced and there is no redistricting, all members are elected at large.

Each of the state legislative chambers has its own system of apportioning representation. Most states use county and town boundaries as much as possible in forming legislative districts. In some, constituencies are required to be as nearly equal in population as possible. In a few cases, weighted ratios are used to give additional seats to certain town or county units.

Problems.—Experience shows that certain practical political problems tend to recur in connection with legislative apportionment. As a system for sharing effective power, legislative apportionment has quite distinct meanings in dictatorships and democracies. Representative assemblies under dictatorships may simply be the continuation of an established system that has suffered political atrophy, or they may be an imitation of democratic forms created to give an illusion of democracy. Within democracies, on the other hand, legislative apportionment rarely accomplishes a division of power satisfactory to all interests. Often rural populations are overrepresented in proportion to urban populations. One political party may gain advantage over other parties under certain apportionment systems and practices, particularly where unnatural divisions are employed. Above all, most legislatures are reluctant to engage in reapportionments that might seriously affect the political futures of incumbent members.

Automatic periodic reapportionments or reapportionments initiated by specific responsible agencies or under clearly defined circumstances have occasionally been adopted by legislatures to overcome the inertia inherent in the reapportionment process. The U.S. supreme court's ruling (1962) in *Baker* v. *Carr* that federal courts had jurisdiction to hear suits alleging malapportionment in state legislatures further spurred efforts at effective reapportionment on the state level. In 1964 the court further ruled that congressional districts within each state must be substantially equal in population. *See* also REPRESENTATION.

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APPRAISAL, REAL ESTATE, an estimate of the value of real property, or the process of making such an estimate. Real estate appraisals require the use of individual judgment; thus they are opinions rather than scientific determinations. Each appraisal is usually made in writing and always applies to particular property as of a specified date.

Not every estimate of the value of real property is an appraisal. Whenever real property changes hands, the buyer and seller have opinions about its value; whenever real property is taxed, the amount of the tax is usually based on a value estimate made by a public assessor. However, these opinions are not classified as appraisals for the term appraisal usually denotes a written opinion of value, the contents of which conform to generally accepted standards of quality.

Because value is a relation between an object and a person desiring it, several types of value can be imputed to any given property. The two most common types of appraisal involve the determination of fair market value and insurable value. Fair market value is the amount of money a given property can be sold for on the open market after being offered for a reasonable length of time, neither buyer nor seller being under duress and both being informed of all its feasible uses. Insurable value is the amount of money which would be compensable under an insurance policy in case of loss covered thereby. Less frequently used are appraisals of going-concern value, which is the worth of a property assuming continuation of its present use, and liquidation value, which is the amount of money a property would bring if it had to be sold immediately. Many other highly specialized concepts of value exist, but there is a growing tendency to confine use of the term appraisal only to estimates of fair market value and to use terms like "costing" or "valuation" for estimates involving other concepts of value.

Since ownership of real property essentially means possession of certain rights regarding it, every appraisal must specify which rights are to be evaluated. Real property consists of physically tangible and immobile objects, particularly the earth's surface, the land and minerals under the surface, the buildings and other objects permanently affixed to the surface and that portion of the airspace above the surface necessary for utilization of the surface itself. Ownership rights regarding such objects include the right to sell them, to occupy them, to use them, to give them away, to bequeath them, to enter them, to lease them to others and to refuse to do any of the foregoing. In many transactions, some of these rights are exchanged for other rights; *e.g.*, leasing a building consists of giving up the rights of use and occupancy in return for the right to receive rent. An appraisal may involve valuation of just one of these rights, a group of them or

all of them.

The process of making an appraisal can be analyzed into five major steps:

1. Identification of the problem. This consists of specifying the property involved, the rights to be appraised, the purpose of the appraisal, the type of value sought and the date at which the appraisal should apply.

2. Preliminary survey and appraisal plan. Next the appraiser determines what procedures and information will be necessary in making the appraisal.

3. Data procurement. The appraiser seeks both general data (concerning the region, city and neighbourhood in which the property is located) and specific data (concerning the particular site, the improvements thereon and the legal status of the property).

4. Analysis and valuation. These data are converted into valuation estimates in three different approaches to value. All three are derived from the principle that a reasonable man will not pay more for a given property than the present cost of purchasing another property which produces equivalent utility or money income.

a. One corollary of this principle is that the normal upper limit of value is "reproduction cost," *i.e.*, the cost of buying a similar site and building a structure on it identical to the one being appraised. In the cost approach the value of the property is estimated by calculating the cost of reproducing the buildings and other permanent improvements on it, plus the value of the land, minus allowances for depreciation caused by deterioration and obsolescence.

b. A second corollary is that a prudent investor will not buy a property which yields a lower rate of return than other available properties of equal risk. Therefore in the income approach a forecast is made of the net income the property would produce as an investment, and similar investments are examined to determine the rate of return commensurate with this degree of risk. Then a value is derived by dividing this rate into the predicted income, with proper allowances for recapturing the capital invested in buildings and other wasting assets.

c. The market date approach begins with an examination of current sales prices of similar properties. The value of the property being appraised is estimated at the price level of the similar properties, with plus and minus adjustments made by the appraiser for minor differences in size, age or other qualities. This method is preferred by most courts because it is easier to understand than the other methods.

5. Correlation of valuations. Any differences between the values arrived at previously are carefully analyzed and evaluated so as to determine which approach embodies the most relevant factors in the given case. In this manner, rather than by averaging his estimates, the appraiser arrives at a final value.

Most real-estate appraisers work for institutions engaged in real estate transactions such as mortgage houses, insurance companies, banks and governments. However, since 1930 an increasing number have become independent agents engaged solely in appraising. In the U.S. there are three national organizations of appraisers, each of which gives some of its members a special designation denoting professional qualification. The American Institute of Real Estate Appraisers, founded in 1932, awards the title "M.A.I." to each member. The Society of Residential Appraisers (1935) gives its senior members the designation "S.R.A." The American Society of Appraisers includes appraisers of commodities from fine arts to real estate and gives its senior members the title "A.S.A." In England the major professional organizations include the Royal Institution of Chartered Surveyors, the Chartered Auctioneers' and Estate Agents' Institute, the Chartered Land Agents' Society and the Incorporated Society of Auctioneers and Landed Property Agents. Similar societies exist in Australia, Canada and New Zealand. *See* also VALUATION.

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APPRENTICESHIP, the learning of an art, trade or other calling by practical experience under the guidance of a master, perhaps also with some classroom study. The term is also commonly used to denote the period of time served by an apprentice. The length and nature of the apprenticeship are usually set forth in a contract entered into by the apprentice and his employer. Throughout history apprenticeship has been an important means of training skilled craftsmen; in the 20th century it remains a major method of training industrial workers and skilled craftsmen. There are brief references to apprenticeship in the Babylonian Code of Hammurabi (2100 B.C.) and in the history of Greece, Rome and China, but the English guilds of the middle ages provide the richest history of apprenticeship practice and are typical of developments in medieval Europe.

Guild Apprenticeship in England.—In the 12th century the craftsmen of English towns were associated in guilds in which masters were those skilled in an art, a science or a craft, and the apprentices were those who were learning its mysteries. Barristers were apprenticed to the law just as the sons of freemen might be apprenticed to a slater, a carpenter or an armourer. (*See* GUILD.)

Under guild rules, no master was allowed to take more apprentices than he could train properly and the method of training was rigidly prescribed, usually in a written contract or indenture. The period of apprenticeship was almost invariably seven years. During this period the master furnished food, lodging and clothing for his apprentice and attempted to train him in habits of industry and sobriety. When the full apprenticeship had been served the apprentice became a journeyman working for wages, or practised his craft as a master with his own journeymen and apprentices.

After obtaining certain privileges and exclusive rights the guilds began to abuse them. Difficulties were placed in the way of those who had served their apprenticeship and wished to become masters, and attempts were made to reserve craft privileges for those born into the guild. To avoid these restrictive measures, at the end of the 15th century journeymen began to set up as masters outside the towns, free of guild and municipal restrictions. The craft guild monopolies were further weakened by the growth of new trades and by the rise of the merchant companies. The decline of the guilds led to enactment of the Statute of Artificers in 1563.

The Statute of Artificers was primarily a consolidating enactment. It attempted to preserve a system which was beginning to break up and at the same time to bring uniformity to local variations. The act prescribed seven years as the period of apprenticeship and provided that no person might exercise a craft unless he had been apprenticed. At first this attempt to perpetuate guild apprenticeship seemed likely to succeed but the apprentice laws were not popular and were never uniformly enforced.

Guild (or domestic) apprenticeship rapidly declined during the 18th century. Three developments—the introduction of machinery in the great new manufacturing industries that were outside the scope of the apprentice laws, the growing dislike of all restrictions under a laissez-faire philosophy and the rise of capitalism—led to the repeal in 1814 of important parts of the statute of 1563. Thereafter a man might exercise any craft or trade he pleased, whether he had been an apprentice or not. The Act of 1814 marked the end of compulsory apprenticeship and (although it was not appreciated at the time) of domestic apprenticeship also.

Industrial Apprenticeship.—Long before 1814, in trades outside the scope of the apprenticeship laws, a new kind of apprenticeship had come into being. The apprentice no longer lived without wages and under the personal control of his master but lived with his parents and received wages. Despite the introduction of machinery and the increasing subdivision of labour, apprenticeship in its new form persisted as an important element in British industry.

At the end of the 19th century apprenticeship was threatened in another way. Employers became less willing to spend time and money on apprenticeship training, which the specialization of processes and the speeding up of production had rendered more difficult and more expensive. The trade unions, realizing that protection was needed against the employment of cheap juvenile

labour, called upon the time-honoured methods of the guilds and imposed restrictions on the number and proportion of apprentices and the conditions of their employment. British apprenticeship weathered difficult times during World Wars I and II, when military needs made consistent training programs impossible, and also during the interwar period, when depressed business conditions reduced the demand for skilled manpower.

Modern British Apprenticeship.—After World War II the ministries of education and of labour supported programs aimed at better education, recruitment and training of young people for industry. Apprenticeship was revitalized in large part through cooperative efforts of British industry and trade unions.

Five years became the standard term of apprenticeship; boys normally entered at 16 and were required to finish by the age of 21, because after that age union rules prohibited paying apprentices less than full adult wages. Most apprentices had attended secondary schools and had left at the age of 15 to work for a year before formally entering apprenticeship. In large firms, apprentices may begin with 12 months of common training, followed by specialized programs in different departments to learn all aspects of particular trades. Until the age of 18, apprentices are often allowed one day a week with pay to attend classes ("day release"), but this is not general; some apprentices attend evening classes and others are unable to secure any classroom training at all. There is no final examination required at the end of apprenticeship.

United States.—Apprenticeship existed in colonial times and served as a means of poor relief, education, penalty for idleness and punishment for debt. The indenture system of master-apprentice relations closely resembled English practice. With the development of the factory system during the 19th century, competitive pressures and laissez-faire government policy brought about a decline of apprenticeship standards. Without effective protection, apprentices were often poorly trained. Recognizing this threat, American labour unions toward the end of the 19th century increasingly enacted apprenticeship regulations themselves and sought enactment of apprenticeship laws by the government.

Acting independently, several major business firms in the 1870s and 1880s established apprenticeship programs, known as corporation schools, to provide a supply of trained craftsmen. Until after World War I, however, the need for skilled workmen in the United States was met primarily by immigration from abroad. Along with the restriction of immigration that came after the war, apprenticeship was encouraged by government policy.

Wisconsin legislation in 1911 and 1915 marked the beginning of effective governmental support. These laws made written apprenticeship agreements compulsory, required their registration, specified minimum standards of education, regulated wages and hours, specified training schedules and provided for supervision by the state industrial commission. At the federal level, the Smith-Hughes act of 1917 provided aid for vocational education and encouraged the establishment of trade schools in which industrial skills could be taught.

The Fitzgerald act of 1937 laid the groundwork for expansion of apprenticeship training in the United States under co-operative arrangements supported by federal and state governments, labour unions and employers groups, and continued the federal committee on apprenticeship first established under the National Industrial Recovery act (1933). This committee (including representatives of management, labour and government) was empowered to recommend policies and encourage program development. The U.S. bureau of apprenticeship within the department of labour maintained regional and local offices and approximately 30 state governments actively participated in promoting apprenticeship training but the primary responsibility for conducting such training remained with employers and unions at the local level.

Official standards for apprenticeship programs include the following: (1) Apprenticeable occupations normally require at least two years (4,000 or more hours) to learn, and apprenticeship terms average three and one-half to four years in length. (2) The starting age for apprentices is at least 16 but is usually higher, especially for returning veterans. (3) Definite schedules of work processes to be learned through training on the job should be followed. (4) Organized classroom instruction (usually a minimum of 144 hours per year) must be offered to provide the apprentice with technical knowledge related to the trade. (5) Progressive standards of wages, with periodic increases, must be set up. (6) Proper supervision of on-the-job training and adequate working facilities are required. (7) Periodic evaluation must be made of apprentice progress in job performance and related instruction, and records must be maintained. (8) Employer-employee co-operation, usually through union agreements, is essential. (9) Recognition must be given to apprentices for successful completion of training.

Thousands of local joint apprenticeship committees are in operation in the U.S., and apprentices are often indentured to these committees rather than to a single employer, being transferred from one firm to another as conditions may require. Apprentices are trained in more than 300 skilled occupations. At the completion of apprenticeship, an examination or the issuance of a license may be required.

After enactment of the Fitzgerald act mentioned above, and with the maintenance of full employment following World War II, apprenticeship training expanded substantially, especially with federal support being given to veterans entering apprenticeship following wartime service.

Apprenticeship rules have served several functions: they have protected apprentices by specifying minimum wage rates and other conditions of employment and training; they have assisted employers by providing a supply of properly trained craftsmen; and they have strengthened the unions by restricting the number of workers entering the trades. Unions have sometimes abused their restrictive powers but most unions have come to recognize that apprenticeship is not the only way to learn a trade and have therefore provided for admission by other means.

Apprenticeship in Europe.—Apprenticeship laws and customs in Europe vary from country to country. In Austria, for example, industrial apprenticeship and related vocational schooling are regulated by law. An apprentice usually learns his trade by working for three to four years with a master craftsman; apprenticeship training shops have been established by large firms, chambers of commerce, and trade union bodies. Practical training on the job is supplemented by part-time attendance at public vocational schools. On the completion of training, the apprentice must pass an examination; after several additional years, a "master's" examination permits him to become an independent craftsman.

In Belgium apprenticeship arrangements are quite flexible. They include training under contract with a craftsman (usually after leaving primary school) and the learning of skilled jobs within a factory. "Technical" instruction in the schools provides general and theoretical education, while "vocational" instruction emphasizes the practice of a craft. The Office National du Placement et du Chômage has encouraged the development of training centres operated by employers or by the O.N.P.C. itself.

In France the government has established *centres d'apprentissage* which offer three-year, full-time courses to teach skilled trades to apprentices, who usually enter at the age of 14 after completing primary education. Examinations are required and certificates awarded on completion. In addition, there are similar establishments run by industry, and some apprentices are under contract to individual enterprises.

In the Federal Republic of Germany apprenticeship requires three to three and one-half years of industrial training supplemented by part-time attendance at a vocational school. Detailed training syllabi are provided by the central authorities, with examinations at the completion of the program. Apprentices begin training at 14 or 15, after completing primary school. Certain industries (*e.g.*, chemical, electrical) have established training centres to meet their own special needs.

There are several means of entering skilled trades in Italy after leaving elementary school: (1) taking an apprenticeship in an enterprise; (2) taking a classroom apprenticeship course of one

to three years; and (3) attending vocational school for three years, followed by either (1) or (2).

In the Netherlands a boy planning to enter a skilled trade may take a two-year course at a junior technical school after completing his elementary education; if so, his apprenticeship in industry need be only two years. If he does not have the junior technical school certificate, his apprenticeship must last at least three years. All apprentices must attend classes on the theoretical aspects of their trades.

Around 1900 the Swiss cantons passed apprenticeship laws providing conditions for industrial training and supplementary schooling, with official supervision and support. The Federal Vocational Training act of 1930 established a unified, flexible program designed to produce good citizens, masters and foremen as well as craftsmen. The apprentice learns his trade through practical experience on the job, supplemented by a trade school program covering materials and methods, business procedures, economics and politics. (F. T. MA.)

Australia.—Apprenticeship is well developed in Australia, but a comprehensive public inquiry in 1954 made many recommendations for the improvement of its administration. Apprenticeship is regulated by commonwealth and state laws. Under legislation: (1) apprenticeship trades are defined, and unapprenticed youths are forbidden to enter them; (2) indentures (or their equivalent) are compulsory, and specified provisions and covenants must be incorporated in them; (3) the length of apprenticeship for each trade is stipulated within close limits; (4) a compulsory probationary or trial period at the commencement of the term is specified; (5) apprenticeship must be completed in early adulthood, rarely later than 23 years of age; (6) the contract must be registered with a government department, which has disciplinary powers against both parties without recourse to courts of law; (7) wages and conditions of employment (such as sick leave, annual leave, holidays, etc.) are prescribed by courts, commissioners, arbitrators and boards of *ex officio* decree, or after arbitration; (8) cancellation of the contract requires acquiescence of a government agency, and in some cases a government agency may dissolve the contract against the wishes of one or both parties to it; (9) limitation of the number, or proportionate number, of apprentices who may be taken by an employer is imposed by law (with, in most cases, power of dispensation vested in a government agency); (10) employers are subject to official scrutiny regarding their competence to train apprentices to required standards; (11) technical education for the apprentice, as distinct from practical training in the employer's plant, is an obligation on both apprentice and master.

New Zealand.—The Apprentices act (1948) makes provision for all matters affecting apprenticeship. The act is administered by a commissioner of apprenticeship who is assisted by district commissioners. All employers bound by awards or agreements filed under the Arbitration law are covered by the Apprenticeship act.

South Africa.—Under the Apprentices act (1944) a National Apprenticeship board was established. This board consists of representatives of employers, trade unions, education authorities and apprentices. The functions of the board are to co-ordinate the work of local apprenticeship committees and to make recommendations to the minister of labour on cognate matters.

Japan.—Joint apprenticeship schemes have been developed so as to enable small undertakings to share available training facilities.

Developing Territories.—Apprenticeship is inevitably less well established in the underdeveloped territories of Asia and the tropical zones. The training of juveniles in manual skills is, however, regarded as of considerable importance. Many of the larger American- and European-owned companies have excellent training schemes, but facilities for training apprentices are often entirely inadequate in the smaller enterprises. By the beginning of the 1960s government-sponsored training schemes were making a contribution, but there remained generally a widespread shortage of fully trained skilled workers calling for a more vigourous development of apprenticeship and other training schemes. *See* EMPLOYEE TRAINING; *see* also Index references under "Apprenticeship" in the Index volume. (B. C. R.)

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APRAKSIN, FEDOR MATVEEVICH, COUNT (1661–1728), one of the architects of Peter the Great's navy, was born in 1661. In 1682 he was appointed table steward (*stolnik*) to the young tsar Peter, in whose warlike sports he subsequently took part and whose lifelong friendship he won. In 1700 he became governor of Azov and chief officer in charge of naval construction responsible for shipbuilding and such naval installations as the new harbour and fortifications at Taganrog. In 1707 he was promoted admiral and, in effect, supreme naval commander. In this capacity he took charge not only of the Baltic fleet but also of the army in the Baltic area. In the autumn of 1708 he repulsed the Swedes from Ingria, thus saving the navy and St. Petersburg, for which service he was rewarded with the title of count. In 1710 he conducted the victorious siege of Vyborg. In 1711 and 1712 he had to supervise the disbandment of the Azov fleet after Russia's defeat by the Turks on the Prut. From 1712 he commanded the army and from 1713 also the galley fleet, operating against the Swedes in Finland. In 1713 he occupied Åbo; in 1714 he took Helsingfors (Helsinki) and won Russia's first naval victory over the Swedes at Hangö (Hanko), an operation planned by Peter and ably executed by Apraksin. Its success and the occupation of the Åland Islands in 1715 put Sweden's southern Baltic shore at the mercy of Russian warships. It was Apraksin who led the landing on Gotland in 1717 and the devastating raid on the coast round Stockholm in 1719. The strategic advantage thus gained led to the conclusion, in 1721, of the peace of Nystad on terms favourable to Russia.

During the Persian campaign of 1722, Apraksin commanded the sea-borne expedition from Astrakhan to the Gulf of Agrakhan. In the reign of Peter I, he was three times tried for peculation but escaped with heavy fines. In 1726 he became a member of the secret supreme council and in the same year he led a task force sent to protect Reval (Tallin) against a possible British attack. He died in Moscow on Nov. 21 (new style; Nov. 10, old style), 1728.

See R. C. Anderson, *Naval Wars in the Baltic During the Sailing-Ship Epoch, 1522–1850* (1910); N. V. Novikov (ed.), *Boevaya letopis russkogo flota* ("War Chronicle of the Russian Navy") (1948).
(L. R. LR.)

APRICOT, the fruit of *Prunus armeniaca*. Like the plum and the peach, the apricot is a stone fruit, cultivated generally throughout temperate regions, and like those fruits it is used fresh for dessert or preserved by canning and drying. In tree, fruit and flower characters, the apricot is somewhat intermediate between the plum and the peach. Trees are large and spreading and in this respect are more like the peach trees. The leaves are broad, heart-shaped, dark green in colour and held erect on the twigs. The flowers are white in full bloom and borne singly or doubly at a node on very short stems. The apricot is self-fruitful and sets fruit when its blossoms are self-pollinated. The pit is smooth, somewhat like that of the plum but broader, somewhat flatter and more winged. The fruit is nearly smooth, round to oblong in some varieties, somewhat flattened and in general more like the peach in shape, but with little to no hairiness when ripe.

The flesh is typically an attractive yellow to yellowish-orange. The kernels of some varieties are sweet.

The apricot was once considered a native of the Caucasus and Armenia, hence the species named *armeniaca;* later studies, however, suggest that China is its native home. The fruit is cultivated in all of central and southeastern Asia and in parts of southern Europe and North Africa. It was, doubtless, among the fruits brought into southern California early in the 18th century by the mission fathers. The American Pomological society lists 11 varieties as grown in the United States in 1879. The apricot has been crossed with varieties of plum, particularly the oriental plum. Some of the more promising of these crosses have been introduced under the group name plumcot. No horticulturally satisfactory peach-apricot varieties, however, have been developed.

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APRICOT. ONE OF THE FRUITS HAS BEEN OPENED TO EXPOSE THE STONE

Apricots are propagated by budding on peach or apricot root stocks, and the peach, plum and apricot may be readily intergrafted. The apricot does well on peach stock, but the peach on apricot is not entirely satisfactory. The tree succeeds in a well-drained, loamy soil, preferably light rather than heavy. Production of this fruit in the United States is restricted to regions where climatic conditions are favourable. Most varieties will withstand winter cold as well as peaches, but the blossom buds, opening earlier than those of the peach, are frequently killed by late freezes. The trees are quite drought resistant and under favourable growing conditions are long-lived. Some trees have been found which are estimated to have lived 50 to 100 years or longer.

The commercial production of the apricot in the United States is confined largely to the Pacific coast and intermountain states. The annual production of the commercial crop is about 200,000 tons, with California accounting for a large proportion of the tonnage. In some years of large yields more than 70% of the crop has been dried. Other apricot-producing countries are Iran and Syria in Asia, and Spain, France, Italy and Yugoslavia in Europe. (F. P. C.)

APRIES, the Greek name for Haa-ib-ra Wah-ib-ra (also called Ouaphris in Greek and Hophra in Hebrew), fourth king of the 26th Egyptian dynasty, who reigned from 588 to 569 B.C. and died in 567. Apries failed to help his ally Zedekiah of Judah against Babylon, but after the fall of Jerusalem received many Jewish refugees into Egypt. Later he took Sidon but failed in an attack on Cyrene. The Egyptians then elected their general Amasis (*see* Ahmose) as king instead (569 B.C.). Apries was imprisoned but escaped and, after a second battle, met his death. *See* Egypt: *History.* (M. S. Dr.)

APRIL (Lat. *Aprilis*), the fourth month of the modern calendar, with 30 days. The Romans considered the month sacred to Venus, and its name has been thought to derive from that of her Greek equivalent, Aphrodite. A more plausible etymology connects the name with Lat. *aperire* "to open," in reference to the unfolding of buds and blossoms at this season; the modern Greek word for spring (*anoixis* "opening") provides a good analogy. As in ancient times April 21 is still celebrated as the *natalis urbis Romae,* the birthday of Rome. Many features of the Parilia, the Roman festival of herds and flocks, find a modern counterpart (and perhaps survival) in the observances practised on St. George's day, April 23, especially in eastern Europe. (F. R. Wn.)

APRIL FOOLS' DAY or All Fools' Day, named from the custom of playing practical jokes or sending friends on fools' errands, on April 1. Although it resembles the Hilaria of ancient Rome (March 25) and the Huli festival of India (ending March 31), the custom is probably of independent origin. Its timing seems related to the vernal equinox, when nature fools mankind with sudden changes from showers to sunshine. It is a season when all people, even the most dignified, are given an excuse to play the fool. In France the fooled person is called a fish (*poisson d'avril*). In April comes the cuckoo, emblem of simpletons; hence in Scotland the victim is called "cuckoo" or "gowk," as in the verse: "On the first day of Aprile, Hunt the gowk another mile." Hunting the gowk was a fruitless errand; so was hunting for hen's teeth, for a square circle or for stirrup oil, the last-named proving to be several strokes from a leather strap. (A. McQ.)

A PRIORI AND A POSTERIORI. These phrases mean literally "from the earlier" and "from the later" respectively. They were used originally to distinguish between arguments from causes and arguments from effects, but they have been employed by philosophers since Kant's time to distinguish between knowledge that is independent of all particular experiences and knowledge that is not.

The first recorded occurrence of the phrases is in the writings of the 14th-century logician Albert of Saxony. Here an argument a priori is said to be "from causes to the effect" and an argument a posteriori to be "from effects to causes" (C. Prantl, *Geschichte der Logik im Abendlande,* iv, p. 78, 1870). Similar definitions were given by many later philosophers down to and including Leibnitz, and the expressions still occur sometimes in nonphilosophical contexts with these meanings. Thus a man might be said to argue a priori if he inferred the guilt of an accused person from the fact that he had been convicted many times before. It should be remembered, however, that medieval logicians used the word "cause" in a wide sense corresponding to Aristotle's aitia and did not necessarily mean by prius something earlier in time. This point is brought out by the use of the phrase *demonstratio propter quid* ("demonstration on account of what") as an equivalent for *demonstratio a priori* and of *demonstratio quia* ("demonstration that, or because") as an equivalent for *demonstratio a posteriori.* Hence the reference is obviously to Aristotle's distinction, knowledge of the ground or explanation of something (*to dioti*) and knowledge of the mere fact (*to hoti*).

It was probably their connection with this antithesis between necessity and fact that made the phrases a priori and a posteriori seem suitable for use in the context in which Kant employed them in his *Critique of Pure Reason.* What we claim to know without recourse to experience is always some necessary truth such as a theorem of mathematics, whereas that which is known only from experience is not seen to be necessary. It is unfortunate, however, that the phrases have come to be applied generally to kinds of knowledge and even sometimes to kinds of concepts. For in this context they are by no means self-explanatory.

Although the use of a priori to distinguish knowledge like that which we have in mathematics is comparatively recent, the interest of philosophers in that kind of knowledge is almost as old as philosophy itself. No one finds it puzzling that he can acquire information by looking, feeling or listening, but philosophers who have taken seriously the possibility of learning by mere thinking have often considered that this requires some special explanation. Plato maintained in his *Meno* and in his *Phaedo* that the learning of geometrical truths was only the recollection of knowledge possessed in a previous existence when we could contemplate the eternal ideas, or forms, directly. Augustine and his medieval followers, sympathizing with Plato's intentions but unable to accept the details of his theory, declared that the ideas were in the mind of God, who from time to time gave intellectual illumination to men. Descartes, going farther in the same direction, held that all the ideas required for a priori knowledge were innate in each human mind. For Kant the puzzle was to explain the possibility of a priori judgments that were also synthetic (*i.e.,* not merely explicative of concepts), and the solution that he proposed was the doctrine that space, time and the categories (*e.g.,* causality), about which we were able to make such judgments, were forms imposed by the mind on the stuff of experience.

In each of these theories the possibility of a priori knowledge is explained by a suggestion that we have a privileged opportunity for studying the subject matter of such knowledge. The same conception recurs also in the very un-Platonic theory of a priori

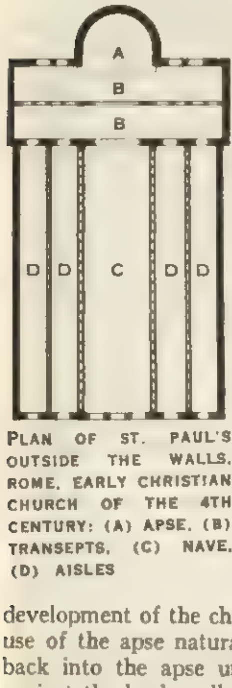
knowledge first enunciated by Thomas Hobbes in his *De Corpore* and adopted in the 20th century by those philosophers who call themselves logical empiricists. According to this theory statements of necessity can be made a priori because they are merely by-products of our own rules for the use of words. In favour of this conventionalist view it may be said that any truth that we know a priori must indeed be certifiable by reference to the rules which determine the meanings of the words or other signs in which it is expressed. But it is by no means obvious that such rules are all arbitrary.

See also Index references under "A Priori and a Posteriori" in the Index volume. (W. C. K.)

APSARAS, in Indian Vedic mythology, a water sprite. In the Rig-Veda the sea apsarases flow to Soma (*q.v.*). Though they are consorts of the Gandharvas (*q.v.*), they also wed mortals. They are also wives of Krishna Vasudeva.

APSE, in architecture, primarily a semicircular recess covered by a half dome. Hence, through the use of such a form to terminate the choir (*q.v.*) in early churches, the word is used, even when no vault is present, for any termination of a choir, a transept, an aisle or a chapel either circular or polygonal in plan. In Roman work, where the apse first appears, it occurred chiefly as an enlarged niche to hold and give importance to the statue of a deity in a temple. From this, the use of the form spread to other types of building, especially to the basilica (*q.v.*) as seen in the Imperial basilica in the palace of Domitian on the Palatine hill.

The apse form thus used was universally adopted by the early Christians as the climax of their churches. In the basilicas of the time of Constantine, in the western part of the empire the apse always faced the west. This was the orientation of the apse in old St. Peter's at Rome. During the 6th and 7th centuries, however, the usage in this matter gradually changed, so that churches in the west, like those in the east, had their apses toward the east and this has remained the custom ever since. The apse of the early Christian basilica was the place in which the clergy sat, the altar being situated between them and the rest of the church. This arrangement is still preserved in the apse of the cathedral at Torcello and in that of the church at Parenzo in Istria. In both cases there are semicircular benches of marble following the line of the apse and arranged in several stages, one above the other, like the seats of an ancient theatre. In the centre, on the axis, was the bishop's throne, raised above the clergy benches and approached by a flight of steps. With the development of the choir as the place for the clergy seats, the old use of the apse naturally disappeared and the altar was pushed back into the apse until, in many Renaissance churches, it is against the back wall.



PLAN OF ST. PAUL'S OUTSIDE THE WALLS, ROME, EARLY CHRISTIAN CHURCH OF THE 4TH CENTURY: (A) APSE, (B) TRANSEPTS, (C) NAVE, (D) AISLES

The apse was the place for the richest decoration in the church structure. It was sheathed with marble, frequently in elaborate patterns of light and dark, and the vault surface was covered with a glass mosaic in which some embodiment of the Godhead was the chief feature. At the end of the 6th century, liturgical changes rendered necessary the addition of other apses besides the main choir apse. These were frequently placed at the end of the side aisles but occasionally, when there was a transept, at the ends of the transept (as in the basilica at Bethlehem and in many examples of Coptic churches).

By the time Romanesque design was developing in western Europe, apse chapels had also been added to the church plan. This at once gave a great opportunity for enriching exterior design, until then severely simple, and led eventually to the development of that complex and magnificent combination of main apse and apse chapels known as the chevet (*q.v.*). In Italy, however, where chapels were usually confined to other portions of the church, the apse remained simple in form and gained its richness from the use of wall arcading, cornices and buttresses.


PHOTOGRAPH, "RADIO TIMES"—HULTON PICTURE LIBRARY

VIEW FROM THE CHOIR, LOOKING EAST, TOWARD THE APSE OF CANTERBURY CATHEDRAL

The apse, because of its shape, enclosed on one side and open on the other, gives great dignity to any object, such as an altar or statue, placed in its centre. It is, therefore, an admirable form with which to terminate any vista or to end any large hall, and it is so used in much modern secular work. *See* also BEMA; RELIGIOUS ARCHITECTURE. (T. F. H.)

APSE or APSIS, in astronomy and mathematics, either of the two points on an orbit that are nearest to or farthest from the centre of motion. They are called the lower (or nearer) and higher (or more distant) apses or apsides respectively. The line connecting these two points forms the "line of apsides," or major axis of the orbit.

APTERYGOTA, the name of the lower of the two subclasses of insects, not to be confused with Aptera, an antiquated term sometimes applied indefinitely to many wingless land arthropods. Apterygota are wingless, a condition apparently inherited from primitive ancestors before their flight organs had been developed. They are world-wide in their distribution and are noted for the generalized condition of many of their anatomical characters, especially for the possession of abdominal appendages. Many groups are seldom seen and only a few have been given common names. Collembola are generally called springtails or snow fleas, and Thysanura bristletails. The silverfish (*q.v.*) and firebrats, which inhabit houses, have become sufficiently well known, however, to receive accepted common names.

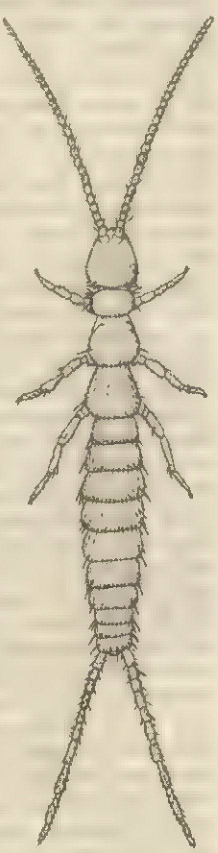
There is a tendency for some taxonomists to separate the Protura, Collembola and Diplura from the Thysanura, placing the first three in a separate class, the Entognatha, which is considered to be co-ordinate with the class Insecta.

The **Protura** (or **Myrientomata**) are very slender, minute, yellowish-brown hexapods, seldom exceeding 1.5 mm. in length. They are commonly found in the lower layers of moist ground litter of forests but occasionally are encountered, even in large numbers, in sphagnum or beneath loose bark. The abdomen of a proturan is composed of 12 segments in the adult. The 9th, 10th and 11th segments are obtained during postembryonic development, one of them being added at a time by a division of the terminal segment, or telson, into two segments.

The process of adding body segments following the embryonic stage is called anamorphosis. It is unknown among any of the other insects but is present in the millipeds and centipeds. Although clearly hexapod in their bodily organization, the peculiar method of development by means of anamorphosis in the proturans together with their possession of certain noninsectan anatomical characters have caused some students to recognize them as a class distinct from the insects, known as the Myrientomata. Fossil proturans have not been discovered.

The **Collembola,** or springtails, have the widest-known world distribution of any group of insects, being found on nearly all land masses regardless of size and in several places on the south polar continent. They occur in great abundance in the soil, in decaying vegetable matter of various kinds, in leaf mould and under loose bark. Some species are aquatic and are found on the surface of the water, a few occur on the snow, where at certain times of the year they congregate in great numbers, while other species live in close association with ants. Springtails vary in size from less than 1 mm. in length to more than 5 mm. They may be almost naked but usually are clothed with setae or scales, the latter giving them a metallic lustre. Although springtails that are provided with the jumping apparatus leap for considerable distances, the more common method of locomotion for most species is a crawling gait. Most springtails are without tracheae, but in the genus *Sminthurus* and some closely related genera tracheae are present. They open through a single pair of spiracles just behind the head. Most springtails are herbivorous, feeding on decaying vegetable matter, fungi, lichens, pollen, diatoms, algae and other lower forms of plant life. A few feed on higher living plants and may cause injury to greenhouse and truck crops. Some are known to be predaceous. Eggs of springtails usually are nearly spherical and are laid singly or in groups in the situation inhabited by the adults. The young are structurally almost the same as an adult but are smaller and frequently of a paler coloration. Individuals moult throughout life. Fossil springtails have been taken in Baltic amber, there being several genera represented. A fossil specimen found in Canadian amber possessed a pair of slender, divergent stylets instead of a true spring. For it the family Protentomobryidae has been created.

The **Diplura** (fig. 1) usually live in the soil, where many of them feed on decaying vegetation or on soft, living plant tissues such as root tips and root hairs. Because of their feeding habits, some species cause damage to growing plants. Some are known to be predaceous. The Diplura are long, slender, white or yellowish insects, and all species are blind. Those in the family Campodeidae possess two long, slender, segmented, apical abdominal appendages, while those in the family Japygidae bear, in place of these slender stylets, two forceplike apical structures resembling somewhat those of earwigs.



AFTER E. O. ESSIG
FIG. 1.—DIPLURAN (CAMPODEA FOLSOMI)

The **Thysanura** (fig. 2) are found in houses, beneath bark and boards, with ants or termites, or in the soil. Because of their long, slender, terminal appendages they are often called bristletails. Thysanura breathe through tracheae that open through paired spiracles. Their food habits have not been investigated exhaustively, but those species that invade houses will attack starchy materials, often causing extensive damage to books and papers. Thysanura are very active insects, running, dodging and jumping with great agility. The house pests prefer warm temperatures and do not exist out-of-doors in northern climates. Thysanura moult throughout their lives. The house-infesting forms grow slowly, maturing in from 3 to 24 months.

BY COURTESY OF ILLINOIS NATURAL HISTORY SURVEY
FIG. 2.—THYSANURAN, THE FIREBRAT (THERMOBIA DOMESTICA), A HOUSE PEST

CLASSIFICATION

Apterygotans may be separated into the following groups:

Order 1. Protura.—Antennae absent; mouth parts apparently withdrawn into the head; abdomen with 12 segments; first to third abdominal segments with appendages.

Order 2. Collembola.—Antennae present; mouth parts apparently withdrawn into head; abdomen with six segments, first always and third and fourth segments usually with appendages, the latter forming a jumping structure.

Suborder 1. Arthropleona.—Body elongate, segments of the thorax and abdomen usually distinct.

Suborder 2. Symphypleona.—Body short, swollen, globular; segments of the thorax and first to third of the abdomen ankylosed.

Order 3. Diplura.—Antennae present, composed of many segments; mouth parts apparently withdrawn into head; blind; abdomen consisting of 11 segments, ending in two long, slender, segmented cerci, or a pair of pincerlike structures.

Order 4. Thysanura.—Many-segmented antennae present; mouth parts not apparently withdrawn into head; eyes usually present; abdomen with 11 segments, ending in three long, slender, segmented stylets.

Suborder 1. Microcoryphia.—Body almost cylindrical in cross section, thorax arched; eyes present and well developed; ventral abdominal appendages well developed and sometimes used as a spring.

Suborder 2. Zygentoma.—Body flattened, nearly crescentric in cross section, thorax not strongly arched; eyes small, and absent in some groups; ventral abdominal appendages weakly developed.

See INSECT: *Classification by the Forms of Metamorphosis.*

BIBLIOGRAPHY.—Literature on the Apterygota is widely scattered and much of it was published many years ago. J. Lubbock's "Monograph of the Collembola and Thysanura," *Ray Society* (1876) is of both scientific importance and historic interest. American Collembola have been dealt with in numerous papers by J. W. Folsom, by H. B. Mills in his *Monograph of the Collembola of Iowa* (1934) and by E. A. Maynard in his *Monograph of the Collembola or Springtail of New York State* (1951). (H. E. E.; H. B. M.)

APTERYX, the genus name for the kiwis (*q.v.*), small flightless birds of remote regions of New Zealand. *See* also BIRD: *Types of Living Birds.*

APTITUDE TESTS attempt to determine and measure those characteristics of a person that are regarded as indices of his capability to acquire, through future training, some specific set of responses (intellectual, muscular, etc.). The tests assume that people differ in their special abilities, and that these differences are related in a predictable manner to their later achievements.

See PSYCHOLOGICAL TESTS AND MEASUREMENTS; DIFFERENTIAL PSYCHOLOGY; PERSONALITY.

APUANIA: *see* MASSA-CARRARA.

APULEIUS, LUCIUS (fl. 2nd century A.D.), Platonic phi-

losopher and rhetorician, author of *The Golden Ass,* the earliest Latin novel extant in its entirety, which secured for him an especial influence on modern fiction after the Renaissance, was born at Madauros in Numidia (near the modern Mdaourouch in Algeria), about A.D. 125. He was educated at Carthage and Athens and then traveled in the east, becoming deeply interested in initiation into religious mysteries. After practising as a rhetorician in Rome, he returned to Africa and married a rich widow, Aemilia Pudentilla. Her family disapproved of the union and accused Apuleius of having won her affections by magic arts. His defense (*Apologia* or *De Magia*) before the proconsul Claudius Maximus is the chief authority for his biography. The remainder of his life was devoted to literature and philosophy.

The work on which Apuleius' fame chiefly rests is the *Metamorphoses* or *The Golden Ass* (the latter title seems not to be the author's, but to have been bestowed in compliment), the narrative of the adventures of a young man changed by magic into an ass. The same theme was treated in a short extant Greek work called *Lucius, or the Ass,* attributed to Lucian, and in the lost *Metamorphoses* of Lucius of Patrae, of which Photius gives a brief report. The relationship between these narratives has been much discussed; probably that of Lucius of Patrae was the earliest and was used both by Apuleius for his elaborate version and by the author of *Lucius, or the Ass,* who gives the story a satirical turn. Apuleius' hero is in some sense also a portrait of the author, and one or two obviously autobiographical details are introduced. In the last book he is restored to human shape by the aid of Isis and finally becomes her priest.

The Golden Ass illustrates the contemporary reaction against a period of skepticism and also the influx of oriental and Egyptian ideas into the old theology. It also has a well-marked literary aim, defined by H. Kretschmann as the emulation of the Greek Sophists and the transplantation of their tours de force into the Latin language. The dignified, the ludicrous, the voluptuous, the horrible, succeed each other with rapidity; fancy and feeling are everywhere apparent, but not less so affectation and meretricious ornament. The style of the Latin is peculiar and has a strong archaistic colouring. The novel as a whole, however, is invaluable as an illustration of ancient manners and is full of entertainment. The "Cupid and Psyche" episode (bk. iv–vi) has been much imitated: in English there are poetical treatments of it by Shakerley Marmion (1637), by Mrs. Tighe (1805), by William Morris (in *The Earthly Paradise*) and by Robert Bridges (1885, 1894); and Walter Pater introduces it in *Marius the Epicurean.* Likewise, Don Quixote's adventure with the wineskins and Gil Blas's captivity among the robbers are borrowed from Apuleius, and several of the humorous episodes reappear in Boccaccio.

Of Apuleius' other writings, the *Florida* is a collection of excerpts from his declamations, ingenious but highly affected. The little tract *De Deo Socratis* expounds the Platonic doctrine of beneficent daemons, an intermediate class between gods and men. Two books on Plato (*De Platone et eius Dogmate*) treat of his life and his physical and ethical philosophy; the third, a spurious work on logic called *Peri hermeneias* or *De philosophia rationali,* was much studied in the Middle Ages. The *De Mundo* is an adaptation of the treatise *On the World* wrongly attributed to Aristotle. Apuleius asserts that he also composed many poems and several works on natural history.

Among works falsely attributed to Apuleius should be mentioned *Asclepius,* a Latin version of an important Greek Hermetic dialogue.

BIBLIOGRAPHY.—Of the collected works of Apuleius the first edition is by Joannes Andreas (1469); later editions are by F. Oudendorp, 3 vol. (1786–1823), by G. F. Hildebrand, 2 pt. (1842) and by R. Helm and P. Thomas (1907–31). *See* further the *Index Apuleianus,* ed. by W. A. Oldfather, H. V. Canter and B. E. Perry (1935); H. Kretschmann, *De Latinitate L. Apulei* (1865); H. Koziol, *Der Stil des Apuleius* (1872).

For the *Metamorphoses* separately *see* the editions by F. Eyssenhardt (1866) and by D. S. Robertson and P. Vallette, 3 vol. (1940–45); also P. Médan, *La Latinité d'Apulée dans les Métamorphoses,* new ed. (1926). For the relation between the *Metamorphoses* and *Lucius, or the Ass* see Erwin Rohde, *Über Lucians Schrift* Λούκιος (1869); K. Bürger, *De Lucio Patrensi* (1887); B. E. Perry, *The Metamorphoses Ascribed to Lucius of Patrae* (1920). There are English translations of *The Golden Ass* by W. Adlington (1566; rev. by S. Gaselee for the Loeb Classical library, 1919); by T. Taylor, with the philosophical works also (1822); and by Robert Graves (1951). Of the "Cupid and Psyche" episode there are separate editions by O. Jahn and A. Michaelis (1883; 5th ed., 1905) and by L. C. Purser (1913).

For the *Apologia,* see the editions by I. Casaubon (1594) and by H. E. Butler and A. S. Owen (1914); also A. Abt, *Die Apologie des Apuleius von Madaura und die antike Zauberei* (1908). For Platonic works and the treatise *On the World* see the edition by A. Goldbacher, *Apuleii Madaurensis opuscula quae sunt de philosophia* (1876). For the *Asclepius* see the *Corpus Hermeticum,* ed. by A. D. Nock and A. J. Festugière, vol. ii (1945).

APULIA, a part of southeast Italy once inhabited by the Apuli, a Samnite tribe (*see* SAMNITES) around Mt. Garganus (Promontorio del Gargano) on the east coast. They mingled with the Iapygians who had come from Illyria, so the district reached the border of ancient Calabria. A rare monument of the Samnite language is the famous *Tabula Bantina* from Bantia on the Lucanian border, a late and important record of the Oscan (*q.v.*) dialect with some southern peculiarities. Dating between 118 and 90 B.C., it shows that Latin had not then spread over the district (*see* LUCANIA). Far older are coins from Asculum Apulum (modern Ascoli Satriano) and Teate (later known as Teanum Apulum, now scanty ruins), the earliest being of the 4th century B.C. Of the few Roman or Latin colonies Luceria (Lucera) and Brundisium (Brindisi) were the chief. The Romans developed the migration of flocks; sheep tracks (*tratturi*) 350 ft. wide, leading from the Abruzzi into the plain of Apulia, date at least from Roman times. Large-scale sheep farming was detrimental to the towns and risings occurred until the Social War. Apulia, with Calabria, formed the second region of Augustus. Hannibalic and later wars, according to Strabo, destroyed the prosperity of the country; in imperial times little or nothing was heard of it. Both Apulia and Calabria were governed by a *corrector* from Constantine onward, but in 668 the Lombards conquered Calabria and Apulia and the former name was transferred to the territory of the Bruttii, the name Apulia being extended to include Calabria also. In the 9th century the greater part of this territory was recovered by the Byzantine emperors.

Teate was the first capital, then Luceria, a military post, and then, under the empire, Canusium (Canosa di Puglia). The old road system consisted of the Via Appia (*see* APPIAN WAY), the Via Traiana and the coast road, more or less parallel east-southeast. The first, east from Beneventum (Benevento), entered Apulia at Pons Aufidi (Ofanto bridge) and ran to Venusia (Venosa), Tarentum (Taranto) and Brundisium. The second, northeast from Beneventum, turned east at Aecae (Troia) and ran through Herdoniae (Ordona), Canusium, Butuntum (Bitonto), Barium (Bari) and Egnatia (Gnatia) to Brundisium. A short cut, from Butuntum to Gnatia through Caelia (Ceglie del Campo), ran inland. The third parallel line ran north of the Via Traiana, entering Apulia near Larinum (Larino), and thence, keeping to the plain south of Mt. Garganus, rejoined the coast near Manfredonia at Sipontum (with a branch at Aecae through Luceria and Arpi just north of Foggia to the Via Traiana). It then passed through Barduli (Barletta) where it was joined by a road from Canusium by way of Cannae to Barium, where it joined the Via Traiana. From Barium a road probably ran through Caelia south-southeast to the Via Appia, some 25 mi. N.W. of Tarentum. Barium was an important harbour, though less so than Brundisium and Tarentum, which, however, belonged to Calabria. (For the modern region and later history *see* PUGLIA.)

APURE, a state of southwestern Venezuela, is one of the most typical llanos states; area 29,537 sq.mi., pop. (1961) 117,577. Cattle raising dominates life, and the size of a ranch is often measured by square leagues (old Spanish unit equivalent to 4,439 ac.). Some ranches exceed 1,000,000 ac. and as many as 4,000 calves are branded at a single roundup. San Fernando de Apure, the capital, has the largest packing house in the country, from which fresh beef is flown daily to Caracas and other large cities. Several dry-season highways run deeply into the state from the north and west. (L. WE.)

APURE RIVER, one of the major tributaries of the Orinoco, has its source in the Cordillera de Mérida of Colombia several

hundred miles to the west and flows northeast and east through the heart of the llanos into the Orinoco. The best part of the llanos lies between the Apure and the northern mountains. The river's principal affluents, including the Portuguesa and the Guárico, flow mostly from the north. During the rainy season (May to November), it is navigable for small steamers from Ciudad Bolívar to the important towns of Nutrias and San Fernando de Apure. The Apure's tributary area is a famous cattle country. Including its headstreams, the river is 509 mi. long. (L. WE.)

APURÍMAC, a department in the interior of southern Peru; area 7,975 sq.mi., pop. (1961) 303,648. Most of the department is at a high elevation, but with deep canyons cut into the highland surface by the Río Apurímac and its tributaries. The inhabitants are mainly farmers and sheep herders. The chief products are wool (from sheep and alpacas), meat, maize, barley, wheat and potatoes. At lower elevations sugar cane, fruit and cotton are grown. The mines are worked for gold, copper, lead and salt. The capital, Abancay, located about 83 mi. W. of Cuzco, is in the centre of the largest area of settlement, located in an intermontane basin that lies between 7,000 and 8,000 ft. above sea level, where sugar cane can be raised. The department was formed in 1873. (P. E. J.)

APURÍMAC RIVER, in south central Peru, one of the headwaters of the Amazon. It rises in the Laguna de Villafro at the north base of the Cordillera de Chilca, 7 mi. from the village of Cailloma. For some 429 mi. it flows northwest and north-northwest through the heart of the Andes, descending from over 15,000 to less than 860 ft., where it joins the Urubamba to form the Río Ucayali. For most of this length it flows through narrow canyons, and its course is frequently interrupted by falls and rapids. It is known as the Apurímac only as far as Puerto Bolognesi at the junction of the Río Mantaro. From this point as far as Puerto Prado at the junction of the Perené it is called the Ené, and thence to the junction with the Urubamba it is called the Río Tambo. Because of its torrential nature and the narrowness of its valley bottom, few people live along the river. It forms much of the Cuzco department western boundary. Its main affluents are the Pampas and Pachachaca. (P. E. J.)

AQABA (AL 'AQABAH), the only sea outlet of the Hashemite Kingdom of Jordan, lies at the head of the Gulf of Aqaba, the northeastern branch of the Red Sea. Pop. (1961) 8,908. It was probably the site of the biblical Elath, and under the Romans it was a military post called Aelana. The old town is built largely of mud brick, with gardens and palm groves down to the water's edge; a ruined castle of the 14th century A.D. stands near the old jetty. There is a small airport, but communication with the interior is mostly by road. It was little used as a port in World War I, developed in World War II, and by the 1960s handled over 400 vessels and more than 700,000 tons annually. (G. W. L. H.)

AQABA, GULF OF, the Sinus Aelaniticus of antiquity, the eastern of the two northern arms of the Red Sea. Varying in width from 12 to 17 mi., it is 100 mi. long, penetrating into northwest Saudi Arabia and the Sinai peninsula (Arabia Petraea) toward the north-northeast. The gulf is in a pronounced cleft with hills rising abruptly from the shore, often to 2,000 ft. The entrance is narrowed and made difficult by Tiran and other islands, while navigation is precarious because of numerous coral reefs and sudden squalls. The gulf is part of the complex Jordan–East African rift valley system, being a southward continuation of the Jordan-Araba depression. At its head the gulf is 5 mi. wide, and there the Egyptian-Israeli, Israeli-Jordanian and Jordanian-Saudi Arabian boundaries converge, giving Israel and Jordan each about 9 mi. of coast line.

The only sheltered harbour in the gulf is at Dahab 33 mi. from the entrance, but both Israel and Jordan, urgently needing outlets to the sea, have created ports at Eilat (Elath) and Aqaba. Aqaba is at the eastern side of the head of the gulf and has a good water supply and refreshing palm groves. Since medieval times it has been a recognized stronghold on the pilgrim route from Egypt to Mecca. It is the site of the biblical Elath (Eloth). The Romans called it Aelana, a military post with paved road up the valley of Wadi Itm to Ma'an and Petra. In the 10th century an Arab geographer described it (Haila or Ailat) as a great port of Palestine and the emporium of the Hejaz. It suffered at the hands of Saladin (12th century), and fell into decay until 1841 when its regular use by Egyptian pilgrims was acknowledged by Turkey's recognition that the Sinai peninsula and Aqaba belonged to Egypt. In 1892 Turkey resumed possession of Aqaba. In 1917 Col. T. E. Lawrence (*q.v.*) and the Hejaz army captured it. Aqaba was then administered together with Ma'an, Petra and Shaubak as part of the Hejaz kingdom until 1925, when Great Britain, fearing a Wahhabi attack, ejected King Husain (*see* HUSAIN IBN ALI) and occupied the Aqaba-Ma'an province. This area later became part of the Hashemite Kingdom of Jordan. During the 1950s the development of the port of Aqaba and improvement of its road and air links with the interior of Jordan were put in hand under agreement between Great Britain and Jordan. The tiny port of Eilat, founded in 1949 (pop. [1961] 5,326), has grown as a result of interference by Egypt with Israeli shipping passing through the Suez Canal and the development of the Negev. An oil pipeline was laid from the port to the Haifa refinery, and an asphalt road built to Beersheba. The port is also served by a small airport. (A. B. M.)

On May 17, 1967, in the course of a Middle East crisis, President Nasser, on behalf of the U.A.R., demanded the withdrawal of the UN force stationed since 1956 at Sharm el Sheikh on the Tiran Strait at the mouth of the gulf. When the UN secretary general complied with his request, Egyptian troops occupied Sharm el Sheikh. Nasser thereupon closed the gulf to all Israeli shipping and to all shipping carrying strategic goods to Israel. Sharm el Sheikh was recaptured by Israeli forces on June 7. (X.)

AQUAE (Lat. "waters"), a name given by the Romans to sites where mineral springs issued from the earth. More than 100 can be identified, some declaring by their modern names their ancient use: Aix-les-Bains in Savoy (*Aquae Sabaudicae*), Aix-en-Provence (*Aquae Sextiae*), Aix-la-Chapelle or Aachen (*Aquae Grani*), etc. Two occur in Britain: *Aquae Sulis*—less correctly *Aquae Solis*—at Bath (*q.v.*) and Buxton (called *Aquae*).

AQUAMARINE, a transparent variety of the beryllium ore beryl (*q.v.*). It is valued as a gem, having a delicate blue or bluish-green colour, suggesting sea water. Emerald is the green variety of beryllium. Aquamarine occurs usually where ordinary beryl does, the finest coming from the U.S.S.R. *See* also GEM.

AQUA REGIA is a mixture of concentrated nitric and hydrochloric acids, usually one part of the former to three parts of the latter by volume. This mixture was given its name by the alchemists because of its ability to dissolve gold and other "noble" metals. Aqua regia and similar mixtures are used in chemistry to dissolve substances that resist being placed in solution.

The solvent action on gold, for example, is caused by the oxidation of the metal by nitric acid and by the ability of the chloride ion (from the hydrochloric acid) to bind the oxidation product, the auric ion (Au^{+++}), in a stable complex, tetrachloraurate ion ($AuCl_4^-$). The formation of this complex ion reduces the concentration of the oxidation product and drives the reaction in the desired direction. The complete chemical reaction can be represented by the equation: $Au + NO_3^- + 4H^+ + 4Cl^- = AuCl_4^- + NO + 2H_2O$. The effect of the chloride ion on the ease of oxidation of gold is reflected in the large lowering of the oxidation-reduction potential of the metal: $E = -1.50$ v. ($Au = Au^{+++} + 3e$) in the absence of chloride, and $E = -1.00$ v. ($Au + 4Cl^- = AuCl_4^- + 3e$) in the presence of chloride.

When the aqua regia solution of gold is concentrated by evaporation, nitrosyl tetrachloraurate ($NOAuCl_4$) is obtained; if an excess of hydrochloric acid is present, tetrachlorauric acid, $HAuCl_4 \cdot 4H_2O$, crystallizes out.

Aqua regia dissolves platinum and palladium rapidly, but the other platinum metals, iridium, osmium, rhodium and ruthenium, are less readily attacked; the reaction must be carried out in a sealed tube to effect complete solution. The reagent is used in analytical procedures for the solution of certain iron ores, phosphate rocks, slags, nickel-chromium alloys, antimony, selenium, etc., as well as for some of the less soluble sulfides; *e.g.*, those of

mercury, arsenic, cobalt and lead. It reacts with the bromide, iodide and cyanide of silver and with lead chromate to give the corresponding chlorides.

Other mixtures of oxidizing agents and complex-forming substances behave in a manner similar to that of aqua regia. The hydrochloric acid may be replaced by hydrofluoric acid or by hydrobromic acid; the nitric acid may be replaced by sodium perchlorate or perchloric acid. In the cyanide process for the recovery of gold, oxygen and potassium cyanide are used for the solution of the metal; the solution process is similar, oxygen serving as the oxidizing agent and the cyanide as the complex-forming substance. (G. W. Sr.)

AQUARELLE, the French term for water colour, used in reference both to the technique and the resultant painting. *See* Water-Colour Painting.

AQUARIUM, a receptacle or institution in which living aquatic animals or plants are exhibited or studied. The term is applied to a public exhibition of aquatic specimens with the object of instructing or entertaining the public, or for scientific study, as well as to such a household ornament as a bowl of goldfish.

Many of the principal cities of the world have or have had public aquariums, supported by either public or private funds, occasionally by both; such institutions have proved so popular that a number of private aquariums have been built, as commercial enterprises, especially in the United States. Although some aquariums engage in scientific activities of greater or less extent, their primary object is that of public education and entertainment. In another category come those aquariums which are chiefly research institutions with or without a secondary public exhibition of relatively smaller size and scope. Among the best known of the latter are those at Naples, Italy; L'Institut Océanographique, Monaco; Plymouth aquarium, Marine Biological station, Plymouth, Eng.; Scripps Institution of Oceanography, La Jolla, Calif. In still another category come temporary aquariums that have frequently been extremely popular exhibits at world's fairs and expositions. Permanent aquariums have always been popular with the public and regularly show larger attendance records than do other comparable public institutions.

Development of Public Aquariums.—The maintenance of living fishes and other aquatic organisms in captivity has a long history. The ancient Romans spent considerable effort in building huge ponds, sometimes directly connected to the sea, which they stocked with rare and valued specimens, while the Chinese of early times developed the practice of cultivating ornamental fishes suitable for keeping in small containers. The Chinese domesticated both the carp and the goldfish and from the latter they developed, by selective breeding, the forebears of the highly modified present-day domestic goldfish. The first public aquarium was opened at Regent's park, London, in 1853. Not until the art of glassmaking had reached a point where it was possible to produce large sheets of clear glass of considerable structural strength, however, did large glass-sided aquariums make their appearance. Glasses used in large-fronted aquariums are generally from 1 to 1½ in. in thickness.

The larger public aquariums suffered heavily after the onset of World War II for a variety of reasons, including those which handicapped most institutions as well as many which are peculiar to aquariums; most of those aquariums which closed or were damaged, however, were later rebuilt and reopened. With 23 public aquariums in the United States, more were in the planning stages. Others were being built in many cities throughout the temperate and tropical parts of the world. In the United States the most notable formal aquariums, as distinguished from the oceanarium type of aquariums which are a special kind of institution, are the Steinhart aquarium, San Francisco; the John G. Shedd aquarium, Chicago; and the New York aquarium, New York city. The pioneer of the oceanarium type of aquarium is Marine studios, Marineland, Fla.; Marineland of the Pacific, Palos Verdes, Calif.; and the Seaquarium, Miami, Fla., are similar. In this type of aquarium the emphasis is on very large tanks, up to 1,000,000 gallons each, in which a great variety of fishes is placed with no attempt to separate them. In the formal aquarium the kinds and types of fishes are separated and the water circulations matched to them. (C. M. Br.; C. W. C.)

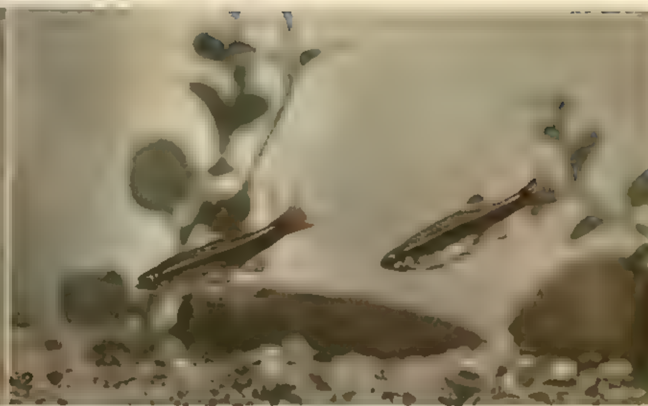
Aquarium Architecture.—The first containers specifically designed for aquatic specimens and positively identified as such were the strictly functional open-air tanks used by the Romans from at least the 2nd century to preserve and fatten fish for the market. It was not until the 18th century that the importation of goldfish into France from the orient for aesthetic enjoyment created a demand for small aquariums; and ceramic bowls, occasionally fitted with transparent sections, were produced to serve as showcases.

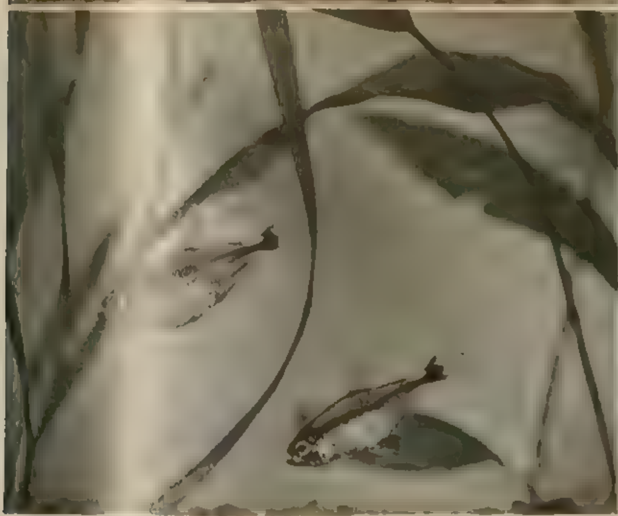
The large public aquariums in many European cities were built for the most part during the epoch of scientific romanticism, between 1850 and 1880—Berlin (1869), Naples (1873), Paris (1878). This was the time when Jules Verne's very popular novel, *20,000 Leagues Under the Sea* was published (1869), and there is no doubt that architects of aquariums were influenced by the romantic concepts of the time and made conscious effort to create the illusion that the spectator was entering into the underwater world. Thus the surface of the water was concealed and labyrinthine plans, rocky wall facings, dark colouring and low lighting were used to produce mysterious and at times terrifying effects.

More recently, as in Marineland in Florida and the New York aquarium (1956), the trend has been to emphasize the natural beauty of the specimens, and to make a sharp distinction between the water and the viewing space. (H. L. Co.)

Maintenance.—Modern aquariums are complex engineering projects involving elaborate machinery for moving and handling water and maintaining it at proper temperature and chemical constitution. In addition, there are the general problems of adaptation and diet, disease and parasitism involved in any project concerned with living creatures. In localities where there is an adequate and suitable water supply, the mechanical features are much simplified; the water is piped or pumped to the exhibition tanks and then allowed to run to waste. Fresh water is usually taken from the municipal supply, although it does not necessarily follow that potable water is suitable for fishes. The heavy chlorination practised by many municipalities for sanitary reasons is quickly fatal to fishes, and such water must first be dechlorinated. Sea water used in open circulation must be pumped from some point removed from contamination or dilution by discharging rivers. This limits the free use of sea water to those aquariums situated in places away from major cities. Even when a suitable site is available, storms may so disturb the water at the place of intake that it is unfit for use. Thus, even under the best of conditions, it is unwise for an aquarium to be dependent on exterior sources alone. When such free use of water is not possible, recourse is made to a closed system in which stored water is recirculated from a reservoir and filtered and conditioned en route. This leads to complicated mechanical operations that require constant vigilance on the part of the technical staff.

The usual arrangement of closed systems is that in which the water flows by gravity from the tank containing the specimens through a filter to a storage reservoir. Here it is lifted by a pump to an elevated distributing reservoir, from which it flows by gravity to the tank of specimens. Temperature is generally regulated in the lower reservoir by a heating or refrigerating unit thermostatically or manually controlled. Chemical treatment is generally made at this same place. Aeration, necessary to replace the oxygen consumed by the specimens and to liberate the carbon dioxide given off by them, may be undertaken at various convenient points along this circuit. In a large aquarium designed to accommodate many different kinds of organisms, both fresh-water and marine, a considerable number of such systems is frequently established. The exhibition tanks of any one system are generally arranged in parallel. Thus in actual practice there may be established three separate marine circulations of three distinct temperatures to accommodate warm, temperate and cold circulations, and a similar set for fresh water. In addition to these it may be necessary or desirable to provide brackish water of varying temperatures and fresh waters of varying degrees of acidity or alkalinity or of special chemical character. The piping and pumps necessary for such purposes must be selected with great care, and





TROPICAL FISHES KEPT IN HOME AQUARIUMS

1. Zebra fish (*Danio rerio*), 1¾ in. An active fish of the minnow family. Habitat: small mountain rivulets, Bengal, India
2. White cloud (*Tanichthys albonubes*), 1¼ in. Habitat: White Cloud mountain, near Canton, China
3. Head-and-tail-light fish (*Hemigrammus ocellifer*), 1¾ in. Habitat: British Guiana and Brazil
4. *Pristella riddlei* (no common name), 1¾ in. Habitat: northeastern South America
5. Black-banded sunfish (*Mesogonistius chaetodon*), 2 in. Habitat: coastal lowland streams, bogs, and marshes, New Jersey to Florida
6. Thick panchax (*Pachypanchax playfairi*), 3¼ in. Habitat: east Africa, Zanzibar, and Seychelles

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COMMON TROPICAL FISHES

1. Buenos Aires tetra (*Hemigrammus caudovittatus*), 3½ in. Habitat: Argentina
2. Rosy barb (*Barbus conchonius*), 3½ in. Habitat: northern India, Bengal, and Assam
3. Pearl gourami (*Trichogaster leeri*), 4 in. Habitat: Thailand and Malaya to Sumatra and Borneo
4. Angelfish or scalare (*Pterophyllum eimekei*), 6 in. Habitat: northeastern South America
5. Swordtail (*Xiphophorus helleri*), 5 in. Habitat: lowland streams of southern Mexico and Guatemala
6. Sailfin Molly (*Mollienesia velifera*), 3½ in. Habitat: coastal waters of the Yucatan peninsula

G. J. M. TIMMERMAN FROM THREE LIONS

metal is usually avoided. Brass is especially likely to produce toxic effects. Tin and titanium are perhaps the least troublesome of the metals, but hard rubber, certain plastics, glass or cement-lined pipes are generally considered most satisfactory, because they are, to all intents and purposes, chemically inert under the special conditions obtaining in aquarium water systems.

Disease and parasites are a continual threat, and there must be a constant guard against epidemics. For this reason it is considered good practice to break the various circulating systems into as small units as is practicable so that any such outbreaks may be more readily isolated. The treatment of fish ailments is difficult, and preventive measures are much more effective than attempts to cure ailing stock. Such cures are chiefly effected by immersing the diseased specimen in a solution which it can stand but which the infecting organism cannot. Selective chemicals of this kind are not always easily found or compounded.

The collection and transportation of aquatic specimens in a living state, especially if they are of considerable size, presents a variety of problems. First, they must be caught in such a manner as to be without serious damage. Transportation must be effected as rapidly as possible and with a full continuation of the immediate needs of the aquatic organism. The water in the shipping tank must be kept in suitable condition by circulation, aeration or chemical treatment throughout the trip. Smaller specimens may be shipped in sealed containers of metal or plastic about half full of water, with the remaining space being filled with air or oxygen under low pressure. Chemicals are now available to render waste products less noxious and to reduce the activity of the animals during their close confinement.

Aquariums in the Home.—A considerable variety of aquatic organisms are accommodated to life in standing water. Such aquariums present none of the difficulties inherent in the maintenance of those in which water is circulated. Caring for standing aquariums is much simpler and it is fishes that can be so accommodated that are generally to be found in the home. These form the basis of the extensive activity of private or amateur aquariists. The principles involved in the maintenance of standing aquariums are naturally similar, whether the tank is a fairly large one in a public exhibition or a relatively small one in a private living room.

A body of standing fresh water such as may be contained in a small, glass-sided aquarium contains in solution the dissolved gases of the air in proportion to their partial pressures. It is the oxygen so dissolved that is available to aquatic organisms unable to use air directly for respiration. As a fish, under these conditions, uses up the dissolved oxygen in the water, more free oxygen from the air dissolves into the water and so replaces that consumed, according to its partial pressure. From this it follows that the rate at which new oxygen dissolves into the water should be equivalent to the rate at which the fish withdraws the oxygen. If the rate is slower, the fish will eventually suffocate. Concomitantly carbon dioxide is expired by the fish. This escapes into the air through the surface of the water, tending to reach a balance with the partial pressure of that gas in the air. The escape of the exhaled carbon dioxide from the water must be at least equal to the rate at which the fish gives it off or the fish will be suffocated, not from want of oxygen but from inability to pass its continually produced carbon dioxide into the already supercharged water. Other things being equal, the rate at which these gases pass through the interface between air and water is determined by the size of that area. Thus, the greater the surface area of a body of water, the more fish—or larger fish—that body will be able to support. It is for this reason that the globular-shaped bowls with their restricted surface areas were largely abandoned. Since for observation purposes and the swimming needs of fishes there are practical disadvantages in extremely shallow aquariums, the practice of making aquariums as wide as they are high, and twice as long, has reached some degree of standardization. Aquariums with circulating water circumvent this limitation because of the opportunity of aerating the water en route. To offset the limits of the surface available in standing aquariums, air in fine bubbles may be passed through the water by means of an air pump. The surface of each tiny bubble adds to the air exposure of the water; the rising bubbles also induce a slow circulation within the tank which checks any tendency toward stratification.

In addition to exhaling carbon dioxide in the process of respiration, a fish also eliminates various body wastes, which, except for the solids, go into solution, thus modifying the chemical nature of the water in which the fish is bathed. Some species are very sensitive to certain of these wastes and are not able to survive long in standing water. Others are not so affected and many are evidently positively benefited. In household aquariums, contrary to popular notions, the water should seldom be completely changed or replenished. Generally, a glass cover should be provided to reduce evaporation and keep the fishes from jumping out.

The introduction of some form of aquatic plant life is practically essential, although the presence of plants in such an aquarium further complicates the situation. What has been mentioned about the respiration of fishes is likewise true of submerged aquatic plants. They consume dissolved oxygen and give off carbon dioxide; also, under the influence of bright light, plants consume carbon dioxide and give off oxygen while engaged in photosynthesis. This operates very well so long as light of a certain intensity falls on the plants; the animals give off what the plants can use and vice versa. Aquariums in which the plants and animals are believed to balance each other in a respiratory sense are generally referred to as balanced aquariums. However, this condition of balance is rarely attained, because when the light falls below a certain value (as at the coming of evening or on cloudy or dull days) the plants are in direct respiratory competition with the animals. Moreover, the atmosphere constantly enters the picture, affecting the exchange of gases through the water surface. Consequently it is best to have the quantities of animal and plant life so related to the surface area that they can survive indefinitely by means of gaseous exchange through the surface film. There is an additional relationship between plants and animals in such an aquarium. The waste products of the fishes form fertilizer or food for the plants and are consumed by them. It is, strictly speaking, such water that aquariists consider conditioned and most suitable for the specimens of their interest. Furthermore, dense, slow-growing plants that consume much of the waste products of relatively few fishes as fast as they are formed usually furnish the most stable and attractive small aquariums. A large variety of plants are suitable for such purposes.

Based on these principles, it is possible to maintain a large variety of fresh-water fishes with relatively little attention and inexpensive equipment. Aside from the aquariums themselves it is necessary to provide only sufficient daylight, a suitable and relatively uniform temperature and the required food. The hobby of keeping fishes in the home supports a sizable business in the importation and culturing of exotic fishes, the manufacture of aquariums and apparatus and a variety of publications devoted to the subject, as well as clubs or societies in the major cities of the world.

Most of the fishes so kept are included in the term tropical, for the vast majority of them come from the areas drained by the Amazon and adjacent lands, from the Indian peninsula and from southeastern Asia and the islands of the East Indian archipelago. These areas supply many hundreds of species of small fresh-water fishes of which 100 or so have found general favour among fish fanciers. A smaller number comes from tropical Africa. Still fewer come from the West Indian islands, Central America and the southern states of the United States.

The most popular groups of fishes usually found in the tanks of fanciers include representatives of the orders Ostariophysi, Cyprinodontes, Percomorphi and Labyrinthici, with a liberal sprinkling from the Nematognathi and a few from several other orders and suborders.

Obviously, not all the members of all these orders can be kept in domestic tanks, or in any tank, but a sufficient number have the requisite abilities to live in relatively stagnant water and close quarters, on artificial diets, and show sufficiently attractive colours or behaviour patterns to keep the fancier interested.

Aside from the attractiveness and colourfulness of the specimens and the aquarium as a whole, one of the principal interests

of the fancier centres on the breeding of the fishes available, not always from a commercial standpoint but rather as the acceptance of a challenge to find exactly what the creature requires to fulfil its life.

Actually, the breeding behaviour of many fishes is astonishingly complete in its familial aspects. This includes the mating for life of some species of cichlids, with the subsequent choosing of a site for the nest, the preparation of it, the careful placing of the eggs and the almost fanatical care and protection of them and the resulting young, even to the extent of providing a place of succour for the young in the mouths of the parents. Some go through all the nesting procedures up to the deposition of the eggs, but then pick them up and carry them until long after hatching, refusing all food until their offspring are ready to leave for good. Others build elaborate nests, using all sorts of materials which may be available, with the bubble-nest-building labyrinthine fishes such as the two-inch-long Siamese fighting fish, *Betta splendens*, using bubbles of air sealed into capsules of mucus secreted by the mouth and assembled into a raft several inches across and sometimes two inches high. The eggs are caught by the male and thrust into the mass of bubbles immediately after shedding, with the male then standing by beneath the nest until hatching is complete and the young are old enough and active enough to be kept no longer in a compact group.

In a different category is the nest building of the stickleback, not properly a tropical fish but one which is sometimes kept in small aquariums. The males of this group secrete a mucoid substance in long filaments which harden into a silklike substance. This they wrap around a small cluster of plant stalks until they have an oval mass with a hole running horizontally through it. Into this they coax a waiting female and induce her to deposit her eggs, which she then abandons to the male for further care. A single male may build three or four such nests, one above the other, for the accommodation of the eggs of as many females, all of which he then attends to, cleaning and causing streams of water to flow over them until hatching.

A simpler breeding pattern is the birth of living young to such fishes as guppies, *Lebistes reticulatus*, and the platyfishes and swordtails, *Xiphophorus maculatus* and *Xiphophorus helleri*, all small fishes of the family Poeciliidae originating in South or Central America or the West Indian islands. Fishes of this group deliver living young in broods which may number 200, at intervals of about a month or so, after they have reached maturity. Of especial interest is the fact that one fertilization is sufficient for the production of as many as eight separate broods. Such fish are able to look after themselves almost from the instant of birth and receive no parental care at all.

A relative of these species, the mosquito fish, *Heterandria formosa*, from Georgia and Florida, is the smallest live-bearing vertebrate known. This fish follows the general pattern of its relatives, but it is so small (approximately one inch long) and its young so large, relatively, that it spreads the delivery of a single brood over a period of about three weeks.

Besides attractive colours or interesting breeding behaviour, some fishes appeal to fanciers by employing odd or unusual means of finding and catching prey. The archerfish, *Toxotes jaculator*, from the brackish waters of the East Indies, has a virtually unerring ability to "shoot down" its prey, insects, by squirting drops of water at them from its mouth. The force of the drops is quite sufficient to knock a large cockroach from a leaf or twig above the water, and the accuracy often is such as to extinguish a glowing cigarette fire at 11-ft. distance. (The fish will sometimes "shoot" at the fire of cigarettes at dusk.)

Such fishes as the mudspringers or mudskippers, *Periophthalmus* species from estuaries and mud flats over a range extending from tropical West Africa to the islands of the South Pacific, always interest fanciers, for they spend more than half their time out of water, hopping about on well-developed pectoral, ventral and tail fins, catching insects on the wing. A mudspringer will even scramble up the knees of mangroves two or three feet above water level in its hunting. It returns to the water to dip first one side of its head, then the other, to replenish storage areas above the gills, and by the constant passage of water from these areas over the gills manages to keep itself alive and moist even in the hottest sun.

Odd fishes as the knifefishes, family Gymnotidae, of which the best known is the electric eel, *Electrophorus electricus*, stir the interest by the habit of swimming backward as easily as forward, and by the habit of retiring beneath the sand to sleep. Fishes as these, once they are brought to the attention of fanciers, readily command a steady market, even though many of them cannot be safely kept in the same tank, let alone bred, and there has developed a considerable trade in these fishes.

Many fishes of the live-bearing kinds are bred literally by the millions in suitable climates, such as southern Florida, with a considerable but lesser number coming from greenhouse types of hatcheries scattered throughout the United States, with a fair number being located in Germany and in England. Germany once held the lead in this type of fish culture, but lost it during World War II.

A fair number of egg-laying fishes, particularly the Amazon angelfish, *Pterophyllum eimekei*, of the family Cichlidae, and the Siamese fighting fish, *Betta splendens*, are raised in commercial establishments, but the majority of the very popular Characidae are caught wild and imported in very large numbers. This is largely a matter of economics, for commercial importers and breeders have found they can catch and import such fishes as the extremely attractive and popular neon tetra, *Hyphessobrycon innesi*, for less than the cost of feed needed to raise a brood to salable size, with no consideration given to housing or heating. Other fishes which are imported must of necessity be so, for their breeding requirements are unknown. Others are of use to fanciers only when they are small and less than breeding size, so that these too must be imported in numbers.

The feeding of tropical fishes is usually not difficult, as they will thrive on many prepared fish foods supplemented with small pond organisms such as *Daphnia*, *Tubifex* and several other tiny animals which may be cultured with a minimum of effort. Fishes take surprisingly small amounts of food, and the novice always errs in the matter of overfeeding. Unconsumed food only serves to pollute the water. Diseases and parasites are not likely to be bothersome unless an aquarium is permitted to be chilled. Chilling lowers the vitality of the specimens to a point where they are likely to become involved in various difficulties, chief of which are outbreaks of disease caused by a ubiquitous protozoan parasite, *Ichthyophthirius*, which may prove fatal. A number of other parasitic, bacterial, rickettsial and fungoid diseases have been identified, and many remedies have been suggested, including dosages with some of the antibiotic drugs. However, it sometimes happens that when these are effective they leave the way open for other organisms to attack the fish, and since the majority of illnesses which afflict fishes seem not to develop as long as the tank is kept warm enough, and proper diet is observed, and besides the fact that most disease-causative agents are unidentifiable by the layman, it seems to be better policy to keep the fishes properly rather than try to identify and treat problematical illnesses.

Prior to World War I the principal interest of U.S. aquarists centred largely on the breeding and development of exceedingly elaborate and fantastic strains of goldfish. Later, the chief interest in fancy fish rearing transferred to so-called tropical fishes breeding of which centred chiefly in Germany before 1900 but gradually spread to all parts of the world. Several domesticated forms of wild types have been developed, including the platyfish, swordtail, guppy and Siamese fighting fish, none of which, however, departs from the wild type to the monstrous degree shown by some goldfish.

Temperate- or cold-water fishes of fresh-water origin can be kept in small aquariums if the water is sufficiently cool and aerated. The usual exotic fishes kept in home aquariums, however, are provided with temperatures of from 72° to 80° F., which is too warm for many temperate-water fishes. Most of these fishes are also not adjusted to living in stagnant water, even though it is kept cool enough, and are not good candidates for domestic fish tanks. They are kept in public aquariums which have large tanks

and great volumes of water under constant circulation. Aside from such fishes as the live-bearing *Heterandira, Gambusia* and *Mollienesia* and the egg-laying *Fundulus, Jordanella* and *Chriopeops* from the warmer states of the U.S., and the Texas cichlid, *Herichthys cyanoguttatus,* there are virtually no fishes in the North American continent suitable for aquarium keeping.

The keeping of small sea-water fishes offers a constantly recurring problem to fish keepers. Many of these, usually from tropical or subtropical seas, are exceptionally brightly coloured, especially in their early stages. One difficulty is that most of them cannot stand much variation in the chemical constitution of the water in which they live, and since sea water removed from the ocean starts to deteriorate almost immediately, the fishes have only a limited life before them. Another difficulty is that most of them are used to, and require, much greater quantities of water than is available to them in domestic tanks, even if it is possible to pump the available water into and out of the tank, so that although this is linked with the other limiting factor, the deterioration of the water, it is a limiting factor in its own right.

These two factors are the main reason for the recurring failure of fanciers to keep marine fishes in domestic tanks, and these are aggravated by the difficulty of obtaining adequate supplies of good sea water. Various formulas for the manufacture of artificial sea water have been produced, all of which are based on analyses of ocean water, but artificial sea water is deficient in many elements which may or may not be necessary to the living of the fishes, and even if these could be provided there are still the organic constituents and the microorganisms of natural sea water which undoubtedly play a vital role in maintaining marine life.

For the fanciers who can afford marine fishes there are few more spectacular, however.

Related to aquarium keeping is the maintenance of fish ponds for ornamental or other purposes, and rather similar principles apply. These may be small garden pools primarily for the raising of water lilies, or larger ponds on farms for the culture of food fishes. Most governments rear fishes in hatcheries for the purpose of stocking public waters. In the United States the federal and many state governments and some private hatcheries have undertaken such work for many years. Most of the activity has centred about the various trouts and salmons, whitefishes, basses, pikes and muskellunge. Where possible the eggs are stripped from the fishes and artificially fertilized. The resulting fry are subsequently released in whatever degree of advancement is desirable or necessary.

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AQUARIUS (the Water Bearer or Cupbearer), in astronomy the 11th sign of the zodiac, situated between Capricornus and Pisces. Its symbol represents part of a stream of water, probably in allusion to the fact that when the sun is in this part of the heavens (January, February) the weather is rainy. The constellation, though large, has no striking features, the brightest stars being of the third magnitude.

AQUATINT, a variety of etching (*q.v.*) in which the effect is obtained by the action of acid on the metal plate through the interstices of a porous ground. To lay the ground, powdered resin may be blown over the plate in a fine dust and then fixed by heating the plate at the back; or a solution of resin and spirits of wine may be applied evenly, so that when the spirits of wine evaporate only the particles of resin remain. Those parts of the plate which are to appear white in the print are then covered with stopping-out varnish, and the plate is immersed in acid, which bites between the particles of resin elsewhere so as to produce a granulated tone when the plate is printed. The process of stopping out is repeated and the plate bitten further to produce such deeper tones as may be required. Aquatint has frequently been used in combination with etched linework.

BY COURTESY OF THE ART INSTITUTE OF CHICAGO

"HERE COMES THE BOGIE MAN." AQUATINT BY FRANCISCO GOYA (1746–1828). IN THE ART INSTITUTE OF CHICAGO

The development of the method is generally credited to J. B. le Prince (1734–81), whose earliest aquatints are of 1768; but it may have been used in some form at a considerably earlier date. F. Janinet, P. L. Debucourt and other French artists of the end of the 18th century brought the process to a technical perfection which has never been surpassed. They used it, with extraordinary skill and success, as a vehicle for printing in colour. In England in the late 18th and early 19th centuries the method was used by such artists as Paul Sandby, Thomas Malton, William and Samuel Daniell, R. Pollard and J. C. Stadler for reproducing water-colour drawings. English aquatints were not printed in colours but were usually coloured by hand. During the latter part of the 19th century the process fell into disuse, but it was revived and successfully employed in the 20th by Sir Frank Short, Théodore Roussel, Oliver Hall, W. Lee Hankey, W. P. Robins and others.

See British Museum, *Guide to the Processes and Schools of Engraving,* 3rd ed. (1933); Sir Frank Short, *Etchings and Engravings,* rev. by M. Osborne (1952). (J. B. S.)

AQUAVIVA (Acquaviva), **CLAUDIO** (1543–1615), fifth general of the Society of Jesus, youngest son of the duke of Atri, was born at Atri in Italy on Sept. 14, 1543. He joined the order in 1567. His exceptional administrative ability marked him out for the highest posts. Shortly after he had terminated his brief course of studies and formation, he was appointed provincial superior of Naples and then of Rome. In 1581 he was elected general, the youngest in the history of the order. Through the fifth general congregation (1593–94) he overcame the interference of some Spanish Jesuits, supported at first by Philip II, which aimed at introducing modifications in the institute of the order and obtaining a privileged status for the Spanish provinces. His tenure of office was marked by rapid growth of the order, from about 5,000 to over 13,000. His practical legislation strengthened the society and made it more efficient in the numerous foreign missions it opened up as well as in the colleges it founded. He promoted the use of the *Spiritual Exercises* of St. Ignatius Loyola for the clergy and laymen. He encouraged the theologians and spiritual writers of the order to more profound investigation and to publication. He organized the first scholarly writing of the history of the order and the compilation of annual reports of all the provinces (*Litterae Annuae*). In the constitutions of the order, St. Ignatius had indicated only in outline the Jesuit system of education. The fourth general congregation, which had elected Aquaviva general, entrusted him with the task of drawing up a practical code of education for its now numerous schools. This work, *Ratio atque institutio studiorum,* was first published in 1586 and sent out to the various schools of the order for criticism and revision; a second edition embodying these suggestions appeared in 1591, and the definitive text of Aquaviva's generalate in 1599. This codification effected essential unity of Jesuit teaching throughout the world and allowed for local adaptation and needs. Besides his work in strengthening the order internally, he also showed himself an able ruler in guiding its external relations. He successfully furthered the apostolate of the church under eight popes from Gregory XIII to Paul V. Aquaviva died in Rome on Jan. 31, 1615. Many have considered him the order's greatest general, called by some its second founder. *See* also Jesus, Society of.

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AQUEDUCT. In the broad sense of the word, an aqueduct is an artificial channel for the conveyance of water. In a more restricted sense it is often understood to mean a bridge formed in a series of arches or spans for the conveyance of water across a valley. In the usual acceptance of the word in modern engineering an aqueduct is a primary channel, or conduit, for the conveyance of water from a source to the principal point of distribution or use, subsidiary distribution conduits being generally not classed as aqueducts.

EARLY AQUEDUCTS

Tunneled conduits for springs feeding open pools or fountains were famous features of the ancient world. Hezekiah's aqueduct at Jerusalem, feeding the pool of Siloam (*c.* 725 B.C.), and the Samian aqueduct of Polycrates (*c.* 530 B.C.) are well-known examples. The experience which produced them was probably based upon the construction of irrigation or drainage channels, known early in the Greek world and in the near east and, for irrigation, employed in very remote times in Babylonia, Assyria and Egypt. The benefits of the practice of that art were no doubt taught by the annual overflow of the Nile, of the Euphrates and of the Tigris. Extensive systems of canals in conjunction with storage reservoirs were in existence in Egypt in the time of Rameses II in the 14th century B.C.

The pattern of settlement in the Mediterranean, however, marked by the choice of hilltop towns, demanded greater ingenuity than was often available, so that early water supplies normally depended upon springs, such as Callirrhoe at Athens or Pirene at Corinth. The practice of the 5th century B.C. is represented by the tunneled aqueducts with manholes at intervals described by Polybius near Hekatompylos.

Rome.—These traditions were drawn upon by Rome for its first aqueducts, Appia (312 B.C.; 10.3 mi. long) and Anio Vetus (272 B.C.; over 32 mi. long). Both were underground channels, delivering below ground in Rome near Porta Trigemina and Porta Esquilina, respectively, the deliberate choice of an underground course being governed by tactical considerations. The builder of the Appia was Appius Claudius Caecus, also the constructor of the Via Appia. His aqueduct brought water from springs situated to the east of Rome. The Anio Vetus brought water from springs in the upper Anio valley in the Apennines. It was built by contract, payment being made out of spoils obtained from the defeat of Pyrrhus. The first overhead aqueduct in the Roman Campagna was Aqua Marcia, built by Marcius the praetor (144 B.C.; 55.9 mi. long), of which 5.9 mi. lay on arches, delivering high enough to supply the Capitoline, the Caelian and the Aventine hills. Thereafter the style of conveyance varied according to the source. Aqua Tepula (125 B.C.) and Aqua Julia (40 B.C.) ran upon the arches of Aqua Marcia across the Campagna. Aqua Virgo (completed by Agrippa in 19 B.C.) ran almost entirely underground from a group of springs on the estate of Lucullus until it emerged in the Campus Martius. Aqua Alsietina (2 B.C.), built during the reign of Augustus, went underground to Trastevere. Aquae Claudia and Anio Novus (A.D. 38–52; both initiated by Caligula) returned to arches in the Campagna so as to serve the highest hills, including the Palatine. Aqua Trajana (A.D. 109) ran to the Janiculum everywhere below ground, while Aqua Alexandriana (*c.* A.D. 226) ran mainly upon arches. In A.D. 97, the nine aqueducts of Rome provided per day 38,000,000 U.S. gallons within the walls and 20,000,000 U.S. gallons outside the walls. The system was organized under the republic by contractors, who both built and ran it, and under the empire by a board of curators, with a slave staff directly supervised after A.D. 52 by an imperial procurator, new works being put to tender.

Of this great series of aqueducts long stretches of arches still stand, indicating in monumental fashion the vast extent of the ancient structures required for the conveyance of the high-level supply across the last broad depression of the Campagna to the city of Rome.

The Roman World.—Other towns of the Roman world were content with much less, according to size; but water supplies for public fountains and baths were common, private consumers being relatively few and privileged. The provinces contain many famous examples. Constantine in Africa; Segovia, Mérida and Tarragona in Spain; and the Pont du Gard in France afford splendid examples of valleys bridged. The Lyons aqueducts of Craponne, La Brévenne and Le Gier are remarkable for their inverted siphons (the course of the last containing 14) and are anticipated by the Italian Alatri (134 B.C.). Conduits of stone pipes are known in Jerusalem and of wooden pipes joined by iron collars in Roman Germany, Britain and elsewhere. Distribution chambers are well known, as at Nîmes, Minturnae or Thuburbo Maius. Overflow waters were used for driving water mills in Rome and near Arles. Supplies being normally gravitational, jet fountains or upper-floor services were rare unless pumps or water wheels raised the water to cisterns at appropriate height. Lincoln, Eng., furnishes a rare example of a main water supply which was pumped uphill.

Cost.—The political and economic aspect of ancient water supplies is of considerable interest. Roman aqueducts were normally paid for either by profit from spoils of war or by wealthy public benefactors or, later, by the imperial treasury. A simpler political version of this attitude to the problem of costs is apparent in ancient Greece, where many of the important waterworks were given to the community by autocratic rulers. Thus, while in Rome very few private consumers might be charged a water rate for their share of the public supply, neither Greeks nor Romans entertained the idea of creating the public utility company which might be financed by investors and organized as a profit-making concern based upon a planned capacity to supply a large number of individual or corporate consumers. This more modern practice is in fact closely related to the creation and development of pressure supplies with a flow of given volume related to a foreseeable number of customers. The supplies of the ancient world, though often fed from large reservoirs (for example, the *lacus Simbruinus*), were gravitational flows, running free and continuously in ducts never full. Their supply was also very inaccurately measured, since the fundamental factors of force and velocity of flow do not enter into the simple (and erroneous) calculations of Frontinus (*see* below), based upon the cross section of a standard orifice. The principal function of the ancient aqueduct was to feed public fountains or buildings, which were a gift to the community and were maintained out of public funds or endowments.

Engineering.—The ancient theory and practice of water supply were thus powerfully influenced by political and economic considerations. But on the engineering side the system of pressure supply, upon which is founded present-day ability to meet the demands of a large private consumption, was beyond the reach of the ancient hydraulic engineer, who was unaware of any means of manufacturing a high-pressure pipeline, being always mistrustful of concrete as resistant to stress. Metal pipes capable of withstanding high pressure were nonexistent. Accordingly, the ancient inverted siphon, which comes nearest to the modern pressure conduit, is furnished with blowholes, multiple pipelines of lead and every possible device to reduce pressure even though the flow of water is never impeded or held back. The impasse thus reached sheds a vivid light upon the handicaps to which ancient engineering was subject in the absence of experimental tests or regular standards.

Within these well-defined limits a very complete picture of ancient practice is given at the close of the 1st century A.D. by Sextus Julius Frontinus, supplemented by the shorter and more severely practical observations of Vitruvius, whose introduction of standard bores for pipes had been an interesting development a century earlier. Vitruvius gives detailed and pithy directions for the initial selection of supplies and for judging the quality of water. He also summarizes the various types of conduit available and describes the leveling instruments by which gradients could be worked out. His recommendations of a fall of 1 in 200 indicates a highly competent expectation of technical achievement, which in fact is often attained both in tunneled and in hillside

Pont du Gard, Nimes, France. Built by Marcus Agrippa in 19 B.C., the aqueduct consists of three tiers of semicircular arches; 155 ft. high

Arches of the Aqua Claudia, Rome, begun in A.D. 38 under the emperor Caligula (Gaius Caesar)

Roman aqueduct at Constantine, Algeria, a walled city built on a rocky plateau 500–1,000 ft. above the Rummel river

Segovia, Spain. A 2,700-ft. aqueduct built under Trajan (A.D. 53–117) and still in working order in the 20th century

Aqueduct De Los Milagros, Mérida, Sp., which carried water to the Roman city Augusta Emerita from a reservoir three miles away

REMAINS OF ANCIENT AQUEDUCTS

PHOTOGRAPHS, (TOP LEFT) PHILIP D. GENDREAU, (TOP RIGHT) LEONARD VON MATT, (CENTRE LEFT) FEDERICO ARBORIO MELLA, (CENTRE RIGHT, BOTTOM) FOTO MAS

BY COURTESY OF U.S. BUREAU OF RECLAMATION; PHOTOGRAPHS (TOP RIGHT) R. A. BAKER, (CENTRE RIGHT) H. E. FOSS, (BOTTOM LEFT) H. W. FULLER

AQUEDUCT PIPES IN THE UNITED STATES

Top left: Concrete and riveted plate steel siphon across Morrison canyon, Kittitas irrigation project, Wash. Inside diameter, 12 ft. 1 in.

Top right: Galvanized plate steel semicircular flume, Deschutes irrigation project, Ore.

Centre left: Welded plate steel siphon, Heart Mountain irrigation project, Wyo.

Centre right: Monolithic concrete siphon with ½-in. plate steel lining, Columbia basin irrigation project, Wash. Inside diameter 22 ft. 4 in.

Bottom left: Welded plate steel pipes for Grand Coulee pumping plant, Columbia basin irrigation project, Wash. Pipe diameter, 12 ft.; maximum pump lift, 260 ft.; ultimate discharge, 16,000 cu.ft. per second

Bottom right: Twin welded steel pressure pipes carrying All-American canal across New river, near Calexico, Calif.

sectors. Frontinus has much less to say about this technical side. His work, *De Aquaeductu urbis Romae,* is primarily intended as a political document, extolling the disinterested care and service given by himself as a senatorial *curator aquarum,* head of the water board. He illustrates the inevitable corruption rife among the working staff of slaves and their freedman supervisors; he also stresses the powerlessness of these elements of society in the face of illicit tapping of supplies by influential citizens, whose illegalities could be controlled or impertinences squashed by the reprimand of a former consul. His work is thus a justification of the senatorial contribution to imperial home government, the counterpart of the *Agricola* of Tacitus in relation to imperial provincial government.

The reforms of Frontinus show a department highly dependent upon the personal knowledge and experience of its key men. Only thus can be explained his introduction, so late in the history of the system, of record maps indicating valleys or streams bridged by the aqueducts, hillside channels where slips or washouts were likely and sectors on arches or solid underpinning. Office reference to the course at high executive level thus became possible. In his zeal for the immense practical value of his commitments, Frontinus makes a rhetorical comparison between the useless monuments of Egypt and Greece and the indispensable aqueduct, an early example of the utilitarian attitude to works of art. As for the abuses, reference has been made above to the surreptitious tapping of supplies by owners of land adjacent to the conduits. On the staff side, the standard inlet pipes to the distribution tanks were enlarged and the standard outlet pipes reduced, so that a hidden surplus might be available for illicit sale through unregistered pipes. Within the city, the mains supplying public buildings and fountains were frequently tapped both with and without staff connivance. Nothing is said of corruption in relation to raw materials, among which lead and bronze must have presented opportunities.

From his experience of the upkeep of the system, Frontinus came to the view that the workmanship of the older aqueducts was better than that of the new. But he also observed that maintenance was heaviest in the arched portions. In these, as on the Marcia-Tepula-Julia and the Claudia-Anio Novus, the later conduits were superimposed upon arches intended for one conduit only. This additional weight made flaws more likely to develop and repairs more difficult to execute, and the fault lay less in the quality of the later work than in the choice of course. The fact that there were arrangements, both permanent and temporary, for switching supplies in case of breakdown and that discrimination was made in the distribution of this or that quality of water made repairs more readily possible but not in themselves easier. The underground channels were more easily maintained, the principal disruptive element being tree roots. But the presence of regular manholes, originally the working shafts for the tunnelers, made inspection and cleaning of the limestone deposit comparatively easy.

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Medieval Aqueducts.—There are a number of notable medieval aqueducts. The water supply to the cathedral city of Spoleto in central Italy is conveyed by a 13th-century aqueduct about 700 ft. long and 270 ft. high. It is noteworthy for its light and graceful proportions and for the use of pointed arches, there being ten of about 66-ft. span. Several fine examples of arched construction exist on the conduit system of Constantinople, the most noteworthy being the aqueduct of Justinian, which constitutes one of the most imposing monuments of its period. It is 720 ft. long, 108 ft. high and has two tiers of pointed arches with 55-ft. spans in the lower story and 40-ft. spans in the upper. The piers are buttressed and lightened by having small arches pierced through them at different heights. (X.)

MODERN CONSTRUCTION

The primary purposes of water supply are generally: (1) domestic water for cities or other populous communities with related sanitary requirements; (2) irrigation; and (3) hydroelectric power production, or any combination of these. For all these purposes relatively large aqueducts are usually required. Since such aqueducts often are long and costly, the communities providing them must adopt the most economical and suitable types of materials and construction for each project, and this results in a great variety of aqueducts.

Ancient aqueducts, with few exceptions, were free-flowing channels, usually built of masonry, with a continuous slight fall in the direction of the delivery point. When it was necessary to cross a valley, the channel was continued on its predetermined level and gradient on a built masonry construction, either of continuous walling or of piers and arches, until the other side was reached, when it again followed the contour of the ground. The advancement of engineering science obviated the necessity for the use on a large scale of such constructions in modern aqueducts, where the water can be conveyed when required in large, closed pipes or tunnels, flowing full under pressure and arranged within limits to follow the depressions, elevations and other topographic features of the ground.

There are, therefore, two distinct methods of flow which may be used according to the circumstances. In the one case the water flows with a free surface in a channel having a regular, gentle slope corresponding to the natural flow in a river; in the other method the water completely fills the closed conduit in which it is confined and exerts pressure on the whole of the interior surface, tending to burst the walls.

Free-Flowing Conduits.—The principal types of construction used for free-flowing conduits are: (1) open canal formed in the earth, with or without an impervious lining; (2) covered or open conduit built of brickwork, masonry, concrete or metal; and (3) tunnel, unlined or with a smooth lining of brickwork, masonry or concrete.

Free-flowing conduits take many shapes in cross section, such as rectangular, horseshoe and circular. In the case of open canals, the commonest form has a straight, flat floor and sloping sides.

Open Canals.—Open canals in Great Britain are not in favour for conveying domestic water supplies because of their liability to contamination and interference; however, they are used for this purpose in important aqueducts elsewhere. They are principally used on a large scale for conveying water to water-power stations and for the irrigation of large cultivable areas in dry countries. When the canal is unlined, the gradient must be such that the velocity does not become great enough to cause erosion of the bed or banks, say from $2\frac{1}{2}$ to 5 ft. per second, according to the firmness and cohesion of the material. Considerable loss of water from leakage may be expected with unlined canals. In lined canals velocities up to ten feet per second and sometimes much more are possible.

An unlined canal at the Humber-Arm Hydro-Electric works, in Newfoundland, to convey a minimum water flow of 5,000 cusecs (cu.ft. of water per second), was built with a bed width of 100 ft. and water depth of 21 ft. The gradient is 1 in 7,450 and the maximum velocity about three feet per second.

A concrete-lined canal for conveying water to the low head power station at Beaumont-Monteux on the Basse-Isère, in France, is 105 ft. wide on the bottom with 15 ft. maximum depth of water, side slopes of 1 to 1 and cement concrete lining 12 in. thick on floor and sides, finished with a surface rendering of cement mortar $1\frac{1}{4}$ in. thick. The lining was laid in sections with a transverse expansion joint every 23 ft. The maximum flow is 10,000 cusecs. The fall is 1 in 6,400. Many other canals, some of much larger size or length, have been built in various countries. Earth canals undoubtedly aggregate in total mileage more than all other forms of aqueducts combined.

There are a number of important materials and methods other than concrete that are successfully used in rendering canals in earth, which would otherwise leak, suitably watertight. Besides steel-reinforced concrete, which is usually much thinner than the 12 in. cited in the example above, the more important of them are: (1) Asphalt and asphalt-concrete lining, which may be in-

stalled with relatively few joints. Maintenance is a large factor with asphalt linings and an important item with concrete linings, but it is feasible where the canal may be emptied at intervals. (2) Buried asphalt membrane lining, wherein the canal is over-excavated, trimmed to smooth lines and surfaces, and a membrane of $\frac{3}{8}$- to $\frac{1}{2}$-in.-thick asphalt of rigidly specified properties is sprayed on hot without joints. After the asphalt membrane becomes cool it is covered with a selected natural material consisting of a stable mixture of earth or clay, sand and small gravel. The protective covering is generally about 18 in. thick. Buried asphalt membrane lining is usually materially lower in cost than concrete lining. (3) Selected earth or clay blanketing has been successfully used on many important canals. It is important that the blanketing consist of a suitable material, usually containing clay, sand and small gravel such that it is readily compacted into a watertight, stable mass. Where conditions demand, such blankets are as much as ten feet in thickness, especially on the side slopes of large canals where modern compacting machinery is used in placing and compacting the material. (4) Clay silting is also successfully used where conditions are favourable, and is the most economical of all methods. In the silting method, selected clay is dumped into the flowing water of the canal just above the leaky reach so that the escaping water in the leaky reach carries the clay particles into the porous formation, deposits them in the interstices thereof and clogs the porous material, thus rendering the canal watertight. The clogging process is expedited and improved if the clay used is of the bentonite type, which has the property of swelling when placed in water.

Covered Conduits.—Built aqueducts for the conveyance of domestic water supplies in Great Britain are almost invariably roofed and covered over with earth. Numerous examples have been constructed in masonry and brickwork, but concrete is generally preferred. Such conduits in suitable circumstances are more economical than pipes where the quantity of water is large, but they are applicable only where a route can be located on ground having the desired fall along a contour gradient tending in the direction of the point of delivery; pressure conduits, tunnels or flumes are built as parts of the over-all aqueduct as circumstances may require.

Tunnels.—Continued improvements in mechanical drilling, the power and reliability of explosives, the methods of handling and transporting the excavated material, and ground support and concrete lining operations contributed to a decided increase in the speed and relative economy of tunnel construction during the first half of the 20th century. The result is that tunneling is used in aqueduct construction to a much larger extent than formerly. It may be the only way for conveying water from one valley to another through a ridge which cannot be circumvented, and in other cases it may be chosen in preference to a covered conduit because of shortening of the route, greater security, lessened maintenance cost and obviation of surface damage. In very sound, unfissured rock, lining of masonry, brickwork or concrete may be dispensed with, but it is seldom that lining of the invert is omitted. In order to improve the hydraulic flow conditions it sometimes promotes economy to line the entire tunnel, even in the soundest rock. Where reliability of service under determinate hydraulic conditions is essential, a smooth lining on the whole of the wetted surface should be provided. The Loch Katrine aqueduct of the city of Glasgow, Scot., has about 19 mi. of lined tunnel of horseshoe shape with a height of nine feet and width at springing of roof arch of ten feet. It has a fall of $11\frac{1}{2}$ in. per mile and a capacity of 76,000,000 gal. per day. Tunneling on a very large scale has been used in the U.S. in aqueducts supplying certain large cities such as New York, and San Francisco and Los Angeles, Calif. A long, concrete-lined tunnel on the Catskill aqueduct for New York has a capacity of 500,000,000 U.S. gal. per day with a horseshoe-shaped cross section having a width of 13 ft. 4 in., a height of 17 ft. and an effective waterway of 165 sq.ft. The gradient is .37 per 1,000. Notable as being the longest in the world in which construction work was done wholly from the intake and outlet portals, the Alva B. Adams tunnel was built by the bureau of reclamation of the U.S. department of the interior in Colorado for transmountain diversion, irrigation and hydroelectric power purposes. It pierces the high continental divide of North America, and the mountains rise abruptly at each portal to great height above the tunnel, rendering impractical any intermediate adit for construction. It is 13.1 mi. in length, 9 ft. 9 in. finished inside diameter and lined throughout with concrete; it discharges 550 cusecs.

Pressure Conduits.—Conduits required to flow full under pressure are subject to limitations in the matter of shape and material of construction. The material must be capable of resisting tensile stresses and is most effective when disposed in circular form. The commonest types of construction are: (1) cast-iron pipes; (2) steel pipes; (3) wood stave pipes; (4) reinforced-concrete pipes or conduit; and (5) tunnel.

Cast-Iron Pipes.—Cast-iron pipes came into use about the beginning of the 19th century, as an alternative to lead and wooden pipe, for the distribution of water in towns. Cast-iron pipes are still being installed in important systems and in great quantities, but other pipes are being used more frequently in important aqueducts, principally for reasons of economy. With the rapid development of the ironfounder's craft, cast iron became available for aqueducts and has been so used in sizes up to 54-in. diameter and over. Cast-iron pipes usually have end joints of spigot-and-socket form made watertight with lead. Pipes with flanged ends to bolt together, with gaskets for watertightness, are also used. Pressure conduits of cast iron or other pipe may follow any irregular profile imposed by the route chosen, ascending here and descending there and crossing summits and hollows, provided always that none of the summits rise above the hydraulic gradient, which for a pipe of uniform diameter is approximately the straight line joining the inlet and outlet ends on the longitudinal profile. Should air collect at any of the summits, the flow will be interfered with. Air valves are therefore installed on top of the pipe at such places, and automatically discharge the air as it collects without allowing water to escape. Sluice valves fixed on scour branches at the bottom of the pipe are required at the lowest points of the pipe for the periodical discharge of any sediment which may collect there and restrict the flow. Should a burst occur on a large pipe, great damage and loss of water may occur before the water can be cut off. Automatic valves for stopping the flow when a burst occurs are desirable at the upper end of an important pipe and also at the principal summits in the case of a long pipeline.

In Great Britain pipes are secure from the effects of frost if laid with a cover of 2 ft. 6 in. of earth, whereas in more severe climates greater cover up to five or six feet as a maximum may be necessary. Where the foundation is unsatisfactory or where exceptional loads have to be resisted or special forces dealt with, as in changing direction at a bend, the pipe should be reinforced by bedding it on, or surrounding it with, concrete. In normal circumstances cast-iron pipe has long life and is generally more liable to deterioration inside than outside, so that some loss of capacity takes place with lapse of time.

Steel Pipes.—The advantages of steel pipe are its lightness, ease of handling, reliability, watertightness, security from cracking and ruptures and, not least, the fact that it can be used in much larger sizes than cast iron. Experience shows that well-coated steel pipe, when buried in normal soils, will endure for many years. Riveted steel pipe, before the advent of modern welding techniques, was for many years the manufacturing standard. There are many notable examples of riveted steel-pipe aqueduct installations, such as the pipeline from Lake Tansa for the Bombay, India, water supply and the Catskill aqueduct in New York. The diameters of the Catskill aqueduct vary from 7 ft. 4 in. to 11 ft. 3 in., and thicknesses vary from $\frac{7}{16}$ in. to $\frac{9}{16}$ in.

The successful use of steel pipe on the 13 inverted siphons, with a combined length of 49,575 ft., in the aqueduct to bring water from the high Sierras and Owens river across 250 mi. of desert to the city of Los Angeles, is an example of the economy and serviceability of this type pipe. Diameters ranged from $7\frac{1}{2}$ ft. to 11 ft., and thicknesses varied from $\frac{1}{4}$ in. to $1\frac{1}{8}$ in.

After the advent of modern welding techniques, nearly all steel

pipe was manufactured by the welding process. Such pipes are formed of steel plates bent to circular form by means of bending rolls having longitudinal joints butt-welded. The pipes are commonly made in lengths of 40 ft., and one or more plates are used to form the circle, according to the diameter. The steel plates used must be of suitable weldable quality. Frequently weldable, high-strength, alloy steel is used for welded steel pipe. Annealing of these pipe plates is not uncommon for some types of alloy material.

Joints in welded steel pipe for water-supply aqueducts are frequently welded in the field or joined by couplings with compression-type gaskets. Forged steel flanges are shop-assembled to pipe ends for connection to regulating valves and other fittings by bolting. Riveted joints are sometimes used on high-strength alloy steel pipe because of difficulty of annealing at the job site should the joints be welded. Couplings of the compression-gasket type have been used successfully for high-head penstocks where the need for annealing after welding made welded joints impractical. Couplings of this type are more economical and installation of the pipe is much easier than with riveted joints.

Great progress was made, especially after about 1940, in improving protective coatings for steel pipe. Plasticized coal-tar pitch was developed as an excellent steel-pipe protection. This coating material is centrifugally cast on the interior of steel pipe, providing a tightly bonded, water-impervious coating approximately $\frac{3}{32}$ in. thick with excellent smoothness and low friction loss. Plasticized coal-tar pitch, commonly termed coal-tar waterworks enamel, is also applied to the exterior of steel pipe by pouring and smoothing, and a bonded coal-tar–impregnated asbestos-felt wrapper is often applied over the hot coal-tar enamel in such a manner that it is bonded into the enamel. A Fiberglas pipe wrapping material is often embedded in the hot coal-tar enamel to act as a reinforcement, as steel is used to reinforce concrete. Cement mortar lining and coating is also used as a protective coating, and petroleum-base asphalt materials are sometimes used.

Steel pipe is particularly adapted to long-span, self-supporting type structures built above ground with the aid of ring girders. The ring girders are stiff, disk-shaped members which prevent distortion of the pipe at the supports. Steel pipe has the inherent beam strength required to support itself over long spans. The Shoshone river siphon built near Cody, Wyo., is an unusual ring-girder pipeline, its clear span of 150 ft. between supports being the longest unsupported span of any similar structure in the world. The diameter of the steel pipe is 123 in., and the plate thickness at the centre of the span is 1 in. The pipe has a maximum head of 155 ft. and was built with a camber to equal the computed deflection needed to make the pipe level when full of water.

Wood Stave Pipes.—Wood stave pipes, with machined staves bound at close intervals with mild steel hoops, have been found economical for low heads in districts where suitable timber is abundant and cheap. At the Humber-Arm works, Nfd., there are seven lines of such pipe, 9 ft. 6 in. in diameter, used for a maximum head of 167 ft.

A wood stave pipe 16 ft. in diameter and 1,318 ft. long to carry 3,000 cusecs was constructed in 1925 to serve the Hydro-Electric Plant No. 2 of the California-Oregon Power Co.

The use of wood stave pipe rapidly declined because of increasing cost of suitable timber, high maintenance costs and better overall economy of competitive pipes.

Reinforced-Concrete Pressure Conduits.—In the simplest reinforced-concrete pressure pipes, closely spaced hoops or helically wound continuous bands of steel, along with a system of longitudinal bars, are contained in a cylindrical concrete shell and serve to prevent bursting and fracture. The chief advantages of this type of pipe arise from small cost of maintenance, security against collapse and, frequently, saving in first cost as compared with other types. For moderate diameters, pipes may be precast in lengths up to about 24 ft., transported to the site and connected together with joints of the bell and spigot, lock joint or other special type. On the Spavinaw aqueduct for the water supply to Tulsa, Okla., there are 53 mi. of reinforced-concrete pressure conduit. Only exceptionally large conduits need to be manufactured on the site.

Precast concrete pressure pipe reinforced with steel circular and longitudinal bars and steel cylinder pipe, wherein a continuous steel cylinder is embedded in the concrete wall of the pipe, but which pipe is usually classified as concrete pipe, is assuming an increasingly important part in aqueduct construction, especially in the United States. However, many of the basic design concepts were developed and important and successful installations were made by French engineers during the latter part of the 19th century and later. Concrete pipe reinforced with circular and longitudinal bars had been built by the second half of the 20th century only in diameters up to about 15 ft. and for operation under hydraulic heads of up to about 150 ft. Embedded cylinder pipe, generally used for higher hydraulic heads, was built in diameters up to about 15 ft. and to operate under heads up to about 630 ft. The pipe is prefabricated and precast in manufacturing yards or plants, often especially constructed for a given project, and transported and placed in position by special hauling and handling equipment. It is manufactured in units up to about 24 ft. in length as circumstances warrant, and concerted attention is given to all design and construction details, especially to the joints between individual units. The type of joint that proved to be the best provides a rubber gasket compressed into an accurately formed space provided by the metal bells and spigots of the ends of the pipe units.

There were many installations of somewhat varying design and construction requirements. The U.S. bureau of reclamation had constructed by private contractors several hundred miles of this type of aqueduct, the details varying with sizes and heads, and continued to build them as the best available type in this highly competitive field, mainly in the states of California and Washington.

Precast, prestressed cylinder concrete pipe came into considerable use, especially in Europe, for important aqueducts where skilled labour was relatively plentiful and where materials, especially steel reinforcement, were relatively scarce. In this class of pipe the reinforcement for resisting the hydrostatic pressure consists of continuous, helically wound, hard-drawn steel spring wire so applied to the concrete cylinder that it retains a minimum tension of about 115,000 lb. per square inch before the pipe is placed in the trench. It appeared likely that this class of pipe would become more generally used as manufacturing difficulties were overcome and processes perfected and as reinforcing steel became relatively more costly.

Pressure Tunnels.—In hard, sound, unfissured rock, low-pressure tunnels may be unlined, but a smooth lining of concrete in conjunction with the supporting of unstable ground and the sealing of fissured places by the injection of cement through drill holes is generally necessary.

Especially interesting examples of pressure tunnels exist on the Catskill aqueduct of New York. A concrete-lined pressure tunnel, about 4 mi. long, is formed in shale deep down below the valley of the Wallkill river, thus obviating construction with pipes on the surface. It is 14 ft. 6 in. in diameter with a capacity of 500,000,000 U.S. gal. per day, and connects with free-flowing conduit at each end by means of vertical shafts. Many miles of similar tunnel have been formed in rock at a depth of 500 ft. below the streets of New York.

Another notable pressure tunnel is the Eucumbene-Tumut tunnel for transmountain diversion, power and irrigation purposes, the contract for the construction of which was awarded by the Snowy Mountains Hydro-Electric authority of New South Wales, Austr., in April 1954. Specifications included a tunnel length of approximately 14 mi. with a 21-ft. finished inside diameter; a concrete lining nominally 18 in. thick, reinforced and supplemented, as ground conditions require, by heavy reinforcing steel rods, steel support beams and roof support anchor bolts, the surrounding rock being pressure grouted with cement grout as required; operation under a maximum hydrostatic head of about 350 ft. with a maximum discharge capacity of 7,500 cusecs.

Aqueducts for City Water Supply.—The increasing distances from the place of use at which additional water supplies have to be

sought are well exemplified in the case of most of the larger towns of Great Britain, London being a notable exception. Glasgow, when its supply from the nearby Gorbals waterworks no longer sufficed, reached out into the Highlands 30 mi. away and by tunneling on a bold scale obtained an abundant and pure supply from Loch Katrine. Birmingham had to go to the Elan valley in the mountains of mid-Wales, a distance of 73 mi. Manchester went to Lake Thirlmere in Cumberland, a distance of 96 mi., to supplement the original supply obtained from Longendale, 18 mi. E. of the city. Liverpool went to the river Vyrnwy in north Wales, a distance of 68½ mi.

Some of the aqueducts for the supply of cities in the United States are colossal in comparison with the largest in Britain. Los Angeles partially obtains its water supply from the headwaters of the Owens river. The work was carried out in five years at a cost of about $23,000,000. Later Los Angeles, in collaboration with 13 other cities and communities, organized as the Metropolitan Water District of Southern California, carried out the construction of the notable Colorado river aqueduct. The main stem of this aqueduct diverts from the Colorado river at Parker dam, carries the water over several mountain ranges by pumping, and delivers it to the main terminal, Lake Matthews, 242 mi. away. Its designed capacity is 1,600 cusecs. It involved the construction of three concrete dams; five large pumping plants to lift the water a total of 1,617 ft.; 92.1 mi. of 16-ft.-diameter, horseshoe-shaped, concrete-lined tunnel; about 63 mi. of open, concrete-lined canal, 20 ft. wide and 11.71 ft. deep, with sloping sides; long reaches of horseshoe-shaped concrete cut and cover section, 16 ft. inside height and 19 ft. 5 in. inside width; and 144 inverted, cast-in-place, reinforced-concrete siphons varying from 175 to 26,400 ft. in length and operating under heads up to 153 ft. The distribution system below Lake Matthews includes several notable branch aqueducts of various construction and size. A leading branch is the aqueduct to serve the city of San Diego. This was built later than the original main-stem aqueduct and takes off from the main stem at about mile 218 and runs for about 75 mi. to deliver water to San Vincente reservoir near San Diego. The aqueduct consists predominantly of 48-in., 54-in. and 72-in. precast concrete pipe built in two adjacent, parallel and nearly identical lines. Only one line was built first because of limited funds, and it was not yet clearly demonstrated that the capacity of the two lines would be required. For static heads of less than 100 ft., steel cylinders are not embedded in the concrete pipe, but for static heads over 100 ft. and up to the maximum of 630 ft., steel cylinders are used. The 48-in. pipe is made in 20-ft. lengths and the 54-in. pipe in 16-ft. lengths. The aqueduct includes some short tunnels and reaches of welded steel pipe where the static head is the highest. The Hetch Hetchy aqueduct, designed to carry 400,000,000 gal. per day from the Sierra Nevada to San Francisco, began delivering water in 1934. This aqueduct contains two welded steel inverted siphons across the San Joaquin valley, each 47½ mi. long, operating under maximum heads of 500 ft. These unusual siphons consist of 56-in.- to 66-in.-diameter pipe of $\frac{5}{16}$-in. to ½-in. plate thickness.

New York city began work in 1937 on a $273,000,000 aqueduct to increase its water supply by 50%. The project brings water from the Delaware river by a tunnel to the existing Croton and Kensico reservoirs. The Catskill aqueduct, as noted previously, is capable of delivering 500,000,000 gal. a day to New York city.

Modern Italy furnishes an example of one of the most remarkable water-supply systems of the world in the Apulian aqueduct, which conveys water from the moist western slopes of the Apennines to an area of 8,000 sq.mi. of semiarid territory in the southeastern corner of the country. The intake is at the perennial Caposele springs, so that, as in the case of the aqueducts of ancient Rome, a storage reservoir is not required. The main conduit, which has a capacity of about 110,000,000 imperial gal. per day, is carried through the ridge of the Apennines in a tunnel 9½ mi. long and extends westward and southward for a distance of 152 mi., terminating at Taranto. Altogether about 67 mi. of the conduit were formed in tunnel, a typical cross section having a horseshoe shape 8 ft. 9 in. wide by 9 ft. 5 in. high. Water is delivered to a population of 3,000,000 in 266 communities by a system of 841 mi. of main and branch pipes and 550 mi. of distribution pipes.

Of surpassing interest in some respects is the aqueduct constructed in 1903 for supplying the gold-mining centres of Coolgardie and Kalgoorlie in Western Australia with water. The source is near the western coast, and the point of delivery is about 1,300 ft. higher in the arid heart of the country 350 mi. away. The aqueduct was formed as pressure pipe of the locking bar type (later replaced largely by welded pipe), 30 in. in diameter, with steel plate ¼ in. thick. The water is forced up, stage by stage, by means of a series of eight pumping stations with balancing tanks at each station.

High-Pressure Hydroelectric Pipes.—Of special importance are the aqueducts required to deliver water to hydroelectric stations utilizing high falls of 400 ft to 5,000 ft. or more. For such cases the fall is concentrated at the power station in as short a distance as possible. Welded steel pipe is almost exclusively used.

Two contrasting methods of installation are in use, which may be designated the Swiss and the French methods, with variations or combinations as circumstances require. In the Swiss method a heavy concrete anchorage surrounding the pipe is provided at every bend, horizontal or vertical, the pipeline being thus divided into a series of straight lengths, each of which is provided with an expansion joint near its upper end. The anchorages are designed to resist the maximum forces transmitted by the section of pipeline attached thereto. In the French method, main anchorages are provided at top and bottom only, there are no expansion joints, subsidiary intermediate anchorages are provided to hold the pipe in position and take care of the stresses produced by local variations of temperature, and generally bends and elbows are left free to spring somewhat under extremes of temperature.

A notable example of a large steel aqueduct is the Hoover (Boulder) dam combined penstock and outlet system. Noted for its height, the Hoover dam, on the Colorado river near Las Vegas, Nev., was built by the bureau of reclamation during the 1930s for irrigation, flood control, power production and other related purposes. The main penstock system consists of four 30-ft.-diameter steel pipes with various smaller branches, the 30-ft. pipes having an aggregate length of approximately 4,710 ft. The entire system is in concrete-lined tunnels in the two abutments of the dam, the 30-ft. pipe being in 50-ft.-diameter tunnels. The pipe is of welded construction, using special firebox steel having a yield strength of not less than 38,000 lb. per square inch. The system contains 45,000 tons of steel. The 30-ft. pipe operates under a maximum computed head of 619 ft. The plates have a maximum thickness of 2¾ in. The pipe sections, which vary from about 17 ft. to 23 ft. in laying length to fit alignment and related conditions, were fabricated in a large, especially constructed plant near the dam and transported to their final point of installation by special handling equipment. The sections weighed as much as 190 tons each. They were joined together by an outer butt-strap type of joint. One side of the butt strap was welded inside and out to one end of each section of pipe, thus forming the bell. The other and major portion of the butt strap was fastened to the spigot portion of the adjoining section of pipe, after the two sections were forced together by heating of the bell and by pressure, by two rows of staggered pins. The maximum-size pin is $3\frac{1}{16}$ in. in diameter by 6.73 in. long. They are countersunk on the inside end and firmly held in place on the outside end by peening of the adjacent metal of the butt strap into a groove that forms the head of the pin. There are 272 pins in each girth joint for the 30-ft. pipe. Several special and powerful tools were required to make the joints. After being otherwise completed the joints were caulked inside and out by blunt caulking tools. *See* also DAM; IRRIGATION; TUNNEL; WATER TRANSPORT, INLAND.

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(J. Wi.; W. H. N.)

AQUIFOLIACEAE, the holly family, a group of dicotyledonous (having two seed leaves) plants, with 3 to 5 genera and about 300 species in the warmer parts of both hemispheres. They are all trees or shrubs and all but a few of the species belong in the large genus *Ilex*. Holly (*q.v.*), the European *Ilex aquifolium*, and allied American and Asian species are prized as ornamental shrubs, while maté (*q.v.*), yerba maté or Paraguay tea, much used in South America, is the product of *Ilex paraguariensis*.

AQUILA, the name of two early Christians.

Aquila (2nd century A.D.), a native of Sinope in Pontus (the modern Sinop, Turk.), was celebrated for a very literal and accurate translation of the Old Testament into Greek, completed probably about A.D. 140. Epiphanius preserves a tradition that he was a kinsman of the emperor Hadrian, who employed him in rebuilding Jerusalem (Aelia Capitolina), and that he was converted to Christianity, but, on being reproved for practising pagan astrology, apostatized to Judaism. He is said also to have been a disciple of Rabbi Akiba ben Joseph. Aquila's version is said to have been used in place of the Septuagint in the synagogues. The Christians generally disliked it, alleging that it rendered the messianic passages incorrectly, but Jerome and Origen speak in its praise, and Origen incorporated it in his *Hexapla*.

Aquila (fl. 1st century A.D.), a Jew from Rome, with his wife, St. Prisca or Priscilla, settled in Corinth, where Paul stayed with them (Acts xviii, 1–3). They became Christians and fellow workers with Paul, to whom they seem to have shown their devotion in some special way (in Rom. xvi, 3–5, he says that they "risked their necks" for his life).

AQUILA, in astronomy, the Eagle, sometimes named the Vulture, a constellation of the northern hemisphere, traversed by a bright part of the Milky Way, which is there divided into two branches. The stars, β, α, γ (*see* Altair), form a conspicuous group slightly reminiscent of Orion's belt. Several Novae have appeared in this constellation; in particular Nova Aquilae III, discovered on June 8, 1918, attained a brightness only slightly inferior to Sirius.

AQUILA, L', a city of central Italy, the capital of L'Aquila province and the chief town of the region of Abruzzi e Molise, lies on a hill 239 ft. above the river Aterno in the heart of the Apennines, 60 mi. E.S.E. of Terni by road. Pop. (1961) 57,265 (commune). The city walls, built in 1316 with 12 gates, are still largely extant and extend for about 4 mi. The 13th-century cathedral was rebuilt in 1711 after earthquakes; to its right is the archbishop's palace. On the highest point of the city stands the majestic castle, built in 1535, in front of which stretches a big park. The castle contains the National museum of Roman remains and artistic relics; in the basement is the geodynamic observatory. There is a university faculty in the Piazza dell' Annunziata. Near the castle park is Sta. Maria di Paganica (1308, restored). The chief church of the southern part of the city is the basilica of S. Bernardino (*c.* 1500), containing the mausoleum of S. Bernardino of Siena. To the west is the Fountain of the Rivera, dating from the foundation of the city, which has jets of water playing from 99 grotesque heads. Outside the walls is Sta. Maria di Collemaggio (1270–80). There are many palaces, a large provincial library and a municipal hospital of ancient foundation. L'Aquila is the chief point of departure for nearby Gran Sasso d'Italia (*q.v.*) and it is also a skiing centre. Radio equipment, bricks, wooden chairs, woolen cloth and chocolate are manufactured, and lacework and other crafts are practised. Many inhabitants are employed in agriculture.

After the destruction of Amiternum, Foruli and Peltunium by the Romans and later by the barbarians, the survivors built on or near the ruins. One of these settlements was to become L'Aquila when in 1229 Pope Gregory IX gave permission for a city to be built in the Acculi (Aquila) district. L'Aquila was founded by Conrad IV in 1253–54 and became an episcopal see in 1257. It belonged to Florence in the middle ages and later passed to the kingdom of Naples. L'Aquila took part in the resistance to the French invasion of 1798 and 1799, and the rebellions of the 19th century against the reactionary Neapolitan kingdom. It became part of the Italian kingdom in 1860. During World War II L'Aquila fell to Allied forces in June 1944. (U. Sp.)

AQUILEIA. Formerly a city of the Roman empire and a patriarchate of the Roman Catholic Church, Aquileia is now a village 22 mi. W.N.W. of Trieste in the Italian *regione* of Friuli-Venezia Giulia, 6 mi. inland from the head of the Adriatic.

Aquileia was founded as a colony by the Romans in 181 B.C., evidently to prevent barbarian incursions. Its rapid growth was due, however, not only to its strategic importance but also to its position at the junction of the Via Postumia with roads to Illyria, Pannonia and Noricum, especially after the Romans had succeeded, in the 1st century A.D., in establishing their rule as far as the Danube. In the 3rd or 4th century it became the capital of the administrative region Venetia and Istria.

Unsuccessfully besieged in A.D. 167 by the Marcomanni and the Quadi, the city was captured and devastated by the Huns in 452. The conquest of the Venetian mainland by the Lombards after their invasion of Italy in 568 marked the final eclipse of Aquileia's political importance, just as it sealed its decline as a commercial centre. The city became part of the Lombard duchy of Friuli.

The seat of a bishop from about the middle of the 3rd century, Aquileia became in the 5th century the metropolitan see for Venetia and Istria as well as for the outlying region north and east. According to local tradition the see had been founded by St. Mark. After the condemnation of the "Three Chapters" by Pope Vigilius in 553, Aquileia seceded from Rome, its bishop, Macedonius, adopting the title of patriarch in defiance of the pope; and the see remained schismatic when the patriarch Paulinus I fled to Grado after the Lombard invasion. When Candidianus, who was loyal to Rome, was elected metropolitan at Grado in 607, the suffragan bishops of the Lombard mainland elected an abbot John at Aquileia, and he continued the schismatic policy of his predecessors. The schism finally came to an end under the pontificate of Sergius I (687–701), when at a council at Pavia the schismatic bishops abandoned their resistance. Henceforth Aquileia and Grado were recognized as separate sees and patriarchates. The residence of the patriarch of Aquileia had been transferred at the beginning of the 7th century to Cormons for reasons of safety. From the early 8th century onward it remained at Cividale.

Aquileia's ecclesiastical importance was much enhanced by the mission of Bishop Paulinus II (d. 802) to the Avars and Slovenes, and in 811 the Drava river became the boundary between the dioceses of Salzburg and Aquileia. In the 11th century the patriarchate acquired extensive privileges and feudal dominions, largely from the German kings: Bishop Poppo, who built Aquileia's cathedral (consecrated 1031), was granted the right to coin money; and in 1077 the emperor Henry IV invested Bishop Sieghard with the county of Friuli and the march or mark of Carniola. In 1209, moreover, the emperor Otto IV enfiefed Bishop Wolfger with the march of Istria. The patriarchate remained a feudal principality until the conquest of Friuli by Venice in 1419–20 dealt the last blow to its temporal power, which the Venetians had previously done much to undermine. By the treaty of 1445 the patriarch finally acquiesced in the Venetian conquest and retained only Aquileia itself, San Vito and San Daniele. From the 15th century onward the patriarchs were always Venetians. From the end of the 16th century they resided at Udine.

Under Austrian rule the ecclesiastical jurisdiction of Aquileia was reorganized. In 1751 Pope Benedict XIV suppressed the patriarchate and created in its place the archbishoprics of Udine and Görz (Gorizia). Aquileia with its cathedral was placed under papal jurisdiction.

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(N. R.)

AQUINAS, SAINT THOMAS (Tommaso d'Aquino) (1225–1274), a Christian philosopher who developed his own original conclusions from Aristotelian premises, notably in the metaphysics of personality, creation, and a particular providence; a theologian responsible in his *Summa theologica* and *Summa contra gentiles* for the classical systematization of Latin theology; and a poet who wrote some of the most gravely beautiful eucharistic hymns in the church's liturgy, among them the *Pangue lingua* and the liturgical office for Corpus Christi. Like an Aristotle between the pre-Socratics and the Skeptics, Thomas linked the humanism of the 12th and the nominalism of the 14th centuries, more scientific in method if less engaging in style than the first, more at ease with metaphysics if less preoccupied with terms than the second. Much loved and venerated, he was canonized by John XXII in 1323 (feast day March 7) and proclaimed a doctor of the church by Pius V in 1567. His title *Doctor communis* dates from the early 14th century; the better-known but less appropriate *Doctor angelicus* was a much later style. His main position was officially confirmed by two encyclicals, Leo XIII's *Aeterni patris* (1879) and Pius XI's *Studiorem ducem* (1923). Though many modern Roman Catholic theologians do not find him altogether congenial, partly in reaction against an over-rabbinic presentation, his position in the authentic tradition of Western Christian theology is firmly established.

LIFE

Thomas Aquinas was born at the castle of Roccasecca near Aquino in the marches between the kingdom of Sicily and the States of the Church. His father was Lombard by origin, his mother was of the later invading Norman strain. Rinaldo d'Aquino, a lyric poet of the Sicilian school, may have been his brother. His people, landed nobility, were distinguished in the royal and imperial service and tragically torn in the civil strife when the Angevin supplanted the Hohenstaufen in southern Italy. Thomas grew to be a man large in physique, with a character of uncommon composure and courtesy, deep and strong in his affections for his family, friends, and religious order, very clear at expressing his thoughts yet so reticent about showing his personal feelings that he is among the most self-effacing of the great writers.

From the abbey school of Monte Cassino near his home he proceeded as arts student at the age of about 15 to the University of Naples, newly founded by the emperor Frederick II, his masters being Peter the Irishman and Martin of Dacia (*i.e.*, Denmark). There, to the formidable displeasure of his family, which had designed a high ecclesiastical career for him (even, it is said, the archbishopric of Naples), he joined the Dominicans in 1243 or 1244. They sent him north of the Alps, perhaps for a year at Paris, and certainly to Cologne (1248–52), where he continued his studies under Albertus Magnus (*q.v.*). The two formed a lifelong friendship and stood together in the controversies that were to come—the master the more extensive, if more ragged, in his learning and the more combative; the disciple the more integrated in his thought and possessing a restraint more deadly in its effect.

Thomas, who began his teaching career in 1252 as bachelor, or reader, at the college of the Jacobins (French Dominicans) in Paris, was officially admitted in 1257 to the corporation of masters in the university. This brought to a head the attack on the friars as para-ecclesiastical formations of unbeneficed clerks, licensed tramps or *vagantes*, which was launched by Guillaume de St. Amour and carried on by Gerard d'Abbeville (for this *see* further Paris, University of). Its defeat, to which the writings of Thomas contributed, was confirmed by the consolidation of his *confrères* in the universities, in Rome, and in the royal courts, particularly of England and France.

Member of a commission to organize Dominican studies, Thomas in 1259 was appointed theological adviser and lecturer to the papal curia, then the centre of Western humanism; his office of "master of the sacred palace" still survives. This was the golden period of his studies, when he assimilated Aristotle in the company of the Hellenist William of Moerbeke. Recalled to Paris in 1269 to defend his brethren and combat radical Averroism (*see* Averroism, Latin), he returned to Naples in 1272 as director of the Dominican house of studies in the university. Summoned by Gregory X to the second Council of Lyons, which was to attempt to repair the schism between Latins and Greeks, he died on his way there, at the Abbey of Fossanova in the Campagna, on March 7, 1274. Three months before he had had a mystical experience of the truth and joy beyond this life, and confessing that his earlier argumentations now seemed like so much straw in comparison he grew increasingly withdrawn; yet he continued to be at the disposal of those of every condition who came to him with their problems and doubts.

WORKS

The output of Thomas Aquinas was prodigious, a fact made possible only by the employment of secretaries for much of his later work; this goes to explain the lack of finish to his style, which is quite unadorned and deceptively sparse—the ideas are more thronging than the words. Authorities do not agree about the dates for some of his works, and those given here are in some cases provisional. The works themselves, apart from sermons, prayers, and hymns, fall into four classes: (1) those arising from his teaching course; (2) monographs; (3) commentaries on Aristotle; (4) systematic expositions of Catholic theology.

Teaching Course.—The standard theological text of the Middle Ages was Peter Lombard's *Sentences*, and Thomas' commentary on it, *Scriptum in IV libros sententiarum* (1254–56), more discursive than the *Summa*, shows his mind as a young lecturer, already anticipating some of the Aristotelian position he was later to hold with more information. There are nine commentaries on books of the Bible, consisting of *expositiones* (on Job, Jeremiah, Lamentations, part of the Gospel of John, some Pauline Epistles) written by himself; *lecturae* or *reportationes* (on Psalms, Matthew, and the rest of John) taken down by students or his chief secretary, Reginald of Piperno; and the *Catena aurea* (as it was later called), a series of comments selected from the Greek and Latin Church Fathers on the Four Gospels. Then there are the scripts of his public debates, comprising (1) ten *Quaestiones disputatae*, each forming a connected series on one topic, such as the considerable *De veritate* (1256–59), *De potentia Dei* (1265–67), and *De malo* (1269–72); and (2) 12 *Quaestiones quodlibetales*, or "quodlibets," the record of free-for-all debates on isolated topics held on special academic occasions.

Monographs.—The opuscula include: (1) three outstanding philosophical pieces, *De ente et essentia* (1254–55) and *De unitate intellectus* and *De aeternitate mundi* (both 1270). (2) Commentaries on the *De divinis nominibus* of Pseudo-Dionysius (the Areopagite; 1261), important for his aesthetic and mystical theory; on the *De trinitate* of Boethius (1258), which contains a careful treatment of the nature of theology and the interrelation of the sciences; and on the *Liber de causis* (1273) (*see* Proclus). (3) Three apologias for the friars, of which the *De perfectione* (1269) is of lasting value. (4) The *Compendium theologiae* (1273). (5) The political treatise, *De regimine principum* (1266), completed by his disciple Ptolemy of Lucca. (6) About 25 other works, some of them replies to correspondents, some of minor interest.

Commentaries on Aristotle.—Between 1266 and 1272 Thomas made close dissections of the works of Aristotle, which he read in Latin translations made directly from the Greek originals. He completed commentaries on the *Posterior Analytics*, *Physics*, *De anima*, *De sensu et sensato*, *De memoria et reminiscentia*, *Metaphysics*, and *Nicomachean Ethics*, but others were left to be completed by disciples (the *De interpretatione* or *Peri hermeneias* by Cajetan, the *De coelo et mundo* and *Politics* by Peter of Auvergne, the *De generatione et corruptione* by Thomas Sutton, the *Meteorologica* by Peter of Auvergne and possibly Jean Quidort).

Systematic Theology.—Thomas Aquinas' two most famous works are (1) the four books of the *Summa contra gentiles* (1259–64) undertaken at the request of the Dominican master general, Raymond of Peñafort, to present a reasoned account of the Christian faith to the world of Islam; and (2) the *Summa theologiae* (*theologica* by later usage; 1266–73), introduced with the modest

intention of instructing undergraduates in Catholic theology.

The majestic and well-proportioned synthesis that is the *Summa theologica* is divided into three parts: the First Part on God and the going forth of all things from him; the Second Part on the return of intelligent beings to him (Part I of the Second Part surveys in general the psychology and morality of human activity, law, and grace; Part II of the Second Part examines in particular the virtues and vices, the gifts of the Holy Spirit, the prophetical spirit, the active and the contemplative life, and the state of perfection); and the Third Part on Christ and his sacraments. This last ends abruptly during the treatise on penance, and the remainder, the Supplement, is a 14th-century compilation from Thomas' commentary on Peter Lombard's *Sentences*.

The *Summa theologica* consists of treatises composed of groups of "questions." The unit of inquiry is the article, which adopts the *sic et non* method (*see* SCHOLASTICISM: *Method*): an open question, not a thesis, is proposed, arguments are advanced for taking one side or the other, a qualifying authority or consideration is advanced, a magistral exposition follows, and the article ends with an assessment of the initial difficulties. Often the whole article must be read for the proper balance of Thomas' teaching.

THOUGHT

The early issue was Thomas' doctrine of the human soul as a single substantial form in the body—the real distinction he drew between essence and existence at the heart of created being was a later debate. It was alleged by his opponents that his thoroughgoing rationalism and even his materialism were irreconcilable with the articles of the Christian faith.

Aristotelian Background.—Western religious philosophy had developed without distinguishing itself from Christian theology; it stressed the directly divine illumination of the mind, its temper was Platonist, and its main sources were Boethius, the Pseudo-Dionysius, and, above all, Augustine (*see* PHILOSOPHY, HISTORY OF: *Patristic and Medieval Philosophy*). Aristotle had been honoured mainly as a logician until, before the middle of the 13th century, his natural and metaphysical and then his moral and political philosophy were gradually recovered, at first transmitted through Jewish and Arab writers, later translated directly from the Greek. This appearance of Aristotle's apparently self-contained system which could engage every rational interest without appeal to the Christian revelation, modified as it was by the speculations of the Muslim philosophers Avicenna and Averroës, set the schools in a ferment. Despite the opposition of the theologians the new movement gained ground in the faculties of arts, and defended itself by proposing the famous double truth theory, associated with Siger (*q.v.*) of Brabant and the Latin Averroists, that reason could reach conclusions contradictory to faith, and vice versa, without detriment to either. A later corollary was the restriction of ecclesiastical authority and the separation of church and state. Doctrines of man's inherent earthiness, of the eternity of the universe, of the triviality of the personal and particular, of an inaccessible God, and of the workings of a cosmic mind apart from individual experience affronted inherited convictions on human immortality, on creation, on the dignity of persons, on a God who spoke to men and shed his light on their minds in a world governed by a particular Providence. Such inherited convictions were defended by the Augustinian schoolmen, nobly represented by the Franciscans. These men were by no means obscurantists who subjected all knowledge to received authorities; they were pioneers in the experimental sciences and were well-versed in the thought of Avicenna and Maimonides.

Christianity and Aristotle Reconciled.—Thomas and Albertus Magnus, however, took a different course. Claiming to be better Aristotelians than the Averroists, they set themselves to prove that the new naturalism could be candidly accepted and without distortion shown to welcome Christian truth and indeed to provide terms apt for its articulation and communication. By the end of the century the whole Dominican order had swung into their position, with the exception of eccentrics, such as Durandus of St. Pourçain. They had to fight on two fronts, against both the conservative theologians and the radical Averroists, though

MANSELL—ALINARI

"THE APOTHEOSIS OF ST. THOMAS AQUINAS" BY FRANCESCO TRAINI, ALTARPIECE IN THE CHURCH OF ST. CATHERINE, PISA, 1363

Thomas' personal relations with both sides, and particularly with the lay-minded members of the arts faculties (*i.e.*, philosophers), were excellent. He had the gift of seizing the point. Thus he showed, for instance, that the question whether the universe is everlasting, which he left an open question to pure reason, was irrelevant to that of its causal dependence on a creator; and again, that the human soul was essentially embodied, and so individuated, and yet could be a spiritual substance. His philosophical interpretation of the world was no more committed to the particular physics of Aristotle, which he did not question, than his ecclesiology was to the papalism of the political canonists, to which he did not refer—a surprising fact when his eminent position at the centre of this theocratic movement is recalled. Though he cannot be compared as an empirical investigator to come of his contemporaries, for instance, Robert Grosseteste, Albertus Magnus, Robert Kilwardby, or Roger Bacon, Thomas resolutely started from the evidence of his senses without imposing on that evidence mental categories or a quasi-mathematical grid; he was so much a phenomenologist rather than an ontologist that it is difficult to appreciate how he has ever been set down as an a priori thinker.

Epistemology.—Though in direct line from Abelard, Thomas is no nominalist on the problem of universal ideas; yet, since the reference of his abstraction is always back to the individual subject as the first substance, he is no ultra-realist either. His epistemology makes no initial cleavage between being and knowing. Recognizing a kinship between all parts of reality and a consequent courteous dialogue between all branches of knowledge, his method of controlled analogy, which sees a likeness between things in

themselves quite distinct, enables him to range from low to high; his thought appears peculiarly coherent. The reason starts from sense data but can support the validity of general judgments. Anselm's ontological argument is not admitted, but the existence of God is arrived at by a posteriori inference along the celebrated "five ways" (*see* THEISM: *Summary of the Theistic Arguments and the Idea of God*). The reason can also reach a guarded knowledge of God's nature; metaphor is respected but anthropomorphism rejected; all the same Thomas' natural theology pushes beyond "negative" theology and the devout agnosticism of Maimonides which held that we can know only what God is not.

Essence and Existence.—Thomas' metaphysical distinction between essence and existence, which is variously interpreted, deepens Plato's and Aristotle's criticism of Parmenides and Heraclitus. Taking the notion of real potentiality (Lat. *potentia;* Gr. *dynamis*) into the heart of being, he establishes the status of plural substances on a basis more general than that of common sense, ethical need, or lyrical protest. Created things are real in themselves, though not of themselves, for there are no realities other than himself of which God is not the exemplar, end, and agent, working in all that they are and do. God is the first and universal cause who without violence produces their very spontaneousness and even that mode of activity called freedom, which lies fundamentally not in a power to choose good or evil but in a poise not subjected to causal determinism by any particular good. Yet under divine causality creatures are not merely occasions or instruments; they are principal causes, though secondary; and so likewise they are not merely means but true final causes, though not ultimate. Thomas sees evil as good out of place and severely argues against Manichaean dualism. His moral teaching is keyed to a world governed by purpose; "ought" presupposes "can," the right coincides with the human good, and obligation is relative to happiness (Lat. *beatitudo;* Gr. *eudaimonia*). Happiness is grasped by an act of mind, not will; Thomas recognizes the present predominance of the dialectic of love, particularly in religion, yet it is the true that defines the good. The "intellectualism" of his position can be contrasted with the "voluntarism" or affective theology of his predecessors and contemporaries. (*See* also ETHICS, HISTORY OF.)

Theology.—Above all Thomas is a theologian, though for long passages he seems to be pursuing the rational evidence, which he never twists to suit an ulterior purpose. His full doctrine, however, can be appreciated only within the dimensions of the Christian revelation. The assent of faith is directly to God himself, not to any lesser teaching authority however august; the life of the spirit lies in friendship (Lat. *caritas;* Gr. *agape*) with God, not in conformity to law properly so called. Thomas' moral theology does not delay on legalism but takes it in its stride; code justice is subordinate to a higher equity. In the history of theology he occupies a salient position with regard to grace; responding to the biblical story of God's deeds with man as progressively construed in the church's consciousness, and acknowledging an almighty justice not tempered but intensified by mercy, he propounded a strongly Augustinian doctrine of what came to be known as intrinsically efficacious grace. The point was not uncreated grace or the condition of being in God's favour, but the actual causality at work in being taken into his friendship. At the beginning of the 16th century Thomas' teaching was not well apprehended by Martin Luther, yet by the end it was the theme of exactingly conducted debates between Dominicans and Jesuits at Rome during 1598–1607 before Clement VIII and Paul V; they finished in stalemate.

Thomas draws a clear typological distinction between the natural and supernatural orders but does not regard a purely natural state as ever having existed in a historical situation. Grace offers no threat to nature; its mode of activity is entirely "connatural," and the life of grace is not to be identified with preternatural or miraculous phenomena. Thomas' dispassionate examination of transubstantiation should be set beside his eucharistic hymnody as a pointer to the many seeming contrasts he combined. Indeed he is a man for the "both," not the "either-or," who sees a continuity between life and thought, mind and sense, faith and reason, law and freedom.

CONCLUSION

Thomas was hotly criticized by traditional theologians after his death, and propositions taken from his writings were condemned by the bishop of Paris. The Dominicans, notably in England and France, however, rallied to his cause, which soon became that of his order. Thomism formed one of the schools of late medieval scholasticism, particularly strong at Louvain and Cologne. The revival of Averroism in north Italy was met by two classical expositors of Thomas' metaphysics, Francesco Sylvestri of Ferrara (Ferrariensis) and Tommaso de Vio (Cajetan), in the early 16th century. They paved the way for the baroque glory of the great Spanish school, whose members included Francisco de Vitoria, Domingo and Petro de Soto, Bartolomeo Medina, Domingo Bañez, and John of St. Thomas.

The tradition stiffened, however, and shrank to courses of ecclesiastical study until, under the aegis of Leo XIII, it was revivified and brought out from the cloister. The movement called Neo-Thomism was a major force in Roman Catholic thought for the first 30 years of the 20th century, particularly strong in its application to social questions and to problems not usually regarded as of ecclesiastical interest. The reasoned conviction, philosophical and theological, that nothing human is alien to it is its strength and will ensure its powerful continuance, less partisan perhaps and better translated into contemporary idiom, as a living body of thought in the church. *See* further THOMISM; SCHOLASTICISM.

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AQUINO, a town of central Italy in the region of Lazio and province of Frosinone, is situated on the Forme d' Aquino stream and on the Via Latina, 27 mi. (43 km.) S.E. of Frosinone by road and 81 mi. (130 km.) S.E. of Rome by road. Pop. (1961) 3,670 (commune). The old town was laid waste by Totila and abandoned for the more fertile present site, which has important Roman remains, including a triumphal arch supposed to honour Mark Antony (1st century B.C.), a doorway and a temple. The Benedictine church of Sta. Maria della Libera (1125), built on the ruins of a Roman temple, is roofless but has a fine doorway and beautiful mosaics. Natives of the town are said to include Juvenal, the Latin poet, and the emperor Pescennius Niger. St. Thomas Aquinas was born at Roccasecca castle, 3 mi. N. Aquino is on the railway from Rome to Cassino and Naples and agriculture is the chief occupation, especially the production of cereals, grapes and oil. There is a sulfur and iron spring.

The ancient town Aquinum prospered from its position on the Via Latina. During the feudal struggles Riccardo, count of Acerra, uncle of St. Thomas Aquinas, was an important figure. His son captured Roccasecca castle from Frederick II. In World War II Aquino was captured by Allied forces on June 1, 1944. (M. T. A. N.)

AQUITAINE, the name given to a region of southwestern France, still occasionally used as a geographical expression (*see* FRANCE: *Geographical Regions*). Historically it was applied at different times to different parts of the region or to the whole region according to the administrative divisions then obtaining.

In Julius Caesar's description of Gaul, Aquitania is an area bordered in the south by the Pyrenees and in the north just reaching the Garonne river. At this time Celtic Gaul extended as far south as Bordeaux and Agen, while Toulouse belonged to the Roman province of Gallia Narbonensis (*see* GAUL). In 27 B.C. when the emperor Augustus reorganized the administrative divisions in Gaul, the name Aquitania was applied to the area stretching from the Pyrenees to the lower Loire and from the Atlantic coast over Berry, the high regions of the Massif Central, Auvergne and the Cévennes. This vast territory had no single capital: Avaricum (Bourges), Limonum (Poitiers), Mediolanum Santonum (Saintes), Burdigala (Bordeaux) and Elusa (Eauze) were all of considerable importance in the administration. This was the period during which Aquitaine reached its greatest dimensions, but there is no evidence that it developed any real sense of unity.

At the end of the 3rd century A.D. an administrative reform by the emperor Diocletian brought about the division of Aquitaine into three provinces—Aquitania Prima, Aquitania Secunda and Novempopulana, with capitals at Bourges, Bordeaux and Eauze respectively (Eauze being later superseded by Auch). It was within this framework that Christianity took root in Aquitaine and the church with its dioceses and ecclesiastical provinces was organized, leading to rivalry between the archbishops of Bourges, Bordeaux and Auch for the primacy of Aquitaine. The Roman poet Ausonius writes of Aquitaine as a rich country; it produced corn and wine and exported the marble quarried in the Pyrenees.

The invasion of the Visigoths in the 5th century disorganized this Christianized Gallo-Roman province in two ways: by merging the country in a vast kingdom extending over Toulouse and Spain and by imposing Arianism in the place of Catholicism. The defeat of the Visigoths under Alaric II by Clovis at Vouillé in 507 made Aquitaine part of Frankish Gaul and resulted in the overthrow of Arianism. In the partitions of the Frankish kingdom after the death of Clovis, however, Aquitaine was the subject of disputes among Merovingian princes. In the 7th century Gascony was separated from the rest of the country, and the kingdom of Aquitaine established by Charibert did not last long. The state of disorder was made worse in the 8th century by the invasion by the Saracens. A certain Eudes (*q.v.*), or Odo, who had made himself master of Aquitaine, was obliged to call for help on Charles Martel, who exacted homage from him as the price of his support. After Charles Martel's victory over the Saracens in the battle of Tours or of Poitiers (732), however, Eudes' successors, Hunald and Waifer, resisted Frankish rule for some years, but Aquitaine was finally subdued by Charlemagne, who bestowed it as a kingdom upon his son Louis (the future emperor Louis I). It remained a kingdom under Louis' son Pepin I (814–838) and under the latter's son Pepin II (838–865), its chief towns being Toulouse, Limoges and Poitiers. Devastation by the Normans in the 9th century, however, led to political and social upheavals during which various feudal domains were established. The title of duke of Aquitaine, which had already been used by various little-known persons in the 7th century, was assumed at the end of the 9th by William I the Pious, count of Auvergne, the founder of the abbey of Cluny. In the first half of the 10th century the counts of Auvergne, of Toulouse and of Poitiers each claimed this ducal title, till it was eventually secured by William (Guilhem) I, count of Poitiers (William III of Aquitaine). The powerful house of the counts of Poitiers retained Aquitaine during the 10th and 11th centuries, endeavouring from time to time to restore to the name its former significance by extending the boundaries of the duchy to include Gascony and Toulouse. Then, on the death of the last duke, William X (William VIII of Poitiers), in 1137, his daughter Eleanor (*q.v.*), or Aliénor, united Aquitaine to the kingdom of France by her marriage with Louis VII. When Louis divorced her, however, she married in 1152 the count of Anjou, Henry Plantagenet, who two years later became king of England as Henry II. English possession of the duchy was subsequently disputed by the French kings, who won it back region by region until Guienne and Gascony (*qq.v.*) were reunited to France at the end of the Hundred Years' War. *See* BASQUE; POITIERS, COUNTS OF. *See* also references under "Aquitaine" in the Index. (RE. C.)

ARA, a constellation of the southern hemisphere (Latin *ara*, "altar"). South of Scorpio, it has three third-magnitude stars.

ARAB, originally the name of the Semitic people of the Arabian Peninsula. First generally used in this sense about the 6th century A.D., the name was more widely applied after great expansion of Arab influence in the 7th century. In contemporary usage it refers to nearly all persons (about 100,000,000 in the 1960s) whose native language is Arabic.

The article contains the following sections and subsections:

I. PRE-ISLAMIC AND TRIBAL ARABS

A. Origins

1. Traditional Accounts.—The Arabic word *'arab* (plural) probably means "those who speak clearly," as contrasted with *'ajam* ("those whose speech is indistinct"); the latter term came to be applied chiefly to Persians. In the traditional view, recorded in later Islamic times, most people of Arabia were Arabs, and comprised three groups. The first, sometimes called "lost Arabs" (*al-'arab al-bā'ida*), were extinct tribes; *e.g.*, those of Ad and Thamud mentioned in the Koran (*q.v.*). Those reckoned as descendants of an ancient patriarch named Qahtan (Qahtān) were frequently called "true Arabs" (*al-'arab al-'āriba*). Though some of them had migrated northward, it was held that they originated in southern Arabia (*see* YEMEN), and they also are known as Yemenite (Yamani). The third group recorded descent from the patriarch Adnan ('Adnān), and were distinguished as "arabized Arabs" (*al-'arab al-muta 'arriba* or *al-musta 'riba*). Considered to have been the original northern Arabs, they often are called Qaysite from one of the genealogical subdivisions. While distinctions among the groups remain relatively stable, use of names shows much variation. Sometimes the first are said to be the "true Arabs," the second *al-muta 'arriba*, "those incorporated in the Arabs," and the third *al-musta 'riba*, "those seeking to be Arabs."

Mohammed (*q.v.*) came from the northern tribe of Quraysh (Koreish), but most of his followers at Medina were from southern tribes: the Aws and the Khazraj. Later Muslim scholars tried to link the existing genealogies (of Adnan and Qahtan) with those in the Old Testament, since the Koran associates Ishmael (*q.v.*) with Mecca. Views differed, but a common theory identified Qahtan with the Joktan of Gen. 10:25 ff., and held Adnan to be a descendant of Ishmael. The Arabs were very interested in genealogical tables and had many that purported to be complete; the major early biography of Mohammed begins with one that lists 20 names between Mohammed and Adnan, 7 between Adnan and Ishmael, and 19 from Ishmael back to Adam (the latter roughly the same as the biblical names).

2. Validity of Traditional Data.—Muslim scholars did not begin to record the traditional accounts until the 8th century A.D., when an Arab empire stretched from Morocco to Central Asia. Since conditions at that time undoubtedly differed greatly from those of earlier centuries, the accuracy of the pre-Islamic genealogies has been questioned. Some Western scholars suggested that the genealogies do not preserve orally transmitted information from earlier times, but reflect tribal relations in the camp-cities of the empire during the later 7th century; but most scholars now tend to reject the view that the genealogies are mere inventions. The general consistency of this vast mass of detail is impressive, despite some discrepancies. In their earliest historical records, too, the Arabs present themselves as intensely conscious of the importance of descent (*nasab*). Also, persistence of the belief in a twofold origin (from Adnan and Qahtan) indicates some basis in reality, whatever its precise interpretation. Modern scholarship is still far, however, from producing a convincing account of Arab origins and relationships to other Semitic peoples.

3. Archaeological Evidence.—Traditional accounts reveal that some of the nomadic tribes in A.D. 600 previously had been agriculturists in the Yemen, and that they took to the desert after the dam of Ma'rib had burst. This event symbolizes the breakdown of an irrigation system on which prosperity in South Arabia depended, a failure confirmed by archaeology. Archaeologists also tend to follow W. F. Albright (*q.v.*) in holding that camels were first domesticated in Arabia between about 1500 and 1200 B.C. Camel-raiders (Midianites and Amalekites) are mentioned in Judg. 6 to 8, dating them before 1050 B.C. The domestication of camels is also linked with development of a trade route called the incense road, over which frankincense, gold, and other valuable commodities moved from South Arabia to the Mediterranean (via Gaza or Damascus). While temporary vegetation presumably had attracted owners of sheep and goats to go into parts of the desert for short periods in earlier times, camels made it possible for human beings to live there permanently. *See* also ARABIA: *History: Pre-Islamic Arabia.*

B. Culture

The great age of the nomadic Arabs immediately preceded Islam; *i.e.*, it spanned the 6th and early 7th centuries A.D. Because some of them deliberately had abandoned settled life for freedom in the desert, nomads were deeply convinced of their superiority to sedentary groups. Settled peoples in contact with the desert tended to accept this belief and to adopt many nomadic values. With exceptions in the southwest and south, Arabia was dominated by the nomadic outlook during this period.

1. Nomadic Tribal Structure.—Life in the desert depended on seasonal movements. As now, rains usually fell in the spring (*rabī'*) producing lush vegetation in the hollows of the *nafud* (sandy desert); there were no wells, but nomads could maintain life with milk from camels. When vegetation dried they moved to gravel desert where wells could be dug. Since Arabian rainfall is erratic, nomadic movements were irregular. The people grouped for defense and to share the work of herding camels.

The group was conceived as constituted by descent from a common ancestor, its subdivisions being traced to his sons and grandsons. In English the larger groups are usually called tribes and the smaller ones clans. In Arabic, the usual word for such a group of any size is Banū (modern Beni, "the sons of"). Thus Mohammed's clan of Hashim, which was also the name of his grandfather, is called in Arabic Banū Hāshim ("the sons of Hāshim") or Banū Hāshim ibn 'Abd-Manāf ("the sons of Hāshim, the son of 'Abd-Manāf"). In the early Islamic period kinship was reckoned in the male line. Some tribes in pre-Islamic times followed matrilineal kinship predominantly, practising forms of polyandry (*q.v.*) in which paternity was neglected. It is not clear how this fact of matriliny was squared with the patrilineal genealogies recorded in the early Islamic period. Islamic insistence on patrilineal descent was complemented by rules designed to ensure that paternity was known; a woman was restricted to one husband at a time, though a man might have four legal wives as well as slave concubines. Before remarrying, a divorced woman had to spend a waiting period (*idda*), usually three months and ten days, to show she was not pregnant.

Beyond full members by descent, a tribe might have persons attached to it. Women and children captured in fighting and not ransomed became tribal slaves, and could be bought and sold. Should one man ask another for protection, he could become the protector's client (*mawlā*), usually undertaking certain obligations toward his patron. When freed, a slave became a client of his former master. Where protection was temporary, a man was a protected neighbour (*jār*), presumably while he camped in the pasturelands of his protector. A man who had a more or less equal alliance with another was his confederate (*halīf*).

As now, the nominal head of a tribe was the shaykh or sheikh (*q.v.*); it was for him to give the word when the tribe was to move its camping ground. Entertainment of guests from other groups usually was the prerogative of the sheikh. His authority depended largely on his personal qualities, limited by assemblies of all adult tribal males to consider matters of policy. Sectional disputes within a tribe, if not resolved behind the scenes, could be settled in such an assembly. Intertribal differences might be referred to an arbiter (*hakam*), a man respected for wisdom, tact, and for knowledge of tribal customs. Immediate settlement was

not always desired since dispute gave excuse for the manly exercise of a *razzia* against opponents. The *razzia* (from Arabic *ghazw*), a raid aimed chiefly at driving off camels, is described as the Arab national sport.

The basis of such security as was to be had in the desert was the communally applied *lex talionis*, ". . . life for life, eye for eye, tooth for tooth . . ." (Ex. 21:23ff.). Family, clan, or tribe was held responsible for a death caused by one of its members, and any member's life might be taken in revenge. Correspondingly, vengeance was a duty of the community. Wanton injury often was prevented by the likelihood of vengeance. Under this system, an individual separated from his own group would seek to be attached to some other tribe to prevent his being injured with impunity. Tribal solidarity thus was central in desert life.

2. Sedentary Arabs.—Even apart from the southwest and south, not all inhabitants of Arabia were nomads. Scattered over most of the country were oases with subtropical agriculture; a few near the west coast had tropical vegetation.

Medina: Agriculture.—The oasis about which most is known is Yathrib, since Mohammed's time known as Medina ("the city," usually said to be a shortened form of "the city of the Prophet"). Probably of more than 25 sq.mi. (65 sq.km.) area, it produced dates chiefly, and some cereals. Here and throughout Arabia agriculture seems to have been pioneered by tribes or clans professing Judaism, some probably the descendants of refugees from Palestine, others Arabs who had accepted that faith. All were indistinguishable from their Arab neighbours except in religion. Some Arab clans already at Yathrib when the Jews arrived were in subordination to them at Mohammed's advent. However the two main Arab tribes (the Aws and the Khazraj) were later arrivals and had become more powerful than the Jews. Each tribe and clan had small forts or castles to which they could retire when attacked. Otherwise they lived on their lands. There appears to have been no concentration of dwellings anywhere in the oasis until after the coming of Mohammed. The Jewish-occupied oasis of Khaybar north of Medina was somewhat similar, though forts seem to have been fewer and larger. In other cases an oasis supported part of an Arab tribe, the remainder being nomadic. (*See* also MEDINA.)

Mecca: Trade.—Of the small settlements without oasis agriculture Mecca (*q.v.*) became by far the most important. Modern Mecca has a little agriculture, but seems to have had none in the 6th century. The original population probably was a family that controlled and served the shrine. Later known as the Ka'ba (*q.v.*), the shrine had a sanctuary area around it; the months for pilgrimage to the shrine were designated sacred. In the sacred territory and during sacred periods blood feuds were in abeyance. Members of hostile tribes met there peacefully to make Mecca a growing trade centre. By A.D. 600 its merchants held monopolistic control of the trade route from the Yemen to Gaza and Damascus; another route linked Mecca to the head of the Persian Gulf. Most Meccans then were Quraysh (Koreish). This northern Arab tribe had clans that sent their leading members to a kind of senate (*mala'*). This body lacked executive power since the *lex talionis* held, unless the head of a clan disciplined his own people. However, Mecca enjoyed a large measure of harmony; its leaders were merchants who put peaceful business considerations first. This tended to undermine nomadic customs in sedentary communities. Other centres combined trade and agriculture; *e.g.*, at-Ta'if just east of Mecca at a higher altitude, where rainfall supported some agriculture. For a time at-Ta'if was a serious trade rival, but by A.D. 600 its commercial activities had become completely subordinated to those of Mecca.

3. Nomadic Religion.—Data on pre-Islamic Arab paganism collected by Muslim scholars and recorded by Ibn al-Kalbi (d. 819) were carefully evaluated by J. Wellhausen (*q.v.*). Archaeology later provided supplementary material. The evidence indicates beliefs and practices similar to those of primitive, animistic Semitic religion elsewhere. Worship of trees and stones, occasionally of springs and wells, is frequently attested. The holy well of Bi'r Zamzam was near the Ka'ba at Mecca, and the principal object of worship there was the Black Stone (probably a meteorite regarded as the seat of a deity). The Ka'ba was a centre of pilgrimage long before Islam.

Evidently animism was passing into polytheism. Eight deities are named in the Koran, five in lxxi:23 and three in liii:19 ff. The latter (Al-lat, Al-'Uzzā, and Manat) had shrines not far from Mecca. They are sometimes called "the daughters of God" (*banāt al-lāh*), but had no connected myths or family relationships as in the Greek pantheon. The shrine of Al-lat ("the divine one") was at at-Ta'if, where she was also known simply as "the lady" (*rabba*); her seat was a square stone. Al-'Uzzā ("the strong one") had her seat in a tree at Nakhla.

Belief in spirits was widespread; *e.g.*, the *jinn* (sing. *jinnī*, the "genie" of the *Thousand and One Nights; q.v.*). Perhaps originally the forces of nature unsubdued by man, in Islamic times they were confused with Judaeo-Christian angels (*see* JINNI). Other more malevolent spirits were called *si'lāt*, *'ifrīt*, and *ghūl*. While the nomads believed in predetermination, fate was not an object of worship. Though Manāt resembles *manaya* ("fates"), she probably was an agricultural deity like Al-lat. The importance of traces of moon worship is uncertain.

Pre-Islamic Arabic poetry and stories concerning the life of Mohammed suggest that animistic and polytheistic religion had ceased to be important to the nomads and those they influenced. Attempts to base opposition to Mohammed on the old paganism had no great success. Polytheism was linked with agriculture, and much of it must have seemed irrelevant to nomads, since rainfall and seasonal changes were erratic in much of Arabia.

The effective religion of the nomads might be described as a form of humanism focused on belief in the nobility of the tribal stock. Need for solidarity in the desert left little place for individualism. Individual worth derived from the genetic membership in the clan or tribe that gave a man opportunity for noble and heroic deeds. The dominant motive was to maintain the honour of the group. Much of the virility and moral courage of Islam seems to stem from this desert outlook.

Although desert ways had lost relevance for oasis-dwellers and for thoroughly materialistic merchants based in towns like Mecca, contacts with the Byzantine, Persian, and Abyssinian empires led to admiration for monotheism. Christianity and Judaism had spread in Arabia, mainly among the settled populations. Archaeology indicates a monotheistic cult of a deity called ar-Rahman, "the merciful," in South Arabia before A.D. 400. Traces of the cult are found in the works of Muslim scholars and in the Koran. Limited evidence suggests that a number of Arabs acknowledged both the old gods (perhaps as a kind of spirit) and a supreme being (identified with Rahman and the Judaeo-Christian deity). A movement toward a nonpolitical monotheism probably arose, since Christianity was closely connected with the Byzantine and Ethiopian empires and Judaism seems to have had ties with the Sasanian Empire (*see* PERSIAN HISTORY). The Koran records some "pure" monotheists (*hanifs*), but it is unlikely that any pre-Islamic Arabs took this name. (*See* also ARABIA: *History: 6th Century* A.D.)

4. Literature.—Material poverty led nomads to use words as the chief form of artistic expression, especially oratory and poetry. Oratory is evanescent, but grounds exist for supposing that much of it approximated *saj'*, a form halfway between prose and verse. This is a peculiar feature of some later Arabic literature, usually short balancing phrases marked off by rhyme or assonance. Many fine examples of pre-Islamic poetry survive, however. The normal form is an ode (*qasīdah*) of 40 to 100 or more lines, each with the same complex metrical scheme and the same rhyme. The most famous examples are from the collection called *Mu'allaqāt* (*q.v.*); the precise meaning of the word is uncertain. Among many others preserved are the *diwans*, collected poems of individual writers (*see* ARABIC LITERATURE).

Although the *qasīdah* is said to have developed in the first half of the 6th century, earlier experimentation is presupposed; even the oldest known show maturity, perfection, and generally a standard order of topics. First came the *nasib* (prelude) in which the poet imagined a former encampment where he had had an intense, transitory love affair. He escaped from this sorrow riding

off on his camel, next compared to a desert animal such as an antelope or a wild cow. The heart of the poem either boasted of the poet's tribe including himself, satirically exposed the shame of a hostile tribe, or was a panegyric on a patron. The writer's art became manifest in his treatment of these fixed subjects, perhaps itself a reflection of attempts to function nobly in the narrow limits of desert life. As the chief art form, poetry had high social importance, exalting the tribe and its adherence to the highest values of desert nomads. In some ways the poet was comparable to the modern journalist, and the satire of an accomplished writer was greatly feared.

C. History

1. Relations with Other Civilizations.—Egyptian interest in South Arabia as a source of incense may have begun before 2000 B.C. Bedouin (*q.v.*) people are pictured in early Egyptian tombs but may represent nomads west of the Red Sea. The first literary reference to Arabs is usually taken to be an Assyrian inscription on the Battle of Karkar (*c.* 853 B.C.) in which Shalmaneser (*q.v.*) III met an alliance led by the king of Damascus, including Gindibu the Arab with 1,000 men on camels. Under Tiglath-pileser (*q.v.*) III (745–727 B.C.) two "queens of the Aribi" are reported to have paid tribute. Arabs also are noted in later Assyrian and Babylonian records, appearing as nomads (from regions between Syria and Mesopotamia and southward toward Egypt) to be kept in order by rulers of the settled lands. Some expeditions against Aribi may have been in an effort to control important trade routes.

Arabians mentioned in the Old Testament mostly seem to have been nomads from the same regions, though "the kings of Arabia" who gave gold to Solomon (II Chron. 9:14) might have come from South Arabia. "All the kings of Arabia, and all the kings of the *'ereb* that dwell in the desert" (Jer. 25:24) probably were tribal sheikhs. The prophecy of Babylon's destruction (Isa. 13:20) states "no Arab will pitch his tent there." The Arabians in Jerusalem at Pentecost (Acts 2:11) presumably were Nabataeans (*q.v.*).

Arabs also served in armies of such leaders as Cyrus, Xerxes, Alexander, Antiochus, and some Roman generals. The disastrous attempt of Romans under Aelius Gallus to march south from Petra (*q.v.*) in 25–24 B.C. was supported by a Nabataean contingent. Eventually Roman policy was to seek alliances with nomads (*e.g.*, the Ghassanids) bordering their empire who would protect against other nomads. The Sasanian Persian Empire similarly used the half-settled Lakhmids in southern Iraq (*see* Hira).

A great struggle between the Eastern Roman (or Byzantine) and the Sasanian Persian empires (ending in collapse of the Persians in A.D. 628) had been extended to Arabia early in the 6th century. Encouraged by Byzantines, an invasion of South Arabia from Ethiopia doubtless was a move against the Persians who (about A.D. 570) sent a force that occupied the Yemen. About 590 a pro-Byzantine faction in Mecca unsuccessfully tried to gain control of the city. Arab culture was influenced in many ways through commercial and political contact with the two empires. (*See* also Babylonia and Assyria: *History;* Persian History.)

2. Pre-Islamic Expansion.—The most generally accepted modern view is that various Semitic peoples flourished in the Syrian or northern Arabian desert and spread into the Fertile Crescent (*q.v.*). This seems to apply to the Arabs long before Islam; colonies of them established in Syria in the Hellenistic period (323–30 B.C.) were associated with the trade route from Petra by Damascus to Mesopotamia. Stability of Roman-Byzantine rule gradually allowed Arab pastoralists on the desert's edge to change to agriculture. Readier to accept discipline, Arabs settled in Syria substantially aided Mu'awiya, governor of Syria, in the first civil war (A.D. 656–661) of the caliphate (*q.v.*) which brought about the Omayyad dynasty. Trade led to limited Arab expansion in other directions. For example, Arab traders were on the East African coast before Islam.

D. Modern Continuation of Nomadism

Mohammed (*c.* 570–632) and subsequent expansion of the Islamic state under the caliphate had important repercussions on nomadic life. Precluded from raiding one another, tribes in alliance with Mohammed turned against non-Muslim tribes of Arabia, next against settled lands in Syria and Iraq, then farther afield. Nomads constituted much of the rank and file of the Arab armies, receiving annual stipends from the state plus a share of movable booty. Few preferred desert freedom to the luxury of new camp-cities; though they continued to exist, the nomadic tribes lost considerable manpower. Scattered notices from about A.D. 900 reflect tribal movements northeastward or through Sinai into Egypt. Although fuller information was gathered after 1700 by European explorers, centuries of obscurity preclude efforts to link all modern tribes with those of A.D. 600.

The major tribes in modern times are the 'Anaza, Shammar, the al-Murra (Murrah), the 'Ujman, and the (Banū) Khalid. The Ruwalā of the 'Anaza confederation were studied by A. Musil before World War I. All these are noble (*asil*) tribes, so-called because they never paid others for protection. Men of these tribes used to spend most of their time raiding or fighting, ensuring effective control throughout their territories. Other so-called ignoble tribes (*e.g.*, the Hutaym and Awazim) pay for protection. These may be camel- or sheep-nomads, some of whom are hired by noble tribes to look after camels. Other ignoble groups make such important specialized contributions that in fighting they are inviolate. These include the Sulaba (Sulayb, Sulubba), workers in leather, wood, and copper; and families of smiths (*sunna'*, Sunnaa), one usually attached to each noble tribe. Temporary desert visitors include general merchants (Kubaysāt) and cattle dealers ('Uqaylis). Nomads in this complex society always have tended to move toward sedentary life as government of settled regions has stabilized. Airplanes and tracked armoured cars led to stricter control of the nomads than ever before, and petroleum discoveries plunged some nomads directly into Western culture. In these modern circumstances nomadism was declining.

While it often is supposed that the Sulaba have some crusader ancestry (*see* Crusades), C. S. Coon identified them as the earliest people of the desert, probably descended from primitive hunters and representing a desert-adapted Mediterranean genetic strain. (The highlands of the Yemen also are thought to exemplify this ancient Mediterranean group relatively unchanged.) The basically Mediterranean noble tribes probably represent somewhat more admixture, though they are now largely endogamous. Sheep-herders like the Shararat seem to have mixed relatively little with other peoples; but the smiths are negroid. In southern Arabia the cattle-raising tribe of Mahra and some of their neighbours speak a peculiar form of the Semitic languages (*q.v.*); Coon suggested this indicates a pre-Arab strain akin to the Vedda (*q.v.*) of Ceylon. (*See* also Arabia: *The People;* Nomads.)

II. THE CALIPHATE (to 1924)

1. Expansion.—Between Mohammed's death (632) and the Battle of Tours (*q.v.;* or Poitiers) in 732, when Charles Martel stemmed its advance into France, the caliphate expanded west to the Pyrenees Mountains and Morocco; and east to Samarkand and the Punjab. Arabs were the spearhead; at first, instead of settling as owners of lands they conquered, they were continuously available for fighting, receiving their annual stipend from the state. Between campaigns they retired to a base or camp-city, such as Basra in Iraq and Kairouan (Qairwan) in Tunisia. By A.D. 700 their manpower was insufficient for the military needs of the Empire; non-Arabs then were permitted to become Muslims as clients (*mawali*) of Arab tribes. In this way Persians and Berbers helped continue the advance. In most provinces far more non-Arabs soon were becoming Muslims than were required as soldiers and some Arabs sought to settle down. For example, most of the relatively small number of Arabs who entered Spain (*see* Spain: *History: Moorish Spain to 1031*) stayed there for the rest of their lives. Thus the Arabs gradually lost their role as a military aristocracy. They retained most of their privileges (especially in the west) however, and small groups of them came to be found all over the domains of the caliphate.

2. Arab and Non-Arab.—Non-Arabs probably had to become tribal clients because the Islamic state essentially was regarded

as an Arab confederation. The status of client suggested inferiority, and Arabs discriminated against these Muslim converts in some ways; *e.g.*, by not fully sharing booty. Discontent, especially among Muslims of Persian origin, was a major factor in the civil war (747–750) in which the Abbasid dynasty defeated the Omayyads (*q.v.*). Persian ideas of administering an empire prevailed and men of Persian descent were influential under the Abbasids (*q.v.*). Fighting on the frontiers became a matter for professionals rather than ordinary citizens. Annual stipends were dropped, along with the idea of the state as a confederation of Arab tribes. All Muslims became basically equal when they rubbed shoulders in the streets of Baghdad.

Important differences appeared between the eastern and western provinces of the caliphate. To the east of Iraq Arabs tended to become persianized, even if the post-Islamic Persian language that appeared about A.D. 1000 borrowed freely from Arabic. From Iraq west to Spain and Morocco, however, Arabic tended to replace such local languages as Aramaic and Coptic. Some writers note a general tendency for Arabic to replace similar (*e.g.*, other Semitic) languages. Even in the eastern provinces Arabic was the usual language for jurisprudence, theology, philosophy, and other branches of higher learning.

3. Arab-Islamic Culture.—Provinces such as Iraq, Syria, and Egypt had their own highly developed art and literature. It may seem surprising that they should have come to be dominated in such fields by the lesser culture of the Arabs.

The Shu'ubiyya or Shu'ubite movement under the Abbasids toward the end of the 8th century was one factor in promoting Arab dominance. As a forerunner of this movement, Ibn-al-Muqaffa' contributed Arabic translations or adaptions of Persian prose. The Shu'ubite movement has been interpreted by Sir Hamilton Gibb as an attempt by Persian or persianized "secretaries" (*i.e.*, civil servants and administrators) to reassert Sasanian Persian values. For a time they seemed to be succeeding; their literary productions were more entertaining to the growing urban populations of Iraq than the writings of Arabic philologists and religious thinkers. Shu'ubite influence waned in the face of new prose that wedded the art and grace of persianized writings with Arabic values (*e.g.*, *see* JAHIZ, AL-).

The "secretaries" fully accepted the Arab-created Abbasid empire in which they found their livelihood. Many shared the conviction that preservation of the empire depended on maintaining the Muslim values on which warlike Arab efforts originally were based. They joined with other urban Muslims in a so-called general religious movement (a kind of pious opposition to the Omayyads). They cultivated Arabic humanities, studying Arabic grammar and lexicography as aids in interpreting the Koran. Pre-Islamic Arabic poetry was recorded to exemplify the pure use of Arabic. Genealogy and historical tradition of pre-Islamic Arabia were required properly to understand the poems. Interpretation of the Koran demanded knowledge of events during Mohammed's life. Legal decisions were guided by traditional Arabic anecdotes about Mohammed (*see* HADITH). By A.D. 850 this conception of an arabicized empire had been accepted by the Abbasids and never was reversed.

In this way the framework of Islamic culture became essentially Arabic. Nevertheless, place was given to Sasanian conceptions of government and administration; Greek philosophy, science, and medicine; some amplifications of the Koran from the Bible and from other Judaeo-Christian sources; and a little of the history of the Roman Empire. Not held valuable from an Islamic point of view, the Homeric epics and Greek tragedy were completely neglected; eventually little was retained from Greek philosophy except the system of logic.

Arab permeation of Islamic culture is manifest, regardless of the ancestry of its leaders. The philosopher of the Arabs (*see* KINDI, AL-) was so called because he was an Arab at least in the male line. The geographer Ibn Batutah (*q.v.*), born at Tangier, was known as the traveler of the Arabs. A great Muslim historian (*see* TABARI, AL-), on the other hand, was a native of Iran. Most of the great poets were Arabs, some taking pride in their membership in desert tribes (*e.g.*, *see* FARAZDAQ, AL-; JARIR IBN 'ATIYAH AL-KHATFI). The distinctive Arabic literary form of *maqama* ("assembly") was perfected by an Arab (*see* HARIRI, AL-), though its inventor (*see* HAMADHANI, AL-) seems to have been partly Persian. The belle-lettrist Abu-al-'Ala al-Ma-'arri (*q.v.*) was an Arab from Syria. Many city-dwellers of the Islamic empire were of mixed origin. The writer al-Jahiz was of Ethiopian descent largely, but his culture was basically Arabic. In short, cultural allegiance was more important than race; however, this is not to say that all non-Arabic cultures were overwhelmed. A distinctive Persian tradition continued, and a noteworthy achievement of Arabic Islam was that through its stimulation there appeared and flourished a Persian-Islamic subculture.

Only a cultural heritage as powerful and unique as the Persian could resist the subtle Arabic attractions. One expression of the Arabs' intense self-confidence was a reluctance to acknowledge borrowings from other peoples. In one tradition it is suggested that even the Lord's Prayer of the Christians was invented by Mohammed. In Islamic Spain an earlier Christian culture was largely obliterated; although most of the original conquerors had been non-Arab Berbers, Spain under the Arab Omayyad dynasty of Córdoba became more Arab than Arabia. Arab descent was so highly prized that non-Arabs invented Arab genealogies. A Christian bishop complained that his young men were neglecting Latin in their fascination with Arabic poetry. Spanish Christians who lived under Muslim rule were known as *musta 'riba*, "arabizers" (in Spanish, *Mozarabes*). (*See* also ISLAM; ISLAMIC LAW; ARABIC PHILOSOPHY; CÓRDOBA; CÓRDOBA, CALIPHATE OF; ANDALUSIA.)

4. Arab-Islamic Art.—The specific share of Arabs in the Islamic arts hardly can be isolated since Arabic values underlie most Islamic art and architecture, and since ancestry (often obscure) counted less than cultural allegiance. Primitive pre-Islamic Arab material culture offered techniques that were unsuited to higher forms of art. However, the Muslim aversion (certainly not Persian) to representing human and other animal forms in painting and sculpture does seem to come from an iconoclastic tendency in the Arab or Semitic character. There were, however, sculptures of human forms in the Arab palace of al-Mafjar near Jericho (built about 730), and mosaic representation of animals and houses in the Omayyad mosque at Damascus. Opposition to representation encouraged development of geometrical patterns that characterize Islamic art. Similarly calligraphy came to be cultivated as a decorative, nonrepresentational art, probably reflecting the Arab interest in language. Arabs themselves chiefly seem to have been responsible for the Kufic and *naskhi* forms of Arabic script.

The great accession of wealth during the Omayyad and earlier Abbasid periods produced much architecture, most commissioned by the caliphs. The caliphs probably had a general influence on buildings produced by local non-Arab craftsmen; *e.g.* the Dome of the Rock at Jerusalem. In Spain the typical Moorish arch seems to reflect Visigothic style, but something of the general conception of buildings like the mosque of Córdoba and the Alhambra at Granada may be ascribed to the continuing influence of Arabs. The so-called Mesopotamian school of painting in the 13th century was likewise largely Arab. (*See* also ISLAMIC ART; ISLAMIC ARCHITECTURE.)

5. The Ottomans.—Paradoxically, Arab expansion led to much loss of consciousness of Arab origins. Descendants of the Arab military aristocracy of Omayyad times merged with the general mass of townspeople. Relatively few people remembered their descent from Arabian tribes. Foremost were the *sayyids* and *sharifs* who prided themselves in claiming descent from the Prophet's own clan. There also were small groups here and there to whom genealogy meant much. Most of those whose first language was Arabic probably thought of themselves first as Muslims, and second as bearers of Arab culture. This tendency probably began about the 10th century A.D.

Arabic-speaking lands were conquered by the Ottoman Empire: Syria, Egypt, and Western Arabia in 1516–17, and Iraq in 1534; North Africa as far as Algeria came under nominal but ineffective Ottoman suzerainty between 1521 and 1574. This period has

been little studied (apart from a useful political history by P. M. Holt; see *Bibliography*). Arab nationalists attribute its cultural stagnation and decline to Ottoman rule, though there is no final agreement about the causes. Before the end of the 16th century central Ottoman administration began to weaken, often being unable to stop local fighting. Nevertheless Ottoman rule may be said to have kept the Islamic heartlands intact until they could deal with European influences.

In this period the language of administration was Turkish, which brought into prominence other non-Arabic cultural aspects; Ottoman scholars of any ancestry often were familiar with Persian. Arnold Toynbee wrote that the Iranic (or Perso-Turkish) civilization swallowed the Arabic culture in the 16th century A.D. Not until European ideas of nationalism began to influence subjects of the Ottomans did waning Arab self-awareness grow again, fostered by the insistence of British and U.S. missionaries on the use of Arabic language. Christian leaders of a 19th-century literary renaissance centred at Beirut contrasted themselves (to Ottoman Muslims) as Christian Arabs. Later in the 19th century an attempt to foster the concept of Ottoman nationality evoked no deep response, soon being replaced by separate Turkish and Arab nationalisms. *See* TURKEY: *History;* EGYPT: *History;* SYRIA: *History;* IRAQ: *History.*

III. MODERN TIMES

1. Contemporary Meaning of Arab.—A conference of Arab students in Brussels, Belg. (December 1938), defined as Arabs "all who are Arab in their language, culture, and loyalty (or national feeling)." Although it probably is widely accepted, such a definition posed problems in the 1940s and 1950s. Arab culture is in general Islamic, but Christians led in the Arabic literary renaissance of the 19th–20th centuries and in the Arab nationalist movement (especially in Palestine). Such people certainly are Arabs by the definition; though their language sprang from Arabic, the people of Malta just as clearly are not (*see* MALTESE LANGUAGE), since they reject Arab culture and "loyalty." Rarely, Arabic-speaking Jews outside Israel are regarded as Arabs, even by themselves in some circumstances. Arab self-awareness among Arabic-speaking Muslims has grown only gradually; there still may be some (*e.g.*, many in Mauritania) who do not think of themselves as Arabs. When the prestige of Arab sultans in Zanzibar was high, many East Africans without Arab ancestry claimed to be Arabs. After expulsion of the sultans (1964), some people there from Arab families repudiated the name. Many who still call themselves Arab may hold their culture to be Swahili–African and barely come under the definition. (*See* also TANZANIA, UNITED REPUBLIC OF: *Population* and *History.*)

2. Arab Nationalism.—The contemporary meaning of Arab developed after abolition of the caliphate (1924), more particularly after World War II. However, this recovered consciousness of being Arab has roots in the literary renaissance led by the Lebanese Arabs Nasif Yaziji (1800–71) and Butrus al-Bustani (1819–83). Their philological studies increased awareness of the beauty and power of Arabic, thus providing the vehicle for a vast literature on contemporary life. Many of the new writers hoped to contribute to the rebirth of an Arab nation. But a genuine nationalistic movement awaited greater political awareness and further acquaintance with Western thinking. Though there were earlier premonitions, the end of the 19th century came before a clear form of nationalism emerged in the writings of al-Kawakibi (d. 1902). It became effective as a political force only after World War I.

The growth of the movement began in Arabic-speaking Ottoman provinces among men aware of misrule and of the advantages of decentralization. In 1915 demands on the British by the sharif of Mecca on behalf of "the whole of the Arab nation" named the Red Sea the Arab western border, implicitly excluding Egypt. Egyptians had been virtually independent since 1805, and therefore less aware of themselves as Arabs under an Ottoman ruling class. Farther west in Tunisia, Algeria, and Morocco colonial policies of France molded education to produce Europeanized intellectuals who wrote in French. Only after 1945, when most colonial territories were moving toward independence, did Arab nationalism begin to flourish in these countries. The Arab League (or League of Arab States, founded 1945) also fostered Arab self-awareness.

These developments indicated growing membership in an Arab nation as defined earlier by the sharif of Mecca. This racial conglomerate was Arab essentially as a linguistic and cultural community. Some writers have tried to describe *'uruba*, "Arabism" or "Arabness," the essential attitude and outlook involved in being Arab; *e.g.*, Isma'il R. al-Faruqi. If Arab writers tend to exaggerate, they may be balanced by Jacques Berque's sympathetic work.

3. The Arab League.—After World War I Arab intellectuals increasingly turned to nationalism in a struggle with Western powers for fuller independence. Spurred by intellectuals agitating for an Arab nation, plans for a League of Arab States were drawn up at Alexandria, Egy. (October 1944), and the Arab League (*q.v.*) was constituted (March 1945). Continued existence of the league is a considerable achievement; the only other existing regional group with a longer history is the Organization of American States. Many Arab intellectuals are disappointed with progress toward unity; but this was not one of the league's objectives. It has increased cooperation among members and secured the region from external control. Support by the league enabled independent original members to shed vestiges of reliance on Europe, and helped others to attain independence.

The importance of the league is reflected in estimated populations (1960s) of member-states:

United Arab Republic (Egypt)	30,054,000
Sudan	13,940,000
Morocco	13,323,000
Algeria	12,093,000
Iraq	8,222,000
Saudi Arabia	8,000,000
Syria	5,120,000
Yemen	5,000,000
Tunisia	4,457,000
Lebanon	2,400,000
Jordan	1,976,000
Libya	1,677,000
Kuwait	467,000
Total	106,729,000

Potential members of the league in 1967 were Aden and other members of the Federation of South Arabia, the Persian Gulf amirates and sheikhdoms, and perhaps Mauritania.

More than 500,000 Arabs (Muslim, Christian, and Druze) lived in Israel, the victor in a brief Arab-Israeli clash in June 1967. Possibly a third of the 3,307,000 inhabitants of Chad were Arabic-speaking.

Arab minorities live in Iran on the shores of the Persian Gulf, on the east coast of Africa, and in the Americas (especially the U.S.). One major non-Arab minority is found in the southern Sudan; others include the Berbers in North Africa and the Kurds of Iraq. Numbering about 1,200,000, the latter discontentedly aspired to political autonomy, perhaps along with fellow Kurds in Turkey and Iran. Berber-speakers (more than 10,000,000) showed little response to French attempts to develop their sense of community. Many also spoke Arabic and, as arabization continued, Berber political separatism grew more unlikely. Non-Arabs in southern Sudan are divided into many tribes, have no common language, and probably will continue to be arabized.

4. Discovery of Petroleum.—Formation of the Anglo-Persian Oil Company (1909) eventually led to a rich strike (1927) near Kirkuk, Iraq. Petroleum was found in Bahrain (1932), in Al Hasa province of Saudi Arabia (1935), and in Kuwait (1938). After 1945 producing wells appeared in other parts of the Persian Gulf and in Arabic-speaking North Africa. Yielding vast quantities annually, the Middle East in the 1960s was reckoned to have nearly two-thirds of earth's petroleum reserves.

Control of the Middle East with its escalating petroleum production was a prominent factor in international strategy before 1939. During World War II the supply to Anglo-European allies was partly interrupted, requiring supplementary petroleum from the Americas. Postwar control of Middle Eastern wells was in the forefront of calculations by the great powers. Aware of its

bargaining potential Mohammed Mossadegh (*q.v.*) nationalized (1951) production in Iran. Such events heightened respect of oil companies toward Arab desires for independence. Middle East producers lost substantial advantage as new sources were tapped elsewhere.

Petroleum revenues have transformed only a few Arab countries. Although the desert sheikhdom of Kuwait rapidly attained the highest per capita income in the world, deposits are far from equally divided among Arab countries. The Arab League has failed to generate economic cooperation for the region as a whole, which benefits only slightly from the new wealth. Among the primary beneficiaries, Iraq has kept a portion of the revenues for national development; Kuwait (*q.v.*) has enlightened educational and medical programs underway; but Saudi Arabia has a reputation for lavish spending on luxuries for the few. Wise use of petroleum resources and royalties might permit rapid development of Arab countries, but favourable political conditions seldom obtain. (*See* PETROLEUM: *History*). *See* also references under "Arab" in the Index.

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ARAB, SHATT AL, the channel formed by the junction of the Tigris and Euphrates rivers of Iraq. The course of the Tigris is clearly defined, but the lower Euphrates spreads into a very shallow lake (Hawr al Hammar), while a channel (Old Euphrates) runs a little to the north of Hawr al Hammar to join the Tigris at Al Qurnah.

The river pattern is probably of relatively recent origin, and divergent views exist regarding the mode of origin of the whole system (*see* IRAQ). From southwest Iran the Shatt al Arab receives the Karun river. Possibly at one time the Tigris and Euphrates entered the Persian gulf by another inlet, the Khawr az Zubayr, and the Karun alone reached the sea by what is now the lower part of the Shatt al Arab.

At Basra the Shatt al Arab is about 40 yd. wide, gradually opening to 600–800 yd. below the confluence with the Karun river near Mohammerah and to about one-half mile in width at Al Faw. Most of the banks are lined with palm groves and the rising tide ponds back fresh river water which floods the groves, providing a remarkable natural irrigation. Another unusual feature is that for about 60 mi. above Al Faw the frontier between Iraq and Iran follows the left (eastern) bank of the Shatt (with one small exception near Al Faw), bringing the entire waterway within Iraq. This has led to a number of disputes. Extensive dredging after 1930 provided a 22-ft. channel at Basra and a 30-ft. one at Al Faw —an indication of the growing importance of the Shatt al Arab as an outlet both for Iraq and Iran. (W. B. FR.)

ARABESQUE, in 16th-century France a word meaning merely "Arabian," but by 1611 translated in R. Cotgrave's *Dictionary* as "rebesque work, a small and curious flourishing." In fact the word arabesque, which should properly have been used to characterize ornament that followed the Muslim law forbidding the representation of the human figure, came to be the appellation of the Renaissance imitations of classical rinceaux which at first seem to have recalled to their finders the graceful scrolls of the Muslim style. (The term has also come to mean a ballet position. *See* BALLET: *Technique of Ballet.*)

The Roman stucchi (plaster modelings), which were revealed to Italian humanists in such remains as the *tombe latine* ("Roman tombs"), were used as models for stonework by Filippo Brunelleschi at the Badia di Fiesole, which, though not finished until 1462, was designed earlier, and inspired the painted decoration by Giulio Romano and the pupils of Raphael in the *loggie* (open galleries) of the Vatican. Similar compositions adorn the walls of the Villa Madama at Rome and the palaces at Mantua. Considerably rationalized, they inspired the design of such decorative sculptures as the Martinengo tomb and the façade of Sta. Maria dei Miracoli at Brescia. They inspired much of the plateresque (*q.v.*) style that gave the delicacy of silver work to the architecture of northern Italy and, later, of Spain. Traveling craftsmen brought them to France; the application of sculptured panels of arabesque design to what is essentially a Gothic structure is the first impress of Renaissance style in France. Native engravers such as Jacques Androuet du Cerceau and Marc Duval did much to naturalize them. Arabesques soon passed from the field of architectural decoration into other spheres; *e.g.*, the decoration of majolica at Urbino, of armour at Milan, of tapestry at Florence and of illuminated manuscripts at Mantua. Such Renaissance arabesques maintained the classical tradition of median symmetry, freedom in detail and heterogeneity in ornament, but there was no slavish copying. Cameolike scenes of modern life in the *loggie* include a medallion of Raphael's pupils working at the very designs that the medallion adorns.

Henry Peacham, writing in 1612, admirably describes such compositions:

> The forme of it is a generall, and (as I may say) an unnatural or unorderly composition for delight sake, of men, beasts, birds, fishes, flowers etc., without (as we say) rime or reason, for the greater variety you show in your invention, the more you please . . . You may, if you list, draw naked boyes riding and playing with their papermils or buble-shels upon Goates, Eagles, Dolphins etc., the bones of a Ram's head hung with strings of beads and Ribands, Satyres, Tritons, Apes, cornu-copias, Dogs yoakt, and drawing cowcumbers, Cherries, or any kind of wild traile or vinet after your owne invention, with a thousand more such idel toyes, so that herein you cannot be too fantastical.

The word arabesque thus came to take a wider range and to mean any elegant ornament upon the surface of verse or prose.

ALINARI

PAINTED ARABESQUE IN THE LOGGIA OF RAPHAEL IN THE VATICAN

Arabesques became familiar to craftsmen who might never have visited Italy through the engravings of such designers as Nicoletto Rosex da Modena and such northern engravers as Lucas van Leyden.

As the humanist conception of classical style passed into the three dimensions of the baroque, such surface ornament gradually lapsed from favour. It was little used during the 17th century and the *rocaille* style fulfilled the same purpose in the first half of the 18th century. Then the discovery of a new series of Roman "arabesques" at Herculaneum and Pompeii, followed by their publication in engravings, revived the style, especially in France. In 1757 the comte de Caylus published his *Recueil de peintures antiques* and by 1770 engraved models for arabesques were once more being published in Paris.

The French reliefs and paintings in the style by such masters as J. Rousseau are, perhaps, the most beautiful arabesques ever produced. The formality of Directoire and Empire design gradually brought the fashion to an end.

In England there was a parallel development of arabesque. Horace Walpole wrote that the discoveries at Herculaneum "testify that a light and fantastic architecture of a very Indian air" was in common use in Roman houses, and it was not long before Robert Adam was applying it to English use. His Etruscan manner, first used about 1775 in Lord Derby's London house and at Osterley, represents a new version of arabesque, purified by a severer taste. By 1780 T. Leverton's decorations of the saloon at Woodhall park showed a pseudo-Grecian version of the style.

Nonrepresentational ornament inspired by the east had, too, its place in Renaissance design, but it was termed not arabesque but Moresque. Arabic forms and inscriptions had long been familiar in Sicilian and north Italian textiles and in the Spanish decorative arts of Mudejar (*q.v.*).

It seems rather to have been from Ottoman Turkey that a revived fashion for such ornament reached 16th-century Italy and inspiration seems to have come not from textiles but from damascened metal work. Benvenuto Cellini tells how he imitated such metal work, but that he introduced birds and animals among the stylized foliage. Far more often the conventional leafage was retained, though it might be a little classicized and the frets and knots and symmetry of its basic lines were little changed. Its essentially surface character seems to have attracted great pictorial artists; Albrecht Dürer and Hans Holbein, the Younger, as well as a crowd of lesser men, designed in the style. It first appeared in Venetian metal work about 1520, and gradually merged into the strapwork and flower decoration current about 60 years later.

See also Islamic Art.

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ARABIA (Jazirat al Arab, "Island of the Arabs"), the name applied to the peninsula in the extreme southwest of Asia, bounded by the Red Sea on the southwest, the Gulf of Aden and the Arabian Sea on the south, and the Gulf of Oman and the Persian Gulf on the northeast. Geographically the peninsula and the Syrian Desert merge in the north with no clear line of demarcation, but the northern boundaries of Saudi Arabia and Kuwait are generally taken as marking the limit of Arabia there.

In shape the peninsula forms a trapezoid whose symmetry is flawed by the eastern projection of Muscat and Oman. The total area is about 1,000,000 sq.mi. (2,590,000 sq.km.). The length, bordering the Red Sea, is approximately 1,200 mi. (1,900 km.) and the maximum breadth, from Yemen to Oman, 1,300 mi. (2,100 km.). The larger political divisions are the kingdom of Saudi Arabia, the republic of Yemen, the sultanate of Muscat and Oman, and the Protectorate of South Arabia with the colony of Aden. Seven British-protected Trucial States lie on the Persian Gulf and the Gulf of Oman, along with the independent amirate of Kuwait and the British-protected sheikhdoms of Bahrain and Qatar on the Arabian side of the Persian Gulf.

Geographically Arabia is linked to Africa by the Sinai Peninsula, whose terrain and inhabitants are similar to those of neighbouring Arabia, though territory held by Jordan and Israel at the head of the Gulf of Aqaba intrudes between the two. The Red Sea affords the usual avenue of approach to Africa. Arabia has easy access to the rest of Asia by both land and sea. The island of Socotra (*q.v.*), though lying about 220 mi. (350 km.) off the mainland, belongs politically and ethnographically to Arabia.

This article contains the following sections and subsections:

I. GEOGRAPHY

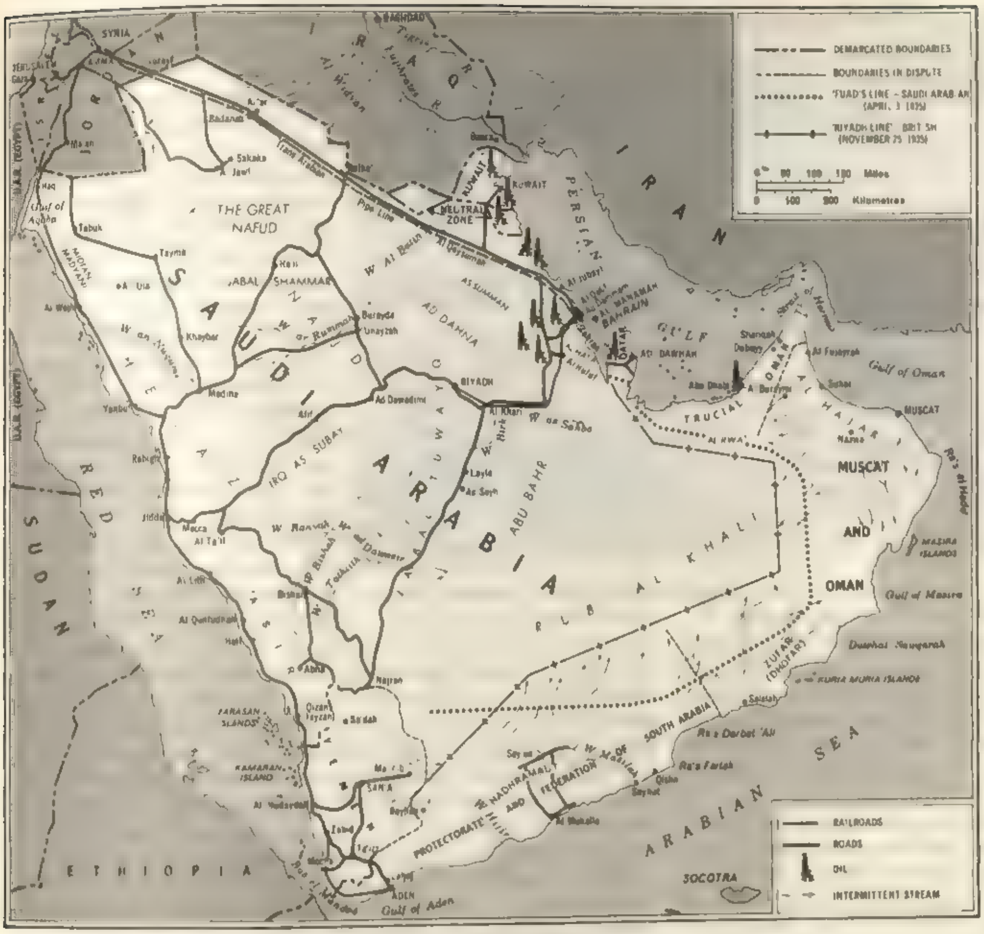
Arabia may be described as a great plateau sloping gently eastward from a mountain range running along the whole length of its west side. At the southeast extremity the character of the peninsula is disturbed by the lofty excrescence of Al Jabal al Akhdar of Oman. Except for Yemen, Oman, and numerous scattered wadis or valleys in the western range, it is a land remarkable for its aridity and barrenness.

1. Geology.—Geomorphologically the bulk of Arabia consists of two main provinces, the Arabian shield in the west and sedimentary areas dipping away from the shield to the northeast, east, and southeast into the great basin consisting of lower Iraq, the Persian Gulf, and the eastern part of the Rub' al Khali. The eastern edge of the shield curves eastward from the head of the Gulf of Aqaba to a point about midway across Arabia and then trends southwestward and southward to the Yemen mountains. Many extinct volcanoes overlie the shield; their eruptions, which ceased seven centuries ago, produced the broad black lava beds (*harrahs*) characteristic of the western Arabian landscape.

The sedimentary areas, not nearly as ancient as the shield, represent the deposits of seas which once reached it and at times partially covered it. The sedimentary strata have been extensively eroded. The harder members, more resistant to erosion, now stand up as westward-facing escarpments following the curve of the shield. The sedimentary province consists primarily of limestone, together with much sandstone and shale. The first deposits are early Paleozoic, which in eastern Arabia may be almost six miles (9,700 m.) below the surface. In the Jurassic and Cretaceous limestone occur oil and gas accumulations at depths of two miles or less. Some of the limestone strata take in rainfall at outcrops in the western highlands and carry it underground to the Persian Gulf lowland.

The Yemen (Yaman) mountains are physiographically very different from those of the shield, even though composed of similar rocks. In Yemen, geological confusion replaces the relative simplicity of the regions farther north. The main range along the southern coast is basically sedimentary in origin. The Oman ('Uman) mountains are geologically more closely related to the ranges of Iran than to their counterparts in Arabia, despite the sea barrier on one hand and the land link on the other. The sea is only about 30 mi. (48 km.) wide at the Strait of Hormuz.

2. Regional Geography.—Mountain walls shut off the interior of Arabia from the sea on three sides. From these lofty walls the interior slopes gradually down into the basin whose lowest portion is filled by the Persian Gulf, the descent being eastward from Hejaz (Al Hijaz) and 'Asir, northward from the southern coast and westward from Oman. The interrelationship of the regions may be emphasized by reviewing in order (1) the western wall, the core of which is the Arabian shield, and the various stages of the descent from this crest into the basin; (2) the southern wall; and (3) the Oman wall, geologically the least intrinsic part of Arabia. As the individuality of Yemen forbids its being bracketed



THE ARABIAN PENINSULA

improvements have been made to the port of Yanbu' (Yenbo) for Medina. Qizan (correctly, Jayzan) is the district capital of Tihamat 'Asir. Islands are particularly numerous along the southern part of the coast, where the Farasan Archipelago lies, and coral reefs are common.

In the Midian hinterland the sandstone plateau of Hisma has an elevation of about 4,000 ft. (1,220 m.). South of it are great *harrahs* such as 'Uwayrid, while others ring Medina. Tongues of lava, lapping over the mountains, descend almost to the coast. The sand plain of Rukbah, traversed by the highway from Mecca to Najd, unrolls south of Harrat Kashb. Among the *harrahs* east of Mecca is one surrounding the mountains of Hidn (Hadn), the traditional border area between Hejaz and Najd. (*See* also HEJAZ; 'ASIR.)

Najd.—The western part of Najd (Nejd), known as Upper Najd, lies within the Arabian shield with an average elevation of 4,000 ft.; the eastern part falls within the sedimentary province with Riyadh (Ar Riyad), near the eastern edge, having an elevation of 1,950 ft. (594 m.). The principal drainage of Najd ("highland") consists of a number of eastward-flowing wadi systems which carry water only seasonally. In the north, Wadi ar Rummah rises in Harrat Khaybar and runs past the twin cities of Buraydah (Buraida) and 'Unayzah (Anaiza) to lose itself in the Ad Dahna' sands, after which it reappears under the name Al Batin and goes on to the vicinity of Basra (Al Basrah) in southern Iraq. In the centre a number of valleys, including Wadi Hanifah, empty into Wadi as Sahba' in the Al Kharj district; after struggling through Ad Dahna', Wadi as Sahba' is submerged in the sands of Al Jafurah. In the south the wadis of Ranyah, Bishah, and Tathlith converge out of the highlands on Wadi ad Dawasir (named after the Dawasir tribe), which sinks away in the Rub' al Khali.

The parallel ranges of Aja' and Salma tower above the plateau to form Jabal Shammar (named after the Shammar tribe), the northernmost district of Najd. Just south of the Mecca-Riyadh road is the Jabal an Nir. East of the Hejaz highlands lies 'Irq as Subay' (named after the tribe of As Subay'), the largest sand desert within the shield.

The broad mountain-studded plateau gives way in central and eastern Najd to a series of escarpments curving from north to south along the contour of the shield: Al Khuff, Jilh al 'Ishar, Jabal Tuwayq, and Al 'Armah. Of these the longest and highest is Jabal Tuwayq, which with its length of 800 mi. (1,290 km.) constitutes the backbone of the most densely settled part of Najd. The steep western face of Tuwayq, rising about 800 ft. (240 m.) above the plains to the west, is pierced by half a dozen wadis, of which the most spectacular is Wadi Birk, a tributary of Wadi as Sahba'. West of Tuwayq a series of sand deserts (*'irqs* and *nafuds*) forms an almost continuous link between the Great Nafud and the Rub' al Khali; these also conform to the curve of the shield.

The district of Al Aflaj on the gentle eastern slope of Tuwayq and the neighbouring district of Al Kharj contain pools remarkable only in a lakeless land such as Arabia. (*See* also NAJD.)

The Great Nafud (*An Nafud*).—The second largest sand desert

with either the western range or the southern, it may be considered separately as a hinge between the two. Unless otherwise noted, all regions belong politically to Saudi Arabia.

Hejaz and 'Asir.—A virtually unbroken mountain chain runs the length of the peninsula above the Red Sea. The stretch from Aqaba to a point about 200 mi. (320 km.) S of Mecca is called Hejaz (*al hijaz*, "the barrier"), and the stretch from there to Najran near the Yemen border has in modern times acquired the name of 'Asir (from the name, meaning "difficult," of a prominent highland tribal confederation). In places the chain consists of two parallel ranges separated by a plateau, with the lower range closer to the coast. In Midian (Madyan), the northernmost part of Hejaz, the peaks have a maximum elevation of nearly 9,500 ft. (2,890 m.). The elevation decreases to the south, with an occasional upward surge such as Jabal Radwa west of Medina (Al Madinah). Wadi al Hamd, drawing water from the Medina basin on the inner side of the chain, breaks through the mountains to reach the Red Sea, though the main road to Medina from the coast takes a shorter course via the village of Al Musayjid. Another pass leads to Mecca and At Ta'if in the highlands. The mountains become higher again in 'Asir, where some peaks rise to more than 9,000 ft. The passes there are particularly difficult. A *harrah* descending from the mountains and reaching the sea near Hali long formed the natural southern boundary of Hejaz. The high plateau of 'Asir, coming within the area watered by the Indian Ocean monsoon, is more fertile and populous than rural Hejaz. Abha is the highland district capital.

The Red Sea coast plain is constricted throughout its length, attaining its greatest widths, well under 50 mi. (80 km.), south of Medina and south of Mecca. The name Tihamah, used for the whole plain, is sometimes subdivided into Tihamat al Hijaz and Tihamat 'Asir. There are no natural harbours adequate for large vessels, but the many inlets are well suited for sailing craft. A modern port for Mecca was constructed at Jidda (Juddah), and

KHAFS DAGHRAH, ONE OF THE MANY OASES SCATTERED THROUGHOUT THE ARABIAN PENINSULA

in Arabia, the Great Nafud, marks the northern limit of Najd. Lying just beyond the shield, it occupies an area of about 26,000 sq.mi. (67,300 sq.km.). Its sands almost reach the oasis towns of Tayma' (Taima) in the west, Al Jawf and Sakaka in the north, and Ha'il in the south. The sands are gradually moving toward the southeast, where they enter either 'Irq al Mazhur, the first of the deserts lying west of Tuwayq, or Ad Dahna'.

The Great Nafud contains few watering places, and the central crossing is not easy for either camels or motor vehicles. When the dunes are covered with annuals after the winter and spring rains, the desert is a favourite grazing ground for the flocks of the nomadic Bedouin herdsmen.

Northern Arabia.—From the northern edge of the Great Nafud the old highway to Jordan and Syria runs northwest through Wadi as Sirhan, a depression rather than a true wadi, about 200 mi. (320 km.) long and 1,000 ft. (305 m.) below the adjacent plateau. Among the settlements there are Qurayyat al Milh (the Little Salt Villages). East of Wadi as Sirhan are wide *harrahs* and chert plains belonging to the southern part of Al Hamad, the Syrian Desert. The basin containing the Great Nafud is rimmed on the north by escarpments, down the northern slope of which run Al Widyan or Widyan 'Anazah (the wadis of the tribe of 'Anazah), to empty into the Euphrates Valley; among the largest of these are 'Ar'ar and Wadi al Khurr. The wadis are crossed by the Trans-Arabian Pipe Line (Tapline), which transports oil from Saudi Arabia to the terminal at Sidon (Sayda) in Lebanon; after its construction in 1950 its companion road became the main artery for traffic to Jordan and Syria, the frontier post in Saudi Arabia being Turayf.

Ad Dahna'.—The Ad Dahna' belt, separating Najd from eastern Arabia, is a sand stream moving slowly over 800 mi. (1,290 km.) from the Great Nafud to the Rub' al Khali. Usually no more than 50 mi. (80 km.) wide, Ad Dahna' is crossed in several places by motor roads and in one place by the Ad Dammam–Riyadh railroad. The sands, often reddish in colour, vary greatly in form; particularly in the central stretches, long parallel ridges rise to heights of about 150 ft. (45 m.), while some dunes are three times that height. Ad Dahna' also provides pasture in winter and spring. In 1957 the Khurays oil field was discovered beneath its sands.

The Rub' al Khali.—The largest uninterrupted sand desert in the world, the Rub' al Khali covers an area estimated at about 230,000 sq.mi. (595,700 sq.km.). The name Rub' al Khali (Empty Quarter) is not commonly used by the Bedouins who roam there; they call it simply Ar Ramlah (the Sand). Only parts of it are truly empty; through the central portion a string of watering places makes the north–south crossing not too formidable for nomads, and camel routes lead into other areas. Traversed for the first time by a westerner, Bertram Thomas, in 1930–31, the desert has been intensively explored by the Arabian American Oil Company since 1950.

Some areas may have droughts of more than ten years' duration, while others sometimes have thunderstorms or high summer humidity. In the west the gravel plains of Rayda' and Abu Bahr separate the Rub' al Khali from the southern end of Ad Dahna', while another gravel plain, Al Jaladah, lies within the Rub' al Khali. What appears to be a northern extension of the Rub' al Khali, Al Jafurah, is regarded by the Arabs as an independent desert. Southeast of Qatar the sands give way before the vast salt flat of Sabkhat Mati, which runs north about 60 mi. (nearly 100 km.) to the Persian Gulf coast. East of Mati the oasis hamlets of Al Jiwa' (Liwa') lie among the dunes on the desert's northern fringe. The largest dunes of the Rub' al Khali are in the far east, where heights of well over 500 ft. (150 m.) are reached and sand ridges extend for more than 30 mi., with salt flats as the usual floor in between. Along the Oman edge is the large salt flat of Umm as Samim, whose surface is unusually soft in places. Near the southeastern corner of the Rub' al Khali is situated the comparatively well-watered area of Muqshin, much frequented by Bedouins. In the southwest, sand ridges running in a straight line reach a length of 150 mi. (240 km.).

Most of the Rub' al Khali falls within Saudi Arabia, but eastern portions of it, including the oases of Al Jiwa', are in dispute between Saudi Arabia and the British-protected Trucial State of Abu Dhabi. The sultanate of Muscat and Oman also has claims in this vicinity.

The Persian Gulf Lowland.—A low-lying region follows the Arabian shore of the Persian Gulf from Kuwait round to the Oman mountains at the mouth of the gulf. The gravel plain of Ad Dibdibah lies inland southwest of Kuwait. Adjacent to Ad Dahna' is the low plateau of As Summan, between which and the coast scattered hills rise a few hundred feet. Broad patches of sand occur here and there and salt flats are numerous. The Persian Gulf on this side provides no good deep-draft natural harbours, but many inlets offer shelter to sailing craft, and modern ports have been built in Kuwait, Saudi Arabia, Bahrain, and Qatar.

This lowland region is relatively well supplied with underground water from springs and wells. Deep in the sedimentary strata enormous accumulations of oil and gas have been found.

The western part of the lowland belongs to Kuwait and Saudi Arabia, which share undivided half interests in a Neutral Zone. Saudi Arabia has a similar arrangement with Iraq respecting another Neutral Zone in the interior. Bahrain consists of one large island and a number of small ones. The boundary between Qatar and Saudi Arabia is not fixed. The easternmost part of the lowland, known as the Trucial Coast, is occupied by six of the seven Trucial States. In the hinterland is the oasis of Al Buraymi, which is claimed both by Saudi Arabia on the one hand and by Abu Dhabi and Muscat on the other. After a long-drawn-out dispute (*see* SAUDI ARABIA: *History*) British-officered forces from the latter states occupied the oasis in 1955. (*See* also MUSCAT AND OMAN; BAHRAIN.)

Yemen.—Arabia's highest mountains occur in Yemen: Hadur Shu'ayb, west of the capital, San'a', reaches 12,336 ft. (3,760 m.). The Tihamah in Yemen, broader and more fertile than the Tihamah farther north, supports flourishing towns such as Zabid set back from the coast. Ta'izz in the mountains is served by the port of Mocha (Al Mukha), which won fame in the Middle Ages for the export of coffee. San'a' is served by the old port of Al Hudaydah and its extension, the new port of Ra's al Katib. Off As

Salif, a salt-mining centre on the coast, lies the British-controlled Kamaran Island. Receiving the monsoon rains, the mountains and high plateaus of Yemen form the most fruitful and populous region in Arabia. The easy slope from the highlands to the southwestern corner of the Rub' al Khali was the principal home of the pre-Islamic civilization of south Arabia (*see* SABAEANS), and the ruins of Ma'rib dam, the greatest monument of that age, still stand there. The seaward descent from the mountains of Al Kawr at the southern end of Yemen is precipitous. (*See* also YEMEN.)

Aden and Hadhramaut (*Hadramawt*).—The harbour of Aden, a British crown colony, is formed by two volcanic peninsulas of the lowland below the southern mountain face of Yemen. The southern coast from Bab el Mandeb (Bab al Mandab), the entrance to the Red Sea, to Ra's Darbat 'Ali, a distance of about 800 mi. (1,290 km.), and the hinterland constitute the Protectorate of South Arabia with the colony of Aden. The coast plain, about 30 mi. wide behind Aden, is narrower nearly everywhere else. Along this coast the stream of Wadi Hijir (Hajar), the only truly perennial river in Arabia, flows about 60 mi. to the sea.

Eastward the mountains of Al Kawr merge with the highlands of Hadhramaut known as the Jol (Al Jawl). Hadhramaut strictly speaking is a great interior valley cleaving through the Jol, with its lower course reaching the sea under the name Al Masilah, but the whole of the eastern area of the Protectorate of South Arabia is often loosely referred to as Hadhramaut. The valley contains many old towns such as Say'un and Tarim, the port for which is Al Mukalla. The island of Socotra is attached to the sultanate of Qishn on the coast of the protectorate. In the interior the sand desert of Ramlat as Sab'atayn lies on the slope descending from Al Kawr to the Rub' al Khali, which is gentle both here and going down from the Jol. (*See* also ADEN; HADHRAMAUT; SOCOTRA; SOUTH ARABIA.)

Zufar (*Dhofar*).—The mountains of the tribe of the Qara in Zufar, the southern province of the sultanate of Muscat and Oman, are about 3,000 ft. (900 m.) high, with one peak higher than 5,000 ft. (1,500 m.). The monsoon keeps the seaward side of the mountains fertile, as well as the coast plain, where the provincial capital, Salalah, lies. A gradual slope leads down from the water divide to the Rub' al Khali; many valleys from the slope converge on the area of Ramlat al Mughshin at the desert's edge.

Muscat and Oman.—The name Oman, formerly applied to the whole eastern protuberance of Arabia, is in modern times restricted to the interior on the landward side of the main Al Hajar mountain range, the remainder of the territory being named after the port of Muscat, the capital of the sultanate of Muscat and Oman. The sultan's authority over Oman was disputed in 1955 and 1957 by the pro-Saudi imam of Oman, Ghalib ibn 'Ali, but, aided by British forces, the sultan defeated the imam and drove him into exile.

The mountains of Al Hajar, about 10,000 ft. high in places, differ from the other Arabian coast ranges in being steep on both sides. An imposing fastness near the centre of Al Hajar, called Al Jabal al Akhdar (the Green Mountain), reaches 10,194 ft. (3,107 m.). The coast plain of Al Batinah belongs to the sultanate of Muscat and Oman. North of it is the sheikhdom of Fujairah, the only Trucial State lying wholly on the Gulf of Oman coast. Among the numerous towns of interior Oman is Nazwa (Nizwa), the former capital of the imam. Plains fall away almost imperceptibly from these towns to the Rub' al Khali basin. No mountains bar Oman's outlet to the Arabian Sea in the south, toward Al Masirah Island; the plateau along the coast has an average elevation of about 500 ft. (150 m.). (*See* MUSCAT AND OMAN.)

3. Climate.—Although the Tropic of Cancer bisects Arabia, passing south of Medina, Riyadh, and Muscat, most of the southern half of the peninsula is too high or isolated to be characteristically tropical, the main exception being the lowland coast.

Meteorological records are not full enough to give a detailed picture of the Arabian climate, but the outlines are clear. The summer heat is intense everywhere, reaching 54° C (130° F) in places. Much of the interior is dry, but along the coasts and in some of the southern highlands and deserts the humidity is extreme in the summer. Fogs and dews are frequent in the humid areas, dew often serving as a substitute for rain. In the dry zones the sun blazes fiercely throughout the summer. Spring and autumn are pleasant seasons, and biting cold and snow are rare in winter, except at high elevations and in the far north.

Rainfall is scanty in all parts beyond the reach of the Indian Ocean monsoon, averaging only 3–4 in. (77–102 mm.) a year. The desert rains are torrential on occasion, causing flash floods in the wadis; sometimes these rains turn into hailstorms. It is not unusual for a drought to last several years. The monsoon increases the precipitation fourfold or more in the southwest and south. Lying within the trade wind belt, northern Arabia receives westerlies from the Mediterranean which blow toward the Persian Gulf and then south and southwest through the Rub' al Khali toward Yemen. The monsoon strikes Arabia from the opposite direction. In midwinter and again in early summer the Persian Gulf experiences seasonal winds laden with dust and sand similar to the Egyptian khamsin; in Arabia these are called *shamal* ("north"), though the prevailing direction is actually from the north-northwest. In contrast to the *shamal* is the less frequent *kaus* from the southeast. The wind regimes of Najd and the Rub' al Khali are complex, particularly during spring. The winds may come from any point of the compass and vary in intensity from zephyr to gale.

4. Vegetation.—The date palm grows almost everywhere, except at very high elevations and in Zufar, on the coast of which it is replaced by the coconut palm. The date is a staple in the diet of both townsmen and Bedouins, and uses are found for the trunk, branches, and fibre of the palm. Among places noted for the quality of their production are Medina, Bishah, and Al Hasa (Al Ahsa'). Alfalfa (lucerne), widely used as fodder, often fills the space between palms. The principal grains are wheat, barley, and millet. Evanescent patches of grain planted by nomads in moist wadi beds are often encountered in the desert. Rice has to some extent supplanted wheat as a food, but little is raised locally. Cotton does well in a few places, such as Abyan near Aden. In general the people of Arabia have a greater fondness for fruits than for vegetables. Melons, pomegranates, and the jujube are particularly favoured, and Al Buraymi is noted for its mangoes. Figs, grapes, bananas, prickly pears, and other fruits are also grown, and the citron and Java almond flourish in the oases. The indifference of the Arabs toward vegetables is indicated by the fact that many of those produced in small quantities have non-Arabic names.

Although Arabia is no longer as renowned as formerly for its coffee, fair amounts are still cultivated on the terraced mountainsides of Yemen and 'Asir. In places coffee has given way to the more profitable *qat* (*kat; Catha edulis*), a narcotic. Tobacco is a product of the Hadhramaut coast.

The home of incense in antiquity, Arabia still numbers various aromatics among its herbs, though the trade in frankincense and myrrh has long been languishing. Mimosas and acacias are widespread, but little advantage is taken commercially of their gums. Indigo and other native dyes are extensively used in the south, both for cloth and for ornamenting the human body. Cactus, cactiform *Euphorbia*, and the aloe grow profusely in some areas.

Arabia is not the most hospitable of lands for flowers, but the roses of At Ta'if are well known, the oleander thrives in a desert environment, and other flowers sometimes brighten the general bleakness of the landscape.

The peninsula is singularly devoid of trees. Clumps of junipers in the southwestern highlands make the closest approach to true forests. The tamarisk, which grows well without much water, is often planted in rows to retard the encroachment of drift sand. The *rak* tree supplies the local version of the toothbrush. Trees are so rare that the standard Arabic word for tree, *shajar*, is ordinarily used by the Bedouin for bushes in the desert which furnish grazing for his animals and firewood for his tent. The leaves of varieties called *hamd* have enough salinity to satisfy the camel's need for salt. The tough perennials are as essential to life as the tender annuals nourished by the rains of winter and spring. The rains also assist in growing the truffle (*q.v.*), which the Bedouins dig out of the ground.

5. Animal Life.—The camel is the chief support of nomadic life in Arabia. Without the camel the Bedouin could never move far from water fit for human beings; with the camel he can survive for months on its milk and penetrate deep into the deserts. The camel also furnishes food, clothing, fuel (dung), transportation, and power for drawing water or for plowing. For the Bedouin the camel represents the best form of capital and the most valuable article of commerce. The noblest breeds of camel come from Oman, but some of the more plebeian breeds show greater stamina. Sheep and goats, known collectively in Arabic as *ghanam*, are numerous, but Arabia has no great herding tribes to compare with those farther north. Mutton and lamb are the favourite meats, and goat's milk makes the best cheese. Ghee (clarified butter) is used universally in cooking. The Arabian horse, noted for its beauty and endurance, is a disappearing strain in Arabia, where only a few thousand remain, though the breed is now fostered in other countries. A large white donkey is raised in eastern Arabia. Cows are usually small and humped, though the humpless variety is found on Socotra. Chickens tend to be of inferior quality. Many Bedouins own salukis, a speedy hunting dog; trained falcons are also used in the chase. Gazelles used to range the plains in large numbers, but formerly unrestricted hunting decimated them. Very few oryx are left in the Rub' al Khali, their last stronghold, and the ibex has also become rare. Other large wild animals are the hyena, wolf, and jackal. Despite the multiplicity of names for the lion in Arabic, the beast itself has long been extinct in Arabia. Baboons abound in the southern mountains. Among the smaller animals are the fox, ratel, rabbit, hedgehog, and jerboa.

Deadly desert snakes are the horned viper and a species of cobra differing considerably from the Indian. The striped sea snakes are also poisonous. Large lizards include the desert monitor, and the smaller lizards the sand-swimming skink.

Ostriches have become extinct. Eagles, vultures, and owls are common, and the lesser bustard is often hunted with falcons. Flamingos, pelicans, egrets, and other sea birds frequent the coasts. Smaller birds found in the towns and oases include the pigeon, cuckoo, swallow, and hoopoe, while the sand grouse, lark, and courser inhabit the desert.

The seas around Arabia contain mackerel, groupers, tuna, porgies, and other food fish, as well as shrimps. Sharks and sardines are plentiful off the southern coast and whales occasionally enter the Persian Gulf.

Swarms of locusts periodically descend as a plague, devouring every green plant in their path. Other common insects are the fly, which appears out of nowhere even in the depths of the desert, the mosquito, tick, beetle, scorpion, and ant. In some places bees are kept for their honey.

II. NATURAL RESOURCES

The mineral resource of greatest value so far discovered in Arabia is oil. Kuwait and Saudi Arabia are leading countries in world production, and the Arabian Peninsula holds perhaps a third of the world's reserves.

The Arabian oil fields lie in the same great sedimentary basin as the fields of Iran and Iraq. Although oil was discovered in Iran in 1908, the first field on the Arabian side of the basin, in Bahrain, was not found until 1932. The appearance of oil in Bahrain inspired an intensive search in eastern Arabia which in time reached far into the interior. Oil was discovered in Saudi Arabia and Kuwait in 1938, in Qatar in 1939, on the mainland of the Saudi Arabian/Kuwait Neutral Zone in 1953, on the mainland of Abu Dhabi in 1959, and in Oman in 1964. In 1951 oil was discovered in the Persian Gulf off Saudi Arabia, in 1958 in the Abu Dhabi offshore, and in 1960 in the Neutral Zone offshore. These discoveries, coupled with favourable geological prospects, provide a strong incentive for continued large-scale exploration. Oman, Zufar, Hadhramaut, Yemen, Najd, and the Red Sea coast and islands are regions where oil may exist in commercial quantities.

Saudi Arabia's proved reserves in the mid-1960s were estimated at about 70,000,000,000 bbl. and the estimate for Kuwait was well over this figure. In association with the oil are enormous amounts of natural gas; Saudi Arabia's reserves were estimated at more

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THE REFINERY AT LITTLE ADEN PROCESSES 5,000,000 TONS OF CRUDE OIL A YEAR: ADEN HAS NO OIL FIELDS OF ITS OWN

than 25,000,000,000,000 cu.ft. Making use of this gas commercially requires extremely large investments. Some gas is liquefied for local consumption or for export, some is reinjected into the oilbearing strata for storage and to help maintain pressure for oil production, and the rest, because of the poisonous elements it contains, has to be burned in flares.

Europe is the principal customer for Arabian oil, taking about half the production. The Far East comes next, followed by the Western Hemisphere, where both the United States and Canada import considerable quantities, and the Near East. (*See* also PETROLEUM: *After World War II*.)

Whether the biblical Ophir (*q.v.*) lay in Arabia or not is open to conjecture, but many ancient mining sites bear witness to the once flourishing production of gold. Between 1934 and 1954 gold and silver worth more than \$30,000,000 (£10,000,000) were taken out of the old mine of Mahd adh Dhahab in Hejaz, but no other site for gold that would be profitable under present conditions has been found. As igneous and metamorphic areas often contain rich deposits of minerals and precious stones, thorough scientific surveys of both the Arabian shield and Yemen are needed, and the governments of Saudi Arabia and Yemen endeavour to promote them. Deposits of iron have been found in northern Hejaz and Najd, but it has not been determined whether exploitation is economically feasible. Other resources, some of which are being used, are copper, barite, gypsum, salt, lime for cement, clay for bricks and pottery, shale, quartz sand for glass, marble, and building stone.

For many centuries the oyster beds of the Persian Gulf produced some of the world's finest pearls, and pearling was once a thriving and profitable occupation, with Bahrain as the chief centre and participation by the Trucial States, Qatar, and Saudi Arabia. Since about 1931 the trade has suffered a sharp decline as a result of the world economic depression, the competition of Japanese cultured pearls, and the siphoning off of labour into other less onerous and more lucrative fields. As the use of mechanical devices for stripping the pearl beds is forbidden, this resource remains abundant, and an increase in the demand for the delicately shaped and tinted Persian Gulf pearl might enable the pearling business to return to its former level of prosperity.

Even in the southwest, where rainfall is heaviest, the water supply is not constant enough for the generation of power. The water scarcity and the frequent poverty of the soil have hampered the development of an export trade in agricultural produce. Some progress has been made in improving the irrigation system and expanding the cultivated area. (G. S. RE.)

III. THE PEOPLE

According to ancient tradition, the Arabs are originally descended from two stocks. Of these the first were believed to have

originated in the uplands of the southwest corner of the Arabian Peninsula, while the second or northern group were those located in northern central Arabia and often alleged to be the descendants of Ishmael (*q.v.*), the son of Abraham. To this day almost every Arab tribe claims to be descended from one or other of these two stocks. It seems probable that these legends, so firmly rooted in tradition, did at one time represent some actual racial variants but, if so, their distinguishing features have long been lost.

A more practical division of the peoples of the Arabian Peninsula, who probably number 10,000,000–12,000,000, is that between the nomads and the settled communities. So scanty and precarious is the Arabian rainfall that the natural grazing available for livestock is everywhere sparse. A flock of sheep or a herd of camels will soon consume all the grazing in any given area, whereupon the owners are obliged to move camp in search of fresh grazing elsewhere. As a result, all the large-scale rearing of camels and sheep must perforce be done by nomadic tribal communities.

As opposed to the nomads, the settled communities live in towns and villages, either on the springs or wells of central Arabia or along the sea coasts. In central Arabia the settled population live either by agriculture, chiefly gardens of date palms, or by acting as middlemen, buying camels, sheep, wool, or animal oil from the tribes and exporting it to neighbouring countries such as Egypt, Syria, or Iraq. These commercial voyages abroad enabled the townspeople of central Arabia to acquire a certain familiarity with other civilizations and thus exercised a refining influence on Arabian society. As contrasted with these settled communities, the Arab nomads, or Bedouins, devoted the greater part of their time to raiding, hunting, and war, were capable of enduring severe physical hardships and, until after World War I, terrorized central Arabia and the surrounding territories. The settled inhabitants themselves, in most cases, were descended from the nomadic tribes and were considerably influenced by their warlike traditions. Thus they formed, as it were, a bridge connecting the tribal warrior class with the civilizations of the outer world.

The mountainous regions of Yemen and, to a lesser extent, of Hadhramaut received rain from the monsoon and a higher level of agriculture was possible. The earliest wealthy Arab kingdoms were established in these southwestern mountain regions at least 1,000 years before Christ, spices being in those days a principal export. Although the fertility of their country should, in theory at least, have resulted in a high standard of civilization in Yemen, the inaccessibility of their mountains and the fanaticism of their religion kept Yemeni society in a medieval stage of development until mid-20th century.

Muscat and Oman has for a long time been considerably influenced by the India-Pakistan subcontinent. There is a sprinkling of Indian inhabitants and more particularly of Balochi (*q.v.*). Many of the sons of the chiefs went to India for their education. The Arabs of the Persian Gulf and the seaboard of the Indian Ocean, unlike the northern Arabs, have always been great traders and seafarers. Hadhramaut has long had an intimate connection with Malaya, a fact which emphasizes the skill in navigation developed by these southern Arabs. Many of the inhabitants of the Persian Gulf coast provinces of Arabia lived by pearl fishing till the industry declined (*see* above, *Natural Resources*).

The province of Hejaz is set apart by the fact that it contains the Muslim sacred cities of Mecca and Medina (*qq.v.*), venerated by the whole Islamic world. Some of the pilgrims who flock there settle in the holy cities in order to terminate their lives on holy ground. Thus, although the inhabitants of the open country of Hejaz consist of largely tribal oasis dwellers and nomads, similar to those of central Arabia, the holy cities and the Meccan seaport, Jidda, contain extremely cosmopolitan populations.

There are few racial minorities in Arabia and indeed the population of central Arabia must be one of the most homogeneous communities in the world. The sole important exception is that of the African Negroes. In the past the Arabs were considerable owners of slaves, and slavery was not abolished in Saudi Arabia until 1962. However, partly for economic reasons and partly because slavery is now illegal throughout Arabia, the Negro population is free, living and working with and beside the Arabs. In certain especially hot areas, such as the oasis of Khaybar in Hejaz, Negroes appear to congregate particularly and to have intermixed with the local people. Considering the length of time during which Africans have been living in Arabia it is surprising that they have not intermarried more with the Arabs.

Such was the general picture of the peoples of Arabia until World War II. The discovery of vast oil fields in Arabia near the shores of the Persian Gulf, however, rapidly began to transform the whole scene. The exploitation of the oil wells was not seriously undertaken until 1943 and 1944. Thenceforward central Arabia, which in the past had been almost closed to Europeans, was suddenly thrown open to great numbers of United States oilmen and their families. In addition to senior officials and technicians, the oil companies needed a great number of minor employees, such as clerks, and foremen, drivers, fitters, and lower-grade technical staff. So primitive were educational standards in the country that the companies were obliged to import nearly all this personnel from Lebanon, Syria, Jordan, Iraq, or Egypt, countries with more modern social organization than existed in central Arabia. The impact of this invasion of Arabic-speaking semiskilled workers could not but be considerable.

The sight of "foreign" Arabs occupying so many lucrative posts in their country naturally impelled the Saudi Arabians to demand technical education for themselves, with the result that, for the first time, students were allowed to go abroad to study. Thus Arabia was suddenly propelled from a primitive patriarchal society straight into the modern oil age. At the same time, Saudi Arabia and some of the smaller Persian Gulf sheikhdoms, previously among the poorest countries in the world, became immensely rich. No oil had been found in Yemen or Hadhramaut by mid-20th century, with the result that in those countries the old social conditions still prevailed.

See further ARAB; BEDOUIN. For population figures *see* articles on the individual countries. (J. B. GL.)

IV. EXPLORATION

The exploration of Arabia is virtually complete, except for parts of Yemen. The term exploration, however, is perhaps a misnomer. Arabia has never been an unknown country, and it has at all times been inhabited even in its remotest quarters. It was divided by the Romans into Arabia Petraea (rocky Arabia) in the Sinai, Arabia Deserta (desert Arabia) in the northern interior, and Arabia Felix (fertile Arabia), usually restricted to Yemen but used by Ptolemy to describe most of the peninsula (*see* also ARABIA, ROMAN PROVINCE OF). In the past its inhabitants had little use for the instruments of the map maker or for the presence of infidels or unbelievers. But Muslims from every part of the world have always been welcome, and many of these were learned men who left interesting and informative accounts of their pilgrimages to Mecca and Medina.

Arabia has mainly appealed to two kinds of travelers—those interested in examining the precepts of Islam as manifested at its centres in the holy cities and those wishing to acquire fresh knowledge by exploring difficult and inaccessible terrain. To the ancient world it was known as the source of spices and incense, eagerly sought after by Sumerians, Babylonians, and Egyptians. So far the only accounts of such trading ventures in this area have been from the latter, if "God's Land" and the "Land of Punt" can be accepted as referring to southwest Arabia as well as to Ethiopia and Somaliland. There is no doubt that the Sumerians journeyed along the east coast to Muscat and Oman in search of gold and other precious materials. In the 8th century B.C. the Assyrians conquered the north Arabian tribes, who were a constant threat to the security of the overland trade routes from Yemen and Hadhramaut. The first connected accounts of the Arabian coastal region come from the classical writers Pliny, Theophrastus, Strabo, and the unknown author of *The Periplus of the Erythraean Sea*, written about A.D. 60. Further information about land routes was brought back by those who took part in Aelius Gallus' ill-fated expedition sent by Augustus to explore the region of the Arabian Gulf and to reduce the tribes to submission.

After the rise of Islam in the 7th century, Arabia became a closed area to those not professing the faith, but in the Middle Ages a large number of Muslim travelers visited the holy places and left records of their journeys. Among these may be recorded Ibn Hauqal and al-Maqdisi (Muqaddasi), both in the 10th century, Idrisi and Ibn Jubayr (12th century), Abdul Feda and Yaqut (13th century), and Ibn Batutah (14th century).

1. Early European Travelers.—European interest in Arabia may be divided into three periods: first, travels from the 15th to the 18th centuries, some of them involuntary, as in the case of Europeans captured and sold as slaves; second, the period of 19th-century exploration; and third, 20th-century travels, scientific missions, and oil surveys. The first recorded European to visit Arabia is Pedro de Covilhão (*q.v.*), who is known to have touched at Aden in 1493 on his way to Ethiopia. One of the earliest Europeans to stay any length of time in the country was an Italian, Lodovico di Varthema (*q.v.*), who traveled extensively in Arabia, Syria, Palestine, India, and Ethiopia. He enrolled himself in the corps of Mamelukes in Damascus and so accompanied the *hajj* (pilgrimage) to Mecca. His description of the city and the religious ceremonies carried out were to a large extent supported by such later travelers as J. L. Burckhardt and Richard Burton. Varthema also visited Aden and Lahej, which he describes in accurate detail. His book on his travels appeared in Rome in 1510.

The next to visit Arabia were the Portuguese under Affonso de Albuquerque (*q.v.*), who in 1513 made an abortive attack on Aden with the object of closing the Red Sea to Muslim commerce, and who later sailed along Yemen and acquired a knowledge of the coastal area. According to Albuquerque's commentaries, Gregorio da Quadras, a Portuguese captain wrecked off the Yemen coast, crossed Arabia after great difficulties and arrived at Hormuz (Ormuz), a Persian Gulf island. If this account is correct, Da Quadras was the first European to cross the Arabian Peninsula.

2. 17th and 18th Centuries.—In the early years of the 17th century the English East India Company was trying to force a way into the Indian trade. By this time Aden and Yemen were in Turkish hands, and in 1609, when Alexander Sharpeigh visited Aden in the "Ascension," he was not allowed to trade without Turkish permission. John Jourdain, the factor on the ship, traveled to San'a', the capital of Yemen, to arrange matters, and returned overland to Mocha. He thus became the first Englishman to travel inland in Yemen. An involuntary English visitor to Mecca and Medina was Joseph Pitts, captured at sea in 1678 as a boy of about 15 or 16; after forcible conversion to Islam he accompanied his master to Mecca, later publishing, on his return to England, a description of the town and an account of his journey. By the end of the 17th century the coasts of Arabia were fairly well known; the Persian Gulf had been examined by ships of the East India Company as well as by Dutch and Portuguese vessels. The Portuguese fort at Hormuz controlled shipping in the Persian Gulf until its capture by the Anglo-Dutch fleet in 1622. J. B. d'Anville's chart of Arabia of 1755 still had some serious mistakes: the Persian Gulf and the Red Sea were too small, and the position of deserts such as the Great Nafud was not shown.

The first scientific expedition to visit Arabia was a Danish one, sent out between 1761 and 1764 for the purpose of biblical and geographical research. The main object was to visit Yemen, once more independent; this region had already been partly explored by Jourdain, Sir Henry Middleton, and the Frenchmen Barbier and De la Grelaudière. The Danish expedition consisted of a doctor, botanist, zoologist, orientalist, and surveyor, but only Carsten Niebuhr (*q.v.*) survived to return to Denmark. Landing at Al Luhayyah on the coast of Yemen, they explored the Tihamah, visiting Ta'izz, San'a', and the mountains. They investigated the coast fairly thoroughly but met with less success and a good deal of suspicion in the mountain regions. At Mocha they got into difficulties and lost some of their equipment. Niebuhr gives a description of San'a', and, though he was unable to draw a ground plan, his account served as useful information for later travelers. His report on Yemen and his information about the recently formed Wahhabi movement provide the first scientific account of Arabian affairs.

3. 19th Century.—*Hejaz and Najd.*—In the 19th century the number of travelers to Arabia greatly increased. Mecca and Medina were frequently visited and described, and the position of the former was accurately ascertained. The first to visit the holy cities in this period was a Spaniard, Domingo Badía y Leblich, who went under the name of 'Ali Bey al-Abbasi and claimed to be a descendant of the Abbasids. He traveled in state with a train of servants and with scientific instruments. Landing at Jidda in 1807, he went to Mecca and fixed the position of that city at latitude 21° 28′ 9″ N, longitude 40° 15′ 0″ E of the meridian of Greenwich. These figures conform closely to the position now recognized. Unfortunately his chronometer was stolen near Mecca. He was turned back from Medina by the Wahhabis but was able to describe the lava formations of western Arabia and the routes to and from Medina and Mecca to the coast. He was able to fix by astronomical observations at least 18 places on the Red Sea. In 1818 he died on his way to Mecca for a second time, traveling overland from Damascus.

'Ali Bey was followed by Ulrich Jaspar Seetzen, a botanist with a European reputation serving at the Russian court. An accomplished Arabist, he nevertheless seems to have aroused a certain amount of suspicion, and although he performed the pilgrimage unharmed he was murdered near Ta'izz in Yemen after extensive travels in that country and in Hejaz. The next Arabian traveler was Johann Ludwig Burckhardt (*q.v.*), who under the name of Ibrahim ibn Abdullah posed as a learned doctor. After perfecting himself in Arabic in Aleppo, he visited all of Syria and later discovered Petra (*q.v.*). In 1814 he disembarked at Jidda and went to Mecca and later Medina. His main interest was in the trade, social life, and religion of the Arabs. His topographical information is somewhat meagre, as he traveled at night and had no instruments save a ship's compass, but his description of the *hajj* and of Mecca has seldom been surpassed. He remained in the country for nine months but was ill for the greater part of the time and died within a few years of his return to Cairo.

Richard Francis Burton (*q.v.*), a British officer on leave from the Indian army, landed in Yanbu' (Yenbo) in 1854 and proceeded to Medina. He followed the inner route, or Darb al Sharqi, to Mecca, a track previously unknown to Europeans. From Mecca he had intended to travel overland to Muscat, thus crossing Arabia; but he found that the journey was not practicable and was obliged to abandon the idea. The last noted European to visit and describe Mecca in the 19th century was the Dutch orientalist Christiaan Snouck Hurgronje (*q.v.*), who spent five months in Jidda and five months in Mecca. He published a detailed account of life in Mecca, of particular value since he stayed there at a period when the *hajj* was not taking place.

Central Arabia was visited by a number of travelers in the 19th century, after the overthrow of the Wahhabi power by Ibrahim Pasha in 1818. The first was Capt. G. F. Sadlier, who was sent in 1819 by the British administration in India to sound Ibrahim Pasha with regard to the suppression of piracy in the Persian Gulf. Starting in June of that year, he reached Al Hufuf (Hofuf) and followed the retiring Ibrahim to Medina, later leaving the country at Yanbu'. Sadlier was the first Englishman to cross Arabia, and as a result of his conscientious observations the distances between many points in central Arabia were established. He was followed in central Arabia by a Finnish Swede, George Augustus Wallin, who, proficient in the language, was disguised as an Arab. In 1845 he reached the Jabal Shammar via the Wadi 'Arabah and the Wadi Sirhan and went on to Al Jawf and Ha'il. Wallin supplied some useful information about the tribes and their localities, although he was equipped only with a compass. He crossed the Great Nafud and later made his way to Mecca and Medina. In 1848 he returned to Ha'il, crossing from the Red Sea coast at Al Muwaylih through virtually unknown country. He died in 1854 before his work really became known.

The next visitor to Ha'il was an Englishman, William Gifford Palgrave, whose intimate knowledge of Arabic led him to write a remarkable account of his journey but whose florid style has led

to doubts as to its authenticity. H. St. J. Philby has disputed his account, but Palgrave had the support of D. G. Hogarth and later R. E. Cheesman. In 1865 Col. Lewis Pelly visited Riyadh to see Faisal ibn Sa'ud, with whom he established friendly relations; but he could do nothing with regard to the suppression of the slave trade and piracy in the Persian Gulf, the real object of his journey. As a result of his sojourn the positions of both Riyadh and Al Hufuf were fixed. Pelly was one of the first to describe the Selaib, a non-Bedouin people about whose origin little is known. Al Jawf was visited in 1851 and 1864 by Carlo Guarmani, an Italian Levantine, who went there to buy Arab horses. His observations were extremely useful to later cartographers, and his maps were published by the Franciscans at Jerusalem. Charles Huber, an Alsatian resident in Syria, also crossed the desert to Al Jawf and Ha'il some years later, in 1878. He returned accompanied by a German archaeologist, Julius Euting, but they were not on good terms and parted after going to Tayma' and purchasing the famous Tayma' stone now in the Louvre. Euting was later attacked by Bedouins but escaped; Huber was less fortunate and was murdered by his guides near Rabigh in July 1884.

In the same year that Huber was at Al Jawf, Wilfrid Scawen Blunt (*q.v.*) and his wife, Lady Anne Blunt, visited Najd accompanied by a young Palmyran sheikh who was searching for a bride among his kinsfolk. His protection enabled the Blunts to travel openly as Europeans and to collect Arabian horses for the establishment of the Crabbet Park stud. They returned to Baghdad via the Persian pilgrim route. Charles Doughty (*q.v.*) traveled down from Damascus to Mada'in Salih to copy the inscriptions. After doing so he went to Tayma', Jabal Shammar, and Ha'il, traveling openly as a Christian. He emerged at Jidda in 1878, having spent 21 months in Arabia. On his return to England he produced a book, *Travels in Arabia Deserta*, regarded by many as the classic of Arabian travel.

The last of the 19th-century travelers to central Arabia was Baron E. Nolde, who crossed the Nafud and visited Ha'il and Ash Shaqra' in 1893, returning via the Persian pilgrim route. Though he contributed little of topographical value, he compiled considerable information on the climate, animal life, and vegetation. Thus it was by the end of the century that the northern part of Arabia had been extensively explored. It is perhaps not chance that the really famous names in Arabian exploration are connected with Hejaz and Najd. 'Ali Bey, Burckhardt, Burton, and Doughty produced books that are classics of exploration and that only those who eventually crossed the Rub' al Khali could emulate.

The Southwest and Southeast.—The southwest and the southeast regions of Arabia were not so extensively explored at an early date. In 1835 the British East India Company dispatched Lieut. James Wellsted to ascertain how far the power of the sultan of Muscat extended inland. He traveled extensively in the interior of Muscat but could not penetrate beyond Obri because of the Wahhabis. Wellsted also pioneered in Hadhramaut, visiting the ruins of Naqb al Hajar and collecting the first Himyaritic inscriptions. He was followed in Oman many years later by Col. S. B. Miles, who crossed the mountains from Suhar to Az Zahirah, visiting Al Buraymi oasis and collecting material for his work on the tribes of the Persian Gulf. In 1843 Adolf von Wrede, a Bavarian from Egypt, entered Hadhramaut disguised as a Muslim pilgrim visiting the tomb of the prophet Hud. He was recognized and never reached his destination but was returned to Al Mukalla with the loss of his notes and baggage. Wrede's information, communicated to the Royal Geographical Society by Captain Haines of H.M.S. "Palinurus," was the earliest account received of the fertile Hadhramaut valleys. He failed to climb the main valley, but this was made up for by the explorations of Leo Hirsch and Theodore Bent, who made a useful survey of this area.

After Niebuhr, there were no travelers of note to the southwest for a long time. Then came Louis Arnaud, who penetrated Yemen from Jidda and went to Ma'rib, where he studied the inscriptions and the dam. Twenty years later he was followed by Joseph Halévy, a French Jew from Edirne (Adrianople), sent out by the Académie des Inscriptions et Belles-Lettres. He visited the ruins of Ma'in and Khirbet al Bayda' (Roman Nesca), where the Romans under Aelius Gallus defeated the Sabaeans in 24 B.C. Halévy copied more than 600 inscriptions and made various contacts with the Jewish colonies in Yemen at Najran and elsewhere. Éduard Glaser, an Austrian archaeologist, also visited this region in 1889 and collected inscriptions from Ma'rib and other parts of the country. His copies numbered more than 1,000, and these two collections formed the basis of the *corpus* of south Arabian inscriptions. Travel in the interior of Yemen continued to be difficult, but accounts of San'a' and other cities in the interior began to appear toward the end of the century from such authors as R. Manzoni and W. B. Harris.

4. 20th Century.—The north Arabian deserts became well known as the result of the work in the first two decades of explorers such as Gertrude Bell (*q.v.*), Alois Musil, Lieut. Col. G. E. Leachman, W. H. I. Shakespear, Douglas Carruthers, H. St. John Philby, and Maj. A. L. Holt. Their interests were varied, including botany, archaeology, surveying, hunting, and politics, but they all added their quota to the increasing knowledge of this area. Shakespear was killed in 1915 in a battle between Ibn Saud and Ibn Rashid, but it was largely because of his careful cartography that maps of the central and eastern portion of Arabia could be compiled. His work on the east was continued by H. R. P. Dickson, working from Kuwait, who also collated and published some useful information about the tribal customs in this region. In Al Hasa Maj. R. E. Cheesman mapped the region and made an important botanical survey.

The Rub' al Khali.—The major interest of 20th-century exploration in Arabia was focused, however, on the crossing of the Rub' al Khali. This was accomplished by three men, independently of each other: Bertram Thomas in 1930–31, Philby in 1932–33, and W. P. Thesiger in 1948–50. Thomas crossed from Zufar in the south to Qatar on the Persian Gulf. His expedition was not just a dash across the sands at their narrowest point but was carefully prepared. He collected valuable geological, anthropological, and botanical information in the course of his journey. Thomas, an accomplished Arabist, was vizier to the sultan of Muscat. He traveled in Arab clothing but was not disguised. He discovered that only part of this great desert was uninhabitable, as the southern sands at Dakkah are occupied by the Rashidi tribes. He was fortunate in that his crossing was helped by local rain, which supplied fodder for his camels. As a result of his journey he was able to write one of the best works on Arabian exploration, *Arabia Felix*.

Philby, who had been living in Saudi Arabia for some time, had been planning the same journey, but from east to west. He crossed the northern Empty Quarter from Al Hufuf but was unable to penetrate to Zufar for lack of a *rabia* (surety). He also collected information of interest to geologists and natural historians. First a political officer with the Mesopotamian Expeditionary Force, Philby later resigned from government service and settled in Mecca, having become a Muslim. With the aid of Ibn Saud he made a series of journeys throughout central and western Arabia, and as a result of his work it became clear that there was no chain of oases linking Najd with either 'Asir or Yemen, or between Najd, Oman, and Hadhramaut. One of the most interesting facts he recorded was the presence of a permanent lake at Umm al Jibal, south of Layla, and he also noted the existence of water tanks and supplies at Aflaj and Al Kharj.

The last traveler to cross the Empty Quarter was Thesiger, who had already made long journeys in Arabia on behalf of the Locust Control. Starting from Zufar, he crossed to the eastern section of Oman and later retraced his steps to the south. All these three travelers suffered from the unsettled conditions rife throughout this territory, where raiding was a constant threat. With Thesiger's journey ended the last great phase in Arabian exploration.

The South and Southwest.—The rich valleys of the south and southwest also received a number of explorers in the 20th century. Yemen still remained for the most part inaccessible, although A. J. Wavell, Col. H. F. Jacob, and G. Wyman Bury all visited the country before 1914. Bury lived there for many years and did much exploratory work on behalf of the Royal Geographical Society. In 1937 a visit was paid to the Yemen mountains by Hugh Scott

BY COURTESY OF (RIGHT) STANDARD OIL CO. (N.J.), PHOTOGRAPH, (LEFT) CAMERA PRESS-PIX FROM PUBLIX

AGRICULTURE IN ARABIA. (LEFT) EXPERIMENTAL FARMS IN KUWAIT GROW VEGETABLES AND CITRUS FRUITS. (RIGHT) BREAKING GROUND WITH PRIMITIVE TOOLS IN SAUDI ARABIA

to make a collection on behalf of the British Natural History Museum. During 1950–52 the American Foundation for the Study of Man conducted archaeological work in Yemen at Ma'rib and elsewhere and also in Hadhramaut.

Hadhramaut was explored, mapped, and described by a number of modern travelers, including O. H. Little, Freya Stark, Harold Ingrams, H. von Wissmann, and D. van der Meulen. The last of these was a Dutch official who was attracted to Hadhramaut through his contacts with emigrants from Arabia in the Dutch East Indies. He undertook a number of journeys in Hadhramaut, of which he left interesting accounts, and eventually was appointed Netherlands minister in Jidda.

Mecca and Medina.—The 20th century has seen further visits to Mecca on the part of Europeans, such as that paid by A. J. Wavell before World War I. He left an excellent account of Medina and Mecca and later visited San'a' in 1911. In 1925 Eldon Rutter, who had learned Arabic in the Malay States, went to Hejaz. He approached from the south, from Al Gaham on the coast to 'Asir, and spent a year traveling in and about the country at the time the Wahhabis were reestablishing their power. In addition to Rutter's account of his experiences, there have appeared a number of books by Muslims of European origin who made the pilgrimage in the middle of the century.

Later Developments.—With the consolidation of Ibn Saud's power in Saudi Arabia after World War I, conditions in this region became increasingly stable; and after World War II there was an influx of foreign technicians, geologists, agricultural experts, entomologists, and economists. The Arabian American Oil Company (Aramco) has explored and surveyed extensively in eastern and southeastern Arabia, particularly in Al Hasa province. An American mining engineer, K. S. Twitchell, sent to Saudi Arabia in 1942 on behalf of the U.S. government agricultural mission, conducted investigations into the natural resources of the area, not only in Hejaz and Najd but in Al Hasa, 'Asir, and Yemen. Such ventures marked a new development in the history of Arabian exploration.

With the advent of the airplane and motor car to Arabia the old days of nonremunerative exploration were over; but the discovery of Arabia had been the work of men who ventured alone with no resources behind them, pitting wits and endurance against an often merciless environment.

V. ARCHAEOLOGY

No adequate archaeological survey of the Arabian Peninsula has been undertaken, and the rather scanty information available depends to a large extent upon the interest and knowledge of travelers, agricultural experts, oil men, and officers of the Locust Control. The difficulties of archaeological work in this region are great, and the problems relating to the pre-Islamic period do not interest the local rulers, who are on the whole reluctant to issue permits. Only in the south and on the eastern coast has some intensive exploration and excavation been undertaken.

It is evident that Arabia was the home of Paleolithic hunters. Flint tools of Acheulean type, including hand axes, have been found at Ad Dawadimi in central Arabia. Other Paleolithic-type tools were discovered in Al Hasa and Hadhramaut. Travelers crossing the Rub' al Khali have reported the presence of flint tools of Neolithic or Bronze Age types.

1. North Arabia.—Archaeologically, Arabia may be divided into the northern region and the southern, the north having settlements only in the oases; while the south and southwest are habitable over a wider area. No archaeological work has been done in the north except in the coastal areas of Al Hasa province near the Persian Gulf. Work in this region was linked to that on Bahrain Island, where burial mounds have been found and investigated at intervals since 1879. These are extremely difficult to date because of the lack of related material. Cairnlike mounds (tumuli), consisting of loosely piled stones over a crude oblong cist burial, also occur on the mainland. Mounds of this nature have been reported from all over Arabia, varying in size from 6 to 20 ft. (2–6 m.) in height and from 10 to 60 ft. (3–18 m.) in diameter, but only a few have been investigated.

At Jawan, where a pre-Islamic and Islamic cemetery of this type was cleared, the earliest graves have been dated to between the 6th and 4th centuries B.C. Investigation of other mounds would probably indicate that they range in date from prehistoric times to the present day, as nomadic burial customs are very similar. Such mounds are usually found in areas where there are wells or subterranean water. They should not be confused with the stone circles which have also been reported from the Red Sea side of Arabia. These were probably refuges for herding animals in times of danger and are well known from farther north in the Arabian desert. Tumuli were not the only mode of burial in Arabia; in the northwest at Mada'in Salih and Al 'Ula, rock-cut tombs of Himyaritic and Nabataean date have been found. These may be as large as 18 ft. square, cut in the soft limestone, and decorated with facades strongly marked by classical influence.

Inscriptions have been found in north Arabia, consisting mainly of graffiti, cut or scratched by nomads. There are three groups of these—Thamudenic, Lihyanic, and Safahitic—and they are usually dated from between the 1st and 2nd centuries B.C. down to about the 4th century A.D.

Ruins of ancient cities have been reported from various parts of the Arabian plateau, but on examination certain of these have turned out to be natural rock, usually of volcanic origin. There is, however, a large ruin at Daht al Oukdud in the Najran Valley, covering an area of about 20 ac. (8 ha.) and containing numerous Himyaritic inscriptions. Rectangular temples are known from Sirwah, Ma'in, Riyan, and Medinat Haram.

2. South Arabia.—The material from south Arabia consists mainly of sculpture, frequently in alabaster. Some of these pieces show classical influence, others Phoenician. Bronzeworking was a south Arabian specialty and a large number of bronze figures must have existed in the temples, although only a few examples are now remaining. The lion riders from Timnah show a marked technical excellence. Coins, minted by the Qataban kings, follow Hellenistic models. An examination of the irrigation works at Bayhan (Beihan) and Wadi 'Amd has shown some of the most remarkable of the south Arabian achievements, consisting of a series of tanks and drainage channels used in former times for the

cultivation of incense trees and spices. Over a large portion of the area *qanats*, or underground water systems, thought to have been derived from Persia, were found. The tradition of fine stone-working begun by the early south Arabian architects can still be seen in the modern towns of Yemen and Hadhramaut.

The most important part in pre-Islamic Arabian history was played by the kingdoms of south Arabia, Ma'in, Saba (Sheba), Qataban, and Himyar (*see* below). Because of the lack of stratified deposits and controlled excavation in these regions, the chronological order of the rulers of these kingdoms has not been finally settled. They owed their prosperity to the incense trade, an important commodity supplied to both Mesopotamia and Egypt and later to Greece and Rome. There is archaeological evidence in Ethiopia to indicate an influx of population from south Arabia before the classical period.

Since Carsten Niebuhr first drew attention to the south Arabian inscriptions in 1772, these have been of the greatest interest alike to the philologist and the archaeologist. But circumstances have made it easier in this area to excavate temples rather than town sites, and as a result the areas dug have not supplied sufficient stratigraphical information. In 1928 C. Rathjens and H. von Wissmann excavated a temple dedicated to a sun-god called Dhat Badan at Hugga in Yemen, and dated it to between 100 B.C. and A.D. 300. In 1937–38 Miss G. Caton Thompson excavated a temple at Al Huraydah in Hadhramaut, dedicated to the moon-god Sin and used between the 6th and 3rd centuries B.C. In 1950–52 the American Foundation for the Study of Man carried out work in Wadi Bayhan in Hadhramaut, at Timnah, the capital of Qataban, and at Ma'rib, the capital of Saba. The Bayhan and Ma'rib excavations were important as serving as a cross check upon one another. At Ma'rib the temple dedicated to the moon-god was only partially cleared, but it appears to have been built in the 8th century B.C. It was a large oval building, 984 ft. (300 m.) in circumference, with an imposing entrance court surrounded by inscribed stones. To the east was a mausoleum contemporary with the temple. In this region, as in other parts of the ancient world, tombs were grouped around important sanctuaries. The end of this site may be dated to the bursting of the Ma'rib dam in the mid-6th century A.D.

The most difficult task in south Arabia has been the deciphering of the inscriptions and the dating of the respective dynasties and establishment of their interrelationship. These kingdoms were almost continually at war with one another, and written evidence for their activities comes, as is so often the case, from classical authors without direct knowledge of the problems concerned or writing later than the events chronicled. There are two schools of thought as to the dating of these dynasties: one, represented by É. Glaser and F. Hommel, advocates a date in the 2nd millennium B.C., while the other, represented by F. V. Winnett, D. H. Muller, W. F. Albright, and A. Jamme, would place Saba at the beginning of the 8th century B.C. and Ma'in in the 5th century. Jamme and Albright suggest that Qataban began at least in the 9th century B.C. because of the date of the graffiti found by the expedition at Timnah. Qataban appears to have come to an end somewhere between 125 and 75 B.C.

The south Arabian inscriptions appear to be of west Semitic origin and number many thousands. They consist chiefly of dedications, building inscriptions, and invocations, but many are as yet unpublished. The first copies reached England in 1837 as a result of the work of Lieut. J. R. Wellsted, but the majority were collected by J. Halévy and É. Glaser between 1869 and 1894. The south Arabian script was deciphered by E. Rödiger and W. Gesenius. (M. V. S.-W.)

VI. HISTORY

A. Pre-Islamic Arabia

Before the rise of Islam (and to some extent after as well) the term "Arab" meant preeminently the Bedouin nomads who inhabited the desert tracts which form the core of the peninsula, with a tongue stretching northward into what is now the Syrian Desert between Damascus and the Euphrates Valley; the term did not apply to the settled populations of the southwest or to those of the townships and oases along the west coast. The historical significance of the Bedouins lay chiefly in the raids they were constantly making on the settled folk around the fringes of the desert. It is this recurrent pattern of incursions from the desert into the sown that led L. Caetani and others to formulate the hypothesis that Arabia was the original home of the Semites and that the village and urban populations of Semitic culture in the Fertile Crescent (the lands of the eastern Mediterranean littoral and the Euphrates Valley) represent an overspill of desert nomads who had become settled. With some modifications, this hypothesis was also advanced by S. Moscati (*Chi furono gli Semiti?*, 1957), who, however, emphasizes that in this context "original" means only as far back as present data make it possible to trace ethnological features and that the settlers have become closely intermingled with other strains. A subsidiary hypothesis—that central Arabia was formerly more fertile than it is now and that it was the process of desiccation which forced the current of emigration outward into the surrounding lands—is, as Moscati allows, hardly tenable. It is true that the configuration of the peninsula shows that at one time considerably more water flowed there than ever does now. But such a time was almost certainly in a remote past, and within historical times it is improbable that there has been any significant climatic change. To this and related problems of Arabian prehistory, however, no final answer will be possible until the archaeological exploration of the peninsula, still in its infancy, has progressed much further.

1. Early Civilization in the South.—More than a millennium before the rise of Islam there flourished in the mountainous southwestern corner of the peninsula a native civilization of a high order, which has left as its evidences the ruins of massive buildings and extensive irrigation works and, above all, a wealth of inscriptions in a language which forms a separate branch of the Semitic linguistic family (distinct from Arabic) and was written with its own alphabet. This culture had trade links across the Indian Ocean, though it is altogether uncertain when these began; it had close links with the part of Africa lying immediately opposite, although the civilization of this latter area seems, from what little is known of its earliest phases, to be an offshoot of south Arabian culture rather than an independent phenomenon; and there are sporadic traces of contacts with Egypt. But the civilization with which the south Arabian culture had by far the most marked affinities is that of the Semitic populations of the northern Fertile Crescent, to such an extent that a common origin seems certain. A few odd features inexplicable on a Semitic basis could be regarded as relics of a pre-Semitic past, if the hypothesis of C. S. Coon were accepted—that the shores of the Indian Ocean were once inhabited by a race which was pushed back by invasions from the north into a few remote pockets, represented by the Veddas of Ceylon and the cow-raising peoples of the Mahrah country of southern Arabia, who are noticeably different from the peoples of the rest of the peninsula with their marked affinity to the northern Semites. Viewed overall, the south Arabian culture is unmistakably Semitic. Nevertheless, in certain limited aspects of life, Greek influence made itself felt. Coinage, for instance, first introduced into southern Arabia in about the 4th century B.C., is from first to last modeled on Greek prototypes; and from at least the 1st century B.C., the plastic art of southern Arabia is strongly subjected to Hellenistic influences.

In spite of a considerable mass of epigraphic texts, scholars are severely handicapped in arranging and interpreting this material by the almost total lack of cross checks in the form of references to Arabian events in the literature of the ancient world outside Arabia. The Greek geographers possessed some data about the peninsula, gathered largely no doubt from the traders from both northern and southern Arabia who made their appearance in the markets of the Mediterranean world. But of the march of events in Arabia the outside world seems to have known virtually nothing until the 6th century A.D. As a result, a controversy exists over the problems of the internal chronology of the Arabian epigraphic sources. Only on one occasion in recorded history did the Mediterranean world attempt to take a direct hand in ancient southern Arabia, with the Roman expedition in 25–24 B.C. under Aelius

Gallus, which perished miserably on the threshold of the south Arabian culture area; yet even in this case it has proved impossible to trace in the south Arabian inscriptions any absolutely certain allusion to this expedition and thereby obtain a cross reference as a basis for the internal chronology of the inscriptions.

2. The South Arabian Kingdoms.—The Greek geographer Eratosthenes (3rd–2nd century B.C.) tells of a fourfold political division of southern Arabia between Minaeans, Sabaeans, Qatabanians, and Hadhramautites. This is confirmed by the inscriptions, which attest four principal kingdoms, each with its own dialect, corresponding to those of Eratosthenes.

The Minaean kingdom had its centre in the lower Wadi al Jawf at Qarnau (now called Ma'in, in northern Yemen). According to a view of which the main proponent was F. Hommel, the whole period of the Minaean kingdom antedated the 6th century B.C., and its beginnings stretched back to around 1200 B.C. Hommel's views have been widely copied in books by nonspecialists, but research since 1937 has conclusively invalidated them and showed that the flourishing period of the Minaean kingdom, insofar as it is attested by the inscriptions, was approximately the 4th to 2nd centuries B.C. It is therefore the period of the early Sabaean inscriptions which constitutes the beginning of written records of south Arabian culture. This has been variously dated to around the 8th or to the 5th century B.C.; in either case there must have been several centuries of evolution preceding the written records, since these present a picture of an already fully developed civilization.

The Minaeans were never a territorial power of great significance. They appear rather to have been a community of traders, as was the population of Mecca in the 6th century A.D. Nearly the whole body of Minaean inscriptional material comes from a narrowly limited range of sites: Qarnau and Yathil (now Beraqish), both close together in the lower Wadi al Jawf, south of Najran; and Dedan (now Al 'Ula in northern Hejaz), where the Minaeans had a colony. The actual territorial area under their sovereignty seems to have been small.

For the kingdom of the Sabaeans, with its capital (at least in the earlier period) at Ma'rib (in eastern Yemen), *see* SABAEANS.

Qataban was centred in Bayhan or Beihan and the adjoining areas. The kingdom flourished from approximately the 5th century B.C. (perhaps somewhat earlier) to the turn of the era. Its capital, Timnah, was destroyed shortly before or shortly after the beginning of the Christian era, and the political fate of the former Qatabanian dominion thereafter is obscure. One text of probably the 1st century A.D. suggests that the Wadi Bayhan was then under the suzerainty of Hadhramaut, but in texts of the following centuries from this area a strong Sabaean dialectal influence is perceptible and it is likely that Saba (Sheba) absorbed it sooner or later in the first Christian centuries.

Hadhramaut had its capital at Shabwah, near the head of Wadi Hadhramaut, and its area spread between there and the sea. It maintained its political independence down to the end of the 3rd century A.D. but was then absorbed by Saba. It is uncertain whether the Ethiopian domination of southern Arabia, which lasted for some decades in the middle of the 4th century A.D., included Hadhramaut, or whether the latter during this interlude regained its independence; but by the end of the 4th century the restored Sabaean kingdom again included Hadhramaut.

A fifth power which made its appearance on the south Arabian political scene about the beginning of the Christian era was that of the tribe of Himyar. The first mention of this tribe, whose original habitat was on the coast rather west of Al Mukalla, shows them in conflict with the kingdom of Hadhramaut in the 3rd or 2nd century B.C. But a Greek source of the 1st century A.D. states that at that time there was a sort of dual monarchy of Saba and Himyar, with the royal residence located at Zufar in the southern Yemeni highlands instead of at the old Sabaean capital of Ma'rib. Himyar figures in the Greek accounts as the "Homerites." In succeeding centuries Himyar seems to have become the dominant element in south Arabian affairs, for the Christian Greek authors commonly refer to the people of southern Arabia as a whole as Homerites and the Islamic authors apply the term Himyarite to all pre-Islamic south Arabian antiquities. Yet the tribal name Himyar never appears in the official title of south Arabian monarchs; "king of Saba" was to the last the first element of the title, to which was added in the early centuries A.D. "and of the Raidan territory," and from the end of the 3rd century (apart from the 4th-century episode of Ethiopian domination) the further addition "and of Hadhramaut and Yemen."

Viewed overall, the pre-Islamic history of southern Arabia is thus one of Sabaean expansion. The kingdom of Saba began by absorbing several petty kingdoms in the near vicinity of Ma'rib, and then gradually over the centuries absorbed the territories of the rival kingdoms of Ma'in, Qataban, and Hadhramaut. By the 5th–6th centuries A.D. the ancient kingdoms and political boundaries had vanished, and the entire south Arabian culture area was under a unified political control which (whatever the actual position of Himyar in it may have been) saw itself as the historical successor to the ancient Sabaean kingdom. Moreover, the earlier isolation of the area now began to break up, and southern Arabia more and more tended to play a part in the political affairs of northern Arabia and the Mediterranean world.

3. The Kingdoms of Central and Northern Arabia.—Information about this area in the early period, down to about the 2nd century B.C., is extremely scanty. It is clear that such culture as it possessed was vastly inferior to that of southern Arabia on the one side and the Fertile Crescent on the other. Throughout the middle part of the 1st millennium B.C. it seems to have been merely a "buffer area" between those two cultures and subject to influences from both. But it is noteworthy that all the pre-Islamic inscriptions of the peninsula (apart from the extreme northwestern sector) are in scripts closely akin to the south Arabian alphabet rather than to the Aramaic types of script prevalent in the Fertile Crescent which are the ancestors of the ordinary Arabic script of today.

In the late 8th century B.C. Assyrian records mention certain "queens of the Aribi," the Aribi being obviously nomad Bedouin confederations of northen Arabia; but these have left no certainly identifiable written records of their own. The oasis of Tayma' emerged briefly into the limelight of history when the neo-Babylonian monarch Nabonidus (*q.v.*) made his residence there for part of his reign.

Perhaps round the 2nd century B.C. a kingdom of Dedan (Al 'Ula; *see* above) had an ephemeral existence, to be succeeded by a kingdom of Lihyan which maintained a governor in Dedan and may have been centred somewhere in the same area; this seems to have flourished in the centuries immediately preceding and following the Christian era. About the same time there also flourished the Nabataean kingdom centred in Petra (southern Jordan; *see* NABATAEANS); but the latter belongs rather to the orbit of the Mediterranean world, for its inscriptions are Aramaic in language and script, in spite of the fact that the majority of the population probably spoke a dialect akin to Arabic. The same remark applies to the Palmyrene kingdom in the 3rd century A.D., whose most famous monarch was Queen Zenobia (*q.v.*).

In northwestern Arabia, after the disappearance of the Nabataean kingdom, a certain Imru' al-Qays, son of 'Amr, who died in A.D. 328, claimed the title of "king over all the Arabs" (*i.e.*, Bedouins). Although he campaigned as far south as Najran, the actually effective extent of his dominance is altogether uncertain.

Somewhere around the middle of the 4th century A.D. a section of the tribe of Kinda emigrated from southern Arabia and settled in central Arabia southeast of Mecca under the rule of a succession of petty kings. In the latter half of the 5th century the kings of Kinda established a hegemony over most of central Arabia. At the same time they maintained their ancestral connection with southern Arabia, and the kingdom was always within the political orbit of the south. The Kinda hegemony broke up early in the 6th century as the result of a disastrous war with Hira, and the remnants of the tribe returned to southern Arabia.

The kingdom of Hira (*q.v.*), in northeastern Arabia, flourished under the Lakhmid dynasty, from the end of the 3rd to the end of the 6th century A.D., and normally aligned itself with Sasanian Persia. A counterpoise to Hira in the northwest was furnished by the kingdom of Ghassan (east of the Jordan River), under rulers

of the house of Jafna, which allied itself with Byzantium; but the history of this kingdom belongs rather to the 6th century.

4. 6th Century A.D.—Early in this century the Arabian Peninsula emerged from its isolation and began to take a part in world affairs. Ghassan and Hira played an important role in the strategy of the intermittent wars between Byzantium and the Sasanian empire.

Southern Arabia, by the end of the 4th century A.D., had abandoned its ancient polytheism in favour of a monotheistic cult of a supreme deity under the name of Rahman, "the merciful." The exact nature of this cult is uncertain; specifically recognizable Jewish and Christian formularies do not appear in the texts until the 6th century. Early in the 3rd decade of that century, however, the south Arabian king, who is said to have professed Judaism, pursued a policy of persecution of the Christians in his dominions, culminating in a massacre of them at Najran (Nagran). This caused a profound shock throughout the Christian world and has left a large martyrological literature in Greek, Syriac, and Ethiopic. Byzantium seized this as an excuse to incite the Christian king of Aksum in Ethiopia to invade southern Arabia; the Greek historian Procopius alleges that the real motive behind this was to draw southern Arabia into the Byzantine political orbit and thereby secure access to the markets of India over a route bypassing the trade channels running through Sasanian dominions. The invasion was successful, the persecutor killed, and a Christian puppet ruler, subject to Aksum, set up. But his reign lasted only a few years, after which he was dethroned by a native rising which placed on the throne Abraha (or Abreha; also a Christian, but possibly of Nestorian tendencies in opposition to the Monophysite doctrine prevalent in Ethiopia), whose long and successful reign was the last flowering of the millennium-old south Arabian sovereignty. By cautious diplomacy, Abraha seems to have early shaken off allegiance to Aksum and maintained southern Arabia in a precarious independence between the powers of Byzantium, Ethiopia, and Iran. He also made military expeditions deep into the heart of central Arabia, bringing him up to the frontiers of Hira, and executed repairs on a vast scale to the great irrigation installations of Ma'rib. But a few years after his death (perhaps around A.D. 570) his kingdom collapsed and southern Arabia was subjected to Iranian occupation for some years; it never regained a unified independence.

The closing years of the century also saw the fragmentation of the kingdom of Ghassan and the decline of the power of Hira. At the opening of the 7th century Arabia was a mass of petty autonomies with no unifying focus. (A. F. L. B.)

B. Muslim Arabia, to the Rise of the Wahhabis

1. The Rise of Islam.—The history of Arabia after the advent of Mohammed (*q.v.*) and the spread of his teaching (*see* Islam) at first followed much the same general lines as in the days of the *Jahiliyah* ("ignorance"). The tribal structure of Arab society remained unchanged and continued to prescribe its horizon and limit its loyalty. The restraints of a central authority emanating from a capital, near or remote, were quite contrary to the Arab way of life and were accepted only under compulsion. The Prophet was well aware of this characteristic of the Bedouins, and the Koran described them as "the worst in unbelief and hypocrisy" (9:97). However, by the ninth year of the Hegira (*q.v.*), Mohammed was able to exact from the majority of the tribes nominal adherence to Islam and, what was more important, payment of the *zakat* tax, with its implication of submission to the rising hegemony of Medina. On his death (A.D. 632), many of those tribes, as well as those which never had acquiesced in Islamic power, seized the opportunity to reassert their independence and the former stopped payment of the *zakat*. In Yemen and Hadhramaut in the south, in Oman and Bahrain in the east, in Al Yamamah (Al Kharj; *q.v.*) and Kinda in central Arabia, and even in Hejaz itself, dissident tribes rose in revolt. At least four rival prophets appeared, but Abu Bakr (*q.v.*), the first caliph (632–634), proved equal to this first important crisis in the life of the new faith since the founder's death. His reign was mostly occupied with *ridda* ("secession," "apostasy") wars, waged not only to bring secessionists back within the fold of Islam but also to win over many who had previously been outside the faith. The brilliant generalship of Khalid ibn al-Walid, backed by the energetic determination of the caliph, ensured complete victory. Arabia was united in a common fraternity; administratively it was divided into ten provinces, each headed by a provincial governor directly responsible to the caliph himself. (*See* further Caliphate.)

The warlike spirit of the tribes, now unable to find expression in intertribal raids, had to be channeled into new outlets outside the peninsula. This step, in all likelihood contemplated by the Prophet, became Abu Bakr's next objective. He therefore dispatched three detachments of about 3,000 men each to start operations in southern and southeastern Syria. But he died (A.D. 634) before he could witness the results of this fateful adventure.

The conquests Abu Bakr started were carried forward by his successor Omar I (*q.v.*; 'Umar), during whose reign (634–644) Arab arms wrested Egypt and Syria from the Byzantine emperor, destroyed the Sasanian empire, and annexed Iraq and Persia to the fast-growing Arab domains. A year before Omar's death in 644, his armies were at the border of India.

Meanwhile, Omar strengthened the hold of the central administration over the peninsula and initiated a policy of making it an all-Muslim country. Non-Muslim communities, however, survived in different areas for several centuries. Omar also addressed himself to the problem of administering the vast territories acquired by conquest. His "reforms" emphasized Arabism, according Arabs a privileged position in the empire, but secured for non-Arab Muslims a status superior to that of non-Muslims. Omar's extreme Arabism may have been partly responsible for his assassination by a disgruntled neo-Muslim.

With his successor, Othman (*q.v.*; 'Uthman), who reigned from 644 to 656, the old Meccan aristocracy, whose predatory predilections were held in check by the strong hand of Omar, was able to reassert itself. Furthermore, the conquests, which absorbed the energies of the tribes and well-nigh exhausted their manpower, came to a temporary standstill. The return to near normality in the peninsula helped to focus attention on internal affairs. Tribal jealousy of the privileged position of the Quraysh (the clan of the Prophet), Arab deep-seated dislike of governmental authority, dissatisfaction in the occupied territories against the growing control of Medina, and rivalries among leading members of the Quraysh combined to precipitate civil war which led to the assassination in 656 of Othman, whose greatest achievement had been the codification of the Koran. The unity of the peninsula, achieved by the first caliph and strengthened by the second, thus came to an abrupt end under the third.

The rift among the aspirants to the caliphal throne widened with the election of 'Ali (*q.v.*), Mohammed's first cousin and son-in-law, who reigned from 656 to 661. Mohammed's widow, 'A'isha, and two of his companions, Talha and al-Zubayr, refused to swear allegiance to the new caliph and rose in rebellion. 'Ali defeated the rebels at the "battle of the camel" and won Iraq, where he established his capital. This marked the beginning of the final recession of Arabia to a secondary position in the Islamic empire. Stubborn resistance, however, came from Damascus, where the provincial governor, Mu'awiya, raised the flag of rebellion, accusing 'Ali of complicity in the murder of Othman. Because of his inability to hold the support of his followers for his policies, 'Ali was never able to follow up his initial successes against Mu'awiya, and after the Battle of Siffin (657) he allowed himself to be tricked by the ruse of the arbitration. His assassination in 661 made Mu'awiya's military and political victory complete and ushered in Omayyad rule of the peninsula from the new capital, Damascus.

2. The Omayyad Dynasty.—The new caliph had no difficulty in securing the abdication of 'Ali's eldest son, Hasan, whom the 'Alids set up as caliph in Kufa, or in reuniting the peninsula, which became simply a province in his vast empire. At the death of Mu'awiya I (680) and the accession of his son Yazid I, however, trouble broke out again. 'Ali's second son, Husain, embarked on an ill-advised adventure against the Omayyads; the little support he was able to muster in Kufa soon vanished, and he met his death

in the same year at Karbala, bequeathing to the Shi'ites an enduring battle cry and to the community of Islam its greatest schism (*see* HASAN AND HUSAIN). It was, however, at Yazid's death that Omayyad (Umayyad) power in Arabia received its gravest challenge, when, for nine years (683–692), 'Abdullah ibn al-Zubayr held the title and power of caliph and received the allegiance of nearly every quarter of Islam.

Both the Omayyads and Ibn al-Zubayr had to contend with the turbulent Kharijite sect (*see* KHARIJITES), which, under Najdah ibn 'Amir of the Banu-Hanifa, threatened to dominate a large part of the peninsula until Ibn 'Amir was overthrown by another Kharijite, Abu Fudayk. During the reign of 'Abd al-Malik (685–705), an Omayyad army under al-Hajjaj crushed Ibn al-Zubayr and another army destroyed Kharijite power in eastern Arabia. Thereafter, until the last years of the dynasty, Omayyad authority in Arabia was unchallenged. The rivalry of the Qays (Kais) (north Arabian) and Yemeni (south Arabian) tribes, however, continued to be felt. This had plagued Omayyad rule since the times of Mu'awiya I, who had leaned heavily on Yemen. The struggle between the two factions flared up again at the death of Mu'awiya II, but Marwan I succeeded in defeating the Qays at the battle of Marj Rahit (684). Enmity between the two groups continued, largely contributing to the fall of the dynasty in 750.

3. The Abbasid Dynasty.—With the coming of the Abbasids, stubborn remnants of the Kharijites known as the Ibadiya established their own imamate in Oman under al-Julanda ibn Mas'ud. Though crushed by Abbasid arms in 752, they were able to revive their imamate in this remote part of the peninsula, whence they spread to Zanzibar and even to North Africa. Trouble broke out also in Medina, where the 'Alids, who thought that the overthrow of the Omayyads presaged an 'Alid restoration, refused to submit to their Abbasid cousins. The precautionary steps taken by the Abbasid governor of Medina precipitated, late in 762, an 'Alid rebellion on behalf of the Hasanid pretender, Mohammed al-Nafs al-Zakiyah. The caliph al-Mansur had no difficulty in crushing the movement but treated the city of the Prophet itself gently. In fact the Abbasids made a point of favouring the two holy cities of Islam to gain popular acclaim among the faithful. Another Hasanid rebellion flared up during the reign of al-Hadi, but was easily put down in 786 at Fakhkh, near Mecca.

'Alid discontent continued to plague the Abbasids. One pretender followed another but their only success was in Yemen. In the early 9th century the struggle for the caliphate between al-Amin and al-Ma'mun favoured such adventures. Al-Ma'mun attempted to appease 'Alid sentiment by designating an 'Alid as his successor and substituted the 'Alid green for the Abbasid black as the royal colours, but with the death of his 'Alid candidate in 818 he withdrew his support. He then tried to deal with the situation by force. Mohammed, his able viceroy in Yemen, defeated the 'Alid rulers there but soon established his own Ziyadid dynasty (820) at Zabid, according the caliph only nominal allegiance. Abbasid attempts to control the peninsula were successful under al-Wathik (842–847), but the situation deteriorated under his successor, al-Mutawakkil (847–861). Toward the end of his reign, the Ya'furids established themselves in San'a' (861). Later the Banu-al-Ukhaydir seized Al Yamamah (*c.* 864) and the Zaidite Rassids seized Sada (*c.* 894). A more serious danger to the empire arose when a certain 'Ali ibn Mohammed who claimed 'Alid descent stirred up the Negro (Zanj) labourers in the salt marshes of southern Iraq in a rebellion (869–883) which spread as far as the two holy cities before it was finally suppressed.

While the central authorities were occupied with the Zanj rebellion, other 'Alids were active in other parts of the peninsula. Isma'ilism found a fertile soil in southern Arabia, where toward the end of the 9th and beginning of the 10th century the chief propagandist (*da'i*) of the Fatimids, Abu 'Abdullah al-Husain al-Shi'i, made his appearance (*see* ISMA'ILISM; FATIMIDS). His missionary labours during the pilgrimage among members of the Kitama Berber tribes ensured support in North Africa for the Fatimids. More serious, however, was the danger in eastern Arabia where, under Abu Sa'id al-Jannabi (fl. *c.* 900) and his son Abu Tahir Sulayman (914–944), the Isma'ilite Karmatians were able to organize a state which for many years was a cause of severe disturbance to the caliphate. Under Ibn Zikrawayh they had already, in 900, moved against Syria, defeated the Tulunids, and laid siege to Damascus. The Abbasids restored their authority over Syria, but the Karmatians in eastern Arabia proved more difficult to suppress. In 930 Sulayman occupied Mecca and carried the sacred Black Stone (*see* KA'BA) off to his capital, Hajar. It was not restored till 20 years later at the behest of the Fatimid ruler al-Mansur, with whom the Karmatians were allied against Baghdad. When the Fatimids occupied Egypt (969), the Karmatians switched to the support of the Buyids. Gradually the Karmatians were forced back to Al Hasa, and their designs on Baghdad were checked by the Buyids.

As the Buyids (*q.v.*) with their Shi'ite leanings reduced the power of the caliphate and Fatimid influence increased, the power of the Abbasid dynasty began to disintegrate, especially in the outlying districts of the empire. In the peninsula the tribal spirit, which had been temporarily checked by Islam, was reasserting itself, and human resources, which had been drained by the conquests and civil wars, were regaining their strength and restiveness. In spite of the arrival of the Seljuks in Baghdad (1055), which gave the empire a new lease on life, petty dynasts continued to appear in different parts of Arabia. (*See* also ABBASIDS.)

4. Minor Dynasties.—In the 11th and 12th centuries the Shi'ite Sulayhids in San'a' were supplanted by the Hamdanids; the Najahids in Zabid gave way to the Kharijite Mahdids; the Isma'ili Zurayids asserted their independence in Aden; while the Zaidite Rassids continued to hold their own in Sada. Oman, Bahrain, and Al Hasa were successfully cleared of the Karmatians. In Mecca a Hasanid dynasty established sharifian rule, and a Husainid dynasty ruled in Medina. Once again tribal loyalties and rivalries dominated the entire area. In 1174, only three years after he had destroyed Fatimid power in Egypt, Saladin moved into Arabia and toppled most of the native dynasties. (*See* SALADIN; AYYUBIDS.) Only the Zaidites survived. Ayyubid rule meant the triumph of Sunnism over Shi'ism throughout the peninsula. Mecca recognized Saladin as sovereign, and he dispatched his brother Turan Shah to occupy Yemen. Turan Shah suppressed the Hamdanids of San'a', the Mahdids of Zabid, and the Zurayids of Aden, and for over half a century (1173–1228) Yemen remained in Ayyubid hands.

On the death of the last Ayyubid ruler in Yemen, his governor of Mecca, 'Ali ibn Rasul, succeeded his master in the government of all the country and established the so-called Rasulid dynasty which extended its control from Hadhramaut to Mecca and maintained its power for over two centuries (1229–1454). At the execution (1258) of the last Abbasid caliph by the Mongol conqueror Hulagu, the second Rasulid ruler assumed the title of caliph; but the Mameluke sultans, whose power in Egypt was increasing, assumed nominal overlordship over the holy cities of Islam and had their own plans for the restoration of the caliphate.

5. The Mamelukes and the Ottoman Turks.—Disturbances in Mecca around the middle of the 14th century offered the Mamelukes (*q.v.*) an opportunity to intervene and dealt a heavy blow to Rasulid power. The eighth Rasulid ruler, Ahmad ibn Isma'il (who reigned from 1400–24), regained temporary control and offered Mameluke trade in the Red Sea keen competition, but soon after his death the dynasty fell. The Rasulids were succeeded by the Tahirids (1446–1517), who maintained their authority until the conquest of Arabia by the last Mameluke of Egypt, Kansu al-Ghuri (who reigned from 1501 to 1516). In the following year (1517) the Ottoman sultan, Selim I (reigned 1512–20), assumed the title of *Khadim al-Haramayn* (servant of the two sanctuaries), but Ottoman authority over Hejaz and Yemen was not established until the reign of Selim's son and successor, Suleiman I the Magnificent (reigned 1520–66). Even then stubborn resistance to Ottoman rule continued, especially under the Zaidite imams who succeeded in 1635 in forcing the Ottomans out of Yemen.

Ten years before Selim I assumed titular authority over the holy land of Islam, eastern Arabia witnessed the first European incursion into Arabian territory proper since the ill-fated Roman

expedition of Aelius Gallus in 25–24 B.C. This was the capture of Oman by the Portuguese in 1508. The remaining years of the century saw Dutch-Portuguese rivalry for trade in the Persian Gulf intensified. In the early 17th century both rivals were displaced by English traders of the East India Company, who allied themselves with the Persians.

At this time the rising power of the Safavid dynasty in Persia and the increasing problems the Ottomans had to face in Europe weakened the Ottoman hold on Arabia and enabled local chiefs to assert their power. Not only were the imams of San'a' able to drive the Ottomans out of Yemen but Hejaz also became practically independent under its sharifian rulers. In the east, the Ibadi Ya'rubids (1624–1741) established themselves in Oman and succeeded in driving the Portuguese out of Muscat. Other Bedouin chiefs drove the Ottomans out of Al Hasa and dominated the grazing grounds of the area until the last quarter of the 19th century.

Except for Yemen, which was at that time controlled by the San'a' imams, and Hejaz, which in spite of nominal Ottoman suzerainty was practically independent, the peninsula reverted to its time-honoured pattern of tribal rivalry and strife. It was in these circumstances that the rivalry between two rather insignificant princes in Wadi Hanifah, the rulers of Al 'Uyaynah and Dar'iya, was destined to serve as the background for a reform movement which ushered in a new era for the peninsula.

(N. A. F.)

C. The Wahhabi Movement

1. Origins and Early Expansion.—Mohammed ibn 'Abd al-Wahhab, the founder of the Wahhabi (*q.v.*) movement, was born in Al 'Uyaynah in 1703 and as a young man traveled widely in Iraq, Syria, and other countries of the Middle East. It was upon his return to Al 'Uyaynah (*c.* 1750) that he first began to preach his revolutionary ideas of religious reformation on puritan lines. The laxity and backsliding of the Arabs in religious matters were at this time notorious; and Mohammed's aim was to restore the practices and precepts of primitive Islam among his countrymen. His teaching was influenced by that of Ibn Taimiya (*q.v.*), whose efforts to revive the puritanical doctrines of the Hanbalite school had resulted in his death in a Syrian prison in 1328. It was among his own fellow citizens of Al 'Uyaynah that Mohammed ibn 'Abd al-Wahhab decided to open his campaign.

The ruler of Al 'Uyaynah, Othman ibn Mu-'ammar, gladly welcomed the returning prodigal and even adhered to his doctrines. But the temper of the people was less complaisant, and Mohammed's preaching and sincerity were put to a number of severe tests. From these he did not flinch, but Othman now received threats from the Banu-Khalid chief of Al Hasa, demanding the death of the innovator on pain of withholding annual gifts from the province, and even of invasion.

Othman, unable to face the risks of financial loss and actual danger, but unwilling to kill his guest, decided to dismiss Mohammed from his territory, leaving it to him to choose his destination. He chose Dar'iya, the seat of Mohammed ibn Sa'ud, some 40 mi. downstream in Wadi Hanifah; and thither he was sent under escort, walking the whole way. Othman soon had reason to regret his action and to remember the words spoken to him by Mohammed on his first arrival at his court: "I hope," he had said, "that, if you rise in support of the one and only God, God Almighty will advance you, and grant you the kingdom of Najd and its Arabs!" Othman had thrown away the chance of making Al 'Uyaynah the capital of an Arab empire; and his later invitation to Mohammed to return was duly declined by the latter, who had transferred his prophetic blessing to his new protector.

The people flocked to the teaching of the new "prophet" (he himself never claimed such a title), conducted at first discreetly on the outskirts of the capital. Women were among his earliest proselytes, including Mudhi, the wife of Mohammed ibn Sa'ud, to whom she introduced the preacher. The latter was then installed in more comfortable quarters in the town itself; and the alliance of priest and prince, duly sealed by mutual oaths of loyalty, soon began to prosper in terms of military success and expansion. The parochial wars of old continued in the new guise of a crusade against the infidel—a term which specifically included all who held aloof from the Wahhabi interpretation of God's will as preached by the founder of Islam.

One by one the enemies of the new dispensation were swept into oblivion. The earliest conquests brought Al 'Uyaynah and Al Hasa under Wahhabi control; but Riyadh and Manfuhah maintained their stubborn resistance for 20 years before succumbing to the steady pressure of the new movement. An invasion in force of the Sa'udi realm by the Makarima (Isma'ili) chief of Najran threatened the stability of the regime for a time; but it ended in a pact of mutual nonaggression, and the invaders withdrew. And by 1765, when Mohammed ibn Sa'ud died, the whole of central and eastern Arabia, in spite of sporadic dissident movements, had fallen under more or less effective Wahhabi rule.

Sa'ud's son and successor, 'Abd al-'Aziz I, who had been largely responsible for this extension of his father's realm by his exploits as commander in chief of the Wahhabi forces, continued to work in complete harmony with Mohammed ibn 'Abd al-Wahhab. It was indeed the latter who virtually controlled the civil administration of the country, while 'Abd al-'Aziz himself, later in cooperation with his warlike son, Sa'ud II, busied himself in the expansion of his empire far beyond the limits inherited by him. In particular, his attacks on the pilgrim caravans crossing Arabia had begun to attract the attention of the Turkish government, and in 1798 a Turkish force invaded Al Hasa, though it was compelled to withdraw.

2. Struggle with the Ottomans.—The Wahhabis retaliated in 1801 with the capture and sack of the Shi'ite holy city of Karbala in Turkish Iraq; and the following year Sa'ud led his father's army to the capture of Mecca itself in Turkish Hejaz. It was soon after his return from this expedition that his father was assassinated by a Shi'ite fanatic in the mosque of Dar'iya in revenge for the desecration of Karbala.

The issue was now fairly joined between the Ottoman caliphate and the fanatical Wahhabis of Arabia. Meanwhile, in 1792, the venerable Mohammed ibn 'Abd al-Wahhab had died at the age of 89 after a faithful ministry of nearly 50 years, bequeathing to his temporal and spiritual successors the divine cause to which he had dedicated his life. They did not fail him; in 1804 Sa'ud captured Medina, and now the Wahhabi empire embraced the whole of Arabia down to Yemen and Oman. Year after year Sa'ud visited Mecca to preside over the pilgrimage as the imam of the Muslim congregation. But the tide was soon to turn to the disadvantage of the Wahhabis. The sultan of Turkey, preoccupied in other directions, consigned to Mohammed 'Ali Pasha, the virtually independent viceroy of Egypt, the task of crushing the "heretics." Sa'ud in 1811 was actually leading them against Baghdad when he received the news of an Egyptian landing in force on the Hejaz coast under the command of Tusun, the pasha's youthful son. Turning west, Sa'ud inflicted a severe defeat on the invaders; but reinforcements enabled Tusun to occupy Mecca and Medina in 1812. The following year Mohammed 'Ali assumed command of the expeditionary force in person, but in 1814 his son suffered a severe defeat near At Ta'if, which was, however, offset by the death of Sa'ud at Dar'iya in the same year.

Sa'ud's son, 'Abdullah I, was scarcely of his father's calibre, and the capture of Ar Ra's in Al Qasim by the Egyptians in 1815 forced him to sue for peace. This was duly arranged and the enemy withdrew from Najd; but the truce was short-lived, and in 1816 the struggle was renewed, with Ibrahim Pasha, another of the viceroy's sons, in command of the Egyptian forces. Gaining the support of the volatile tribes by skilful diplomacy and lavish gifts, he advanced into central Arabia, bypassing Ar Ra's after an unsuccessful siege of four months to occupy 'Unayzah and Buraydah, the two principal towns of Al Qasim, and to capture Ash Shaqra' after a short siege. Joined now by most of the principal tribes (Harb and 'Utaiba, Mutair and Banu-Khalid), he appeared before Dar'iya in April 1818. Desultory but desperate fighting among the palm groves of the Wahhabi capital ended six months later in the surrender of 'Abdullah, who was sent to Constantinople and there beheaded. Dar'iya was razed to the ground and Egyptian gar-

risons were posted to the principal towns. The Sa'udi family had suffered heavy losses during the fighting. A few had managed to escape before the surrender; the rest were sent to Egypt for detention. The Wahhabi empire had ceased to exist, but the scattered embers of the puritan fire smoldered on in the desert spaces in defiance of the new rulers of the land.

Matters came to a head in 1824 when Turki, a grandson of Mohammed ibn Sa'ud, succeeded in capturing Riyadh and expelling the Egyptian garrison. By accepting the nominal suzerainty of Egypt and agreeing to pay an annual tribute, he was left in peace to consolidate the new Wahhabi regime, with its capital at Riyadh. In 1834, however, he was murdered by an ambitious cousin, a son of Sa'ud II named Mishari. The latter was deposed and executed by Turki's son Faisal, who refused to pay the Egyptian tribute. In 1838 an Egyptian expeditionary force besieged Riyadh, and Faisal, duly deposed, was sent to serve a prison sentence in the citadel of Cairo, while Khalid, another son of Sa'ud II, was installed as ruler of Najd. Both Faisal and Khalid had been carried away into captivity in Egypt after the fall of Dar'iya, but the former had escaped in 1828 to rejoin his father and to play a prominent part in the reestablishment of the Wahhabi regime. Khalid had been released from prison to accompany the expeditionary force sent to restore Egyptian rule in Arabia as the ruler designate, on his undertaking to recognize the suzerainty of Egypt. So Faisal returned to Cairo for a second period of incarceration until his second escape and return to Najd in 1843.

Meanwhile the subservience of Khalid to his Egyptian masters was increasingly resented by his Wahhabi subjects; and in 1841 his cousin, 'Abdullah ibn Thunaian, raised the standard of revolt. Riyadh was captured by a bold coup, and its Moroccan garrison was expelled. Meanwhile Khalid, who was in Al Hasa at the time, made a virtue of virtual necessity and fled by ship to Jidda, leaving the throne to the usurper. The latter, when Faisal reappeared in 1843, made a show of resistance, only to be overpowered and slain. So Faisal resumed his reign after an interruption of five years, to rule unchallenged till his death in 1865. A sturdy champion of militant religion, he was able to combine the defense of his uncompromising unitarian faith with the substantial expansion of his realm, though not to the limits achieved by Sa'ud II. Hejaz remained in Turkish hands, while northern Arabia (the province of Jabal Shammar) was virtually independent, acknowledging only the shadowy suzerainty of Riyadh. However, he reestablished his authority in Al Buraymi and the Oman hinterland and even extended his influence as far as Hadhramaut and the frontiers of Yemen.

In 1865, when his power was an acknowledged factor in Arabian politics, menacing even British interests on the Persian Gulf littoral, Faisal was visited in state by Sir Lewis Pelly, the British political resident for the Persian Gulf area, though no specific agreement seems to have materialized from their discussions. In that same year Faisal died—a blind old man, bigoted, fanatical, and uncompromising, surrounded by evil counselors and unhappy in his own family, with sons at daggers drawn with each other, ready to dispute the throne on their father's demise. His eldest son, 'Abdullah, succeeded to the throne, maintaining himself uneasily thereon against the open rebellion of his brother Sa'ud III for six years until his defeat at the Battle of Judah in 1871. 'Abdullah's flight from that field left Sa'ud in possession, but the next five years saw the throne change hands no less than seven times in favour of five different members of the Sa'udi family. Meanwhile 'Abdullah had appealed to the Turks in Baghdad, who readily came to his assistance but took advantage of the situation to occupy the province of Al Hasa for themselves—an occupation destined to last for 42 years.

3. Ibn Rashid.—Sa'ud III died of wounds in 1875, and after a brief interval of chaos 'Abdullah II returned to the throne the following year, only to find himself powerless in the presence of a greater man in the north, Mohammed ibn 'Abdullah al-Rashid, whose capital was at Ha'il and of whom Charles Doughty left a brilliant picture in his *Travels in Arabia Deserta*. (*See* Ibn Rashid.) Ibn Rashid had succeeded to the throne of his father, the founder of the Rashidi dynasty, after a short period of anarchy following upon the suicide of his eldest brother, Talal, in 1866 and the murder of his second brother, Mit'ab, by the sons of Talal soon afterward. Ibn Rashid's accession was marked by the spilling of royal blood on an impressive scale, but he made amends for the blood bath by the smooth and efficient administration which he succeeded in imposing on his realm at a time when chaos seemed to reign unchecked in the whole peninsula.

Ibn Rashid was undoubtedly the dominant factor in Arabian politics when 'Abdullah II ibn Sa'ud returned to Riyadh for his third spell of authority. At first Ibn Rashid refrained from any forward action, but he soon found himself forced to intervene in the chaotic affairs of the Wahhabi realm. And it was not long before 'Abdullah was "invited" to be the "guest" of Ibn Rashid at Ha'il, while a representative of Ibn Rashid was appointed governor of Riyadh. 'Abdullah's health now began to show serious signs of deterioration, and Ibn Rashid very generously not only allowed him to return to Riyadh but actually restored the throne to him unconditionally in 1889. 'Abdullah did not live long in enjoyment of his restoration, however; he died in the same year, leaving to his youngest brother, 'Abd al-Rahman, the almost hopeless task of saving the realm of their ancestors from its impending doom.

But 'Abd al-Rahman, the father of 'Abd al-'Aziz II, the greatest Arab ruler since the Prophet himself, was not of the calibre of his distinguished son and was soon embroiled in senseless hostilities with Ibn Rashid. The Battle of Al Mulaida (in Al Qasim) settled the issue between them decisively in 1891, and for the second time in the space of 70 years the Wahhabi state suffered eclipse. 'Abd al-Rahman fled with his family to take refuge in Kuwait as the guest of its rulers, and Mohammed ibn Rashid added the Wahhabi realm to his Shammar fief. At Ibn Rashid's death in 1897 the throne passed to his nephew, 'Abd al-'Aziz ibn Mit'ab, whose political acumen fell far short of his military prowess. By the turn of the century he had alienated the sympathies of all Najd. Meanwhile his namesake, 'Abd al-'Aziz ibn 'Abd al-Rahman, had taken full advantage of his enforced sojourn in Kuwait to imbibe from his host, Sheikh Mubarak ibn Sabah, a knowledge of world politics which was to stand him in good stead as soon as he was old enough to embark on an adventure destined to avenge in full the humiliations of the past.

Kuwait was at that time the cynosure of European imperialism. Its port was coveted by the Germans as the logical terminus of the Berlin-Baghdad Railway. Britain, long the dominant power in the Persian Gulf, naturally opposed a project which would result in the outflanking of its imperial communications. The Rashid coveted Kuwait as a desirable outlet for the commerce of Arabia and readily lent himself to the Turko-German designs on the port; but the British government made it abundantly clear that it would tolerate no interference with the "independence" of Kuwait. Thus Ibn Rashid's probing raids in that direction came to nothing; and in 1900 it was Sheikh Mubarak who, with the co-operation of 'Abd al-Rahman ibn Sa'ud, staged a counterattack on the enemy's territory, while the latter's son, 'Abd al-'Aziz, led a diversion against Riyadh. This expedition ended in a disastrous defeat in Al Qasim province.

The following year the young 'Abd al-'Aziz (he was about 21 years old) sallied out with a small force of 40 followers on what must have seemed a forlorn adventure. Keeping clear of Al Hasa, and gathering considerable tribal support on the way, he reached the neighbourhood of Riyadh with some 200 men on Jan. 10, 1902. On the 15th, with a select body of only 15 warriors, he scaled the walls of the capital, surprised and utterly defeated the Rashidi governor and his escort before the gate of the Mismak fort, and was gratefully hailed by the oppressed population as their ruler.

4. Ibn Saud.—Thus began a reign destined to be one of the most famous in Arabian history. (*See* Ibn Saud.) The following years witnessed the development of the struggle between the Rashidis, whose power was by no means spent and who received substantial help from the Turks in men and material, and the restored Saudi dynasty. In 1904, at the Battle of Bukairiya, the combined Rashidi and Turkish (eight regular battalions) force was utterly defeated by Ibn Saud (as 'Abd al-'Aziz ibn 'Abd al-Rahman ibn Faisal Al Sa'ud became generally known outside Arabia); and in agreement with him the Turks, accepting the new situation

withdrew all their troops from central Arabia. Ibn Rashid continued the struggle alone; but in 1906 he himself was killed at the battle of Raudhat al Muhanna, and thenceforth Ibn Saud remained the undisputed master of Arabia, excluding the Jabal Shammar fief of the Rashidis and the Turkish provinces of Al Hasa, Hejaz, and Yemen. His ambition of regaining the whole of the realm of his ancestors was not yet satisfied, but he bent himself to the task of achieving it.

Meanwhile he busied himself with the reorganization of the country's administration, including the inception of a scheme designed to ensure the stability and permanence of his regime. History had taught him that the Arabs had frequently been inspired to great achievements under the stimulus of religious fervour or of outstanding personal leadership, while the death of the leader or the cooling of religious zeal had invariably resulted in the dissipation of the gains achieved, a result of the volatile character of a mainly nomadic society. It was the foundations of Arab society which needed examination and strengthening; and it was to this task that he set his hand in 1912 with the establishment of the first *Ikhwan* ("brothers") colony on the desert wells of Artawiya, peopled entirely by Bedouins, and forming a militant cantonment based on agriculture and dedicated to the service of God and prince. Within the next decade nearly 100 similar colonies were founded on suitable sites throughout the country, providing Ibn Saud with a formidable territorial army of fanatics, destined to win for him the whole of Arabia except the British-protected coastal enclaves and Yemen.

Ibn Saud's first exploit was the spectacular conquest of Al Hasa province from the Turks in 1913. During World War I he was forced by circumstances to be relatively quiescent, though surrounded by enemies (for the Arab rising in Hejaz against the Turks in 1916, *see* HEJAZ). In 1919, however, he struck his first blow, against King Husain of Hejaz (*see* HUSAIN IBN 'ALI), whose army was annihilated at Turaba by the *Ikhwan*. In 1920 Ibn Saud's son Faisal (*q.v.*) captured the province of 'Asir between Hejaz and Yemen. In 1921 Ibn Saud defeated the forces of Ibn Rashid (Mohammed ibn Talal, the last Rashidi amir) and annexed the whole of northern Arabia, occupying Al Jawf and Wadi Sirhan in the following year. Sheikh Salim of Kuwait died in 1921, and his successor, Ahmad ibn Jabir, established friendly relations with Ibn Saud. Meanwhile King Husain's sons Faisal and 'Abdullah (*see* FAISAL I; 'ABDULLAH IBN HUSAIN) had been placed on the thrones of Iraq and Transjordan respectively by the British government, these territories, with Hejaz, forming a formidable British-protected cordon around the northern and western borders of the Wahhabi state, with the inevitable result of frequent frontier incidents.

In 1923 the British government invited all the rulers concerned in these sporadic hostilities to attend a conference at Kuwait and if possible to agree on a settlement of their differences. It also made it clear that the subsidies hitherto paid to Ibn Saud and King Husain would be terminated from the end of that financial year.

The conference ended in complete disagreement on all points, and in September 1924 the Wahhabis attacked Hejaz. They captured At Ta'if after a brief struggle and occupied Mecca without opposition. Ibn Saud then laid siege to Jidda and Medina, while King Husain abdicated his throne in favour of his son 'Ali, whose situation was virtually hopeless from the beginning. By the end of 1925 both Medina and Jidda had surrendered to Ibn Saud, King 'Ali having previously abdicated and departed from the country. Meanwhile the Aqaba-Ma'in district of northern Hejaz was occupied by British troops on behalf of Transjordan, to prevent its falling into Wahhabi hands, and, on Jan. 8, 1926, Ibn Saud, who had adopted the title of sultan of Najd in 1921 after the capture of Ha'il, was proclaimed king of Hejaz in the great mosque of Mecca. In 1927 he also changed his title of sultan to king of Najd and its dependencies, the two parts of his dual kingdom being administered for the time being as separate units. In the same year the treaty of Jidda, negotiated by him with Sir Gilbert Clayton, in supersession of the Hadda and Bahrah treaties of 1925, placed his relations with Great Britain on a permanent footing. The Soviet government was the first power to recognize him as king, the British government following soon after, as did other powers formerly in diplomatic contact with Hejaz. Thus for the first time Ibn Saud found himself in direct contact with international politics.

He also found himself in difficulties with the more fanatical elements of Najd, because of his association with infidel powers and his alleged complaisance in regard to the British-protected sharifian regimes in Iraq and Transjordan, which were still the objects of Wahhabi lust. Incidents on their frontiers created a state of virtual though undeclared war, in which British aircraft played a part in discouraging Wahhabi incursions. Ibn Saud also had on several occasions to deal sternly with the disobedience of his more fanatical *Ikhwan* leaders; and in vigorous operations during 1929–30 the leading opponents of his moderate policy, Faisal al-Dawish and Sultan ibn Bijad, were defeated and consigned to prison in Riyadh, where they died in due course. This was virtually the end of the *Ikhwan* movement in Najd. The stage was now set for a long period of tolerance and understanding between the new Arabia and the outside world, and for the unification in 1932 of the two parts of the dual monarchy under the name of Saudi Arabia.

For later history *see* SAUDI ARABIA; YEMEN; MUSCAT AND OMAN; KUWAIT; *see* also references under "Arabia" in the Index.

(H. ST. J. B. P.)

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ARABIA, ROMAN PROVINCE OF, extended from the west coast of the Sinai peninsula northeastward along the Palestinian-Syrian border to a line south of Damascus and southeastward down the east coast of the Red sea to Egra (Mada'in Salih in the Hejaz). It comprised the territory of the former kingdom of the Nabataeans (*q.v.*) with the addition of some adjacent cities, including Gerasa (modern Jerash, Jordan) and Philadelphia (Amman) from Roman Syria. The Roman conquest of the Nabataean kingdom—formally annexed by the emperor Trajan in A.D. 105—was effected by Cornelius Palma, legate of Syria. The province was governed by a *legatus Augusti* of praetorian rank, who commanded one legion. Bostra (*see* BOZRAH) in the extreme north was made the capital of the province and the legionary camp, but the old royal capital Petra remained the religious centre and was given the title of metropolis by Hadrian. A road was constructed by the legate Gaius Claudius Severus (111–114) "from the boundaries of Syria to the Red sea," linking Damascus via Bostra, Gerasa, Philadelphia and Petra to Aelana on the Gulf of Aqaba, and forts were built to control the Bedouin to the east. Much of the southern Arabian caravan and maritime trade in incense and other valuable commodities from the far east passed through the province and yielded a high customs revenue—the main motive for the annexation. The cities also profited from this trade and flourished greatly in the 2nd century, as their impressive surviving monuments show.

The emperor Diocletian divided Arabia into two provinces, a northern (to which he added the Palestinian regions Auranitis and Trachonitis) and a southern, with Bostra and Petra as their capitals. The southern province was united to Palestine by Constantine the Great. When it was detached again in 357–358 it was styled Palaestina Salutaris (or Tertia). Both provinces were governed by *praesides;* Justinian I promoted the *praeses* of Arabia to the higher rank of *moderator*. Their garrison commanders were styled *dux Arabiae* and *dux Palaestinae*. The churches show that the cities enjoyed a marked revival of prosperity in the 5th and 6th centuries and fell into decay only after the Arab conquest in 632–636.

See R. E. Brünnow and A. von Domaszewski, *Die Provincia Arabia* (1904–09). (A. H. M. J.)

ARABIAN ART: *see* ISLAMIC ART.

ARABIAN DESERT or EASTERN DESERT (AS SAHRĀ ASH SHARQĪYAH), of Egypt, 86,000 sq.mi. in area, extends from the Nile cliffs to the coral-reef coast of the Red sea. The much broken country culminates in a mountain range 4,000 ft. or more above sea level (Jabal Sha'ib, 7,150 ft.). The scanty population is based on wells and springs, especially in the valley of the Wadi Qina and around the administrative centre of Hurghada (Al Ghurdaqah). The desert was the source of some of the building stones of ancient Egypt (such as porphyry and granite). Phosphate is mined near Al Qusayr and petroleum is obtained from the area north of Hurghada. *See* also EGYPT; SAHARA. (R. W. SL.)

ARABIAN NIGHTS ENTERTAINMENTS: *see* THOUSAND AND ONE NIGHTS.

ARABIAN SEA (ancient MARE ERYTHRAEUM), the northwestern section of the Indian ocean, is bounded east by India, north by West Pakistan and southern Iran, and west by Arabia and the Horn of Africa. It has two important branches—the Gulf of Aden, connecting with the Red sea through the Strait of Bab-el-Mandeb; and the Gulf of Oman connected by the Hormuz strait leading to the Persian gulf. The sea, long a centre of coastwise sailing, forms part of the chief highway between Europe and India.

Over the greater part the Arabian sea is deep, exceeding 1,600 fathoms and there are no islands over the centre. Deep water reaches close to the bordering lands except in the northeast off the mouths of the Indus, Cutch, Kathiawar peninsula and the Gulf of Cambay. To the southeast, stretching for over 1,000 mi. from north to south, is the Maldive ridge, the highest parts of which are above sea level and form the Maldive and Laccadive Islands—very largely coral atolls. On the western side of the Arabian sea the Horn of Africa terminates in Cape Guardafui, 160 mi. to the east of which is the long plateau island of Socotra (British). Stretching southeastward from Socotra is the submarine Carlsberg ridge over which the water is less than 1,500 fathoms deep but drops to over 2,100 fathoms on either side. No boundary exists to demarcate the Arabian sea from the main part of the Indian ocean but this ridge may conveniently be used.

The Arabian sea lies in trade wind latitudes: from October to May the trade wind or northeast monsoon is blowing; from June to September it gives place to the strong southwest monsoon, and stormy seas result. (L. D. S.)

ARABIC LANGUAGE, one of the Semitic languages (*q.v.*), is spoken (1960s) by 100,000,000 people in a large area including the Arabian peninsula, the Fertile Crescent and north Africa. In addition, as the language of the Koran and the prayers of Islam it is important as a religious language throughout the Muslim world, and it has served as the vehicle of a vast literature (*see* ARABIC LITERATURE) extending from before the time of Mohammed up to the present day. It is customarily written in its own distinctive alphabet (*q.v.*), which has also spread with Islam and is used for writing several other languages of the Islamic world. Thus, in terms of the number of speakers and extent of its influence, Arabic is by far the most important Semitic language today and must be regarded as one of the important world languages.

As may be expected for a language used over such an expanse of space and time, Arabic shows tremendous variation, and the language of a pre-Islamic poem and the speech of a Cairo tradesman are quite dissimilar. On the whole, however, Arabic has been a conservative, slowly changing language, and the degree of difference, for example, between Arabic of the 8th and 20th centuries is clearly less than that between the English of the same periods. Two kinds of differences within Arabic are of special significance at the present time: the dichotomy between classical Arabic and the spoken dialects, and the differences among the various dialects themselves. The kind of Arabic which is used today for almost all written purposes and for certain formal kinds of speaking is substantially the Arabic of the Koran and the classical literature of the past; it is called classical Arabic (*al-lugha al-fuṣḥā* "the eloquent language"). The Arabic which is used in ordinary conversation by all speakers of Arabic, no matter how well educated, is quite different; it is often called colloquial Arabic (*al-lugha al-'āmmiyya*, "the popular language"). Although the classical is relatively uniform throughout the Arab world, showing only minor differences in vocabulary and syntax in different regions, the colloquial is split into various dialect areas with considerable divergence in sounds, grammar, and vocabulary. With the spread of literacy and increase in higher education in the Arab world the classical is becoming more and more widely known, and it is the hope of almost all Arab thinkers and leaders that eventually the common spoken language of Arabs will be either the classical or a middle language (*al-lugha al-wusṭā*), which pre-

serves the essential features of the classical with some changes introduced from the colloquial or elsewhere. This ideal is far from attained at the present time.

Phonology.—In structure Arabic is radically different from English and other well-known languages of Europe. Its sound system includes six "throat" consonants (*kh gh h ' ḥ '*) of particular difficulty for speakers of English and a series of "emphatic" consonants (*ṭ ḍ ṣ ẓ*) which influence strongly the pronunciation of the surrounding vowels. It has three short vowels and three long vowels (*a i u; ā ī ū*). Words always start with a single consonant followed by a vowel, long vowels are rarely followed by more than a single consonant, and there are never more than two consonants together.

The presence of certain consonants (especially the pharyngeals *ḥ* and '), the alternation of consonants and vowels, and the "emphatic" features of pronunciation give Arabic a highly characteristic sound which sets it apart from other languages.

Morphology.—The grammatical system of Arabic is based on the root-and-pattern structure typical of Semitic languages, which shows its fullest and most pervasive development in Arabic. The overwhelming majority of Arabic words have a stem which consists of two parts fitted together: the root, which is generally of three consonants and provides the basic lexical meaning of the word, and the pattern, which generally consists of vowels interlocked with the root consonants and gives the more specific grammatical meaning of the words. For example, the word *kātib* consists of the root *ktb* which has to do with writing and the pattern *-ā-i-* which identifies the active participle; the word *kātib* means approximately "one who writes," specifically often "a clerk." The full extent of this system becomes apparent from a listing of other words sharing either the root or the pattern.

ktb	*-ā-i-*
kitāb "book"	*shārib* "one who drinks"
'uktub "write!"	*'āmil* "one who does," "worker"
takātabū "they corresponded"	*sākin* "one who dwells," "inhabitant"
maktab "desk," "office"	*ṭālib* "one who begs," "beggar," "student"
kutub "books"	*khāliq* "one who creates," "Creator"
kuttāb "clerks"	*lāji'* "one who takes refuge," "refugee"
mukātib "correspondent"	*rākib* "one who rides," "passenger"
maktūb "letter"	*ṣāni'* "one who fashions," "craftsman"

In addition to the primary words the stems of which consist only of root plus pattern (*e.g., kātib, kitāb, 'uktub*) there are derivative words, the stems of which contain an additional element such as a doubling of the second root consonant (*sharrib*, "one who drinks to excess") or an infix *t* after the first root consonant (*'iftakara*, "he thought"). A pattern of this kind, which includes vowels and an additional element may be called a pattern complex, *e.g., ma--a* means the place where the action indicated by the root is carried out.

Classical Arabic also has a fairly small number of prefixes and suffixes, reduced still further in the dialects. These include prepositions (*bi-*, "at, by"), the definite article (*'al-*), subject markers of verbs (*e.g., ya-*, "he"; *-tum*, "you pl."), feminine and plural suffixes (*e.g., -at* fem., *-ūna* pl.), pronoun endings (*-hā*, "her") and, for classical only, case endings (*e.g., -u* nominative). The characteristic structure of an Arabic word is root + pattern (or pattern complex) + one or more affixes. A few words consist of prefix plus suffix with no stem at all (*bihā*, "by her"), and some others, chiefly particles, are not analyzable (*mā*, "what"; *sawfa*, sign of future; *yad*, "hand").

Compound words like English *bookcase, housekeeping* are almost nonexistent.

Conjugation.—The Arabic verb, which in many ways is the core of the grammatical system, has many derivational and inflexional forms, but the complexity is matched by the regularity and symmetry of the forms. Apart from several almost trivial exceptions, there are no irregular verbs in Arabic. For most primary verbs it is necessary to know only two forms to be able to predict all the rest, and for derivative verbs one form is usually sufficient. The complexity has been somewhat reduced in the dialects, but regularity and symmetry are still characteristic.

(Arabic Alphabet)

SIGN	NAME	EQUIVALENT	SIGN	NAME	EQUIVALENT
ا	alif	'(*)	ض	ḍād	ḍ
ب	bā	b	ط	ṭā	ṭ
ت	tā	t	ظ	ẓā	ẓ
ث	thā	th	ع	'ain	'(†)
ج	jīm	j	غ	ghain	gh
ح	ḥā	ḥ	ف	fā	f
خ	khā	kh	ق	qāf	q
د	dāl	d	ك	kāf	k
ذ	dhāl	dh	ل	lām	l
ر	rā	r	م	mīm	m
ز	zā	z	ن	nūn	n
س	sīn	s	ه	hā	h
ش	shīn	sh	و	wāw	w
ص	ṣād	ṣ	ى	yā	y

*A glottal stop when used as a sign of vowel length; represented by a macron when used as a sign of vowel length. † A pharyngeal sound.

Arabic verbs have two tenses: one, usually called the perfect, formed by the addition of suffixes; the other, usually called the imperfect, formed by the addition of prefixes and in several forms a suffix marking feminine or plural. The perfect generally refers to past time, the imperfect to present or future, but there are many uses in which this time difference is not so clear, and many scholars like to emphasize the aspectual nature of these two tenses. The same suffixes and prefixes are added to all verbs, whether primary or derivative. In classical Arabic the imperfect has three varieties differentiated chiefly by the final short vowel (indicative *-u*, subjunctive *-a*, jussive no ending). In the modern dialects, where the final short vowels have disappeared, this distinction is generally lost, but in some dialects it is continued in part by two forms of the imperfect, one with an added *b-* prefix (corresponding in usage to the classical indicative), the other without the *b-* (corresponding to the subjunctive and jussive). In addition to the two tenses there are imperative forms, active participle, passive participle, and verbal noun or *maṣdar*. In classical Arabic there are also some special forms called the "energetic," characterized by endings containing *n* added to certain jussive forms; these have disappeared completely in the dialects.

Arabic verbs are inflected for three persons, three numbers, and two genders. The first person, however, has no dual form and no gender differentiation. The modern dialects have all lost the dual forms, most sedentary dialects have lost the feminine forms of the second and third person plural forms, and in a few dialects the gender distinction in the second person singular of the perfect has disappeared. Otherwise the colloquial forms are analogous to the classical. A sample paradigm of the third person forms in classical and the Syrian dialect:

kataba	"he wrote"	*katab*
katabat	"she wrote"	*katbit*
katabā	"they (two) wrote"	*katabu*
katabatā	"they (two, fem.) wrote"	
katabū	"they wrote"	
katabna	"they (fem.) wrote"	

yaktubu	"he writes"	*byiktub*
taktubu	"she writes"	*btiktub*
yaktubāni	"they (two) write"	*byikitbu*
taktubāni	"they (two, fem.) write"	
yaktubūna	"they write"	
yaktubna	"they (fem.) write"	

The derivative verbs are traditionally listed in ten forms (plus several rare ones). All ten are never in use for the same root, but many roots have four or five derivative verbs in common use. The semantic value of each form may be indicated by terms like causative, reflexive, intensive, etc., but the precise meaning must be learned for each verb.

The traditional list follows—*f ʿ l* representing the first, second and third consonant of the root respectively (I is used for primary verbs).

II	*faʿʿala*	VI	*tafāʿala*	IX	*'ifʿalla*
III	*fāʿala*	VII	*'infaʿala*	X	*'istafʿala*
IV	*'afʿala*	VIII	*'iftaʿala*	XI	*'ifʿālla*
V	*tafaʿʿala*				

Most of these are alive in the modern dialects except that IV is rare or nonexistent everywhere; VII has been replaced by a form with initial *t-* in Maghrebi dialects and to some extent in Egypt; and IX and XI, which are equivalent in classical, have nowhere both been preserved.

Finally, the classical language has a passive which may be found with primary and derivative verbs (except IX and XI, and rare with VII). This is formed by the patterns: perfect *-u-i-a*, imperfect *u--a-;* thus *kutiba,* "it was written," imperfect *yuktabu.*

Declension.—The noun system of Arabic, in contrast to the complex, regular, highly predictable verb system, is relatively simple in number of inflexional forms but highly irregular and unpredictable. First, there is no difference in form, although there is in syntactical behaviour, between nouns and adjectives. Second, the number and gender of a given noun form are usually not clear from the form alone. Finally, for any given noun there is no way to predict whether it will have collective, singular and plural forms; or whether it will have one plural, several plurals, or no plural at all; or, if it has several plurals, whether they will have different meanings. All this is equally true of classical Arabic and the modern dialects.

Classical Arabic has in addition a declension system of three cases, called nominative, genitive, and accusative, which correspond in a limited way to the cases of these names in Latin. Duals and "sound" plurals have only two case forms, one for the nominative, the other for the genitive-accusative: nominative *-āni,* genitive-accusative *-ayni;* nominative *-ūna,* genitive-accusative *-īna;* nominative *-ātu(n)*, genitive-accusative *-āti(n)*. A handful of nouns have under certain circumstances long vowel case endings (*e.g.,* nominative *'abū-,* genitive *'abī-* accusative *'abā-* "father of"). All other noun forms, whether singular, collective, or plural follow a system which has short vowels as case endings (nominative *-u*, genitive *-i*, accusative *-a*) and an indefinite suffix *-n* which may be added after the case ending. Since some nouns take the indefinite *-n* and others do not, and since for various reasons, mostly connected with the presence of a semivowel as the final root consonant, some nouns have only a limited declension, there are actually six subtypes of declension. The declensional system is very simple compared to that of Latin, Russian, etc., but even this has disappeared completely in the modern dialects.

The pronouns of Arabic are outside the root-and-pattern system. The personal pronouns have two forms, independent and enclitic; the latter are added to nouns as possessives, and to verbs and prepositions as objects. Like the verb, the pronoun has forms for three persons, two genders and three numbers. The modern dialects have lost the same categories here as in the verb, but otherwise the forms are generally very similar to the classical. The third person pronoun forms in classical and Syrian are as follows:

Independent			Enclitic	
Classical	Syrian		Classical	Syrian
huwa	*huwwe*	"he"	*-hu*	*-o*
hiya	*hiyye*	"she"	*-hā*	*-ha*
humā	—	"they" (two)	*-humā*	—
hum	*humme*	"they"	*-hum*	*-hun*
hunna		"they" (fem.)	*-hunna*	

The demonstrative pronouns are quite varied in classical Arabic and have diverged greatly in the dialects.

See also Index references under "Arabic Language" in the Index volume.

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ARABIC LITERATURE begins with the poems and proverbs of the northern Arabs of the late 5th to early 7th century A.D. The proverbs (of considerable linguistic and sociological interest) are recorded in several compilations made in the 8th century and after, of which the most celebrated is that of Maydani (d. 1124). Of written literature, before the redaction of the Koran in the 7th century, nothing is known.

PRE-ISLAMIC POETRY

The origins of Arabian poetry can only be guessed. Poets to whom the earliest pieces are attributed exhibit a fully developed art. Their poems are couched in elaborate metres, of which 16 were recognized when the metrical system was standardized in the 8th century by al-Khalil ibn Ahmad. What the original basis of this system was has given rise to many conflicting theories; for an exposition of the problem, with an ingenious new hypothesis, *see* G. Weil, *Grundriss und System der altarabischen Metren* (1958). In general, the system is quantitative, based on long and short syllables; to what extent ictus is an integral part of it, is disputed; the verse is divided into equally balanced halves, and the same rhyme is repeated at the end of each verse. The rule that every verse should form an organic whole gives a certain jerkiness to the poem, making it easy to displace lines and to extract pieces for inclusion in anthologies. The poetic language was that of the desert Arabs, somewhat standardized, and amplified by dialect variations. This became, under the influence of the Koran, the standard language of Arabic literature, and its richness led to the compilation of numerous commentaries and lexicons.

In form and content, the poems are of two kinds. On the one hand are the short occasional poems evoked principally by the emotions of war or revenge. Indeed, praise of his own tribe and abuse of its enemies were the functions of the ancient poet (*shāʿir,* literally "he who knows," an expression probably arising from the primitive feeling that poetic utterances were supernaturally inspired). Also important in this kind are elegies, for which a number of women poets, notably al-Khansa (*q.v.*), are famed. Distinct from this type of poems is the elaborate ode (*qasidah*) of from 60 to 100 lines. In this a regular scheme is followed whatever the subject. In the opening verses (the *nasib*) the poet depicts himself on a journey; he halts with his companions at a deserted camping ground, whose moldering traces recall an ancient passion, and tells of his love and the sorrow of parting; after this section he continues his journey and describes his horse or camel, comparing it to some wild animal of the desert. The natural descriptions or accounts of the chase thus introduced

are often the most attractive part of the poem. This leads to the occasion of the poem, which may be praise of his tribe or of his own gallantry, descriptions of camp or desert life or, most frequently, panegyric of some patron.

Transmission.—The oral transmission of these compositions over a period of 150 to 250 years or even longer was by a class of professional reciters (*rawi*), among whom many of the most famous poets were numbered. The *rawis* certainly possessed remarkable powers of memory, but it must be allowed that the poems thus preserved were liable to mutilations, omissions and transpositions. The divergences in the texts of many ancient poems are great, and often portions of different poems are found pieced together. Unfortunately several of the most famous *rawis*, especially two of those who first undertook the writing down of the early poems in the 8th century, Hammad al-Rawiyah (*q.v.*) and Khalaf al-Ahmar, are suspected of dealing arbitrarily with their material and have been declared to be clever forgers. Thus, whenever any particular verse is attributed to a pre-Islamic author, it is necessary to consider to what extent it can be regarded as authentic. Few modern scholars, however, would agree wholly with the revolutionary views propounded by D. S. Margoliouth (in *Journal of the Royal Asiatic Society*, 1925) and Taha Husayn (in *Fi al-Shi'r al-jahili*, 1926), according to whom the entire canon of "pre-Islamic" poetry is a forgery of early Islamic date. Margoliouth's views were ably refuted by E. Bräunlich in *Orientalistische Literaturzeitung* (1926); and the modern view more or less coincides with the summing-up of the authenticity problem in relation to the seven *Mu'allaqat* by A. J. Arberry in *The Seven Odes* (Allen & Unwin Ltd., 1957, p. 253): "The weight of evidence is heavily in favour of the Seven Odes being genuine products of the age to which Arab tradition has assigned them. But this is not to say that the form in which we have received them is their original form."

Collected Poems.—The poems attributed to the early bards have survived in two kinds of collection. There are the *diwans*, or collected poetical works, of the principal poets; *e.g.*, of Imru'-al-Qays, Zuhair, al-Nabighah, A'sha, Tarafah, Hassan ibn Thabit (*qq.v.*). There is one tribal *diwan* (of the Hudhayl tribe); and there are many poets of whom only a few pieces survive; *e.g.*, the robber poets Ta'abbata Sharran and Shanfara, the Christian poet 'Adi ibn Zayd, the Jew Samaw'al ibn 'Adiya and the religious poet Umayyah ibn Abi-al-Salt.

The second category consists of anthologies, of which the most famous are the *Mu'allaqat* (*q.v.*), the name given to a group of seven pre-Islamic poems, which represent almost every type of ancient Arabian poetry in its excellences and its weaknesses; the *Hamasah* (*q.v.*), compiled by Abu Tammam (*q.v.*) *c.* 836 A.D.; and the *Mufaddaliyat* (*q.v.*), an anthology in which almost all the poets represented belong to the pre-Islamic age.

In addition to the anthologies, various other works contain poetical citations of value: above all the *Kitab al-Aghani* ("Book of Songs") of Abu-al-Faraj al-Isfahani (*q.v.*). The *Kitab al-shi'r wa' l-Shu'ara* ("Book of Poetry and Poets") of Ibn Qutaybah (*q.v.*) and the *'Iqd al-Farid* of Ibn 'Abd Rabbihi (*q.v.*) are also noteworthy. (C. J. L.; TH. N.; H. A. R. G.; X.)

POST-ISLAMIC POETRY

Umayyad Period.—During the 1st century after Mohammed there was little change in the character of Arabic poetry. The four outstanding poets were al-Akhtal (*q.v.*), al-Farazdaq (*q.v.*), Jarir ibn 'Atiyah al-Khatfi (*q.v.*) and Dhu al-Rummah. In the work of the last it is obvious that the *qasidah* is becoming a stereotyped and academic exercise. Poets still carried on the traditions of tribal panegyric and satire but the new conditions of city life, both in the conquered lands and in the metropolitan cities of Arabia, brought about a change in Arab manners and pursuits which led to the rise of new modes in poetry. The love lyric was established as an independent form by Omar ibn Abi Rabi'ah of Mecca and his fellow-countryman Jamil, and a sort of Platonic love became the theme of several poetic romances associated with the tribe of 'Udhrah, and attributed to a number of poets, of whom the most famous are Majnun Bani 'Amir and Layla. The poems of the caliphs Yazid I (680–683) and Walid II (743–744) were the precursors of the wine songs and hunting poems of the next period. An attempt to remodel the *qasidah* in the freest of Arabic metres, the *rajaz* (with an iambic-type rhythm), was made by 'Ajjaj and his son Ru'bah. Although this tendency was not developed, the *rajaz* metre was retained for impromptus (as in the pre-Islamic period) and for long descriptive poems.

Abbasid Period.—The Persian atmosphere of the Baghdad court after the establishment of the Abbasid caliphs in 750 strongly favoured these new tendencies, which reached their apogee in Abu Nuwas (*q.v.*) and his brilliant contemporaries. Thenceforward Arabic poetry flowed in a number of channels. The traditionalists continued to imitate in their ceremonial odes the subjects, mannerisms and metres of the old desert poetry, save for the introduction of rhetorical tropes (*badi'*) in place of the pictorial imagery of the ancient poets. This fashion was set by Muslim ibn Walid (d. 803), followed by Abu Tammam (*q.v.*), and carried to the verge of excess by al-Mutanabbi (*q.v.*). On the other hand the school of Abu Nuwas used metres with much more variety and excelled in anacreontic and occasional verse. Even for this later period the text or authenticity of many poems is uncertain. Generally speaking, the poets sought less after depth and originality than elegance in expression and brilliance of metaphor, and the polished and delicate productions of later writers such as Baha al-Din Zuhair (*d.* 1258, *q.v.*) recall English 17th-century and Augustan verse. Nevertheless some struck out new paths: Abu-al-'Atahiyah (*q.v.*), whose moralizing verse is expressed in unaffected popular language; Bashshar (d. 783), chiefly celebrated as an erotic poet, who employed a Wordsworthian simplicity of language; Ibn al-Mu'tazz (d. 908), the author of a long historical poem and of other brilliant and original verse; Abu-al-'Ala al-Ma'arri (*q.v.*), in whose *Luzumiyyat* Arabic poetry touches its deepest human note; and the mystical poets Ibn al-'Arabi and Ibn al-Farid (*q.v.*).

Western Poetry.—In Spain and the west, Arabic poetry at first continued along traditional lines, represented by Ibn Hani' (d. 983) of Seville. Later, Ibn Rashiq (d. 1070) of Kairouan, Ibn Zaydun (d. 1071) of Cordoba, Mu'tamid king of Seville (d. 1095) and his vizier Ibn 'Ammar (d. 1078), with whom was associated the most famous of the Arab poets of Sicily, Ibn Hamdis (d. 1132), were the principal among a galaxy of poets who released themselves from the old conventions and used their verse for self-expression. A still greater breach with tradition was the rise of strophic verse, which conservative influences had hitherto succeeded in repressing in the east. This new verse-form is marked by internal rhymes with a rhyming refrain to mark the end of each strophe, and makes its appearance in the *muwashshah* (*q.v.*, in literary language) and the *zajal* (in colloquial Arabic), which was raised to literary rank by the troubadour Ibn Quzman (d. 1160). These productions, which are nearly all erotic, exercised a strong influence on nascent Provençal poetry and also, reaching Egypt at the end of the 12th century, took root there. The Spanish-Arabic *muwashshah* has the curious feature of concluding with a couplet written in one of the early Romance dialects of the peninsula.

There are numerous anthologies of later poetry. Some were devoted to special genres; *e.g.*, wine songs. Among those of more general scope mention should be made of the *Yatimat al-dahr* of Tha'alibi (d. 1038); the *Khizanat al-adab* of 'Abd al-Qadir al-Baghdadi (d. 1682); and two anthologies of Spanish-Arabic verse, the *Qala'id al-'iqyan* by al-Fath ibn Khaqan (d. 1134), and the *Rayat al-mubarrizin* by Ibn Sa'id al-Andalusi (d. 1274), translated in A. J. Arberry's *Moorish Poetry* (1953).

From the 13th century until the rise of the modernistic movement in the 19th century (*see* below) Arabic literature fell into a period of decadence in which most works were imitative. (H. A. R. G.; X.)

BELLES-LETTRES

The most striking and characteristic feature of Arabic literary prose is the style known as *saj'* or "rhymed prose." This typically consists of a succession of pairs (occasionally triplets or more) of short rhyming expressions. There is a rhetorical and antithetical

balance of sense between the pairs, and they are expressed with a certain loose rhythmical balance not bound by strict metre. There is no doubt that the formal oration (*khutbah*) cast in this style is of great antiquity, and in pre-Islamic tribal society the orator (*khatib*) was a figure whose importance was nearly comparable with that of the poet. In the earliest times of Islam, in spite of a tendency to frown on poetry and *saj'*, the Koran itself was partly drafted in a form of rhymed prose, while the *khutbah*, turned to religious and homiletic uses, became an integral part of the Friday religious ceremonial and was employed on numerous other occasions. One of the most famous later exponents of the *khutbah* style was Ibn Nubatah al-Fariqi (d. 985). Such was the dominance of the *saj'* tradition that it affected much Arabic prose, giving it a tendency to a rhetorical and antithetical style reminiscent of 17th- and 18th-century English sermons, even when strict *saj'* is not being employed.

The beginnings of Arabic literary prose fall in the latter days of the Umayyad caliphate, the chief pioneers being 'Abd al-Hamid al-Katib (d. 750) and Ibn al-Muqaffa' (d. 760). The works of both exhibit a mingling of the *khutbah* style and a more sophisticated and fluent style which may derive from the literary traditions of Sasanian Persia. The most celebrated work of Ibn al-Muqaffa', *Kalila wa Dimna*, is a translation from a Pahlavi (middle Persian) version of the Indian book of animal fables, the *Panchatantra*. (*See* BIDPAI, FABLES OF.)

The following three centuries are the golden age of Arabic prose, studded with the names of brilliant writers, such as the essayists al-Jahiz (*q.v.*) and Abu Hayyan al-Tawhidi (d. *c.* 1000), and the critic Ibn Qutaybah (*q.v.*). Here, too, we encounter Abu-al-'Ala al-Ma'arri (*q.v.*) with his letters in formal *saj'* and his brilliantly original fantasy the *Risalat al-Ghufran*, which pictures a visit to the other world. These writers forged out of Arabic a prose diction which for subtlety and expressiveness is not easily paralleled.

Anecdotal writings occupy a special place in Arabic prose literature. The Arabs were an avid audience for moral, instructive or amusing anecdotes, and this gave rise to a number of compilations under classified headings. The outstanding name is Tanukhi (d. 994), who was responsible for three such compilations: the partly extant *Nishwar al-muhadarah* (Eng. trans. by D. S. Margoliouth, *The Table Talk of a Mesopotamian Judge*, 1922, and in *Islamic Culture*, vol. 3–6, 1929–32); the *Mustajad*, anecdotes of generosity; and above all the immensely popular *Faraj ba'd al-shiddah* ("Deliverance After Anguish"), later translated into Persian.

Works of this kind led to a new literary form, the *Maqamat* ("Assemblies"). Al-Hamadhani (d. 1007, *q.v.*) is credited with initiating it. Previous anecdotal literature had at least purported to be factual. Hamadhani's *Maqamat* make no pretence of being so; they are a collection of short stories, mainly picaresque, woven round the names of two fictitious protagonists. The genre was developed and standardized a century later by al-Hariri (*q.v.*), and although numerous later authors followed him, none achieved the lasting fame of his *Maqamat*.

The popular romances and story-cycles of the type of the *Thousand and One Nights* (*q.v.*) were early in vogue. But such tales, the stock-in-trade of professional storytellers, were beneath the notice of an educated man. Ibn al-Nadim in his bibliographical *al-Fihrist* (composed 988) characterizes the *Thousand and One Nights* as a "worthless and silly book." The only serious author to concern himself with such tales is Jahshiyari (d. 942), who collected a large number from storytellers as well as from manuscripts. (For further specimens of this genre *see* SINDBAD THE SAILOR; LUQMAN; and a collection edited by H. Wehr, *Das Buch der wunderbaren Erzählungen*, 1956.) (A. F. L. B.)

HISTORY AND BIOGRAPHY

Early Forms.—Before Islam, history, like other types of prose literature, was virtually unknown, although tribal stories and genealogies—often embellished by legend—were transmitted orally. In the 2nd century of Islam—the 8th–9th century A.D.—oral transmission was systematized in the science of Hadith (*q.v.*)—the system of tradition—and statements were not considered authoritative unless they were supported by a chain of authorities (*isnad*). This method was applied to other sciences, including history. Thus, the earlier histories are encumbered by these *isnads*, which had to precede each major statement of fact. Normally, the historian did not synthesize or generalize—Ibn Khaldun (*q.v.*) being a notable exception—he used his critical judgment in selecting facts only by checking *isnads*. Another feature of Arabic history was the relating of events in strict chronological order (the Arabic word for history, *ta'rikh*, means "to date") so narratives tended to be disjointed. In shorter biographies, year-by-year chronicling was often abandoned, and the use of *isnads* was mitigated according to the writer's taste. Later historians and biographers largely abandoned the *isnad* in favour of the verbatim quoting of earlier writers.

In the 1st century of Islam, preoccupation with religion and wars impeded the writing of history, though they made it all the more necessary. With the widening frontiers of the Islamic state, the dispersion of the Arabs and the increasing complexity of life and government, oral traditions had to be written down, if they were to survive in reliable form. An early life of the Prophet by Ibn 'Uqba (d. 758) has survived only in fragments. The oldest extant history is the life of the Prophet by Ibn Ishaq (*q.v.*), but this is only available in the revision by Ibn Hisham (*q.v.*). It is considered generally reliable, despite some admixture of fables and the inclusion of spurious early poetry. Al-Waqidi (*q.v.*) wrote a book about the Prophet's campaigns more detailed than Ibn Ishaq's work, and Ibn Sa'd (*q.v.*) wrote biographies of the Prophet and his companions. During this early period, historians, like other writers, preferred the short, specific monograph to the general work. Among authors of these, besides al-Waqidi, were Abu Mikhnaf (d. 748), al-Mada'ini (d. 840), Abu Ubaydah (d. 825), and al-Azraqi (d. *c.* 858), whose history of Mecca was the precursor of numerous local histories.

General Histories.—From the 9th century A.D., the general history became popular. Ya'qubi (*q.v.*) wrote a general history of value, and al-Baladhuri (*q.v.*) wrote an account of Arab conquests and a large genealogical history of the Arabs. Al-Tabari (*q.v.*) was the first general historian of genius; and some still consider his *Annals* the finest history written in Arabic. It was freely drawn on by later historians; it was abridged and completed and it was translated (in part) into Persian by Bal'ami in 963, thus providing a pioneer work of Persian prose. Modern readers may find Tabari's year-by-year arrangement and his use of the *isnad* tiresome. Yet the *Annals* are of vital importance. Moreover, they do treat the more important events at greater length. Among later historians to draw freely on Tabari was Ibn Miskawayh (or Miskawayh) (d. 1030). His *Tajarib al-Umam*, containing the history of the kings of ancient Persia, and that of the Arabs up to his time, is highly praised by D. S. Margoliouth and Bernard Carra de Vaux (see *Bibliography*). Miskawayh is outspoken, reasonably impartial and skeptical of the supernatural. He includes vivid detail, and depicts exciting scenes which remain in the mind. He throws much light on political, administrative and economic matters. Ibn al-Athir (*q.v.*) abridged and completed Tabari's work in his *Kamil* ("Complete"). It contains important information about the western Islamic world—Sicily, North Africa and Spain. Mention must also be made of the autobiography of 'Usama ibn Munqidh (Eng. trans. by G. R. Potter, *The Autobiography of Ousama*, 1929) which shed much light on Saladin and his times.

Later Works.—The number of historical and biographical compilations in the later centuries is enormous. The most important writers—al-Masudi, al-Biruni, Abu 'l-Faraj (*see* BAR-HEBRAEUS), Ibn Khaldun, al-Suyuti, and Hajji Khalifa (*see* KATIB CHELEBI)—are the subjects of special articles. Several works by other authors deserve mention. The *Kitab al- Wuzara'* ("Book of Wazirs") of Hilal al-Sabi' (d. 1056) is a mine of information about the social life of the 9th and 10th centuries. The history of Mohammed al-Ghaznawi (*Kitab al-Yamini*) by al-'Utbi (d. 1036) set the fashion for the rhetorical style in history-writing. 'Imad al-Din (d. 1201) followed it in his histories of Saladin and of the Seljuk dynasties,

and Ibn 'Arabshah (d. 1450) carried it to excess in his history of Timur (Tamerlane).

During this period many local histories were written. These were usually either bare chronicles of events, or panegyrics of local dynasties. An exception is the excellent history of Egypt by 'Abd al-Latif (d. 1231), but many so-called local histories degenerated into collected biographies of the citizens of the provinces or towns with which they dealt. Two monumental works of scholarship belong to this category—the history of Baghdad by al-Khatib al-Baghdadi (d. 1071), and the history of Damascus by Ibn 'Asakir (d. 1176).

Besides those devoted to particular localities, there are collected biographies of a general nature, and also those dealing with men of learning. In the first category, the biographical dictionary of Ibn Khallikan (*q.v.*) stands out. The *Mu'jam al-Udaba* ("Dictionary of Learned Men") compiled by Yaqut is the leading example of the second category. Ibn Khallikan's work was expanded, completed, or brought up to date by several authors, notably by al-Safadi (d. 1363) in his *Wafi bi 'l-Wafayat* and by Ibn Shakir al-Kutubi (d. 1363) in his *Fawat al Wafayat*. Ibn Abi-Usaybiah (d. 1270) wrote a history of physicians and there were collected biographies of lexicographers, grammarians, theologians, Koranic readers, *sufis*, etc. Such books, when not arranged alphabetically, were often termed *Tabaqat* ("categories"), since they grouped the subjects of their biographies according to geographical location, generations, or schools of ideas and methods. It was a form in which the Arabs excelled. These works are useful, not only for the technical information which they contain, but also for the vivid pictures they paint of the life of the people. Characters are sketched by interesting anecdotes, which often display a strong sense of humour.

The 14th and 15th centuries were remarkable for the appearance of encyclopaedic compendiums, intended as handbooks for the official classes. The two earliest were the encyclopaedia of al-Nuwari (d. 1332) and the *Masalik al-Absar* by Ibn Fadlallah (d. 1348). Later came the *Subh al-A'sha* of al-Qalqashandi (d. 1418). Meanwhile there were last flickers of the flame of history-writing before Arabic literature suffered almost total eclipse under the Ottoman Turks. Al-Maqrizi (d. 1442) wrote a history of Egypt, a history of the Mamelukes, and an enormous biographical dictionary of Egyptian princes and notables. A worthy conclusion to the long sequence of great histories was provided by the history of Muslim Spain by al-Maqqari (d. 1632).

Historical Romances.—From the earliest days of Islam, love of the marvelous and veneration of the Prophet gave rise to fables about him which found their way into serious histories. Later, there were legends about the wars of conquest, and about Ali and his family. So there sprang up a romantic tradition, with a popular literature of its own. In the oldest specimens, such as the story by Ibn 'Abd al-Hakam (d. 871) of the conquest of Egypt and North Africa, truth and falsehood are mixed. Most extant literature of this kind is, in its present form, much more recent; *e.g.*, the story of the death of Husain by the pseudo-Abu Mikhnaf, and of the conquest of Syria by Waqidi. Later, such books were often treated as authentic, and material from them found its way into accepted history.

On the other hand, there was a class of popular romance which was never taken for serious history. The best-known examples are the story of 'Antar (Antara), a romance of Arab desert life, and the story of the Bani Hilal, one of the Arab tribes which occupied the Libyan desert in the 11th century. These stories are still retailed in school textbooks, and by village storytellers, in the middle east.

TECHNICAL AND SCIENTIFIC LITERATURE

Geography and Travel.—Arabic geographical literature was stimulated in the first place by Greek mathematical geography and the necessities of administration. The first roadbook was written in the 9th century by Ibn Khurdadhbih, the royal postmaster at Samarra. Soon afterward love of travel and intellectual curiosity produced a valuable series of descriptive works of which those of Ya'qubi (*q.v.*), Ibn Haukal, al-Masudi (*q.v.*) and Makdisi (Muqaddasi) are the most famous. While these early writers prided themselves that their knowledge was derived from personal investigations, their successors, Idrisi, Abulfeda (*qq.v.*), Yakut and Bakri, contrived to compile excellent geographical treatises based almost entirely on written and narrative sources. There are also accounts of embassies and journeys both into central Europe and the remoter parts of Asia. Ibn Jubayr wrote an admirable journal of his travels to and from Mecca by way of Syria and Egypt in 1181–84. In the 14th century Ibn Batutah (*q.v.*) earned the title of "The Traveler of the Arabs" by his extensive journeys. The commercial relations long existing between the Persian gulf and India and the far east produced several exceedingly interesting works on those countries, notably the *Kitab 'Adja' ib al-Hind* (*Marvels of India*) by Bozorg ibn Shahriyar, besides manuals of navigation in prose and verse. In the 10th century some Spanish-Arab sailors even set out from Lisbon to cross the Atlantic. In later times geography shared the general decline, and, except for the geographical sections of the great encyclopaedias mentioned above, was merged into cosmography. The works of the earlier cosmographers, Qazwini (d. 1283) and Dimashqi (d. 1327), are not without interest and importance, but with the economic ruin of the Arabic world all study of geography ceased. (*See* also GEOGRAPHY.)

Philology.—The systematic study of Arabic grammar began in Iraq, as an aid to the study of the Koran, probably even in the 7th century, and it was fully established by the end of the 8th century. Ancient Arabic poetry, previously transmitted orally, was collected and recorded to help the understanding of the language. Rival grammatical schools were set up at Basra and Kufa. The Kufans set less store by analogy than the Basrans. Later, scholars gravitated to Baghdad. Sibawayh (*q.v.*) of Basra wrote the first full-scale grammar, and other members of the school were Abu 'Ubaydah, al-Asma'i (*q.v.*), and Ibn Duraid (*q.v.*). The first dictionary was compiled by Khalil (*q.v.*) at the end of the 8th century, and a whole series followed, notably those of Ibn Duraid, Jauhari and Ibn Faris (10th century).

The great dictionaries, still in use, date from a later period. They are the *Lisan al-'Arab* by Ibn Manzur (d. 1311) (new edition with introduction by Ahmad Faris, 15 vol., 1955–56); the shorter *Qamus* of al-Firuzabadi (d. 1414); and the late commentary on the latter, the *Taj al-'Arus*, by Murtada al-Zabidi (d. 1790), on which Edward Lane (*q.v.*) based his lexicon.

Philosophy and Science.—Arabic philosophical and scientific studies are dealt with elsewhere (*see* ARABIC PHILOSOPHY; ASTRONOMY; CHEMISTRY: *History of Chemistry;* MATHEMATICS, HISTORY OF, etc.). All such studies came to the Arabs through Syriac translations from Greek, supplemented by Indian and possibly Persian influences, and were confined to comparatively small circles of students. (J. A. HD.)

MODERN LITERATURE

While the writing of books and composition of poetry continued in Egypt and Syria, and sporadically elsewhere, throughout the 17th and 18th centuries, little of originality or value was produced. During the 19th century the new political, social, economic and intellectual movements resulting from contact with Europe prepared the way for a revival of Arabic letters, particularly in Syria and Egypt. This took on the one hand the form of a throwback to classical Arabic models, represented in Syria by Nasif Yaziji (1800–71), the author of *Maqamat* on the model of al-Hariri, and in Egypt by the activities of the orthodox theological seminary of al-Azhar. On the other hand the influences exerted by the missionary schools in Lebanon, and the western sympathies of Mohammed Ali and Ismail (*qq.v.*), khedives of Egypt, led to a rapid and superficial assimilation of western ideas, fostered by the translation of large numbers of French works, especially scientific works, novels and plays. The westernizing movement was strengthened by the creation, in the last decades of the century, of an Arabic daily press which contributed to the evolution of a new and more flexible literary style, and also of an Arabic theatre. In Egypt a movement to reconcile the two schools, classical and modernist, was initiated by Shaykh Mohammed 'Abduh (d. 1905),

but it broke up after his death into a conservative and a modernist wing. The latter crystallized out in Egypt after 1920 in the essays, novels and descriptive works of a remarkable group of writers (*see* C. C. Adams, *Islam and Modernism in Egypt*, 1933), followed in other Arab countries with varying degrees of success. In the first quarter of the century a more radical reorientation was attempted by a number of Syro-American writers of Lebanese origin in the United States and Brazil, but it died out with the generation that produced it, and had little influence except in Lebanon. After the outbreak of World War II, the Egyptian movement also lost much of its impetus, and was succeeded by a period of psychological reaction, offset by some tentative experiments. Throughout this period Taha Husayn and al-'Aqqad in Egypt remained sobering influences in all fields of Arabic literature. The improvements in education and communications following World War II coupled with the rise of Arab nationalism led to a greater diffusion of Arab literary movements throughout the middle east and North Africa. Arabic poetry in particular began to free itself from the conventions of Ahmad Shauqi (*q.v.*) and Hafiz Ibrahim (d. 1932) and to emerge as the main outlet for the new political consciousness. (H. A. R. G.; A. EL-T.)

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(A. F. L. B.; J. A. HD.; A. EL-T.)

ARABIC PHILOSOPHY. Medieval Arabic philosophy represents a case of the adaptation of Greek philosophy to a different civilization and to a new language. Latin translations of Hellenistic philosophy in Cicero's day and of Neoplatonic thought by Christians (such as Marius Victorinus and Boethius) in the 4th and 5th centuries and the philosophical works in Latin based on these translations are both of a different character from it. The Jewish philosopher Philo of Alexandria (1st century A.D.) and, following his lead, the Greek Fathers of the Christian church (from Clement of Alexandria to Gregory of Nyssa and beyond) had made successful attempts to give Greek philosophy, divorced from its roots in Greek religion, a place within a world dominated by new and fundamentally different religious attitudes of the Hebraic type; there was no linguistic difficulty involved in this. The syllabus of learning thus established in the Greek church was adopted by the different Syriac churches, and hence there are Syriac versions of Greek philosophical texts from the middle of the 5th century A.D. down to the 5th century of the Muslim era. But Islam as a religion is different from Judaism and from Christianity, although likewise based (unlike the Greek way of life) on divine revelation and on a holy book; and Arabic proved to be a very suitable medium for expressing Greek thought, more adaptable to it than Syriac (although the precedent of previous translations into a Semitic language facilitated the rapid growth of an abstract Arabic language and terminology). It goes without saying that, apart from these fundamental factors, special historical circumstances and special trends in the development of Islam influenced the destinies of Islamic philosophy and the work of individual Muslim thinkers. Since Islam is a universal religion, it is not surprising that most of the outstanding philosophers of the Arabs, like many of their other famous writers, were not of Arabian descent (al-Farabi, for instance, was a Turk, Rhazes and Avicenna were Persians).

THE TRANSLATORS

Since medieval Arabic philosophy is wholly dependent on the Greek texts which reached the world of Islam, we cannot afford to neglect the work of the translators, who, from the second half of the 8th century onward, provided the philosophers who could read neither Greek nor Syriac with the Greek scientific view of the world and with Greek natural theology. These translators were, with very few exceptions, Nestorian, Jacobite and Melchite Christians and translated sometimes directly from the Greek and sometimes from intermediate Syriac translations (the only Latin author ever translated into Arabic in the middle ages was the Christian historian Orosius). Greek manuscripts were still to be found in the cities of Mesopotamia, of Syria, of Palestine and of Egypt in the 9th century A.D., when the eminent translator Hunain ibn Ishaq was working; we know of the study of Greek texts of Galen in Baghdad at the same time and have good reason to believe that Greek was still spoken there at the end of the 10th century. The activity of the translators continued, in varying intensity, until the 11th century, the main groups being (1) the "old" translators, who worked in the days of the Mu'tazilite caliphs al-Ma'mun (813–833) and al-Mu'tasim (833–842); (2) Hunain ibn Ishaq (called Johannitius by the scholastics; d. 873) and his numerous pupils in Baghdad; and (3) the Baghdad school of the 10th and 11th centuries, who seem to have translated exclusively from the Syriac. They succeeded in establishing a continuous teaching of Greek philosophy in the capital of the Abbasid caliphate. The "old" translations are not entirely superseded by the more recent ones, and we find them still being used much later; *e.g.*, in Averroes' exegesis of Aristotle. The growth of an abstract Arabic style is mainly due to these versions of Greek philosophy, and we can follow its gradual improvement in the works of the Islamic philosophers who used them for their own purposes. Very few Greek loanwords are eventually preserved (for instance *hayula* from *hyle*; *ustuqus* from *stoicheion*). It was not always possible to reproduce the subtle distinctions of the refined philosophical terminology of the Neoplatonists and the late commentators on classical Greek philosophy with equivalent Arabic terms; but, on the other hand, the Arabs could sometimes use various words for an ambiguous Greek term. They even coined new abstract terms, some of which found their way into medieval Latin: *mahiyya-quidditas*, "quiddity," for instance, is still in use, as also is *qabliyya-prioritas*, "priority." Some pairs of correlative concepts can be expressed in Arabic more adequately than in Greek, by using the same root. There are a few changes for religious reasons, such as the frequent substitution of the singular (*allah* or *ilah*) or of "angels" (*mala'ika*) for the Greek plural "gods" (*theoi*), which makes it easier to accept the cosmology and astronomy with its stellar gods who are common to most late Greek philosophers. A Greek-Arabic glossary of philosophical terms from the translations would greatly assist the study of Arabic philosophical texts.

The works thus made available to Arabic thinkers were those which were still being read and studied in the Greek philosophical schools during the 6th century, as follows: (1) Plato and Aristotle and their commentators; (2) philosophical works by Galen and a few Middle-Platonic authors (*see* ACADEMY, GREEK); and (3) books by Neoplatonists and other later writers. Arabic thinkers knew most of the major lecture courses of Aristotle except the *Politics* (upon which no ancient Greek commentary seems ever to have been written) and studied them with the help of commentaries by Nicolaus Damascenus (1st century A.D.), Alexander of Aphrodisias (early 3rd century), Porphyry (late 3rd century), Themistius (4th century), Simplicius and John Philoponus (both 6th century) and others. Of the original philosophical writings of Alexander, they possessed more than have survived in the Greek. There were also texts with marginal notes, and abridgments of original works in the form of summaries and paraphrases. The whole of Plato seems to have been known in some form, but translations of the complete *Timaeus*, *Republic*, *Laws* and *Phaedo* are particularly conspicuous. The main interpreters of Plato who were followed were Middle Platonists and the Neoplatonist Proclus (5th century). Other works known were the *Placita philosophorum* included in the writings of Plutarch and a paraphrase of Plotinus, known as the *Theology of Aristotle*, but Plotinian ideas also reached the Arabs in other ways. It would be premature to give a com-

plete list of all the works translated, but three writings deserve mention: the first two are the *De aeternitate mundi* of Proclus and the reply to this by John Philoponus, in which the former defended the eternity of the world, appealing to the authority of Plato and Aristotle, whereas the latter argued in favour of a real beginning and end of the world and was prepared to accuse the great philosophers of error; the third is a similar work exclusively against Aristotle. These writings proved important for later discussions between various groups of Arabic philosophers; so, too, was the *De causis* (a rearranged extract from Proclus' *Elements of Theology*) for its impact on Latin medieval thought. The number of Greek philosophical texts known in Latin versions before the days of the schoolmen in the later middle ages was only a very small fraction of those known to the Islamic world.

By the middle of the 20th century only a relatively small number of the Arabic translations known to have been made had actually been traced and published, but new material was constantly turning up in western and, particularly, in eastern libraries. As some Greek philosophical texts which had still been available when Muslims became interested in Greek thought were lost during the subsequent centuries of Byzantine history and are preserved only in Arabic versions or reflected in Arabic philosophical works, these versions, apart from their usefulness to the student of Arabic philosophy, can help to increase our knowledge of Greek literature, not only in the philosophical field, but also in those of science, of medicine and of mathematics. Three of Galen's works may be cited in this respect: his treatise on moral philosophy, *Peri ethon;* his paraphrase of Plato's *Timaeus;* and his treatise *On Medical Experience,* which contributes to the history of Greek skepticism. Another example is the pseudo-Aristotelian *Peri phyton* (by Nicolaus Damascenus); and the case of Alexander of Aphrodisias has already been mentioned. Themistius' commentaries on the *De caelo* and on the *Metaphysics* are preserved only in a Hebrew version of an Arabic translation.

THE PHILOSOPHICAL SYLLABUS

Medieval Arabic philosophy is almost entirely based on the late Greek syllabus of learning. All the philosophers were eager to naturalize it in the Islamic world; there is no striking difference in this respect between al-Kindi's *Introduction to the Study of Aristotle,* al-Farabi's *De divisione scientiarum* (extensively used by Dominicus Gundisalvi), Avicenna's encyclopaedias of philosophy (well known in the west, at least from 1200 onward) and Averroes' expositions of Aristotle's various treatises (which helped the west for centuries in the understanding of Aristotle), though these authors flourished each in a different century, from the 9th to the 12th.

While they all—with the exception of the Platonist Rhazes and his like—considered Aristotle as the greatest philosopher, they yet believed, with Porphyry and others, though in varying degrees, in the substantial identity of Plato's and Aristotle's views; and their view of Aristotle was, again in different ways, generally coloured by Neoplatonism. This attitude applies to metaphysics, to ethics and to psychology in particular but can be noticed in other fields of philosophy as well.

This philosophical syllabus was commonly accepted as a treasure house of truth discovered by the ancients, and the new tradition followed the static system established in the late Neoplatonic schools. It comprised mathematics (based on the reading of Euclid as a primer), astronomy (based on Ptolemy's *Almagest*), logic (based on Porphyry's *Isagoge* and on Aristotle), the natural sciences and psychology (based on Aristotle), metaphysics (based on Aristotle and on Neoplatonic books), ethics (based on Platonizing treatises and on Aristotle) and politics (based, if studied at all by Arabic thinkers, on Plato's *Republic*). It is needless to emphasize again that the late Greek commentators were considered the appropriate guides to the understanding of the classical texts and that there was no attempt at a completely fresh and original approach. There were no organized or properly endowed schools of philosophy such as had existed in the Greek world since the days of Plato and Aristotle, nor was there anything comparable to the medieval universities of Paris or Oxford; but there is a continuous tradition of philosophical reading from the 9th century, which spread over the whole Islamic world, from Bukhara, the home country of the Persian Avicenna, to Spain and to Morocco, where Averroes composed his philosophical works.

It is important to be aware of these peculiar conditions in order to understand the history of Islamic philosophy, which is by no means uniform or repetitive. Its variety depends, especially in the early stages, on the various trends of ancient thought with which each philosopher became acquainted and on the material which each selected in accordance with his personal predilections and particular gifts. They all were concerned to give philosophy a permanent and decisive position in an environment which was utterly different from that in which Greek philosophy had grown and existed for more than 1,000 years. They attempted this naturalization in various ways, seeking to establish that philosophy could provide the best answer to the basic problems of Islamic life; in the long run, however, they did not succeed in this endeavour. Al-Ghazzali's efficient and determined attack on them in *The Incoherence of the Philosophers* (*c.* A.D. 1100) marks the turning point; and Averroes' spirited defense in *The Incoherence of the Incoherence,* while it showed the accumulated strength of the philosophical tradition, was nevertheless the last outstanding work to be recorded. Philosophy never died out completely; but firmly established religious tradition and mysticism came to be the dominating factors in Islamic life. Thus already Averroes' younger contemporary, the Persian mystic al-Suhrawardi al-Maktul (1155–91), appreciated only the mystical side of Plato's thought and disliked al-Farabi and Avicenna, whose works he knew well; the "intoxicated" mystics were, in his view, true philosophers and true wise men. The great Muslim historian Ibn Khaldun (1332–1406), himself a thinker of the first order, was obviously interested in philosophy and also wrote an epitome of the greater part of Averroes' treatises, which were evidently still studied. Both men were high religious dignitaries. But whereas Averroes saw no difficulty in administering Islamic canon law and upholding the primacy of philosophical reason at the same time, Ibn Khaldun definitely considered philosophy as useless and futile and agreed with the theological critics of Greek theistic philosophy.

PHILOSOPHERS

Al-Kindi.—Yaqub ibn Ishaq al-Kindi (*see* KINDI, AL-), who was flourishing in the first half of the 9th century A.D., followed the Baghdad Mu'tazilite theologians' interpretation of Islam which was officially accepted by the Abbasid caliphs of his day, to whose court society he belonged. But, instead of adhering to the explanation of the world in terms of time and space that most of them favoured (he wrote a treatise against it), he attempted to give to their speculative theology a philosophical counterpart based on Neoplatonic Aristotelianism. He maintained that revealed and natural theology arrive at the same conclusions, but he subordinated philosophy to revelation and reason to the illuminated insight of the prophets.

In several respects the philosophy that he adopts is more akin to the Athenian trend of late Neoplatonism (represented, for example, by Proclus) than to others; but insofar as he, alone among Islamic philosophers, introduces creation out of nothing and the divine decree into metaphysics, he rather reminds us of the Alexandrian Christian philosophers Zacharias of Mytilene and John Philoponus and their attack on the eternity of the world as upheld by most pagan Platonists and Aristotelians and, in due course, by most later Islamic philosophers (John Philoponus is criticized for this very reason by al-Farabi and Averroes). Al-Kindi's description of the Divine Being in negative terms is more consistent than the compromise followed by al-Farabi, Avicenna, Averroes and others. He did not identify "the one" and "the first cause," the eternal source of emanation, with the Aristotelian description of God as supreme intellect, as they did and as Middle-Platonic thinkers had done before. He moved, in this respect, much more on orthodox Neoplatonic ground.

In logic, al-Kindi showed preference for hypothetical and disjunctive syllogisms and was criticized by later philosophers for his neglect of the Aristotelian method of demonstration used by

al-Farabi and others. He believed, like Avicenna, in the immortality of the individual soul but was unable to give philosophical proofs for the resurrection of the body, which he proclaimed as a truth of faith. In conformity with certain Greek Neoplatonists, he accepted astrology as part of philosophy (his pupil Abu Ma'shar became a widely recognized authority in this field), whereas al-Farabi, Avicenna and Averroes rejected it. He was the first philosopher to be familiar with Indian arithmetic. We are still much in the dark about the immediate sources of al-Kindi's philosophy; he lived more than 200 years after the last well-known Greek philosophers in Alexandria.

Al-Kindi succeeded in stating, in very impressive terms, the typical attitude of Arabic philosophers to the Greek legacy; he was conscious at once of his dependence on the Greeks and of his own contribution to the collective experience of the centuries. He says, in the preface of his *First Philosophy:* "It is fitting to acknowledge the utmost gratitude to those who have contributed even a little to truth, not to speak of those who have contributed much [*cf.* Aristotle, *Metaphysics*, 993 a 30]. We should not, then, be ashamed to recognize truth and assimilate it from whatever quarter it may reach us, even when it is brought to us by earlier generations and by foreign peoples. For him who seeks the truth there is nothing of higher value than truth itself; it never cheapens or abuses him who searches for it but ennobles and honours him. We must then remain faithful to the principle that we have followed in all our works: first to record all that the ancients have said about the subject; secondly to complete what the ancients have not fully expressed; and this according to the usage of our Arabic language, the customs of our age and our own ability." Three hundred years later Averroes reaffirmed this cosmopolitan attitude as something obvious; to do as al-Kindi did had become an established practice, and the enthusiasm of the first philosopher had turned into a routine of teaching.

Al-Farabi.—Abu Nasr al-Farabi (*see* FARABI, AL-; d. 950) firmly upheld the primacy of philosophy; philosophical truth is one and the same all over the world. The various religions, he thinks, represent truth in symbolical form adapted to the nonphilosophical mind and are of different excellence and rank. Although he may well have considered Islam the highest of the religions, he had Christian teachers himself and there were contemporary Christian thinkers who were obviously influenced by him and proclaimed similar views. He was, accordingly, very determinedly opposed to all forms of speculative theology (*kalam*), which can have no universal appeal; in this respect he by no means agreed with al-Kindi. He claimed to have revived Greek philosophy (which he believed to be dead in its homeland) in the Islamic world. Philosophy was now no longer content to be accepted in new surroundings; it claimed ascendancy over the other component elements of Islamic life.

Al-Farabi was very much aware of the political aspect of Plato's thought, which most of the Greek Neoplatonists (*e.g.*, Plotinus and Proclus) had disliked. In proclaiming Plato's philosopher-king, he may have been influenced by his own political experience and in any case was consciously speaking as a philosopher in the contemporary debate as to what type of man was best equipped to be caliph (that is, the spiritual and political head of Islam): "If at a given time it happens that philosophy has no share in the government, though every other qualification for rule may be present, the state will remain rulerless, the actual head of the state will be no true king, and the state will head for destruction; and if no wise man is to be found and associated with the acting head of the state, then after some time the state will undoubtedly perish" (*cf.* Plato, *Epistle*, vii).

This "political" attitude (with its emphasis on Plato's *Republic* and *Laws*) was not shared by most subsequent Islamic philosophers (with the exception of Averroes, who also used the *Republic* as a textbook of politics). Avicenna's several encyclopaedias of philosophy have no section on politics at all. Like Plato and the Platonists, al-Farabi was loath to dissociate politics from metaphysics, psychology and ethics; the same hierarchical order which he demands for the perfect society exists in the human soul (if it is properly cared for) and is almost self-evident in the eternally established order of the universe.

Al-Farabi's ultimate source in philosophy was the Neoplatonic school of Alexandria (which had become a Christian school of philosophy during the 6th century); the Neoplatonic doctrine of emanation had been combined with the Aristotelian view of God and of the universe in the teaching of the last Alexandrian Greek thinkers. He showed, as did Averroes after him, a stronger interest in Aristotle's *Physics* than did Avicenna, who only admitted the metaphysical proof of the existence of God and did less justice to the proof based on the analysis of the physical world. As the Greek commentators had done before him, al-Farabi distinguished between different kinds of intellect (*nous*, '*aql*) in the human soul: the passive or potential or material intellect; the actual intellect; and the acquired intellect, the highest grade of perfection which human beings can reach (Avicenna and the Spanish philosophers share this view). He seems to have been the first among Arabic philosophers to introduce the Aristotelian "active intellect" (*nous poietikos*, '*aql fa''al*)—which Alexander of Aphrodisias had identified with the supreme being—as a metaphysical entity mediating between the first cause and the human intellect and actualizing it as light actualizes the colours which already exist potentially. In doing this he probably followed some unknown Greek predecessor who had modified the Neoplatonic universal intellect in this way. There are star intellects (corresponding to "angels" on the religious level; these are to be found in Averroes as well) but no star souls as assumed by Avicenna, who like Averroes accepted the "active intellect" (which al-Farabi equated with the Koranic Angel of Revelation); but apart from this, the physical world is understood on Aristotelian lines. In the account of the soul, Alexander of Aphrodisias is closely followed, but divination and prophetic inspiration are explained in accordance with some otherwise unknown Neoplatonic doctrine. Prophetic inspiration is a function of imagination and hence only ancillary to reason; the perfect man is philosopher and prophet in one and has in addition all the qualities which enable him to govern the perfect state (which may comprehend the whole inhabited world). There is no union with the "active intellect" in life (as Plotinus and, in a different way, the Arabic mystics believed); it is only after life that the souls of the good, *i.e.*, of the philosophers, become part of the "active intellect," thus losing their individuality, whereas the souls of those who knew the truth and acted against it survive in utter wretchedness. The souls of the majority perish at death. The Koranic promises of reward and punishment in a future world have a practical value on the religious level but no philosophical validity.

Miskawayh.—No major treatise on moral philosophy by one of the more representative Islamic philosophers has come down to us. But the work of a not very independent minor thinker, Abu 'Ali Miskawayh (d. 1030), an older contemporary of Avicenna who has some links with al-Farabi's general attitude to philosophy and religion, can be examined instead. His survey of ethics, *Tahdhib al-Akhlak* ("On the Improvement of Character") was influential in later Islamic literature and gives a good idea of the different trends of Greek ethics which appealed to Islamic philosophers. It is an error to think that Aristotle and his later successors were the only authorities recognized by them; many treatises accept as a basis Plato's threefold division of the human soul and his four cardinal virtues (temperance, valour, justice and wisdom). A particularly popular version of this Platonic doctrine, represented in Greek by Galen (who in his turn depends on the great Stoic philosopher Poseidonius), is reported by Miskawayh in great detail. Apart from this, we find in his treatise (but also elsewhere) an interesting combination of the four Platonic virtues, to which numerous subordinate virtues have been added, with the Aristotelian classification of the virtues as means between extremes. It looks as if Miskawayh had become acquainted with this otherwise not very well-attested Greek scheme of ethics through al-Kindi. As in metaphysics and logic, so in ethics, after the time of al-Farabi, the influence of Aristotle is more noticeable. Hence Miskawayh—following ultimately, it seems, Porphyry's exegesis of the *Nicomachean Ethics* and more immediately al-Farabi—insists that Neoplatonic and Aristotelian views must be reconciled in this field as well. Aristotle is an appropriate guide for human happiness, the highest form of which manifests itself in the philosopher's life,

while Plato shows how to prepare oneself for the world to come. This entails, as in other sections of philosophy as well, that Aristotle appears as a more decided Platonist than he actually was. Thus, for instance, Plato's divine *eros* ("love," "desire"), tacitly disowned by Aristotle, comes, as in Neoplatonic and patristic thought, to its full life again. Developing an Aristotelian idea, Miskawayh establishes a new class of friendship based on the absence of passions (*apatheia*), which comprehends the relation of children to their parents, that of the most excellent men, *i.e.,* the philosophers, to God and that of the disciple to his teacher—who is, for the first time in this Aristotelian tradition, qualified as his "spiritual father" and described as a God-like authority (in the Neoplatonic manner). Many other similar instances could be mentioned. Since the study of moral philosophy, as Aristotle (and Plato) had pointed out, can be undertaken only by those who have been properly brought up in their traditional education, the established Islamic law takes the place of the customarily read Greek authors, and Homer is replaced by the Koran. Whereas by al-Farabi, for instance, the religious law is understood as an approach to truth through symbols (which are different in different religions but all tend, though in varying degrees, in the same direction), for Miskawayh the agreement between the divine law and a theistic philosophy is absolute. Hence it is not surprising that the theological critics of Arabian philosophers not only refrained from condemning their ethical teaching but could even take the greater part of it over without reservation (as al-Ghazzali actually did).

Avicenna.—Avicenna (*q.v.;* 980–1037), who lived in Persia and never stayed in Baghdad (as al-Kindi and al-Farabi had done), partly built on the foundations laid by al-Farabi; but there are very marked differences in his philosophical attitude, to be noticed in certain by no means trivial details and, above all, in his emphasis on Plotinian thought wherever he approached the transcendent world. Besides Aristotle, he knew the spurious *Theology of Aristotle* well and even wrote a kind of commentary on this remarkable Neoplatonic work. He also evidently had access to Greek traditions not known to previous Arabian philosophers, as appears from his discussion of the inner senses, of imagination and of animal instinct and from his definition of prophecy as an intellectual acuteness (*agchinoia*) of the highest order—views which seem to be of pre-Plotinian Hellenistic origin. He maintained the immortality of individual souls and supposed them to survive in different forms according to the degree of perfection attained during the time when each was united to a particular body and thus acquired individuality. This was for him the real meaning of the Islamic belief in resurrection.

On the whole, philosophy was for Avicenna the only way of understanding Islam, and Islam as interpreted in Aristotelian and Plotinian terms was the highest and most perfect way of life to be conceived. He successfully applied this rule wherever philosophical and religious traditions overlap; philosophical contemplation of the higher world, reached as the ultimate result of intense and consistent rational training and self-education, takes the place of the personal prayer of the mystic and expresses its true function. Prophecy is no longer confined to imagination or to the creation of impressive symbols of philosophical truth, but is in itself the highest intellectual quality conceivable. Avicenna defined it by a philosophical (and religious) term as *intellectus sanctus* (*qudsi*), thus making it unambiguously clear that philosophical understanding is the only way of establishing the supremacy of prophecy as shown in the Koran and that religion and philosophy do not represent different levels of truth but are one and the same thing (provided that religion be interpreted in philosophical terms).

Plotinian ideas modified Avicenna's view of the world above the moon and made him add star souls and nonintellectual qualities to the transcendent intellects which rule the different astral spheres. The logical concept of essence and the metaphysical concept of existence are identical for the highest being, the "necessary existent": in God alone essence, what He is, and existence, that He is, coincide. God is the first cause, the highest light and the source of all light, as He is the highest intellect and the highest love. There is a gradual pluralization through a timeless emanation from "the one," and, as in most Arabic philosophers, Aristotle's astronomical theory is combined with this Neoplatonic idea. From God, the necessary being, proceeds the first separate intellect, and this is the only emanation which is produced directly by the Eternal Creator ("from one only one is made"). There is a progressive degradation implied in this eternal emanation. The first separate intellect is the source of a threefold emanation: a soul, a body and a second intellect. When it thinks itself as if being in action and owing its existence to the first principle, the soul of the highest heaven proceeds from it; when it thinks itself as not being absolutely necessary but somehow contingent, the celestial body of the highest sphere, the sphere of the fixed stars, proceeds from it; when it thinks its cause, *i.e.,* the necessary being, it produces the intellect of the next sphere, the sphere of Saturn. This creation recurs eternally and timelessly and repeats itself constantly on every level within the world above the moon. Thus the second intellect produces the soul and the body of Saturn and the intellect which rules the sphere of Jupiter. Mars, the sun, Venus, Mercury and the moon follow. There are always an intellect, a soul and a celestial body—Plotinus' universal intellect and universal soul are thus split up into individual separate intellects and individual separate souls. Al-Farabi (who, more Aristotelian than Avicenna, did not assume that star souls exist) had established an additional sphere surrounding the world, located between the highest being and the sphere of the fixed stars. (This sphere can also be found in some works of Avicenna, who is not consistent as far as the number of separate intellects is concerned.) The active intellect is, according to Avicenna, coordinated with the ever-changing world below the moon and the plurality of human souls and human bodies, the world of temporary coming-to-be and passing away. It has, as the bestower of forms (*wahib as-suwar*), the function of the Plotinian *choregos ton logon* and the *dator formarum* ("giver of forms") of scholasticism, and connects man with the higher world of eternal being. The separate intellects and the souls and bodies of the different spheres can all be equated with the angels of Islam.

Avicenna was a vigorous and systematic mind of the highest order and a master in the lucid arrangement of the vast heritage of Greek thought, which he explained again and again in huge philosophical encyclopaedias of varying size. He was well aware of the individual turn that he gave to many tenets of philosophy and accordingly styled himself an "oriental philosopher" as opposed to the "occidental philosophers" of Baghdad. He was less bent on commenting on the ancients than on expounding philosophical thought as such.

Like Rhazes and Averroes, Avicenna was also an outstanding physician; he became famous in the west from the 12th century onward both as a medical and as a philosophical authority. His impact on Islamic life was profound and continued for a long time.

Al-Ghazzali.—Avicenna was, more than any other Islamic philosopher, the target of the determined attack by al-Ghazzali (*see* GHAZZALI, AL-; 1058–1111) mentioned above. Al-Ghazzali denied that philosophy and natural theology can in fact validly prove the existence of God, the creation of the world, the immortality of the soul, the structure of the universe, divine providence and many other problems. He attacked the philosophers on their own ground and tried not without success to defeat them with their own weapons in his work *The Incoherence of the Philosophers*. He re-established, without rejecting a philosophical approach altogether, religion and prophetic inspiration in their own right and in their superiority. His answer to the inner tensions of Islamic life turned out to be more acceptable and more appropriate to the very spirit of Islam than Avicenna's attempt to identify philosophy and religion in imitation of the Greek religion of the mind. Hence it is with him that the definite though gradual decline of Arabic philosophy begins.

Averroes.—Spanish Arabic philosophy, however (continuing the development which started in the 9th century in the east), did not begin much before al-Ghazzali's time. It is represented by Avempace (*q.v.;* d. 1138), by Ibn Tufail (*q.v.;* d. 1185) and, above all, by Averroes (*q.v.;* 1126–98). It depends to a large extent on al-Farabi and is, accordingly, very critical of Avicenna, who was

well known to all the Spanish Arabic philosophers and particularly to Averroes. Averroes' scholarly and scrupulous commentaries on Aristotle seem not to have found many Arabic readers, but a great number of them were almost at once translated into Hebrew and into Latin and became very important for Aristotelian studies, both Christian and Jewish, up to and beyond the days of the Italian Renaissance. In these commentaries Averroes continued, with some originality, the tradition established in late Greek philosophy which had reached the Arabs in the days of al-Farabi. Following this great predecessor, he even applied himself to the exegesis of Aristotle's *Poetics* and *Rhetoric* and of Plato's *Republic*. His most independent work, indeed almost the most impressive book written by any Arabic philosopher, is his defense of philosophy against al-Ghazzali, entitled *The Incoherence of the Incoherence,* in which he made a supreme effort to show that only philosophy could give a satisfactory answer to the questions raised. He reproached al-Ghazzali for having made God an immortal man, whereas He is in truth the nonhuman and transcendent first cause of all being. His view of the relation between philosophy and religion is almost identical with that of al-Farabi. The so-called Latin Averroists misinterpreted their master in ascribing to him the doctrine of a double truth, namely, that what is true for religion may be false for philosophy. What Averroes maintained was that the same truth may be expressed either in philosophical or in symbolic form.

A doctrine of Averroes which became particularly well known in the Christian west is the doctrine of the unity of all human intellects. Some adhered to it, others rejected it, and the church eventually condemned it as heretical. Averroes adopts the distinction between the material, actual and acquired intellects that is to be found, among Arabic philosophers, already in al-Farabi (*see* above). The human or material intellect is, for Averroes, eternal and is no part of the essence of the individual soul but one and the same for all mankind. In opposition to Aristotle (*De anima*, 430a 23) he can thus, through his Neoplatonic interpretation of the Peripatetic doctrines, regard the passive or material intellect as incorruptible. The active intellect transmits the *intelligibilia* for this material intellect, which, in grasping them, becomes, in a particular individual, first actual and then acquired intellect. Although different persons differ in intelligence and knowledge thus obtained, there is always the same amount of intellectual knowledge in the world. "Scientific knowledge is eternal, ungenerated and incorruptible. By being connected with Socrates or Plato, it perishes when these persons die, but this is accidental and does not impair its essence." For the influence of Averroes on scholastic philosophy in western Europe *see* AVERROISM, LATIN.

Rhazes and the Ikhwan al-Safa.—Such was the highroad of Islamic philosophy, which was still followed for some time after Averroes in various parts of the Islamic world; but two sidelines deserve to be mentioned.

Rhazes (*i.e.*, Mohammed ibn Zakariyya al-Razi; d. 923 or 932) went so far as to disapprove of all the prophets as impostors and promoters of discord among the nations and to see no road to salvation but through philosophy. He rejected both the eternity of the world and creation out of nothing and believed in a divine formation of the world in time out of eternally existing matter. There are five eternal principles, not one as in the other systems: the Creator, the soul of the world, matter, absolute time and absolute space. He wanted to be considered as a Platonist, but was at the same time prouder of his independent judgment than any other Arabic philosopher. He assumed an atomic structure of matter which can only be compared with Democritean and Epicurean doctrines.

The writings of the 10th-century brotherhood known as the Ikhwan al-Safa, which represent philosophical doctrines accepted by the Ismaili movement, are the chief but by no means the only evidence of another influential trend of Arabic philosophical speculation. This in its origin may be earlier than al-Kindi, although it has certain affinities with his general philosophical outlook. It may be characterized as a simplified but rather orthodox Neoplatonism without the admixture of so many Aristotelian elements as are to be found on the main line of Arabian philosophy from al-Farabi to Averroes.

The Kalam and al-Ash'ari.—A word should be said here about the Greek philosophical ideas which had been adopted by Muslim speculative theologians even before the rise of philosophy under the Mu'tazilites and which in the form given to them in the school of al-Ash'ari (10th century) came ultimately to have a stronger impact on Islamic life than the Aristotelian-Neoplatonic trend of Greek provenance. This speculative theology is called *kalam* and its representatives are the *mutakallimun* (*dialektikoi*, "dialecticians"). In its early stage, the *kalam* was merely a defense of Islam against Christians, Manichaeans and believers in other religions; but as the influence of philosophy increased (quite apart from the independent growth of theological speculation) it came to be directed also against the Islamic synthesis of Aristotle and Plato, and arguments which the Greek skeptics and the Stoics had found effective against those two philosophers were employed. The *mutakallimun* rejected potentiality in the Aristotelian sense; possible and actual are identical for them, and before the fact nothing is possible. Hence they would not accept the philosophers' theory of movement and of becoming or the metaphysics and natural theology based on that view. As the Eleatics and the Megarians had done before, the Ash'arites denied becoming and transition in time and movement in space altogether and spoke of "timeless leaps" instead; what we call movement is for them the being of a material atom at the next time-atom in the next space-atom. This implies a peculiar atomic structure of nature which is very different from the Democritean and Epicurean atomism, with which Rhazes was familiar. There are only atoms and "accidents" connected with them by God. There is no natural law and no natural causation but a material passive universe. God is the only agent, the sole active principle, who as the omnipotent transcendent Allah discontinuously creates and recreates His atomic world. It is improbable that this atomic theory depends on Indian views, as has been suggested; links with Greek thought seem to be more obvious.

In ethics, the Ash'arites adopted a determinist view and borrowed Stoic arguments in support of it.

See also JEWISH PHILOSOPHY.

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ARABI PASHA (properly AHMAD URABI PASHA) (1839–1911), Egyptian nationalist leader, was born of peasant stock near Zagazig, in Lower Egypt. He was conscripted into the army and later commissioned (1862). In the Egyptian-Ethiopian war of 1875–76 he served as a commissariat officer. He joined a secret society formed by Ali al-Rubi (later created pasha), a brother officer, with the object of eliminating the Turkish-speaking (mainly Circassian) officers who monopolized the higher ranks of the army. After playing a subordinate part in the officers' mutiny of 18

he was promoted colonel and began to win great popularity among the Egyptian troops as the embodiment of their resentment against foreign control whether Turkish or European. When, early in 1882, Mahmud Sami al-Barudi Pasha (Egyptian patriot and poet, a Circassian by origin) became prime minister, Arabi, with the rank of pasha, was his minister of war, and such was his growing influence that the British government showed alarm and sent a fleet to Alexandria, a gesture which led to riots in which many Europeans were killed. Arabi took command of the rebel forces and put the harbour forts in a state of defense. On the refusal of the French to co-operate, British warships silenced the forts on July 11, 1882. A British expeditionary force under the command of Sir Garnet Wolseley landed at Ismailia on the Suez canal and on Sept. 13 defeated Arabi's army at Tall al-Kabir (Tell el-Kebir). Arabi surrendered in Cairo, where he was tried for sedition. He was sentenced to death, but the sentence was by previous arrangement changed to one of banishment. He and other nationalist leaders were banished to Ceylon, but after an exile of 19 years he was pardoned and returned to Egypt in 1901. He died in Cairo on Sept. 21, 1911. Though not a great leader and certainly no soldier, his popularity rested on his simple, kindly disposition.

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ARABIS, a genus comprising more than 100 species of annual, biennial and perennial herbs, commonly known as rock cress, belonging to the Cruciferae (*q.v.*) family. The usually numerous small, white, pink or purple flowers are borne in terminal spikes or racemes. The species are widely distributed in the northern hemisphere, and *A. albida*, the wall cress, a white-foliaged plant from the Caucasus, is a popular garden perennial for gritty soil or pockets in a wall. Its white flowers are especially fragrant. It has many fine horticultural varieties with pink, yellow and double flowers and one with variegated foliage. Ten other species are cultivated, mostly in British gardens. (N. Tr.)

ARABISTAN, Persia: *see* Khuzistan.

ARAB LEAGUE. The Arab League came into being on March 22, 1945, when the seven Arab states (Egypt, Syria, Lebanon, Iraq, Transjordan, Saudi Arabia, and Yemen) that had become independent since 1919 signed a covenant in Cairo, Egy., forming a loose confederation. The objects of the league, as stated in the covenant, were "to strengthen the ties between the participant states, to coordinate their political program in such a way as to effect real collaboration between them, to preserve their independence and sovereignty and to consider in general the affairs and interests of the Arab countries." A league council was to implement this program. On it each member state was to have one vote, and decisions were to be binding only if unanimously reached. A permanent secretariat was set up in Cairo, and the first secretary-general was the Egyptian 'Abd-al-Rahman 'Azzam (succeeded in September 1952 by another Egyptian, Mohammed 'Abd-al-Khalek Hassuna).

This league fell far short of the ideal of Arab unity which had inspired the Arab movement since its early beginnings in the 19th century. In the period between World Wars I and II, the aspiration to unity came into conflict with local identities and interests in the states created by Great Britain and France and also in Egypt. The Arab states in 1945 found it impossible to embody the idea of greater Arab unity in anything more than a league of sovereign states.

However, the league covenant contained a provision permitting any two or more of its members to enter into a closer form of association than the covenant itself set up. Another significant provision was that Arab countries still under foreign control should have the right to join the league on attaining independence—a right of which Libya (1953), the Sudan (1956), Tunisia and Morocco (both 1958), Kuwait (1961), and Algeria (1962) availed themselves, thus bringing up the membership of the league to 12 states (considering Egypt and Syria as one country, the United Arab Republic).

From the beginning the league was handicapped by differences among its members. These first became clear during the military intervention it attempted in 1948 in Palestine to prevent the establishment of the state of Israel. The intervention was unsuccessful because it lacked unity of purpose and coordination of effort. The league survived, but the differences reappeared in one form or another thereafter. The league's existence may have helped the Arab states to coordinate their policies toward problems of general interest, like those of Palestine and Algeria; but it was not found possible to create a closer political unity. In 1950 the members signed a joint defense treaty setting up a system of collective security; but in the next few years the split between Egypt and other Arab countries which followed a neutralist policy and those with a more pro-Western alignment, as well as local disputes, prevented cooperation except at the moment of the Suez crisis in 1956. In 1961 the disputes were sufficiently composed for the league to hold a council meeting in Baghdad at which all members were present. In the same year the conflict between Tunisia and France provided an occasion for a display of unity, although Iraq's claim to Kuwait subjected the league to internal strain. In spite of Iraq's objection the league admitted Kuwait to membership and raised an Arab force which replaced British troops in Kuwait.

In the following years the plans of the Israeli government in regard to use of the waters of the Jordan River led to further attempts to work out a united Arab policy. In January 1964 a "summit conference" of heads of states, held in Cairo, agreed on a counterdiversion of the Jordan headwaters and the establishment of a joint Arab command. A second summit conference was held at Alexandria in September 1964, a third at Casablanca in September 1965. But this effort also came to nothing, because of disagreements, and in particular because of the civil war which broke out in Yemen in 1962 and into which Egypt and Saudi Arabia were drawn. The fourth summit conference, which was to have been held at Algiers in September 1966, was postponed.

In spheres other than the political the league has proved somewhat more effective. The Economic Council and the economic section of the league's secretariat have done something to strengthen economic ties; but the Arab Development Bank created in 1959 has been inactive. The Boycott Office has had some effect in organizing an economic boycott of Israel. The annual petroleum conferences have provided for the discussion of oil problems, and other specialized conferences and seminars have been held. The Institute of Advanced Arab Studies and the Institute of Arabic Manuscripts, both in Cairo, have done useful work.

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ARACAJÚ, a city and seaport of Brazil, capital of the state of Sergipe (*q.v.*), 170 mi. N.N.E. of Salvador. It is on the right bank of the Cotinguiba, or Cotindiba river, 6 mi. from the coast at the base of a ridge of sand hills. The *municipio* of which it forms a part had a population in 1890 of 16,336, about two-thirds of whom lived in the city itself. Pop. (1950) 78,364, mun.; 67,539, city; (1960) 112,516, city.

Good limestone is quarried in the vicinity of Aracajú, and the country tributary to the port produces sugar and cotton. The back country sends down hides and goat skins for shipment. Electric power comes from the Paulo Afonso falls (*q.v.*). The anchorage is good, but a dangerous bar at the mouth of the river prevents the entrance of vessels drawing more than 12 ft. The river is navigable as far as the town of Maroim, about 10 mi. beyond Aracajú.

The city was founded in 1855. (R. d'E.; P. E. J.)

ARACEAE (Aroideae), the arum family, a large group of monocotyledonous plants containing upward of 100 genera and more than 1,000 species, of which the cuckoopint in Great Britain, and the jack-in-the-pulpit, found in eastern North America, are familiar examples. Neither of these small plants, however, gives more than meagre indication of the characters of this interesting plant family, which attains its most conspicuous development in the tropics.

The aroids are generally herbaceous, often, however, reaching gigantic size; but they are sometimes shrubby climbing plants.

Many are peculiar in form and habit and grotesque in appearance. Various climbing species of *Philodendron* have feeding roots which penetrate the soil and clasping roots that fix the plant to its support. Some are epiphytes (plants that grow perched upon others), and a few, such as the water lettuce (*Pistia stratiotes*), are floating plants.

The leaves, which show great variety in size and form, are generally broad and net veined, though sometimes sword shaped and parallel veined. In *Arum* the blade is simple. In other genera the leaves are divided and sometimes very large; those of *Dracontium* (tropical America) may be 15 ft. high. In the ceriman (*Monstera*) the large perforated leaves appear as if cut full of holes. The small flowers are crowded on thick, fleshy spikes (spadix), which are usually enveloped by a large leaf (bract), the spathe, which is often the most conspicuous feature of the plant. For example, in the cuckoopint the spathe is large and green; in the jack-in-the-pulpit it is purple-striped; in the callas it is white or yellow; and in the anthuriums it is scarlet. In *Amorphophallus*, a genus of about 80 species characteristic of tropical Asia and Malaysia, the "flower" (really an inflorescence consisting of the spathe and the spadix) varies from a few inches to several feet in diameter. The largest is the *krubi* of Sumatra, *Amorphophallus titanum*, its spathe being up to 4 ft. in diameter and its spadix attaining a height of 8½ ft. While this has been claimed to be the largest flower in the world, it is really an inflorescence, its numerous individual flowers being small in size. The true flowers are often extremely simple, sometimes, as in *Arum*, reduced to a single stamen or pistil. The fruit is a berry. Usually the plant tissues are exceedingly irritating when brought in contact with mucous membranes, because of the presence of myriads of minute needlelike crystals (raphides) of calcium oxalate in the plant cells. The raphides are responsible for the pungent taste. Historically the extract has been used in medicine as a carminative. The underground stems (rhizomes or tubers) are rich in starch, those of the tropical taro (*q.v.*) providing a valuable article of food. From the rhizomes of the cuckoopint Portland arrowroot was formerly prepared. The starchy corms of the jack-in-the-pulpit, after proper treatment to eliminate the raphides, were utilized for food by the Indians of eastern North America.

T. H. EVERETT

ANTHURIUM ANDRAEANUM, ORNAMENTAL SPECIES OF ARACEAE, FOUND IN COLOMBIA

Besides the cuckoopint, the *Acorus calamus* (*q.v.*) or sweet flag occurs in Great Britain, though it is supposed to have been introduced. In North America about 15 native species of aroids are found, chiefly in the southern and eastern United States. Among these are the jack-in-the-pulpit, golden club, skunk cabbage (*qq.v.*), green dragon, water lettuce, wild calla (*see* CALLA) and sweet flag. Only one, the western skunk cabbage (*Lysichiton*), occurs on the Pacific coast.

In tropical America taro (*Colocasia*) is replaced in cultivation by the yautia (*Xanthosoma*) which, like the taro, is an important food plant. Because of their unusual foliage and inflorescence, numerous species of *Alocasia, Anthurium, Caladium, Colocasia, Dieffenbachia, Scindapsus, Xanthosoma* and other genera are grown in greenhouses for ornament and as curiosities.

A good series of tropical aroids may be seen in the aroid house at Kew, and in the United States in the display greenhouse of the New York Botanical garden in the Bronx, New York city. Perhaps the best collection in tropical gardens is that in the Botanic Gardens of Indonesia at Bogor, Java.

ARACENA, a town of Huelva province, Andalusia region, southwest Spain, is situated on the southern slopes of the Sierra de Aracena, 94 km. (57 mi.) by road N.W. of Seville. Pop. (1960) 7,643 (mun.). The parish church of the Assumption has fine sculpture by Juan Martínez Montañés. The 13th-century castle church is situated on the summit of the hill on which are the ruins of the castle, and has three naves and an apse shaped like a polygon (13th century). There is a gateway of the former convent of Santa Catalina and a 12th-century tower remaining from the mosque. The bracing climate and the Gruta de las Maravillas, which has a subterranean lake and a great number of stalactites and stalagmites in weird shapes and beautiful colours, attract many tourists.

ARACHNE, in Greek mythology, the daughter of Idmon of Colophon in Lydia, a dyer in purple. She had acquired such skill in the art of weaving that she ventured to challenge Athena. The goddess wove a tapestry depicting the gods in majesty, while Arachne showed their amorous adventures. Enraged at the perfection of her rival's work, Athena tore it to pieces, and Arachne hanged herself in despair. But the goddess out of pity loosened the rope, which became a cobweb, while Arachne herself was changed into a spider (related by Ovid in the *Metamorphoses*). The name Arachne means spider. An ancient illustration of the story can be seen on a frieze from the Forum of Nerva in Rome.

(T. V. B.)

ARACHNIDA, a class of the phylum Arthropoda (*q.v.*) that includes spiders, scorpions, daddy longlegs (harvestmen), mites, ticks and many other less familiar forms. Arachnids are a ubiquitous group: the great majority of them are land animals, encountered in a variety of habitats throughout the world. They are chiefly predators, subsisting on other arthropods. Their characteristics are typically arthropodan: paired, jointed appendages; anterior sense organs; and a hardened outer covering (chitinized exoskeleton). They are distinguished in part from other arthropods by having a body divided into two principal regions, six pairs of appendages and only simple eyes.

Arachnids are variable in both size and appearance. They range from tiny mites no more than 0.1 mm. long to the enormous black scorpion of Africa that is 180 mm. (slightly more than 7 in.) long. In form they vary from small rounded, inconspicuous kinds to long-legged, agile runners; crablike spiders; and elongate fast-running predators.

This article is divided into the following sections:

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I. INTRODUCTION

The following living orders are included in the class Arachnida: Scorpiones (or Scorpionida) (scorpions); Pseudoscorpiones (or Chelonethida) (false or book scorpions); Acari (or Acarina) (mites and ticks); Opiliones (or Phalangida) (harvestmen, or daddy longlegs); Schizomida (schizomids); Palpigradi (palpigrades); Phrynichida (tailless whip scorpions); Thelyphonida (whip scorpions); Araneae (or Araneida) (spiders), Ricinulei or

Podogona (ricinuleids) and Solifugae or Solpugida (solpugids, or sun spiders). In addition, five fossil orders are known from strata dating no later than the end of the Upper Carboniferous (about 235,000,000 years ago).

At times the "horseshoe crab" (*Limulus*) is included in the Arachnida, but because of certain features of its anatomy and life habits it is usually awarded a class of its own, the Merostomata.

For a more detailed classification see *Classification* below.

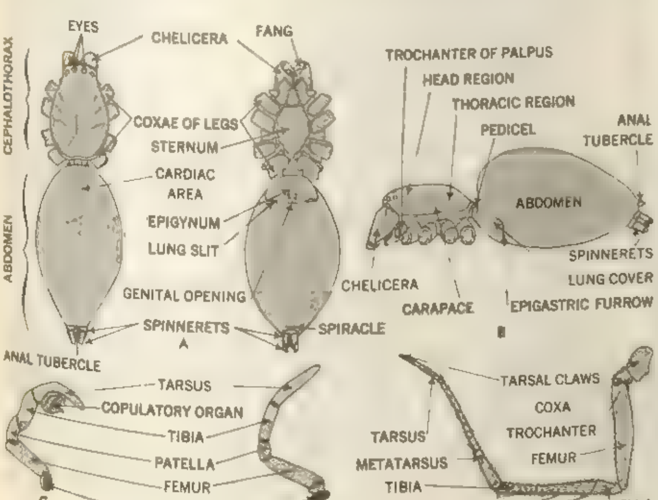
1. Distribution.—Although the number of arachnids encountered in the temperate portions of the world is truly impressive, the number and variety is even greater in the tropical and subtropical zones. In both temperate and tropical areas, spiders are the most conspicuous arachnids; the smaller mites and ticks, however, exceed them in numbers. Opilionids and pseudoscorpions likewise are abundant in temperate areas, and a few scorpions may be found in milder climates. In tropical and subtropical areas scorpions are frequently encountered along with schizomids and palpigrades under leaves, stones or fallen logs. The thelyphonids are often conspicuous and abundant, as are the solpugids. Spiders are everywhere.

Arachnids of various kinds may be found in all parts of the habitat. Thus some dwell chiefly in shrubs, herbs and trees, others on the ground, and still others are encountered only under fallen leaves, twigs, logs and stones. Spiders are the most diverse of the arachnids in their structure, habits and distribution. Many of the tarantulas of the United States and Central and South America make elaborate silk-lined burrows in the ground in which they live for several years. Young spiders are able to utilize a strand of silk as a "balloon," and as a result, may drift to very high altitudes or far from land.

2. Relationships.—Members of the phylum Arthropoda, to which the arachnids belong, have many characteristics such as a segmented body, paired appendages and anterior sense organs in common with the segmented worms (phylum Annelida). The arthropods have of course gone far beyond the annelids in their evolutionary development and have added a chitinous exoskeleton and jointed appendages. The arachnids are related to other arthropods such as the crustaceans, millipedes, centipedes, insects and horseshoe crabs. Their possession of four pairs of walking legs (instead of three pairs) and lack of antennae, wings and compound eyes distinguish the arachnids from all other arthropods.

II. EXTERNAL ANATOMY

Typically, arachnids have a body divided into two principal portions, the cephalothorax (the joined head and thorax) and the abdomen. Segmentation of the body is very variable among the different orders. Six pairs of jointed appendages are present: the first pair, the chelicerae (sing. chelicera), are prehensile and are used to hold or grasp prey; the second pair, the palpi (sing. palpus), or pedipalps, may be leglike organs of touch (tactile organs) or large chelate (pincerlike) raptorial organs; and the remaining four pairs are so-called walking legs.



(A, B) FROM KASTEN, "HOW TO KNOW THE SPIDERS," WM. C. BROWN COMPANY, PUBLISHERS; (C, D, E) FROM D. J. BORROR & D. M. DELONG, "AN INTRODUCTION TO THE STUDY OF INSECTS," HOLT, RINEHART AND WINSTON, INC. (1959)

FIG. 1.—SPIDER BODY PARTS: (A) LEFT, DORSAL AND RIGHT, VENTRAL VIEWS; (B) LATERAL VIEW; (C) MALE PEDIPALP; (D) FEMALE PEDIPALP; (E) WALKING LEG

1. Segmentation.—The segmentation of the adult arachnid is not the same as that of the embryo. Presumably the embryo has the original, primitive number of 21 longitudinally arranged segments (somites). The exact number, however, is not certain, for it is difficult to determine the number of somites in the head region. The thoracic portion of the cephalothorax is believed to be composed of five somites, and the abdomen of 12. This original number is retained in the adult segmentation of thelyphonids, schizomids, phrynichids, pseudoscorpiones and some spiders. The adult scorpion also has 12 somites in the abdomen: although the first one is reduced, the eighth is subdivided so that the total number is still 12.

A commoner condition is that in which there is either a partial or complete loss of segmentation either through a fusion of somites or through their disappearance beginning with the last somite and progressing forward. The solpugids and palpigrades have only 11 somites in their abdomens, for the 12th has been lost. Most spiders have lost as many as seven posterior somites. The first abdominal somite forms a slender pedicel by which the abdomen is attached to the cephalothorax, and the second to fifth somites fuse. Among the acarids external segmentation is usually lacking.

In those arachnids having segmented abdomens, the sternites (ventral plates of the somites) are also subject to fusion, resulting in a smaller number of sternites than that of tergites (dorsal plates). The second and third sternites show all degrees of fusion, with some fusing to form a single plate. Among the pseudoscorpiones each sternite is subdivided by a longitudinal line into a pair of scuta. The tergites are less subject to fusion than are the sternites, possibly because the first sternite is crowded out by the basal segments (the coxae—sing. coxa) of the fourth pair of legs. Nevertheless, as many as eight tergites may be completely fused and form a single dorsal plate with the carapace. This is true among the opilionids. Among the pseudoscorpions, the tergites are subdivided by longitudinal lines, and a superficial segmentation (not reflecting the true segmentation) is found among some acarids.

The telson and cucullus are movable structures that have no relationship to the true embryonic segmentation. The telson is a dorsal postanal outgrowth of the body wall, articulated to the anal segment; it may be single-jointed as in scorpions in which it is developed as a sting or composed of numerous segments as in whip scorpions. The cucullus is a dorsal hoodlike plate articulated to the anterior edge of the carapace among the ricinuleids. It also is an outgrowth or fold of the dorsal body wall.

2. Cephalothorax.—The head and thorax of the arachnids form a single unit, the cephalothorax. This is true even in animals such as the solpugids that have evident thoracic segmentation as adults. If the fusion of the thoracic somites with the cephalic ones is complete, the dorsal surface of the cephalothorax is protected by a chitinous shield, the carapace. This condition is found among the scorpions, pseudoscorpions, thelyphonids, phrynichids, spiders and ricinuleids. When only one, two or three thoracic somites are completely fused with the head and the following ones remain independent and have their own dorsal plates (tergites), the segmented carapace is divided into three portions. The first (peltidium) forms the front and extends over the first two pairs of walking legs, the second (mesopeltidium) is over the third pair of walking legs, and the third portion (metapeltidium) is over the fourth pair of walking legs. This is characteristic of the schizomids, palpigrades and solpugids.

Most arachnids have eyes that are situated on the carapace. They are always simple eyes (ocelli), never compound.

The ventral surface of the thorax is occupied chiefly by the basal segments (coxae) of the appendages. Those portions of the thoracic ventral wall that are retained are represented by the underlip and the sternum. The sternum may be a single plate as

in spiders, or three or four sternites. The number and structure of the sternites are characteristic for each order and show considerable variation.

Appendages.—Typically, arachnids have six pairs of appendages on the cephalothorax. Among the mites there are exceptions to this generalization: larval mites frequently have only three pairs of legs; the eriophyids have only two pairs of legs in all stages; and two other families have only three pairs of legs as adults or at times only a single pair.

The first pair of appendages, the chelicerae, are not invariably chelate (pincerlike). Some are retrovert; that is, the claw opens and closes like the blade of a pocket knife. The immovable "finger" of the distal (end) segment of the chelicera is merely a process of the body wall, not an independent segment as is the movable finger. Chelicerae may be two-jointed, as in spiders, or three-jointed, as in scorpions; in the embryo of all orders they are postoral, but in the adult they are always preoral. The chelicerae usually function as mouthparts but often have other important functions as well.

Among the solpugids the males use the chelicerae to transfer sperm into the genital opening of the female. Among the spiders the fanglike process of the distal segment of the chelicerae is perforated by the duct of the poison gland, the poison being injected into the wound inflicted by the fangs. In pseudoscorpions the movable finger of the chelicerae bears a galea (spinneret) through which silk produced by a special gland is passed. Chelicerae are often provided with sound-producing devices (organs of stridulation), as in many spiders and solpugids. Among the thelyphonids and the mygalomorph and liphistid spiders, the terminal joint of the chelicera moves up and down in a plane parallel to the body. The fangs of other spiders and the movable fingers of the chelicerae in scorpions moves in and out laterally.

The second pair of appendages is the palpi. Each palpus usually has six segments: the basal joint, or coxa, which may have a chewing or crushing jawlike process (the "maxillary"); the trochanter; femur; patella; tibia; and tarsus. In scorpions and pseudoscorpions the palpi are powerfully developed, the last two joints forming a "hand" with two fingers acting as pincers. One of these fingers is always immobile and is merely a process of the hand; the other finger is movable. The hand of pseudoscorpions bears a poison gland, the duct of which opens at the tip of the immobile finger. The palpi of thelyphonids and phrynichids, also powerfully developed as grasping organs, are termed raptorial. The palpi of solpugids have a tactile function and are used occasionally in locomotion. Stridulating organs are found on the trochanter of the palpi in many spiders. The most remarkable modification of the palpi, however, is found in all male spiders; in these forms the terminal joint is developed as an organ of copulation.

Each leg of the four pairs of walking legs usually has seven segments: the coxa, trochanter, femur, patella, tibia, metatarsus and tarsus. The placement of the coxae is typical for whole orders of Arachnida, with some variation among species occurring within any one order. In scorpions the coxae of the first and second pairs of walking legs are provided with somewhat elongate processes, the gnathobases, that bear maxillary glands producing digestive enzymes. In opilionids the coxa of the first walking leg and occasionally that of the second also have gnathobases, but in all other arachnids gnathobases in coxae of walking legs are lacking. The trochanter forms the "hip" joint and usually is very short, with only a single point of articulation with the coxa. Among spiders and opilionids this articulation is a weak point and the animal can cast off the leg if it is injured or trapped. Among some arachnids the trochanter is subdivided into two joints, or a piece of the femur becomes independent and assumes the function of a second trochanterial joint. The "knee" is formed by the articulation of the femur with the patella; the latter can move only up and down. The articulation of the tibia with the patella is in a plane at right angles to the knee articulation. The upward movement of the metatarsus, like that of the patella, cannot go beyond the complete extension of the leg when the axis of the joints forms a straight line. Further upward motion of the foot is therefore restricted to the tarsus. The tarsus, the "foot" proper, is usually single-jointed and rigid but may be composed of several segments or of many secondary subdivisions and may show considerable flexibility, as in opilionids and some spiders.

The first pair of so-called walking legs in thelyphonids, schizomids and phrynichids is modified as tactile organs. Among most opilionids the second pair of legs is tactile and the first is used for walking. The ricinuleids have the third pair of legs modified for copulation, special devices on the metatarsi and tarsi being used for that purpose. Among the solpugids the coxa and trochanter of each leg of the fourth pair are supplied with special sense organs in the shape of stalked plates, the malleoli or racket organs.

With few exceptions the legs end in one, two or three claws. An adhesive pad is often present, formed either by modified hairs that are flattened and supplied with minute barbs holding them together, or by concave, sometimes trumpet-shaped, pads known as arolia. Adhesive structures are usually present only on legs with two claws; this is always the case when the structure is an arolium. Hairs adapted for clinging, however, occur among some spiders that have three-clawed legs.

3. Abdomen.—The abdomen of arachnids may be broadly joined to the cephalothorax, as in the opilionids, scorpions, pseudoscorpions and mites, or narrowly joined by means of a stalklike petiole, as in the palpigrades, thelyphonids and spiders. The sexual ducts usually open on the second segment, beneath the base of the abdomen in all arachnids but the acarids. Among the spiders a special chitinous structure (the epigynum) present around the genital openings of the females, is useful in classification.

Appendages.—Abdominal appendages, which appear as round knobs in the embryo of most arachnids, disappear before completion of development. Among scorpions the abdominal appendages of the third body segment (somite) develop into combs that persist throughout life. These appear to detect ground vibrations. In spiders each embryonic knob of the fourth and fifth somites becomes forked (biramous) during development, forming four pairs of silk-spinning nipples called spinnerets; all other rudiments of abdominal appendages disappear. In most spiders, however, the inner branches of the first pair of the developing spinnerets disappear, so that only six spinnerets remain. The disappearance of more spinnerets results in only four being present in the mygalomorphs and some other spiders and only two in other forms. Among the cribellate spiders the inner branch of the rudimentary abdominal appendages of the fourth somite flattens out and becomes perforated by numerous openings for the ducts of special silk glands, forming the cribellum. The nipplelike colulus of noncribellated spiders is the last remnant of the same branches but is without the corresponding silk glands. The book lungs also may represent modified abdominal appendages.

4. Sense Organs.—Most arachnids have simple eyes (ocelli) situated on the carapace. The corneal lens is discarded and replaced by a new one at every molt. The cells that produce the lens are themselves modified and form a transparent "glass" body. The lens may be spherical, oval or even irregularly triangular, as in some spiders. The light-sensitive retina is direct in the median pair of eyes (anterior median in spiders) but inverted in lateral eyes. Images formed on the retina vary in sharpness and size, depending upon the shape of the lens. The fields of vision are determined by the position of the eyes on the carapace.

The acuity of vision is always less than that of vertebrates and is different for each pair of eyes in the same individual. Scorpions may have as many as five pairs of lateral eyes in addition to the median pair. Opilionids have only median eyes. Some arachnids are blind. Eyes with an inverted retina often have a layer (tapetum) of pigment cells that reflect light and give the eyes a pearly appearance. Such eyes have been termed nocturnal in contrast to those eyes lacking a tapetum.

The best developed sense among arachnids is the sense of touch. Sensory hairs of various types are found all over the body but chiefly on the appendages. One type, known as trichobothria, is sensitive to currents of air.

Crab spider (*Misumen[illegible] aleatorius*), white in summer turning to yellow in autumn

Black widow (*Latrodectus mactans*), with red mark on underside of abdomen, is venomous but rarely fatal to adult human

Scorpion (order Scor[illegible]). Smaller forms, like those found in southwestern U.S., are moderately venom[illegible]

Spiny-bodied spider (*Micrathena sagittata*), marked by its fearsome-looking spines and vivid colour

"Tarantula" (*Dugesiella hentzi*), among the largest of American spiders, is, contrary to popular belief, harmless to man

Striped harvestman (*Leiobunum vittatum*), though spiderlike is not a spider but a phalangid

ARACHNIDS

PHOTOGRAPHS, (EXCEPT LEFT CENTRE) JOHN H. GERARD, (LEFT CENTRE) ENCYCLOPÆDIA BRITANNICA FILMS; IDENTIFICATION OF SPECIMENS (EXCEPT LEFT CENTRE) BY WILLIS J. GERTSCH, AMERICAN MUSEUM OF NATURAL HISTORY

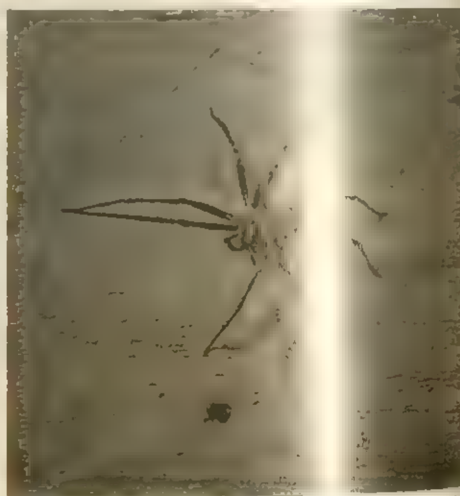
ARACHNIDA

Hunting spider (*Castianeira longipalpus*), aptly named because it does not lie in wait for its prey

Stick spider (*Tetragnatha elongata*) has elongated body and legs that ... nes camouflage among branches

Golden garden spider (*Argiope aurantia*) is found throughout the U.S. It is an orb-weaving species

Mite (suborder Trombidiformes). Some are smaller than a pinhead



Brown spider (*Loxosceles reclusus*) a venomous species found in Missouri and neighbouring states of the U.S.

Wolf spider (*Lycosa aspersa*), like the hunting spider, chases and captures its prey

Say's harvestman (*Libitiodes sayi*), of an order entirely different from spiders

ARACHNIDS

PHOTOGRAPHS, JOHN H. GERARD; IDENTIFICATION OF SPECIMENS BY WILLIS J. GERTSCH, AMERICAN MUSEUM OF NATURAL HISTORY

The olfactory sense seems to be restricted to sexual odours, though strongly irritant substances are detected. It appears that the minute lyriform slit organs situated on the appendages of some forms are olfactory in function.

Although many arachnids have sound-producing organs, no sense of hearing has been demonstrated in the group.

III. INTERNAL ANATOMY

1. Endoskeleton and Musculature.—All arachnids possess an endoskeleton located in the cephalothorax and in the abdomen. In the cephalothorax the endoskeleton consists of a chitinous endosternite and pocketlike apodemes, both of which originate as invaginations of the body wall. In the abdomen the endoskeleton consists of apodemes alone. Both elements serve for the attachment of muscles.

The muscular system is extremely complex. Some muscles hold the endosternite in place and act as the locomotor muscles of the palpi and legs. Other muscles in the cephalothorax are those moving the chelicerae and those expanding the pharynx and gizzard. At the posterior end of the cephalothorax are the muscles attached to the abdomen; these are especially developed in those arachnids having a petiolated abdomen. The abdomen itself contains many muscles including segmentally arranged longitudinal dorsal and ventral muscles of the abdominal wall; dorsoventral muscles; muscles moving the combs in scorpions, the spinnerets in spiders; etc. Within the appendages also are many muscles.

2. Digestive System.—The alimentary canal of arachnids is divided into three portions. The anterior portion, or fore-gut, and the posterior portion, or hind-gut, are ectodermal in origin and their chitinous lining is replaced by a new one at every molt. The middle portion, or mid-gut, has an endodermal lining and is without a chitinous lining. The three sections of the alimentary tract have more or less the same structure in all arachnids but vary considerably in detail, and are more or less correlated with the method of feeding.

Fore-gut.—The fore-gut serves for the passage of food into the mid-gut, where the food is digested. In many cases the fore-gut serves also for the outward passage of digestive enzymes through the wound inflicted by the chelicerae into the body of captured prey for predigestion. In its highest development in the spiders, the fore-gut consists of a pharynx, an esophagus and a gizzard. The pharynx is a complex organ acting both as a pump for sucking in food and a sieve for preventing coarse particles from passing into the esophagus. The esophagus is merely a conducting tube that passes ingested fluid into the gizzard, a second powerful pump aiding both in ingestion of food and in its passage into the mid-gut. In opiliones the pharynx has no straining action; thus these arachnids are capable of ingesting fairly coarse particles. The gizzard may be poorly developed, as in scorpions in which it is merely a dilation of the esophagus.

Mid-gut.—The anterior portion of the mid-gut (the thoracenteron) is situated in the cephalothorax. It consists of paired blind tubes with outpocketings (caeca). The thoracenteron wall is built up of two types of cells, absorbing and enzyme-producing. The interstitial tissue between the tubes is poorly developed or

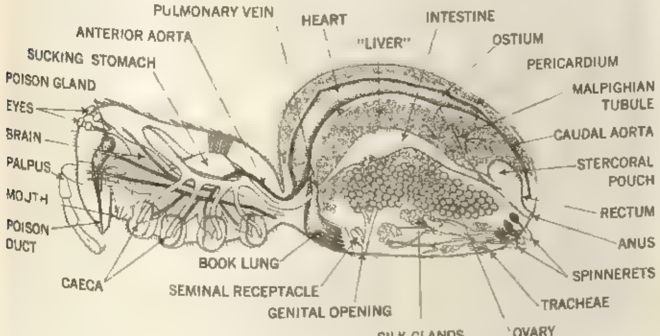


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FIG. 2.—STRUCTURE OF SPIDER AS SEEN WITH LEFT SIDE OF BODY REMOVED

lacking, except in scorpions. The portion of the mid-gut situated in the abdomen consists of a tube with several many-branched tubules that end in sacs (ampullae) held together by interstitial tissue; the whole complex was formerly spoken of as the "liver," but is rather a digestive gland. The walls of this gland are built up of the same type of cells as those of the thoracenteron. The main tube forms the stercoral pouch at its posterior end near the rectum. Excrements are formed in this pouch.

Hind-gut.—The hind-gut consists merely of a very short rectum that opens by means of an anus at the end of the abdomen. An anal covering (operculum) is present in some arachnids but lacking in others.

Living arthropods form the chief food of arachnids; scavengers are known only among mites. Some opilionids feed on snails, and certain mites are the only arachnids that feed on plants.

3. Circulatory System.—Most arachnids have an open circulatory system in which there are no true capillaries and no veins; certain acarids, however, lack any kind of circulatory system. The main cavity of the arachnid body is termed a haemocoele; it consists of expansive blood channels (sinuses) that lie among the tissues and surround all the organs. (A true coelom is represented by segmental coelomic sacs.)

The tubular heart, dorsally situated in the abdomen, pumps blood through the vessels and into the sinuses, where tissues absorb oxygen and food and release carbon dioxide and other waste products. The heart has from two to seven pairs of funnel-shaped valvelike openings (ostia) that allow blood to enter the heart but not leave it through channels other than the anterior aorta and the abdominal arteries. The elongate heart is composed of two layers of muscular fibres, an inner circular and an outer longitudinal one, and is surrounded by a tubular membrane, the pericardium. A large artery (anterior aorta) goes forward into the cephalothorax, then forks, the two branches passing on either side of the gut under the endosternite. At this point they open into a sinus from which arteries supplying the appendages arise. In the abdomen the heart gives off lateral arteries and a posterior artery (caudal aorta) that usually forms three branches. Blood, after circulating, is returned to the heart through the pericardial sinus.

Blood.—There are several types of corpuscles in the colourless circulating blood. The copper-containing respiratory pigment hemocyanin, dissolved in the blood plasma, turns blue upon exposure to air. Clotting is effected by agglutination of blood corpuscles.

4. Respiratory System.—Arachnids respire by means of book lungs, tracheal tubes, or a combination of the two. Each book lung consists of an invaginated pouch located in the anterior portion of the ventral abdomen, and opens to the surface by a thin slit. A series of thin, leaflike plates, through which course very fine blood vessels, are arranged horizontally within each lung. The hollow, thin-walled tracheal tubes are like those found in insects: openings (spiracles) allow air to flow into the larger elastic tubes (tracheae) and from them into the finer branches (tracheoles) that ramify throughout the body. Both types of respiratory organs, in proximity to tissue cells and blood sinuses, effect easy exchange of gases through moist lining membranes.

Four pairs of book lungs, the greatest number known, are found only in scorpions. Schizomids have but a single pair; phrynichids and thelyphonids two pairs. Solpugids, pseudoscorpions, ricinuleids, opiliones and acarids have only tracheal tubes. Spiders show the greatest diversity in the structure of their respiratory system. Some have two pairs of book lungs; others have only a single pair and, in addition, tracheal tubes; and still others only tracheal tubes. The number and position of the tracheal spiracles often varies within the same order but is fixed in others. The solpugids have seven spiracles: the first pair is situated on the cephalothorax between the second and third coxae, the second and third pairs on the third and fourth abdominal sternites and the single seventh spiracle on the fifth sternite. Opiliones have a single pair of spiracles on the second abdominal sternite.

The position of the spiracle also varies among the acarids. In some acarids there are no respiratory organs; oxygen passes di-

rectly through the thin body wall. Among palpigrades certain ventral sacs may have a respiratory function.

5. Excretory System.—Excretion is accomplished by the coxal glands or by Malpighian tubules. The coxal glands are modified nephridia (small, tubular excretory organs of invertebrates) consisting of a blind pouch (sacculus), a more or less convoluted tubule (labyrinth) and one or two outlets to the outside at the base of the coxae. The position of these outlets varies from order to order. One or two pairs of Malpighian tubules are present in most arachnids but are lacking in the opilionids. These tubules open into the gut, at the junction of the hind-gut and mid-gut, and excrete crystals of guanine, the end product of nitrogenous metabolism. These crystals may be excreted through the anus or stored in special cells that form white patterns visible through the skin.

6. Nervous System.—The central nervous system of arachnids is of the same type as that of other arthropods; it consists of a dorsal brain and a ventral chain of paired ganglia, typically one pair for each somite. This original condition is found only in the embryos of scorpions and possibly some other arachnids. In all adult arachnids the ventral chain presents numerous modifications generally consisting of a forward displacement of ganglia and a more or less complete fusion of them in the cephalothorax. The brain is composed of a fore-brain with nerves for the eyes and a hind-brain with nerves for the chelicerae. It is connected with the ventral nerve cord by means of heavy nerves that surround the anterior portion of the digestive tracts. In some arachnids, such as scorpions and thelyphonids, some of the ganglia remain in the abdomen, though rarely in their original place; in others, such as spiders, all abdominal ganglia move into the cephalothorax. The five pairs of thoracic ganglia give off nerves to the thoracic appendages; the second abdominal ganglia, always incorporated in the thoracic mass, give off nerves to the second somite. The sympathetic nervous system (responsible for involuntary functions) is represented by a cardiac nerve and a pair of stomodeal nerves (innervating the fore-gut) originating in the hind-brain.

7. Reproductive System.—Among the arachnids the sexes are always separate, and the genital opening is found on the second abdominal somite in both sexes. This is true of all orders but the acarids. Among the latter the genital openings may be either dorsal or ventral in position, apparently varying with the habits of the various species.

Among scorpions and opilionids the male copulatory organs are connected with the reproductive organs. The copulatory organs of scorpions consist of a pair of ventral outgrowths of the genital operculum; in the opilionids there is a single tubular penis that can be withdrawn into a sheath. The pseudoscorpions have a pair of noncopulatory accessory reproductive structures, the "ram's horns," which are protrusible (see *Mating Behaviour* below).

Neither the ricinuleids nor spiders have male copulatory organs that are directly connected with the reproductive organs. Among the ricinuleids the third pair of legs has a copulatory apparatus, and among the spiders the palpi of the males are modified for the transference of sperm to the female.

When present, the external genitalia of females are on the second abdominal somite. Female opilionids have a long retractile egg-laying structure (ovipositor), and many female spiders have the aforementioned epigynum, a chitinous structure of unknown function that surrounds the genital openings.

In the male two small testes lie below the intestine; each is joined by a coiled tubule to a single seminal vesicle that leads to the genital opening. The female has two large ovaries, also below the intestine, that each join the vagina (the chamber that receives the male copulatory organ) by an oviduct; two seminal receptacles, which join the vagina near the genital opening, store the sperm deposited in the vagina by the male.

IV. REPRODUCTION AND GROWTH

1. Development.—Most arachnids are egg layers (oviparous). Some groups, however, produce living young (are viviparous), and still others produce eggs that are incubated and often hatched within the parent's body (are ovoviviparous). Some mites are parthenogenetic; that is, they are able to produce young from eggs that have not been fertilized by sperm.

The oviparous forms include, among others, spiders, opilionids, thelyphonids and some mites. Many of these forms, such as the spiders, encase their eggs in cocoons that they deposit in small crevices or attach to the web or some other support. Other arachnids simply lay their eggs in a crevice or small hollow in the soil, and some forms carry their eggs about or guard them in a nest.

The viviparous arachnids include some species of scorpions and some acarids. These forms retain the eggs within the oviducts of the females. Among some scorpions, however, the embryo has a tubular extension, somewhat like an umbilical cord, along which nutrient fluids from the intestinal wall of the mother pass to the mouth of the embryo.

A few solpugids and certain acarids are considered to be ovoviviparous. In one solpugid, *Galeodes*, the eggs develop in the ovarian tubes to an advanced stage, then hatch from the eggs within a day or two after being laid.

The young arachnid emerging from the egg resembles the adult, yet shows considerable differences. The freshly hatched ricinuleid or acarid has only six legs—only four among some acarids—and is called a larva. Later stages among the pseudoscorpions are termed nymphs. In other arachnids the shape of the body, the proportions of the appendages and the placement of the eyes are not quite the same as in the adult. Sexes are difficult to distinguish until the later stages. Among some arachnids the young remain with the mother until after the first molt and then disperse.

2. Growth.—The heavy, chitinous exoskeleton, which very effectively protects the arachnid from mechanical injury and drying, must be shed periodically as the animal grows.

Molting.—Molting (ecdysis) occurs at varying intervals during the growth period of arachnids, and the periods of time between molts are known as stadia. When the animal is about to molt, it usually hides in some protected spot. Some spiders spin special webs or sheets upon which they lie while discarding their outgrown exoskeleton. The new exoskeleton is soft and flexible, and all growth in size can occur only during this period directly following the molt. Until the new exoskeleton hardens, the arachnid is quite helpless and is often preyed upon by small insects that it ordinarily could avoid.

The number of molts required to reach maturity varies widely from group to group. Among the scorpions *Palamnaeus longimanus* apparently has eight stadia and *Androctonus australis* seven. The spiders show great variation. Small species molt 4 or 5 times, medium sized ones 7 or 8, and the large tarantulas may molt as many as 22 times before reaching maturity.

Life Span.—Although it seems quite certain that in the temperate areas most arachnids live but a single year, there are species which apparently survive for several years. Whip scorpions, scorpions and solpugids appear to live more than a single year, and some of the large tarantulas have been kept in captivity for as many as 20 years.

V. NATURAL HISTORY

1. Living Habits.—Most arachnids are free-living terrestrial forms. There are, however, exceptions to this generalization: some acarids live in fresh water, others in the sea and some are parasitic. Some species of spiders have become adept at living near water; they are able to run upon the water's surface and dive. One spider, found in Europe and Asia, *Argyroneta aquatica*, builds a tent under water and fills it with air. All arachnids are characterized by the fact that their behaviour, no matter how complex, is instinctive.

The great majority of arachnids lead solitary lives, hunting or waiting for their prey. Apparently the only time they get together is during mating. Even this "socializing" may be for only a brief period, for often the female is larger than the male and will consume him after mating if he does not escape.

Some opilionids, a few acarids and a dozen or so species of spiders are gregarious. In drier areas, such as the southwestern U.S., the opilionids sometimes congregate by the thousands in

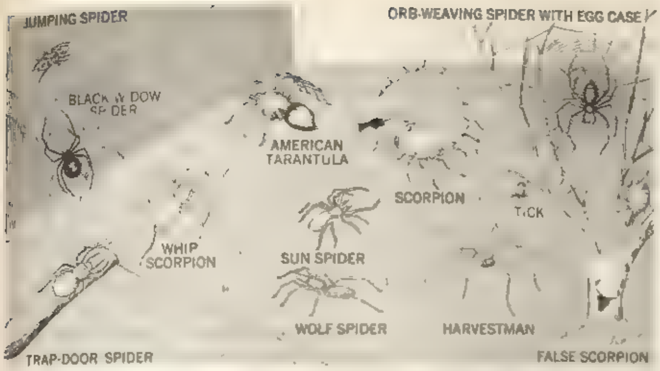

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FIG. 3.—REPRESENTATIVE ARACHNIDS IN CHARACTERISTIC HABITATS: (NOT DRAWN TO SCALE) JUMPING SPIDER (SALTICUS); BLACK WIDOW SPIDER (LATRODECTUS), TRAP-DOOR SPIDER (BOTHRIOCYRTUM); WHIP SCORPION (MASTIGOPROCTUS); AMERICAN TARANTULA (APHONOPELMA); SCORPION (VEJOVIS); SUN SPIDER (EREMOBATES); WOLF SPIDER (LYCOSA); HARVESTMAN (PHALANGIUM); FALSE SCORPION (APOCHEIRIDIUM); TICK (DERMACENTOR); ORB-WEAVING SPIDER (ARGIOPE)

great masses under roofs, bridges or other protected areas. This behaviour pattern appears to be a method of conserving moisture during dry periods. Those spiders that are gregarious live in large "community" webs.

2. Food-getting.—The manner in which arachnids obtain their food also varies greatly. Scorpions probably do not go out to seek their food, rather they wait in their lairs until suitable prey comes along. The solpugids are predatory and have an extraordinary voracity; the long-legged forms can run at a great speed in search of prey. They have been known to kill not only insects, but even large spiders, scorpions and lizards. Only when they are gorged with food or are pregnant do the solpugids become sluggish. It appears that the pseudoscorpions also wait for their prey to come along. The large American whip scorpion (*Mastigoproctus giganteus*) is nocturnal and moves about slowly and cautiously, touching all objects as it searches for prey. Once an insect is grasped it is carried to the burrow before being eaten. The opilionids feed on fresh or recently dead animal tissue; they also eat a great variety of other materials such as fungi, seeds or even bird droppings.

Spiders show tremendous variation in their food-getting habits: some forms sit quietly beside their webs, waiting for some hapless insect to get entangled, while others actively run over the ground in search of prey.

3. Mating Behaviour.—The most interesting aspect of arachnid behaviour is in their mating habits. In many, a "dance" or "promenade" precedes the actual mating. Among several different groups, including the scorpions, whip scorpions and pseudoscorpions, the male grasps the palpi of the female with his palpi and then walks sidewards or backwards while she follows. The male pseudoscorpion also may display his ram's horn organs in an effort to interest the female.

In many cases the male does not directly transfer the sperm to the female, rather he first deposits the sperm on the ground or on a special web, then transfers it. The male scorpion deposits a capsule of sperm (spermatophore) on the ground, then draws the female over it. She lowers herself over the spermatophore, thereby inserting the capsule in her genital opening. Pseudoscorpions have a similar behaviour. The spider male uses his highly modified palpus as a special intromittent organ for transferring the sperm to the female.

Mating among the solpugids is rapid and seemingly brutal. The male strokes the female until she becomes lethargic. He then grasps her with his chelicerae, palpi and walking legs and lays her on her side. After he expands her genital opening, he emits a mass of sperm which falls to the ground; this he gathers with his chelicerae and forces into the female's genital opening.

The opilionids are more casual in their mating habits. Males and females encounter one another accidentally, mate briefly—the male transferring sperm directly to the female by means of his penis—separate and then wander off. Among the spiders there are often elaborate courtship displays or special signs, such as tweaking the web, by which the often smaller male makes himself known to the larger female.

4. Special Glands and Poisons.—Among the arachnids are many types of specialized glands that often are characteristic of each group. The better known glands are the silk glands of spiders and pseudoscorpions, the poison glands of scorpions and spiders and the repugnatorial (odoriferous) glands of opilionids. Of these, the poison glands of the scorpions and spiders are probably the most notorious.

Poison Glands.—The poison glands of the scorpion are found in the enlarged base of the sting at the end of the tail. Two types of poisons are recognized as being produced by different scorpions. One of these poisons is local in effect and harmless for man; the other attacks the nervous system (is neurotoxic) and is extremely toxic for man. In the United States the scorpion *Centruroides vittatus* is harmless, but *C. sculpturatus* and *C. gertschi* are very poisonous. The symptoms of poisoning appear rapidly and are characterized by a feeling of tightness in the throat. Death may follow if treatment with antivenom is not instituted soon after the person is stung.

The poison glands of spiders are associated with the chelicerae, as mentioned earlier. It may be in the basal segment of the chelicera or may extend farther back into the head region. The poison, released from a tiny opening at the end of the fang, is in most cases quite harmless for man; at most it causes only momentary discomfort. A few spiders of the genus *Latrodectus*, however, produce a poison which is considered very virulent. Fortunately, however, the amount injected is usually so small that death has occurred in only about 5% of the known cases of persons bitten. The black widow spider (*Latrodectus mactans*) of North America is the most notorious of this genus. Its bite may induce in the person bitten profuse sweating, difficulty in breathing, vomiting and prostration. Although the illness may seem grave, rarely is it fatal.

Some spiders of the genus *Loxosceles* likewise have the reputation of being dangerous. The bite of *Loxosceles reclusus*, found in the midwestern and southern U.S., results in a severe local reaction that may be followed by more general symptoms. *Loxosceles laeta* of South America is also regarded as dangerous.

Silk-Producing Glands.—Among the arachnids spiders are best known for their ability to spin webs from silk produced in glands within their bodies. They are not alone in this ability, for pseudoscorpions and some mites too can spin silk, but to a much lesser extent.

The silk of the pseudoscorpion is derived from glands in the cephalothorax whose ducts traverse the chelicerae to the tip of the movable finger. The spinning is actually done by the chelicerae. Pseudoscorpions use this silk chiefly for the construction of nests in which they may molt or hibernate and for the weaving of cocoons for their eggs. Nest-building is carried out in this manner: the silk is drawn out in several very fine, sticky threads, the spinning being accompanied by forward and backward movements of the body as well as by lateral movements of the chelicerae. The animal works until it is gradually imprisoned by a dense covering.

Spider silk has its origin from the special silk glands located in the mid-ventral portion of the abdomen. At least seven different types of silk glands are known, each of which produces a different type of silk having a special function. The spinnerets, through which the glands open, are located at the end of the abdomen. The tiny spinning tubes, located on the spinnerets, average about 100 in number.

Spiders have many uses for their silk. Whenever they move about, they spin a dragline or securing thread, by means of which they can drop rapidly if threatened. Far more complex are the webs that are used as snares for unwary insects. The spider also utilizes its silk for cocoons for its eggs, for the construction of retreats in which to molt, for webs on which to deposit the sperm when the male charges his palpus and for the lining of burrows. The threads are usually not single fibres but actually strands from

several glands. A few mites also have silk glands. The spider mites ("red spiders") of the family Tetranychidae cover the leaves of trees with silken webs that serve as protective coverings for their eggs and young.

Repugnatorial Glands.—These glands occur chiefly in opilionids and thelyphonids. In most cases they secrete a fluid that because of its odour repels possible predators. The odoriferous glands of the opilionids are found in both sexes of all species. They are located near the anterior margin of the cephalothorax, opposite the attachment of the first pair of legs. The glands themselves often can be seen through the carapace, and their openings are on the surface of the cephalothorax, above the coxa of the second leg. In some species the glandular secretion can be discharged to a distance of more than an inch, but in most forms it simply flows from the gland opening. Among the tropical and subtropical members of the suborder Laniatores, the secretion is bright yellow or reddish brown, highly volatile and has an acrid smell. Some of the large opilionids of the family Gonyleptidae from Brazil produce a strong nauseating odour when handled. The opilionids of temperate areas have a colourless fluid with no detectable odour for man.

In the southern United States, whip scorpions (thelyphonids) are known locally as vinegarroon because of the vinegarlike aerosol secretion which they exude from the anal region when annoyed. This secretion is not poisonous but probably serves to repel threatening predators.

5. Beliefs Concerning Arachnids.—Arachnids very often are disliked by people, not for any rational reason, but because they crawl, run, hide or have predaceous habits. Many are regarded as being poisonous, when actually few are. Possibly because arachnids are common and abundant, they have long been the subjects of many interesting stories in folklore.

The opilionids, for example, are sometimes called shepherd spiders because it was once believed that fields heavily infested with them were good sheep pasture. An old Essex superstition says that it is unlucky to kill a harvestman because of the belief that these animals helped farmers reap their fields; the harvestmen's long legs brought to mind the scythe, rake and sickle.

Some unfounded stories maintain that scorpions can commit suicide by stinging themselves when surrounded by a ring of fire.

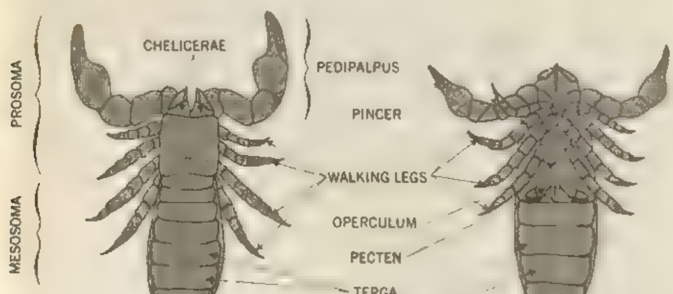
Spiders, of course, have many legends associated with them. Among their virtues are supposedly industry, patience and persistence. In parts of the United States it is believed that killing a harvestman or spider will bring rain.

VI. FOSSIL ARACHNIDS

The earliest known fossil arachnids are scorpions found in the Silurian (from about 320,000,000 to 350,000,000 years ago). It was supposed for a long time that they were marine. The American *Proscorpius osborni* was found in limestone strata of New York together with the extinct scorpionlike marine eurypterids. But the structure of both the European *Palaeophonus* and the American *Proscorpius* is so typical of the order Scorpiones that it is more probable that the fossil scorpions led a terrestrial rather than an aquatic life. They may have lived, however, near water. Excellently preserved remnants of arachnids belonging to the orders Trigonotarbi, Araneae and Acari are found in later strata, the Devonian Red Sandstone of Scotland. Apparently all orders of Arachnida were represented in the succeeding Carboniferous period, though Palpigradi have been described as fossils only from the still later Jurassic of Europe and Schizomida from the late Cenozoic era (the present to about 70,000,000 years ago) of Arizona.

The Mesozoic era (from about 70,000,000 to 200,000,000 years ago) left practically no fossil records of Arachnida. On the other hand the Cenozoic era is rich in fossil Arachnida. Those found in Baltic amber and in the Tertiary shale of Colorado possess all the characters of recent Arachnida. It is reasonable to assume that Arachnida as a group distinct from other Arthropoda must have appeared in the early Paleozoic era (about 500,000,000 years ago).

The larval or immature forms of the horseshoe crab (*Limulus*) resemble the ancient trilobites so closely that they were termed trilobite larvae. According to some authorities, this relationship indicates that the ancient trilobites were ancestral to present-day arachnids. The eurypterids, also closely related to the horseshoe crabs, were abundant during the Paleozoic. These forms bore a strong superficial resemblance to present-day scorpions. *See* also EURYPTERIDA; TRILOBITE.



FROM R. R. SHROCK & W. H. TWENHOFEL, "PRINCIPLES OF INVERTEBRATE PALEONTOLOGY" (1953); REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC

FIG. 4.—RESTORATION DRAWING OF THE ANCIENT SILURIAN SCORPION PALAEOPHONUS, OF THE ORDER SCORPIONES, SHOWING PRIMITIVE BODY PARTS: (A) DORSAL VIEW OF P. NUNTIUS; (B) VENTRAL VIEW OF P. CALEDONICUS

VII. IMPORTANCE TO MAN

Inasmuch as so many of the arachnids have secretive or nocturnal habits and are most abundant in the tropical and subtropical areas of the world, their economic importance may often be underestimated. Certainly any group of predators that occurs in as great numbers as arachnids, can and does exert quite an influence on the insect population of any habitat. Spiders in particular can attain enormous numbers; for example, an estimate of some 14,000 individuals on shrubs and herbs on an acre of woodland in the midwestern U.S. may be quite modest.

The solpugids are known to have voracious appetites. A young *Galeodes* species was observed to devour over 100 flies in 24 hours. One small nocturnal species, *Eremobates pallipes*, from Colorado is reputed to hunt bedbugs; and it has been said that a predaceous crab spider *Thanatus flavidus* effectively controlled an outbreak of bedbugs in Athens, Greece, during 1923–24.

Of the arachnids the mites and ticks are the more directly important to man. Tiny mites occur in such numbers in soil that it is certain that they play a role in the gradual change of leaves and other organic debris to humus. Ticks are better known, for most of them can be readily seen and they are pests of man and his domestic animals.

Tick-borne rickettsial diseases are common in many parts of the world. In the United States, Rocky mountain spotted fever is transmitted by the wood tick *Dermacentor andersoni* in the northwestern states and by other ticks in other regions (*see* ROCKY MOUNTAIN SPOTTED FEVER AND OTHER SPOTTED FEVERS; RICKETTSIAE). In the southern states, most people have been bothered by chiggers (*q.v.*), which are actually the larvae of chigger mites (family Trombiculidae). Fruit growers know the spider mites and dog owners are well acquainted with the itch and mange mites (Acaridae, Psoroptidae and Sarcoptidae). Many mites infest stored grains and copra. People dwelling in overcrowded areas frequently are infested with itch mites.

VIII. CLASSIFICATION

The following classification of the Arachnida is the one generally recognized by most students of the class. In it are described four subclasses with their 16 orders, 11 of which are living and 5

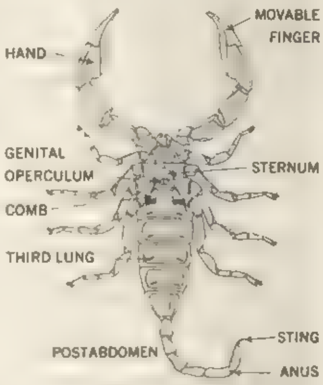
(preceded by †) wholly extinct.

A. Subclass Latigastra

Arachnida in which the abdomen is broadly joined to the cephalothorax.

Superorder Pectinifera.—With a pair of abdominal appendages on the third somite.

1. Order Scorpiones (Scorpions).—(Fig. 5) Carapace entire, with a pair of median and from three to five pairs of lateral eyes. Abdomen segmented, subdivided into a preabdomen of seven segments and a postabdomen of five segments, the so-called tail ending in a sting. First abdominal somite disappears during development, original number of 12 segments restored by subsegmentation. Preabdominal tergites and sternites separated by intersegmental membranes and lateral pleurae. Postabdominal segments annular. Chelicerae pincerlike (chelate), three-jointed. Pedipalpi powerful, chelate, with rudimentary processes called gnathobases. First and second coxae with gnathobases bearing maxillary glands. Abdominal appendages modified as combs, situated immediately behind the covering of the genital opening. Four pairs of book lungs on third to sixth preabdominal sternites. Heart in the preabdomen, with seven pairs of ostia. Size from 14 to 180 mm. Ovoviviparous. Six recent and five fossil families. Earliest fossil records from the Silurian. Several hundred species now living mostly in tropics, several species in southern Europe and in the U.S.



FROM A. PETRUNKEVITCH IN "TRANSACTIONS OF THE CONNECTICUT ACADEMY OF ARTS & SCIENCES"

FIG. 5.—SCORPION (OPISTHACANTHUS LEPTURUS), OF THE ORDER SCORPIONES; VENTRAL VIEW

Superorder Epectinata.—Without abdominal appendages.

a. Branch Chelata.—Abdomen clearly segmented, with 12 tergites and sternites.

2. Order Pseudoscorpiones (False or Book Scorpions).—(Fig. 6) Carapace entire, with one or two pairs of eyes. First to tenth abdominal tergites and fourth to tenth sternites often subdivided into a right and left sclerite. Twelfth segment small, rudimentary. Chelicerae chelate, two-jointed, their movable finger with a spinneret (galea). Pedipalpi powerful, chelate, with a poison gland opening on the immobile finger. All coxae meet in median line, movable. Legs with an additional joint called trochantin or basifemur, between trochanter and femur. Patella fused with tibia. Tarsus one-jointed, ending in two claws with an arolium. Lungs lacking. Two pairs of tracheal spiracles on third and fourth abdominal sternites. Heart with three or four pairs of ostia. Central nervous system concentrated in the cephalothorax. Males with ram's horn organs used for excitation of female in mating. Females with a brood pouch for eggs. Size from 0.8 to 6 mm. Oviparous. Three suborders: (1) suborder Chthoniinea with two families; (2) suborder Neobisiinea with nine families; (3) suborder Cheliferinea with six families and about 300 species. Common book scorpion, *Chelifer cancroides*, found in homes and libraries all over the world. Many species blind.

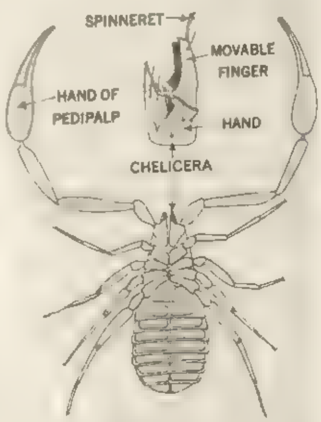
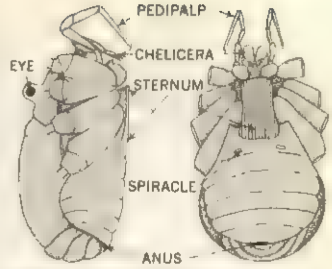


FIG. 6.—COMMON BOOK SCORPION (CHELIFER CANCROIDES), OF THE ORDER PSEUDOSCORPIONES; VENTRAL VIEW. DETAIL OF THE CHELICERA AT TOP

Majority live on the ground, in vegetal detritus, under bark, etc. Some species are found in caves. Species of *Garypus* are found on algae along the seashore. *Neobisium maritimum* of England and France lives between low and high tide lines.

b. Branch Jugata.—Abdomen either partially or completely fused with cephalothorax.

3. Order Opiliones (Harvestmen, Daddy Longlegs).—(Fig. 7) From three to eight abdominal tergites fused with carapace, remainder free. A single pair of eyes, usually on a median tubercle. Chelicerae chelate, three-jointed. Pedipalpi leglike or raptorial. Walking legs usually long and slender, in some species 20 times longer than body, typically seven-jointed, but tarsus often subdivided. First and second tarsi with a single claw, third and fourth with one or two claws. Arrangement of coxae variable. All coxae movable in Phalangiidae and some other groups; all immobile in Nemastomatidae and Trogulidae; first pair movable, the rest coalesced and immobile in Laniatores. Lungs lacking. Single pair of tracheal spiracles on second abdominal sternite. Heart with two pairs of ostia. Nervous system highly concentrated. Males with a penis, females with an ovipositor. Pharynx hexagonal, without sieve, making ingestion of coarse particles possible. Gizzard lacking. Size from 1 to 22 mm. Oviparous. More than 3,000 species distributed among three suborders: (1) Suborder Cyphophthalmi. A single abdominal segment free. One family Sironidae. (2) Suborder Laniatores (=Mecostethi). Not more than five abdominal tergites fused with carapace. Pedipalpi raptorial. Third and fourth tarsi with two claws. Six families: Oncopodidae, Phalangiidae, Assamiidae, Cosmetidae, Gonyleptidae and Triaenonychidae. (3) Suborder Palpatores (=Plagiostethi). Pedipalpi leglike. All tarsi with a single claw. Five families: Trogulidae, Nemastomatidae, Acropsopilionidae, Ischyropsalidae and Phalangiidae.



ALEXANDER PETRUNKEVITCH

FIG. 7.—DADDY LONGLEGS (LIOBUNUM LONGIPES), OF THE ORDER OPILIONES: (LEFT) LATERAL VIEW; (RIGHT) VENTRAL VIEW OF BODY WITH ENDS OF LEGS CUT OFF

4. Order Acari (Mites and Ticks).—(Fig. 8) Abdomen usually more or less fused with cephalothorax, rarely segmented. Body often subdivided into a head region (gnathosoma or capitulum) and a body proper, the latter dorsally further subdivided by a groove between second and third legs into a propodosoma and a metapodosoma. Mouthparts adapted to piercing, sucking, biting, grating or sawing and correspondingly modified, often completely withdrawn into a special anterior cavity, the camerostome. Arrangement of coxae variable, characteristic of whole suborders. Four pairs of legs except in Tetrapodili which have only two pairs. Gizzard lacking. Salivary glands often present. Anus ventral or lacking. Respiration by tracheal tubes, or, in absence of such directly through the skin and gut. Position of tracheal spiracles and their number characteristic for different suborders. Lungs lacking. Heart with one or two pairs of ostia or completely lacking. Male genital opening variable in position, ventral, posterior or dorsal, with or without a penis. Female genital opening also variable in position, usually ventral, in Acaridae dorsal. Size from 0.1 to 30 mm. Oviparous, a few species ovoviviparous. Development with a six-legged larva, four-legged in Tetrapodili. Many thousands of species distributed among 167 families in six suborders; (1) Suborder Notostigmata. Abdomen (opisthosoma) clearly segmented with four pairs of dorsal tracheal spiracles on anterior four segments. All coxae freely movable. A single family Opilioacaridae. (2) Suborder Holothyroidea. Highly chitinized body without visible segmentation. Two pairs of spiracles above third and fourth coxae. All coxae freely movable. Genital opening in both sexes ventral, between third and fourth coxae. A single family Holothyridae. (3) Suborder Parasitiformes. Capitulum well developed. One pair of spiracles behind second, third or fourth coxae. Coxae either freely movable or immobile. Male genital opening ventral, variable in position. Female genital opening ventral, between second and third coxae. Superfamily Mesostigmata with 27 families and superfamily Ixodides with two families, Ixodidae and Argasidae. To these two families belong all the ticks. (4) Suborder Trombidiformes. Traces of segmentation often present. One pair of spiracles behind the mouthparts, or absent. Coxae immobile, incorporated in the body wall. Anus and heart lacking. Male genital opening variable in position, ventral, posterior or dorsal, with or without a penis. Superfamily Tarsonemini with four families. To this superfamily belongs the remarkable louse mite *Pediculoides ventricosus*. Superfamily Stomatostigmata with seven families. Superfamily Prostigmata with 59 families, among them the Tetranychidae or spider mites ("red spiders"), the Demodicidae or follicle mites, the Trombiculidae or chigger mites, the Hadrachnidae or water mites and the Halacaridae or marine mites. (5) Suborder Sarcoptiformes. Coxae immobile, incorporated in the body wall. Propodosoma clearly defined. Mouthparts in a camerostome. Four pairs of spiracles in the soft membrane between the body wall and the trochanters, or spiracles lacking. Heart absent. Male genital opening posterior, with a penis. Female genital opening dorsal, above anus. Superfamily Acaridiae with 37 families, among them Tyroglyphidae or cheese mites, Acaridae or acarid mites, Psoroptidae or scab mites, Sarcoptidae or itch mites. (The last three families are important mites causing dermatitis in man and other animals.) Superfamily Oribatei with 26 families, among them Ori-

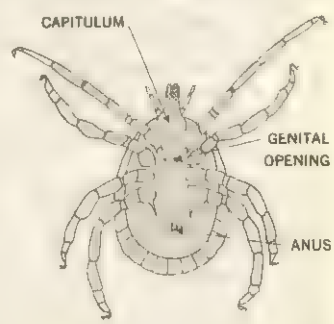
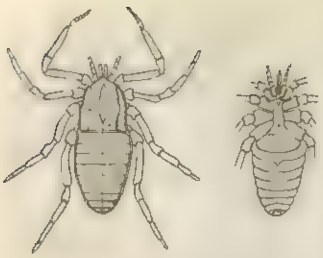


FIG. 8.—TICK (AMBLYOMMA CAYENNENSE), OF THE ORDER ACARI; VENTRAL VIEW OF MALE



FROM R. I. POCOCK IN PALAEONTOGRAPHICAL SOCIETY MONOGRAPH (LONDON)

FIG. 9.—FOSSIL ARACHNID (PLESIOSIRO MADELEYI), OF THE ORDER HAPTOPODA: (LEFT) DORSAL VIEW; (RIGHT) VENTRAL VIEW

batidae or beetle mites. (6) Suborder Tetrapodili or gall mites. Only two pairs of legs. Body often with false segmentation. Coxae immobile, incorporated in the body wall. Tracheae and heart absent. Male genital opening ventral, with penis. Female genital opening also ventral, the opening in both sexes anterior in position. Vegetation-eaters. Larva with two pairs of legs. Two families, Eriophiidae and Phyllocophidae.

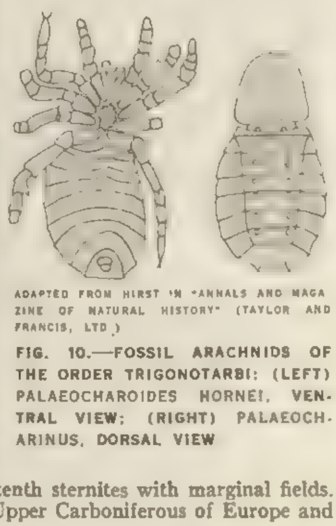
c. Branch Corrugata.—Several anterior abdominal tergites considerably shorter than the rest.

†5. Order Architarbi (= Phalangiotarbi).—Fossil Arachnida with segmented abdomen having from 8 to 11 tergites, the anterior 5 or 6 considerably abbreviated. Sternites often subdivided into three longitudinal fields. Carapace entire, with from two to six eyes. All coxae movable, without gnathobases. Chelicerae chelate. Pedipalpi leglike. Walking legs normal. Four families—Architarbidae, Heterotarbidae, Opiliotarbidae and Phalangiotarbidae. Upper Carboniferous of Europe and Pennsylvanian of North America.

B. Subclass Stethostomata

Arachnida with abdomen broadly joined to the cephalothorax, but with the basal joint of chelicerae wedged in between the coxae of the pedipalpi and the mouth and situated ventrally behind the latter.

†1. Order Haptopoda.—(Fig. 9) Fossil Arachnida with carapace entire, with a pair of eyes. Abdomen composed of 11 segments, not counting the anal covering. Genital sternite very large. Chelicerae three-jointed, chelate. Pedipalpi leglike. All tarsi segmented. A single species, *Plesiosiro madeleyi*, from the Upper Carboniferous, England.



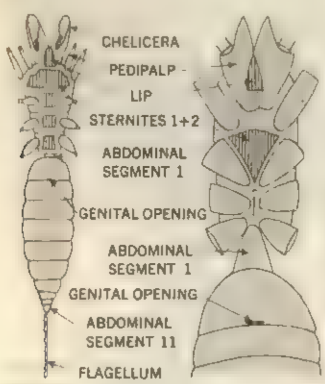
ADAPTED FROM HIRST IN "ANNALS AND MAGAZINE OF NATURAL HISTORY" (TAYLOR AND FRANCIS, LTD.)

FIG. 10.—FOSSIL ARACHNIDS OF THE ORDER TRIGONOTARBI: (LEFT) PALAEOCHAROIDES HORNEI, VENTRAL VIEW; (RIGHT) PALAEOCHARINUS, DORSAL VIEW

†2. Order Anthracomarti.—Fossil Arachnida with carapace entire, without eyes. Abdomen composed of ten segments. Second and third tergites fused, forming a single plate. All but the first and tenth tergites with marginal and submarginal fields. All but the first and tenth sternites with marginal fields. Several genera with species in the Upper Carboniferous of Europe and Pennsylvanian of North America.

C. Subclass Trigonotarbi

Arachnida with abdominal tergites with marginal fields, but sternites entire.



ALEXANDER PETRUNKEVITCH

FIG. 11.—(LEFT) PALPIGRADE (KOENENIA), OF THE ORDER PALPIGRADI, VENTRAL VIEW. LEGS CUT OFF AT THE TROCHANTERS, FLAGELLUM AT ABOUT A QUARTER OF ITS TOTAL LENGTH. (RIGHT) SCHIZOMID (SCHIZOMUS), OF THE ORDER SCHIZOMIDA; VENTRAL VIEW SHOWING ONLY COXAE AND ANTERIOR THREE ABDOMINAL SEGMENTS

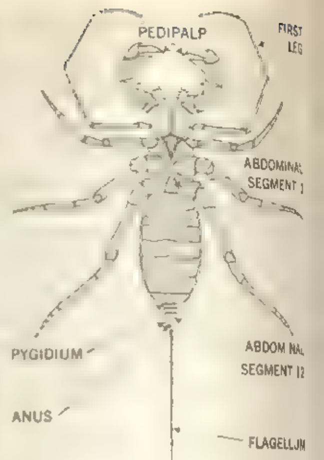
†1. Order Trigonotarbi.—(Fig. 10) Fossil Arachnida with carapace entire, with or without eyes. Abdomen either broadly joined to the carapace or else the juncture is considerably narrowed. Chelicerae two-jointed, retrovert. Pedipalpi leglike. Sternum and underlip and arrangement of coxae as in spiders. Family Palaeocharinidae known only from the Devonian of Scotland. Four families represented by several species in the Upper Carboniferous of Europe and Pennsylvanian of North America.

D. Subclass Caulogastra

Arachnida with attenuated first abdominal somite narrowly joined to the cephalothorax.

Superorder Sternifera.—A sternum composed of a single or more sternites present between the coxae.

1. Order Palpigradi (Palpigrades).—(Fig. 11, left) Carapace subdivided into a propeltidium, mesopeltidium and metapeltidium. Eyes absent. Pedipalpal and first pedal sternites fused into a single plate which is followed by three separate sternites. All coxae movable, without gnathobases. Chelicerae chelate, 3-jointed. Pedipalpi leglike, 9-jointed. First pair of legs 12-jointed, second and third 7-jointed, fourth 8-jointed. Abdomen composed of 11 segments, the last three small, annular, forming a process called the pygidium. Telson a multisegmented flagellum. Book lungs and tracheae lacking. Fourth to sixth sternites each with a pair of ventral sacs capable of turning inside out and supposedly having a respiratory function. Heart in the abdomen, with five pairs of ostia. An abdominal ganglionic mass present in the second abdominal somite. Size 0.6 to 2.8 mm. Presumably oviparous. One recent family, Koeneniidae, and one fossil Mesozoic family, Sternarthronidae.



FROM A. PETRUNKEVITCH IN "TRANSACTIONS OF THE CONNECTICUT ACADEMY OF ARTS AND SCIENCES"

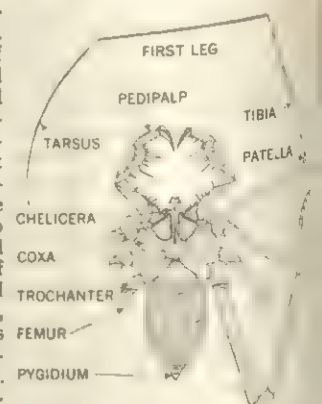
FIG. 12.—WHIP SCORPION (MASTIGOPROCTUS GIGANTEUS), OF THE ORDER THELYPHONIDA; VENTRAL VIEW. CHELICERAE ARE NOT VISIBLE IN THIS POSITION

2. Order Schizomida (Schizomids).— (Fig. 11, right) Carapace subdivided into a propeltidium, mesopeltidium and metapeltidium. Median eyes absent, lateral eyes present or absent. Three thoracic sternites. All coxae movable, without gnathobases. Chelicerae chelate, two-jointed. Pedipalpi raptorial. First tarsus eight-jointed. Abdomen composed of 12 segments, the last three small, annular, forming a pygidium. Telson short, one- or three-jointed. Ventral sacs lacking. A single pair of book lungs, on second abdominal sternite. Heart in the abdomen, with five pairs of ostia. An abdominal ganglionic mass composed of the 5th to 12th ganglia, present in the second abdominal segment. Size from 5 to 7 mm. Oviparous. One recent family, Schizomidae, and one fossil Cenozoic family, Calcitronidae.

3. Order Thelyphonida (Whip Scorpions).—(Fig. 12) Carapace entire, with one pair of median and three pairs of lateral eyes. Three thoracic sternites. All coxae movable, without gnathobases. Chelicerae two-jointed retrovert. Pedipalpi raptorial. First tarsus tactile, nine-jointed. Abdomen composed of 12 segments, the last three small, annular, forming a pygidium. Telson long, whiplike, multijointed. Ventral sacs lacking. Two pairs of book lungs, on second and third abdominal sternites. Heart with nine pairs of ostia, first and second pair in the cephalothorax, third to ninth in the abdomen. Anterior seven abdominal ganglia incorporated in the thoracic ganglionic mass, 8th to 12th ganglia form an abdominal ganglionic mass in the 8th and 9th segments. Size from 25 to 70 mm. Oviparous. A single family, Thelyphonidae.

†4. Order Kustarachnae.—Fossil Arachnida with coxae radiating from an apparently very small sternum. Carapace entire, with a pair of eyes on a median tubercle. Chelicerae not known. Pedipalpi chelate, their coxae fused, forming a single plate. Coxae without gnathobases. Legs thin and long. Abdomen with from seven to ten sternites. Tergites not preserved. A single family, Kustarachnidae, from the Pennsylvanian of North America.

5. Order Phrynichida (Tailless Whip Scorpions).—(Fig. 13) Carapace entire, with a pair of median and three pairs of lateral eyes. Three thoracic sternites. All coxae movable, without gnathobases. Chelicerae two-jointed, retrovert. Pedipalpi raptorial. First tarsus tactile, multijointed. Abdomen composed of 12 segments, the last one forming a pygidium. Two pairs of lungs, on second and third abdominal sternites. One pair of ventral sacs on third abdominal sternite. Heart in the abdomen, with six pairs of ostia. Nervous system concentrated in the cephalothorax. Size from 8 to 45 mm. Oviparous. A single family, Tarantulidae.



FROM A. PETRUNKEVITCH IN "TRANSACTIONS OF THE CONNECTICUT ACADEMY OF ARTS AND SCIENCES"

FIG. 13.—TAILLESS WHIP SCORPION (TARANTULA FUSCIMANA), OF THE ORDER PHRYNICHIDA; VENTRAL VIEW. BOTH PEDIPALPS AND CHELICERAE ARE SHOWN; ONLY FIRST AND FOURTH LEGS ARE SHOWN

6. Order Araneae (Spiders).—(Fig. 14) Carapace entire, with a pair of median and three pairs of variously arranged lateral eyes. Number of eyes often reduced to two or three pairs, in some cases a single pair or none. Chelicerae two-jointed, retrovert, with ducts of poison glands, except in two fami-

lies. Pedipalpi leglike, in adult males with copulatory apparatus on terminal joint. Pedipalpal coxae with gnathobases bearing maxillary glands. Pedal coxae movable, without gnathobases. Legs seven-jointed. Abdomen entire, except in Liphistiomorphae in which it is composed of 12 visible segments. Abdominal appendages present on fourth and fifth somites and modified as spinnerets. Respiration by means of book lungs or tracheal tubes, or a combination of both, with lung slits and spiracles always on second and third abdominal somites. Heart in the abdomen, with from two to five pairs of ostia. Nervous system concentrated in the cephalothorax. Size from 1 to 75 mm. Oviparous. Nearly 3,000 genera with many thousands of species. Sixty-four recent and seven fossil families distributed among five suborders: (1) Suborder Liphistiomorphae. Spiders with segmented abdomen, chelicerae in the same axis as the body (paraxial), two pairs of lungs, eight spinnerets and four or five pairs of cardiac ostia. Two recent and two fossil families. (2) Suborder Mygalomorphae. Spiders with abdomen entire, paraxial chelicerae; two pairs of lungs; four, rarely two or six, spinnerets; and three or four pairs of cardiac ostia. Eight families including the trap-door spiders and tarantulas. (3) Suborder Hypochilomorphae. Spiders with abdomen entire, chelicerae directed slightly outward (diaxial), two pairs of lungs, six spinnerets and a flattened vestige of the appendage of the fourth somite (cribellum) and four pairs of cardiac ostia. A single family Hypochilidae. (4) Suborder Dipneumonomorphae. Spiders with abdomen entire, chelicerae diaxial, one pair of lungs and one pair of (or a single) tracheal spiracles, six spinnerets with or without a cribellum, sometimes only two or four spinnerets without cribellum, two or three pairs of cardiac ostia. Forty-nine recent and five fossil families including among them the Argiopidae or geometric orb weavers, Theridiidae or reticular web weavers, Thomisidae or crab spiders, Salticidae or jumping spiders. (5) Suborder Apneumonomorphae. Spiders with abdomen entire, chelicerae diaxial, lungs absent, one or two pairs of tracheal spiracles, six spinnerets without cribellum, two pairs of cardiac ostia. Four families.

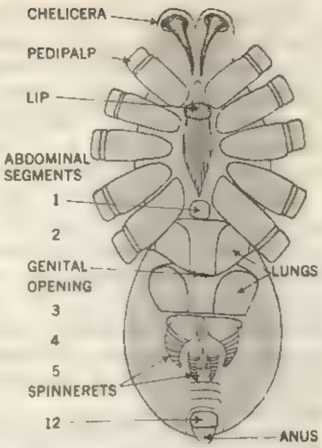


FIG. 14.—SPIDER (LIPHISTIUS MALAYANUS), OF THE ORDER ARANEAE: VENTRAL VIEW. OF THE PEDIPALPS AND LEGS, ONLY THE COXAE AND TROCHANTERS ARE SHOWN

Superorder Cucullifera.—A movable plate, the cucullus, present, attached to the anterior edge of the carapace. Thoracic sternite concealed, rudimentary.

7. Order Ricinulei (Ricinuleids).—(Fig. 15) Carapace entire, without eyes, always with a cucullus. Abdomen composed of nine segments, the last three small, annular, forming a pygidium which is telescoped in recent species. Two anterior abdominal segments concealed from view by carapace. Chelicerae two-jointed, chelate. Pedipalpi chelate. Coxae, except fourth pair, immobile. First and second trochanters single-jointed; third and fourth two-jointed in recent species. First tarsus one-jointed, second five-jointed, third four-jointed, fourth five-jointed. Lungs absent. One pair of tracheal spiracles above third coxae. Third metatarsus and tarsus modified in mature males as organs of copulation. Size from 4 to 10 mm. Oviparous. Development with a six-legged larva. One recent family Ricinoididae (= Cryptostemmidae) and two fossil families, Polyocheridae and Curculioididae (= Holotergidae).

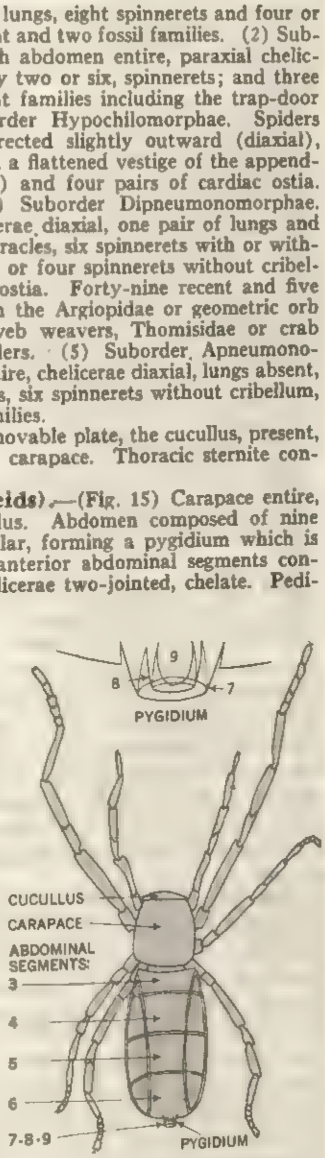


FIG. 15.—RICINULEID CRYPTOCELLUS DOROTHEAE, OF THE ORDER RICINULEI; VENTRAL VIEW. ABDOMINAL SEGMENTS 1 AND 2 CONCEALED BY CARAPACE. DETAIL OF PYGIDIUM AT TOP

Superorder Malleolifera.—Fourth coxa and trochanter with racket organs, or malleoli. Thoracic sternites lacking. Carapace segmented.

8. Order Solifugae (Solpugids, or Sun Spiders).—(Fig. 16) Carapace proper or propeltidium includes only head and first thoracic somite. This is followed by independent tergites representing individual thoracic somites, and by mesopeltidium and metapeltidium. One pair of median and one or two pairs of rudimentary lateral eyes on the propeltidium. Chelicerae powerful, two-jointed, chelate, with movable finger ventral. Pedipalpi tactile. First leg seven-jointed, second seven- or eight-jointed, third and fourth nine-jointed. Abdomen composed of 10 or 11 segments with soft intersegmental and lateral membranes. Seven tracheal spiracles: first pair between second and third coxae, second pair on third abdominal sternite, third pair on fourth abdominal sternite, seventh single median spiracle on fifth sternite. Lungs absent. Heart with eight pairs of ostia, first and second pairs of which are in the cephalothorax, third to eighth pairs in the abdomen. Anterior five abdominal ganglia incorporated in thoracic ganglionic mass, posterior five forming an abdominal ganglionic mass in the sixth segment. Mouth at end of a beak. Size from 10 to 50 mm. Oviparous. Some 200 species distributed among 10 families.

For the different kinds of arachnids *see* separate articles; *e.g.,* MITE; SCORPION; SPIDER; TICK; WHIP SCORPION; and BLACK WIDOW; DADDY LONGLEGS; TARANTULA. *See* also references under "Arachnida" in the Index.

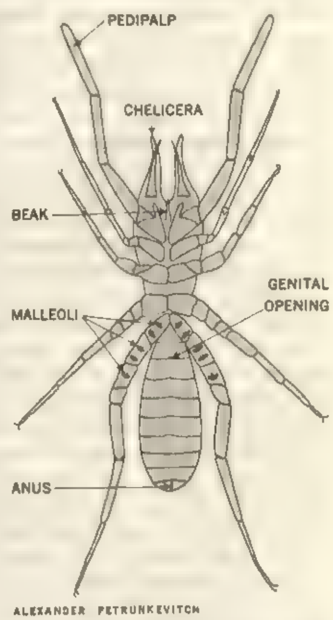


FIG. 16.—SUN SPIDER (EREMOBATES FORMICARIA), OF THE ORDER SOLIFUGAE: VENTRAL VIEW

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(A. PE.; C. J. GO.; M. L. G.)

ARACHOSIA (Persian HARAUVATISH or HARAHUVATISH), a province of the Persian, Seleucid and Parthian empires, which took its name from the Arachotas branch of the Etymandrus river, the modern Arghandab. It occupied southern Afghanistan and was bounded on the south by Gedrosia (Baluchistan). The capital city, Alexandria-of-the-Arachosians, founded by Alexander the Great and usually identified as Kandahar, is placed at Ghazni by W. W. Tarn. The Arachosians appear among the tributary nations depicted on the Achaemenid reliefs at Persepolis; their gifts include a Bactrian camel. Darius I obtained ivory from Arachosia and Darius III elephants. (J. M. M.-R.)

ARAD, a town in western Rumania, capital of the Arad district in the Banat region, lies on the north bank of the Mureş river near the Hungarian border. It consists of an inner town and five suburbs. The population in 1956 was 106,412, about one-third Magyar. Arad is a modern town and the seat of a Greek-Orthodox bishop and has a theological seminary, teachers training schools, a conservatoire of music, state theatre and puppet theatre, a museum of art and history, and philharmonic and folk orchestras. In the museum are relics of the Hungarian revolution of 1848–49, and one of the public squares contains a martyrs' monu-

ment commemorating the 13 Hungarian generals shot there by order of the Austrian general J. J. Haynau on Oct. 6, 1849.

Arad is an important railway junction and the largest industrial and commercial centre of western Rumania. Its principal industries are distilling, milling, the manufacture of textiles, machine tools and railway cars, leather-working and saw-milling. A large trade is carried on in grain, flour, alcohol, cattle and timber. An air service links Arad with Bucharest.

Arad, a fortress conquered by the Turks in 1551 and rebuilt by them three years later, was lost to the Austrians in 1685. It was captured by the Hungarians on July 1, 1849, and was their headquarters during the latter part of the insurrection. There Lajos Kossuth (*q.v.*) issued his famous proclamation, and handed over his supreme military and civil power to Arthur Görgei. The fortress was recaptured shortly after Görgei's capitulation at Világos. Arad became Rumanian after World War I.

The town of Aradul Nou (New Arad) on the opposite bank of the Mureş is practically a suburb of Arad, with which it is connected by a bridge.

ARADUS (modern ARWAD or RUAD), the Greek name for the Hebrew ARVAD, an ancient Phoenician city situated on a small rocky island of the same name less than 2 mi. off the Syrian coast halfway between Latakia and Tripoli (Tarabulus al-Sham). The island, with a circumference of one mile, still shows remains of the Phoenician walls on the eastern side. Strabo (xvi, 2, 13) attributed the founding of the city to the Sidonians, and Eusebius thought that the city was founded in 761 B.C., but the name appears in near eastern texts in the 2nd millennium. The Old Testament lists the Arvadites as the sons of Canaan (Gen. x, 18); they are mentioned in the Ugaritic tablets as *'rwdn*. Aradus, which resisted conquest by Thutmose III in the 15th century B.C. but succumbed to superior force, is often mentioned in Egyptian sources. The Amarna letters of the 14th century state that Aradus (Arwada) allied itself with Sidon and Beirut against Rib-Addi of Byblos. Later the Hittites gained control of the city; Aradus was on the side of the Hittites at the battle of Kadesh (1288 B.C.). Aradus paid tribute to the Assyrian kings Tiglath-pileser I (reigned 1116–1076) and Ashurnasirpal II (reigned 884–859), who received gold, silver, tin, copper, linen garments, monkeys, ebony, boxwood and ivory from the Phoenician coastal areas, including Aradus; the city must therefore have had a flourishing trade with Africa. Matinu-ba'lu of Aradus provided 200 soldiers for the Aramaean coalition against Shalmaneser III at the battle of Karkar (853). A king with the same name paid tribute to Tiglath-pileser III (reigned 745–727), and both Sennacherib and Esarhaddon received tribute from the city. Ashurbanipal forced Iakinlu of Aradus to submit to his yoke, and the king brought his daughter to Nineveh with a dowry to do menial service. In the Persian empire Aradus with its mainland counterpart Tartus (Antaradus) was the capital of a province extending from Latakia to the Eleutherus river (Nahr al-Kebir) and to the borders of Hamath to the east. Ships of Aradus were in Xerxes I's fleet in his attack on Greece (480 B.C.). The province of Aradus was handed over to Alexander the Great in 332 B.C. without a struggle.

(J. S. I.)

ARAFURA SEA, a shallow continental shelf sea, lies between Australia and New Guinea. It includes technically the great bight of the Gulf of Carpentaria and extends eastward as far as Cape York, the extreme northern tip of Queensland and Australia. It is generally under 100 fathoms; the maximum depth, south of the Tanimbar Islands, is 642 fathoms. The entrance from Torres strait is notoriously dangerous, and the Arafura sea probably contains numerous uncharted shoals; currents are variable except during the southeast monsoon. (O. H. K. S.)

ARAGO, (DOMINIQUE) FRANÇOIS (JEAN) (1786–1853), French physicist who discovered the principle of the development of magnetism by rotation, was born on Feb. 26, 1786, at Estagel, Roussillon, and died in Paris on Oct. 2, 1853. He was educated in Perpignan and at the École Polytechnique, Paris.

He joined J. B. Biot in 1806 to complete the measurement of an arc of the meridian. At the age of 23 he succeeded J. J. L. de Lalande in the chair of analytical geometry at the École Polytechnique and became one of the astronomers at the observatory. In 1830 he entered politics as a republican deputy, advocating measures for the advancement of science and for technical developments, and was appointed director of the observatory and permanent secretary of the Academy of Sciences. As minister of war and marine in the provisional government formed after the revolution of 1848, he introduced many reforms.

Arago's original scientific work was mainly concerned with electromagnetism and the wave theory of light. Following up the work of H. C. Oersted, he showed in 1820 that a cylindrical spiral of copper wire through which an electric current was flowing attracted iron filings as if it were a magnet, but that the filings fell off when the current ceased; he showed also (1824) that a rotating copper disk produced rotation in a magnetic needle suspended above it. These effects were later shown by Michael Faraday to be due to induction.

His researches on light were closely linked with those of A. J. Fresnel, E. L. Malus and Thomas Young, who were shaping the wave theory of light at the beginning of the 19th century. Fresnel's arguments were not accepted by Laplace, S. D. Poisson and Biot, who favoured the emission theory, but they were strongly supported by F. H. A. Humboldt and by Arago, who had been appointed by the Academy of Sciences to report on Fresnel's work. As a result Fresnel and Arago joined in further researches which led to the enunciation of the fundamental laws of the polarization of light.

Arago's many studies on the wave theory included his crucial experiment for comparing directly the velocity of light in air and in water or glass. According to the emission theory, the velocity should be accelerated as light passed from a rarer into a denser medium; according to the wave theory, it should be retarded. In 1838 he described his apparatus, which employed the revolving mirrors used by Sir Charles Wheatstone in 1835 for measuring the velocity of the electric discharge; but, because of the great care required in the experiment, as well as the interruptions of the revolution of 1848, Arago was not ready until the spring of 1850, and then his eyesight suddenly failed. Before his death, however, the retardation of light in denser media was experimentally demonstrated by A. H. L. Fizeau and J. B. L. Foucault by his method with improvements in detail.

Arago's writings were published in 17 volumes in 1854–62. He was elected a foreign member of the Royal Society of London in 1818 and became in 1825 the first Frenchman to receive its Copley medal. (D. McK.)

ARAGON was a constituent kingdom of the Spanish monarchy. Historically, "Aragon" is an ambiguous term. Strictly, it refers only to the political entity which, at the close of the middle ages, was comprised within the area of the three modern Spanish provinces of Huesca, Saragossa and Teruel. But the kings of Aragon were also rulers of the constitutionally separate county of Barcelona (Catalonia), the kingdom of Valencia and various oversea territories in the Mediterranean. Moreover the kingdom of Aragon proper was inferior to Catalonia and Valencia in political, economic and cultural importance. Despite this, all the peninsular possessions of the Aragonese crown are frequently referred to as Aragon.

The original kingdom was brought into existence by a testimentary act of Sancho III of Navarre in 1035. Sancho left to his third son, Ramiro, the then small Pyrenean county of Aragon, elevating it to be an independent kingdom. To this mountain domain (which took its name from the river flowing through Jaca, its capital) Ramiro (1035–63) was soon able to add the counties of Sobrarbe and Ribagorza, to the east of it. All the counties had long been under Frankish influence, which had an important bearing on the character of some Aragonese institutions. By 1104 the kings of Aragon had doubled the size of the original kingdom by conquests southward toward the Ebro. Saragossa, capital of the important Almoravid kingdom of the same name, fell to Alfonso I of Aragon (1104–34) in 1118, and the occupation of the valleys of the Jalón and Júcar rivers, to the south of Saragossa and the Ebro, soon followed. These conquests, involving the absorption into Aragon of large numbers of Mudéjar and Mozarab farm-

ers and artisans, greatly altered the social complexion of the country. The pattern of future operations against the Moors was fixed by the treaty of Cazorla, signed by Alfonso II of Aragon (1162–96) and Alfonso VIII of Castile in 1179, which divided those parts of Spain remaining in Muslim hands into two zones—one for each kingdom to reconquer.

In 1150 the ruler of Catalonia, Ramón Berenguer IV, count of Barcelona, married the heiress of the kingdom of Aragon. Thus, until 1410, both countries came to be ruled by the Catalan house of Barcelona. The previous history of Catalonia, formerly the Frankish-dominated Spanish March, had been unlike that of Aragon (*see* BARCELONA, COUNTS OF). It possessed a unified legal code (in which feudal custom played a large part) and a written political constitution and was much more cosmopolitan and bourgeois in outlook than Aragon. Until 1412 Catalan influence dominated the union, with the Catalans tending to support the crown in its frequent constitutional struggles with the feudal Aragonese nobility. The union was of great value to the Catalans, who were able to devote themselves to commerce and maritime expansion, knowing that the financial and military responsibility of defending them from Castile would fall largely on the inhabitants of the Aragonese hinterland. Navarre, ruled by Aragon since 1076, became independent again in 1134; it once more came under the crown of Aragon in the reign of John II (king of Aragon from 1458 to 1479 and of Navarre from 1425).

At the time of their union, both Aragon and Catalonia had developed important territorial interests in southern France. These occupied much of the attention of the crown until Aragonese pretensions in France were finally abandoned in 1258. The only territory north of the Pyrenees that remained permanently attached to the Aragonese crown was the county of Roussillon (*q.v.*). The occupation of the Balearic Islands (*q.v.*) took place in 1228 and the conquest of the rich Moorish kingdom of Valencia (*q.v.*) in 1238. Valencia, like the Balearics, was colonized by Catalans, though it retained a large Mudéjar population. It was administered as a separate kingdom of the crown of Aragon, with its own laws and parliament. Having thus completed the occupation of the Moorish territories allotted to Aragon by the treaty of Cazorla, the Aragonese began expansion in the Mediterranean, made possible by the seapower of the Catalans. In 1282, after the Sicilian Vespers, Peter III (1276–85) was received by the Sicilians as their king, and thenceforward Sicily was ruled either directly by the kings of Aragon or by their relatives. Sardinia was incorporated in the Aragonese empire in 1320. A further accretion to Aragonese power came in 1442, when Alfonso V (1416–58) successfully concluded his long struggle to conquer the kingdom of Naples (*q.v.*).

Between 1356 and 1369 Peter IV (1336–87) had been involved in a disastrous war with Castile. This war and its aftermath revealed that the powerful feudal nobles of Aragon tended to sympathize more with the Castilian magnates than with their own municipalist dynasty. Their chance came in 1412 when, after the extinction of the house of Barcelona in 1410, they procured the election of a Castilian prince, Ferdinand of Trastámara, to the vacant throne against strong Catalan opposition. The final blow to Catalan supremacy came when Alfonso V of Aragon transferred his capital to Naples in 1443, though, later, the Catalans waged an unsuccessful civil war against Trastámaran rule. John II countered this resistance by arranging for his heir, Ferdinand, to marry Isabella, heiress of Henry IV of Castile. In 1479, therefore, on John's death, the countries of the Aragonese crown were united with Castile.

Under this union the Aragonese countries retained their own political and administrative systems (for details *see* SPAIN: *History*), despite certain modifications under Philip II, until the beginning of the 18th century, when, in consequence of the rebellion of the lands of the crown of Aragon during the War of the Spanish Succession, their constitutional privileges were abrogated by Philip V. As an administrative unit the old kingdom of Aragon proper survived until 1833, when the division of it into the three existing provinces took place.

See H. J. Chaytor, *A History of Aragon and Catalonia* (1933); Andrés Jiménez Soler, *La edad media en la corona de Aragón*, 2nd ed. (1944). (P. E. R.)

ARAGONITE, one of the five known forms of calcium carbonate ($CaCO_3$), was named for its first-known occurrence in Aragon province, Spain. Together with calcite and vaterite, it occurs as a mineral in nature. The other two forms, calcite II and calcite III, are found only in the laboratory under pressures of the order of 20,000 atm. at room temperature. Calcite is the commonest natural form of calcium carbonate, while aragonite is second. Vaterite is comparatively rare.

Aragonite crystallizes in the orthorhombic system and is colourless, white or yellowish, transparent to translucent, with a vitreous lustre, and thus resembles calcite. It may be easily distinguished from calcite, however, by its lack of any pronounced cleavage and by its greater hardness (3.5 to 4) and specific gravity (2.94). All forms are soluble with effervescence in hydrochloric acid.

Aragonite may be manufactured in the laboratory from calcite by the application of approximately 7,000 atm. pressure while heating at 350° C.; at higher temperatures more pressure is required. On the other hand, under atmospheric pressure aragonite converts rapidly to calcite at about 425° C. Aragonite may be easily prepared by the reaction of calcium chloride ($CaCl_2$) with sodium carbonate (Na_2CO_3) at about 90° C., using solutions of high concentration. Lower temperatures produce mixtures of calcite and aragonite. At room temperature vaterite may be produced.

There are no known natural occurrences of aragonite in which it has formed in its own stability field, hence it (together presumably with vaterite) is unstable with respect to calcite under natural conditions; therefore it must with geological time eventually be transformed to calcite, even in the absence of high temperatures. Calcite and aragonite were among the earliest recognized examples of polymorphism (the ability of one chemical substance to exist in two or more crystalline forms).

Aragonite is found all over the world. It occurs in near-surface, low-temperature deposits primarily as sinter or evaporation deposits from hot springs or in caves as stalactites. The skeletal remains of many invertebrates both fossil and recent consist of aragonite. *See* also CALCITE. (J. C. JN.)

ARAGUA, one of the smaller states of Venezuela with a short coastline on the Caribbean. Area 2,708 sq.mi.; pop. (1961) 312,274. The central highlands there are composed of two ranges, separated by an intermontane basin, in which Lake Valencia lies. The climate is tropical and, though there is considerable rain inland, the coast is dry. The state lies in Venezuela's most important political and agricultural region, with the densest rural population. The capital, Maracay (*q.v.*), is situated in the fertile Aragua valley, 1,500 ft. above sea level and 77 mi. S.W. of Caracas. It was by gaining possession of the fine fattening pastures around Lake Valencia that Juan Vicente Gómez, dictator and one-time cattle rustler, cornered Venezuela's cattle industry (*see* VENEZUELA: *History*), and Maracay became the centre of his far-flung cattle operations.

The Aragua valley produces a variety of agricultural products; although sugar cane has for many years ranked first, the acreage in such food crops as beans, maize and rice increases steadily, as does that of cotton. Aragua is one of the country's most diversified states, both agriculturally and industrially. The famous and extensive 210,000-ac. Parque Nacional Rancho Grande occupies the entire northern half of Aragua. Probably no Venezuelan state is so well served by hard surface roads.

Several small towns of importance are La Victoria, Cagua, Turmero and Villa de Cura. Puerto Ocumare handles a modest trade by sea. (L. WE.)

ARAGUAIA, a river of Brazil rising at about 18° S., and 53° W., on the *Planalto Central*. In its upper part it forms the boundary between Mato Grosso and Goiás. It flows north northeast for a distance estimated at 1,366 mi. to its junction with the Tocantins (*q.v.*) a little south of 5° S. In its middle course this river divides into two channels on either side of the island of Bananal, which is about 250 mi. long. The *braço maior*, or major arm, is interrupted by many falls and rapids; the *braço menor*, the

smaller eastern channel, can be used for navigation by small boats. A major tributary of the Araguaia is the Rio das Mortes, which rises near Cuiabá. The river drains a vast area of interior Brazil in which there are few people and which has yet to be carefully mapped. As a line of travel the river is poor, for it is frequently interrupted by falls. Downstream from Bananal Island there are two major falls, one dropping 85 ft. in 18 mi., the other 50 ft. in 12 mi. For short stretches, however, it is navigable for small river boats. The river was explored in part in 1897 by Henri Coudreau, who wrote *Voyage au Tocantins-Araguaya.* (P. E. J.)

ARAK, the chief town of the former province of that name in Iran, has, since 1938, been incorporated into Gilan the First *ostan* (province). Pop. (1956) 58,929 mainly of Persian stock with some admixture of Turks and Armenians. It lies 5,750 ft. above sea level at the entrance of an important mountain gap giving access to the inner valleys of the southwestern Iranian ranges. The gap is used by the Trans-Iranian railway and by a metalled road connecting Qom (Qum) to Kermanshah, Khorramabad (Khurramabad) and Dezful. The climate is cold in winter but agreeable in summer. The adjoining plain of Farahan is dotted with many villages, all irrigated, the surplus waters being dissipated in the central salt pan of Tuzlu Gol (Namak-e Mighan). Vines, fruits, melons and cereals are the main crops, supplies being increased by the produce of the mountain valleys, which includes sugar beet. Arak is the marketing centre of the district and has a sugar refinery. It is also known for its carpets and rugs.

The town was formerly named Sultanabad. It was founded in 1808 by a local dignitary and laid out on a regular grid plan. The former capital of the province was Saruq, 28 mi. N.W. (H. Bo.)

ARAKAN, a natural region and an administrative division of Burma. The former comprises a strip along the eastern coast of the Bay of Bengal from the Naf estuary on the border of Chittagong (in East Pakistan) to Cape Negrais, and is about 400 mi. long and 90 mi. wide at its broadest in the north. The southernmost 100 mi. of the region is in the Irrawaddy division. The chief of many islands bordering the coast are Cheduba, Ramree and Shahpura. The principal rivers are the Naf estuary; the Mayu, an arm of the sea running almost parallel with the coast for about 50 mi.; the Kaladan, rising near the Blue mountain in the extreme northeast and falling into the sea south of the Mayu, and navigable for 40 mi. by vessels up to 400 tons; and the Lemro, which enters the sea south of the Kaladan. Farther south the nearness of the boundary range of the Arakan Yoma shortens the rivers; the Dalet and An are navigable by boats; of the Sandoway, Taungup and Gwa, the last affords harbourage for small vessels. The easiest of several passes over the Arakan mountains are the An route to Ngape and Minbu in central Burma, and the Taungup route to Padaung on the Irrawaddy. The latter route is now an all-weather motor road; previously the main access to Arakan was by sea. Air services link Sandoway and Rangoon.

The three districts of Arakan division are Akyab, Kyaukpyu and Sandoway (*qq.v.*) (formerly Ramree), and its headquarters is at Akyab. Before Burma's independence (1948) it included the wild, forested northern Arakan Hill Tracts, now in the Chin Hills Special division (*q.v.*). Its area was then 16,000 sq.mi. The population at the time of the British initial occupation did not exceed 100,000; by 1941 it had risen to 1,186,738. Only one-tenth of this very hilly division is cultivated and rice occupies nine-tenths of the cropped areas. Other crops include fruits, chillies, dhani and tobacco. The natural vegetation of the lower slopes (up to 3,000 ft.) is evergreen forest, in most areas too wet for teak; that of the higher slopes is evergreen oaks. The forests have however been destroyed over huge areas by *taung-ya* (shifting cultivation) and their place taken by a useless tangle of bamboo.

The Arakanese are Burmans, but separated from the parent stock by the Arakan Yoma. Like the Burmans, they are Buddhists, but have a dialect and customs of their own. They trace their history back to 2666 B.C., with a lineal succession of 227 princes, and claim that their empire once extended over Ava and part of China and Bengal, though known facts of history do not corroborate this claim. The Moguls and Pegus invaded the country at different times, and the Portuguese gained a temporary foothold in Arakan. But in 1782 the Burmans conquered the province, and it was ceded to the British in 1826. The former capital, Arakan (now called Myohaung, "old city"), is on a small branch of the Kaladan, 50 mi. N.E. of Akyab. Its remoteness from harbours and extreme unhealthiness led to its decay, and Akyab became the chief town. (L. D. S.)

ARAKCHEEV, ALEKSEI ANDREEVICH, COUNT (1769–1834), Russian army officer and statesman noted for his stern discipline, was born near Bezhetsk, Tver province, on Oct. 4 (new style; Sept. 23, old style), 1769, of an old Novgorod family. So impressive was his reorganization of the army corps maintained by tsarevitch Pavel Petrovich at Gatchina that, upon the tsarevitch's accession to the throne as Paul I, Arakcheev was entrusted with the reorganization of the whole army. He introduced many important reforms, including vital hygienic measures, but the sternness of his discipline alienated the officers' corps and he was dismissed in 1798 and, after a brief reinstatement, again in 1799.

In 1803, under Alexander I, Arakcheev became inspector-general of the artillery. His wise reorganization of the whole department contributed greatly to the victories of the Russians during the Napoleonic wars. With the discovery of commissariat scandals, the services of an incorruptible disciplinarian were especially valued, and Arakcheev was appointed inspector-general and war minister (1808). When, on the outbreak of the Swedish war of 1809, the emperor ordered the army across the ice of the Gulf of Finland, it was only the presence of Arakcheev that compelled an unwilling general and a semimutinous army to begin a campaign which ended in the conquest of Finland. On the institution of the imperial council, Arakcheev was made a member of the council of ministers and a senator (1810), while still retaining the war office. Although he took no active part in the war of 1812, all the correspondence and dispatches relating to it passed through his hands, and he was the emperor's inseparable companion during the whole course of it. In Alexander's last years Arakcheev was his chief counselor and friend, to whom he submitted all his projects for consideration and revision. On the accession of Nicholas I, Arakcheev, broken in health, restricted his immense sphere of activity and, in April 1826, resigned all his offices and retired to Carlsbad. His last days he spent on his estate at Gruzina, carefully collecting all his memorials of Alexander. He died there on May 3 (N.S., April 21, O.S.), 1834.

See V. Ratch, *Svedeniia o grafe A. A. Arakcheeve* ("Information About Count A. A. Arakcheev") (1864); M. I. Semevski, *Graf Arakcheev i voennye poseleniya* ("Count Arakcheev and the Military Colonies") (1871). (G. A. Ln.)

ARALIA, a genus of aromatic herbs, shrubs and small trees of the aralia or ginseng family (Araliaceae), containing about 35 species, in North America, Asia, Malaya and Australia. Some are cultivated for ornamental foliage and some possess medicinal properties. The stems and leaf stalks are often spiny or bristly; the leaves are usually much divided into toothed leaflets; and the small flowers, which are borne in panicled umbels, are sometimes very numerous, the entire inflorescence being showy. Among the North American members of the genus are the American spikenard (*Aralia racemosa*), which grows from three feet to six feet high in rich woods from New Brunswick to South Dakota and south to Georgia and Missouri; the wild sarsaparilla (*A. nudicaulis*), a foot in height, found in woods from Newfoundland to British Columbia, south to North Carolina and Colorado; the bristly sarsaparilla (*A. hispida*), about two feet high, native to sandy clearings from Newfoundland to Hudson bay and southward to North Carolina and Indiana; the elk clover (*A. californica*), a robust form, sometimes ten feet high, found along mountain streams in California. The angelica tree, Hercules'-club or devil's-walking-stick (*A. spinosa*) is a spiny shrub or small tree, sometimes 40 ft. high, native to low grounds from Delaware to Indiana and southward to Florida and Texas, frequently planted for ornament and sometimes escaping to roadsides and thickets. The Chinese angelica tree (*A. sinensis*) and the Japanese angelica tree (*A. elata*) are the east Asian counterparts of the North American *A. spinosa*, but less

prickly and with more showy flowers. Many hardy varieties of the Chinese angelica tree are in cultivation. Numerous greenhouse plants called aralias are species of *Polyscias*, *Schefflera* and related genera of the aralia family. Ginseng (*q.v.*) is obtained from *Panax schinseng*, native to China, and from the American *P. quinquefolius*, plants closely related to the aralias.

The American spikenard (*A. racemosa*) and the related *A. nudicaulis* and *A. spinosa* contain in their roots or rootstocks a mucilaginous compound yielding calcium oxalate, used as an alterative. (N. Tr.)

ARAL SEA (Aralskoye More), a lake or inland sea in Soviet western Asia, lies between latitude 43° 30′ and 46° 50′ N., and longitude 58° 0′ and 62° E., in the Kazakh S.S.R., the Uzbek S.S.R. and the Kara-Kalpak Autonomous S.S.R., about 175 mi. E. of the Caspian sea. It was known to the ancient Arab and Persian geographers as the Sea of Kharezm, from the neighbouring district of the Chorasmians, and derives its present name from the Kirghiz designation of Araldenghiz, or Sea of Islands. It is the fourth largest inland sea in the world, having an area of 25,659 sq.mi. and a total length of 266 mi. and a width of 176 mi. The maximum depth is 223 ft., in a depression parallel to the west coast, and the average is 65 to 80 ft. Its altitude is 241 ft. above the Caspian, *i.e.*, 164 ft. above sea level. It is surrounded on the north by steppes; on the west by the rocky plateau of Ustyurt, separating it from the Caspian; on the south by the alluvial district of Khiva; and on the east by the Kyzylkum (*q.v.*) desert. The northern shores are low, and broken by irregular bays such as those of Sary-chaganak and Paskevicha. On the west an almost unbroken wall of clay formation extends from Chernyshëva bay southward, and attains a height of about 250 ft.

On the south is the delta of the Amu-Dar'ya (*q.v.*), one of the arms of which forms a swamp, 80 mi. long and 10 mi. broad, before it discharges into the sea. The Syr-Dar'ya (*q.v.*) enters in the northeast. These rivers bring down vast quantities of sediment; the delta of the Syr-Dar'ya increased by about 13 sq.mi. between 1847 and 1900, but because of the increased demands of irrigation the flow of water from both rivers greatly decreased. The eastern coast is fringed with multitudes of small islands, and others, some of considerable size, lie in the open toward north and west. Frequency and violence of storms, and almost total absence of shelter hinder navigation; shipping is confined to seven months in the year. The northeast wind is the most prevalent, and sometimes blows for months together. The salinity of Aral is a low 10.7‰, but salinification is proceeding. The surface temperature varies between 32° F. in winter, when long stretches of the coast are ice-fringed, and 80° in late summer. Variations of level are remarkable and irregular.

Within historic times the Aral sea may have had a connection with the Mertvyy Kultuk gulf (Zaliv Komsomolets) of the northeast Caspian, and in this case would then have been a fresh-water lake. Its level was much higher in post-Pliocene times, for shells of Pecten and Mytilus species occur in the Kara-Kum desert 34 mi. to the south of, and 80 ft. or perhaps even 213 ft. above, the present sea. Between the 13th and 16th centuries and in antiquity the Amu-Dar'ya may have sent an arm to the Caspian south of the Ustyurt plateau. Until 1880 the sea had long been diminishing and this gave rise to the idea, in western Europe, that the inland basins of west central Asia were drying up, but from 1880 to 1908 the level rose by nearly 10 ft., and there was increased utilization of the waters of Amu-Dar'ya and Syr-Dar'ya in their upper courses for irrigation. Islands previously linked with the shore became widely separated from it.

The fish of Aral are fresh-water species and some of its rapid streams still preserve the ancient fish type *Scaphirhynchus*. Fishing is not so productive as in the Caspian but is considerable, the most common types being carp, barbel and sturgeon. Aralsk and Muinak are the centres of the industry. (G. E. Wr.)

ARAM, EUGENE (1704–1759), English scholar and murderer, was born at Ramsgill, Yorkshire. In 1745, when he was schoolmaster at Knaresborough, a man named Daniel Clark, his intimate friend, after obtaining a considerable quantity of goods from tradesmen, disappeared. Suspicions of being concerned in this swindling transaction fell upon Aram. His garden was searched, and some of the goods found there. As, however, there was not evidence sufficient to convict him of any crime, he was discharged. For several years he traveled through parts of England, acting as usher in a number of schools, and settled finally at Lynn, in Norfolk. During his travels he had amassed considerable material for a projected *Comparative Lexicon of the English, Latin, Greek, Hebrew and Celtic Languages.* He was undoubtedly an original philologist, who realized, what was then not yet admitted by scholars, the affinity of the Celtic language to the other languages of Europe, and could dispute the then accepted belief that Latin was derived from Greek. But he was not destined to live in history as the pioneer of a new philology. In Feb. 1758 a skeleton was dug up at Knaresborough, and some suspicion arose that it might be Clark's. Aram's wife had more than once hinted that her husband and a man named Houseman knew the secret of Clark's disappearance. Houseman was at once arrested and confronted with the bones that had been found. After denials, he confessed that he had been present at the murder of Clark by Aram and another man, Terry, of whom nothing further was heard. He also gave information as to the place where the body had been buried in St. Robert's Cave, a well-known spot near Knaresborough. A skeleton was dug up here, and Aram was immediately arrested, and sent to York for trial. He was found guilty, and condemned to be executed on Aug. 6, 1759. While in his cell he confessed his guilt, and asserted that he had discovered a criminal intimacy between Clark and his own wife.

His story has been romanticized in verse by Thomas Hood ("The Dream of Eugene Aram") and in prose by Bulwer Lytton (*Eugene Aram*). Reports of the trial are in (Borrow's) *Celebrated Crimes*, the *Newgate Calendar, Tyburn Chronicle* and similar publications. The best study is E. R. Watson, *Eugene Aram* (1913).

ARAMAEANS, a confederacy of tribes speaking a North Semitic language which, between the 11th and 8th centuries B.C., occupied Aram, a region comprising a large area of northern Syria. In the same period some of these tribes, migrating to the east and southeast, seized large tracts of Mesopotamia.

Sources for the history and language of the Aramaeans are (1) archaic Aramaic inscriptions from northern Syria going back to the 10th or to the 11th century B.C.; (2) references in contemporary Assyrian records; and (3) references in the Old Testament.

History.—In the Old Testament traditions exemplified in the national pedigrees (Gen. xi, 28 ff.) and in the tale of Jacob and Laban (Gen. xxxi, 17 ff.) the Aramaeans are represented as being closely akin to the Hebrews and as having been resident in northern Syria around Harran from patriarchal times; *i.e.*, perhaps the 16th century B.C. Though these traditions are regarded by many scholars as anachronistic, the original home of the Aramaic-speaking tribes may well have been where Old Testament tradition places it, namely in the Syrian desert (Qedem, "the east"; Gen. xxix, 1). It can be assumed that these tribes followed the normal pattern of many other nomad Bedouins who, welling out of the desert, settled in adjacent agricultural lands and mingled with other peoples there. The Aramaeans are often mentioned in Assyrian records as freebooters jointly with another people called Akhlame. The Akhlame are first mentioned in a letter of *c.* 1375 B.C. found at Tall al Amarna in which they are said to be on the Euphrates river. About 50 years later they had reached the upper Tigris, but were repulsed by the Assyrians. In the 13th century B.C. they were attacked by the Assyrians on the Khabur river and on the middle Euphrates, where they are later found settled. The first mention of the Aramaeans is made by Tiglath-pileser I, king of Assyria from 1116 to 1076, who claims to have launched 28 campaigns against them and the Akhlame on a front from Tadmor (Palmyra) to Anat and Rapiqu on the middle Euphrates. By the end of the 11th century B.C. the Aramaeans had formed the state of Bit-Adini on both sides of the Euphrates below Carchemish. In the Khabur valley they formed the sheikhdoms of Laqe, Bit-Bahiani (Tall Halaf) and Bit-Halupe. The Temanai tribe seized Nasibina (Nisibis), Huzirina and Gidara, southwest of Mardin (in Turkish Kurdistan), the northernmost point that they reached being Suru in the Tur 'Abdin hills. West of the

Euphrates, they penetrated to the Amanus mountains and settled at Sam'al (Zincirli). The centre was held by the sheikhdom of Bit-Agusi, with Arpad (*q.v.*) for capital, and Hamath also fell to them. Farther south, the Anti-Lebanon area was divided between the sheikhdom of Zobah in the Beqa' (perhaps forming one with Bit-Rehob on the Litani river), Maacah and Geshur east of Galilee, and Damascus. About 1030 B.C. a coalition of these southern Aramaeans, led by Hadadezer, king of Zobah and in league with the Ammonites, with the Edomites and with the Aramaeans of Mesopotamia, pressed hard on Israel, but was defeated by David in three campaigns. All of Syria is said then to have done homage to David. David's son Solomon (reigned *c.* 973–936) also claimed supremacy over the same area with the exception of Bit-Adini and seems to have occupied Tadmor (Palmyra), but Damascus, under Rezon, appears to have freed itself. Rezon's successors Bar-Hadad I (Hebrew, Ben-Hadad; throne name, Hadadezer; Akkadian, Adad-idri) and Bar-Hadad II (Hadadezer in Assyrian records) renewed the struggle, but Bar-Hadad II was defeated by Ahab, king of Israel (*c.* 875–*c.* 852), who made peace with him.

Ahab's clemency to Bar-Hadad was due to his anxiety over a worse threat, the aggressiveness of Assyria. During the 11th century the Aramaean tribes had not merely occupied Syria; they had also spread along the middle and lower Euphrates, along the middle Tigris and farther eastward into Babylonia, where an Aramaean usurper was crowned king of Babylon under the name of Adad-apal-iddin. By the 9th century the whole area from Babylon to the sea was in the hands of the Aramaean tribes known collectively as Kaldu (or Kashdu)—the biblical Chaldeans. Assyria was thus nearly encircled, but Ashurnasirpal II of Assyria (reigned 884–859) took the offensive against the Aramaeans and received the submission of Bit-Bahiani on the west. Shalmaneser III of Assyria annexed Bit-Adini in 856 and in 853 fought a battle at Karkar against the army of Hamath, Aram, Phoenicia and Israel. This battle was indecisive, but in 838 Shalmaneser was able to annex the area held by the tribes on the middle Euphrates.

Between Israel and Damascus, wars and uneasy pacts alternated for a century after Ahab's time. Then Tiglath-pileser III of Assyria captured Arpad, the centre of Aramaean resistance in northern Syria, in 740 B.C., overthrew Samaria in 734 and Damascus in 732. Finally the destruction of Hamath by Sargon II of Assyria in 720 marked the end of the Aramaean kingdoms of the west.

Aramaeans on the lower Tigris maintained their independence longer. A Chaldean, Merodach-baladan, ruled Babylon from about 722 to 710 and withstood Assyrian attacks. In the bitter struggle after his death the Assyrians deported 208,000 Aramaeans and even in 689 B.C. razed Babylon. Yet the Aramaeans were undaunted; Babylon was rebuilt and the struggle was soon renewed. In 626 a Chaldean general, Nabopolassar, proclaimed himself king of Babylon and joined with the Medes and Scythians to overthrow Assyria. In the New Babylonian or "Chaldean" empire, Chaldeans, Aramaeans and Babylonians became largely indistinguishable. (*See* BABYLONIA AND ASSYRIA: *History.*)

Script and Language.—Aramaic is a Semitic language closest to Hebrew and Phoenician but bearing some points of similarity to Arabic. It used the Phoenician alphabet; the earliest example is of the 10th–9th century B.C. on an altar from Tall Halaf. There are many examples from Syria from the 9th to the 8th century, by which time Aramaic was used for religious and state purposes. These inscriptions show signs that Aramaic was already becoming a literary language. By the 8th century it had developed into dialects, but a general form was widely spoken among the educated (*cf.* II Kings xviii, 26–28 where, in the Authorized Version, it is called, as sometimes elsewhere, "the Syrian tongue") and was accepted by the Assyrians themselves almost as a second official language. Mass deportations of people by the Assyrians and the use of Aramaic as a *lingua franca* by Babylonian merchants served to spread the language. By the neo-Babylonian period it was in general use in Mesopotamia. Under the Persian empire (539–332 B.C.) "imperial Aramaic" was officially employed from Egypt to India. After the conquests of Alexander the Great, Greek displaced it as the official language of the east throughout the former Persian empire, but Aramaic dialects survived into Roman times, their scripts developing local forms such as Palmyrene, Nabataean, Samaritan and Syriac. Certain portions of the Old Testament, *e.g.*, in Daniel and Ezra, are in Aramaic. The Babylonian Talmud was written largely in one Aramaic dialect, the Jerusalem Talmud in another. In Palestine, Aramaic continued as the current speech of the people, Hebrew being that of religion and state and the upper class. Aramaic was the language of Jesus and of the apostles, and Aramaic translations (Targums) circulated with the Hebrew Bible. Apart from its preservation in daily life into modern times in a few isolated villages near Damascus and in southeastern Turkey, in the Tur 'Abdin hills, and on the east bank of Lake Urmia (Azerbaijan province, Iran) it has continued in use among the East Syrian Christians till modern times. It is still recited in parts of the Jewish liturgy. (*See* SEMITIC LANGUAGES.)

Culture.—It is scarcely possible to disentangle a specifically Aramaic culture from the relatively few works of art and objects discovered by archaeology. The Aramaean princes, notably those of Bit-Bahiani and of Sam'al, patronized a provincial form of Syrian art under strong Hittite or Mitannian influence. These Aramaeans evidently wore the local dress of those peoples. Assyrian artists, however, depict Aramaeans on frescoes at Til-Barsip as Bedouin, and on their sculptures they show the Aramaeans of Mesopotamia wearing a short kilt and bearded, with a headband, the women wearing long draperies.

Religion.—Though their pantheon included Canaanite, Babylonian and Assyrian gods, the Aramaeans had deities of their own. Their chief god was Hadad, or Ramman (in the Old Testament Rimmon), equated with the Hurrian storm god, Teshub. His chief temple was at Damascus. Their chief goddess was Atargatis (Atar'ate), a fusion of two deities corresponding to the Phoenician Astarte and Anath. Her chief shrine was at Hierapolis in Syria. They also worshiped the Babylonian Sin, god of the moon; Nabu, god of wisdom; Shamash, the sun god; the Canaanite El, father of the gods; Reshef, god of war and lightning; and many others. There is some evidence that Yau, *i.e.*, Yahweh, was included in the gods worshiped by the Aramaeans at Hamath.

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ARAMAIC LANGUAGES: *see* SEMITIC LANGUAGES.

ARANDA, PEDRO PABLO ABARCA DE BOLEA, CONDE DE (1718–1798), Spanish statesman and general, who typified the spirit of enlightened despotism in the government of Charles III, was born at Siétamo, in Aragon, on Dec. 18, 1718. Under Ferdinand VI he was director-general of artillery and introduced the Prussian system of drill into the Spanish army, which he commanded during the Portuguese campaign of 1762. He was appointed captain general of Valencia in March 1764, and later of Aragon.

Aranda's political career began in 1766 when riots in Madrid forced Charles III to dismiss his unpopular Italian minister, Leopoldo de Squillace. Aranda was then made president of the council of Castile. As an aristocrat, soldier and moderate reformer, Aranda was useful to Charles III in restoring the order and confidence shaken by his early reforms. Imperious in character and contemptuous of those who opposed him, Aranda valued only his own opinions, yet he was the efficient executor of the royal will rather than the author of a policy himself. His devotion to absolute monarchy and his religious views were both revealed when he prepared and, in April 1767, executed the royal decree expelling the Jesuits on the pretext that they had instigated the riots of the previous year. His partiality for reform and new ideas was accompanied by enthusiasm for contemporary French thought, but in spite of his skepticism, his sympathy for *Encyclopédiste* ideas and his association with Spanish freemasonry, of which he was grand master, he remained nominally a Catholic and felt that it would be dangerous to undermine the Inquisition. Aranda's

contempt for the lawyers and officials whom Charles III chose as ministers made him a difficult colleague and, being held responsible for Spain's failure to eject England from the Falkland Islands, he was dismissed in 1773 and appointed ambassador to France, where he remained until 1787. A revolutionary report on the future of the Spanish colonies, alleged to have been written in 1783 for the advice of Charles III, cannot be regarded as the work of Aranda, though many historians have accepted it as such.

Aranda returned to office under Charles IV and was first minister for a short time in 1792, when he relaxed the official Spanish attitude toward the French Revolution and revoked the stringent press laws. In Nov. 1792 he was replaced by the queen's favourite, Godoy. After the French invasion of Spain in 1794, Aranda objected violently in the council of state to Godoy's policy of continuing the war with France. Godoy then obtained a royal order dismissing Aranda from the council and exiling him to Jaén. In 1795 Charles IV allowed him to retire to his estates in Aragon and he died at Epila on Jan. 9, 1798.

See R. Konetzke, *Die Politik des Grafen Aranda* (1929); A. P. Whitaker, "The Pseudo-Aranda Memoir of 1783," *Hispanic American Historical Review*, vol. xvii, pp. 287–313 (1937). (Jo. L.)

ARAN ISLANDS (ARAINN), three islands in Ireland covering 18.1 sq.mi., part of County Galway, lie between the rocky coast of Connemara and the Burren limestone coast of Clare to the south. Facing the open Atlantic on the west and Galway bay to the east, the islands are made up of horizontal sheets of Carboniferous limestones like the Burren of Clare. The largest, Inishmore (Aranmore or Aran-na-naomh), has the only pier at Kilronan, a village of 231 people with a fine technical school; on the two smaller islands to the southeast, Inisheer (Inis Thiar) and Inishmaan (Inis Mheadhóin), the steamer from Galway cannot land and all passengers and cargo are landed on the shore by currach. The total population (1961) was 1,648 of whom 358 were on Inisheer and 357 on Inishmaan. The people are Irish-speaking and preserve some traditional clothing made from homespun tweeds with shoes (pampooties) of hide. They fish for home consumption rather than sale, and the main resource is farming. Rich crops of oats and potatoes are gathered from fields on "made ground," using seaweed, sand and manure. There are some magnificent prehistoric and early Christian hillforts and other remains. (T. W. FR.)

ARANJUEZ, a town of central Spain in the region of New Castile and the province of Madrid, lies in fertile flat land at the confluence of the Jarama and the Tagus 29 mi. S. of Madrid by road. Pop. (1960) mun. 27,251. The town was built in the mid-18th century by Ferdinand VI to a prearranged plan. Among several royal residences are the palace (completed in 1778 after being damaged several times by fire), which has a large collection of treasures, and the Casita de Labrador, built by Charles IV who abdicated at Aranjuez in 1808, which recalls the Trianons at Versailles. There are many parks and formal gardens. Aranjuez is on the main railway from Madrid to the south. Its chief industries are the manufacture of chemicals, metal products, textiles and preserved fruits. It is the centre of a rich agricultural district where asparagus and strawberries are especially important and horses are bred. (V. G. U.)

ARANY, JÁNOS (1817–1882), the greatest Hungarian epic poet, was born in Nagyszalonta, March 2, 1817, of an impecunious farming family. He went to school in Debrecen, but abandoned his studies to join for a short time a group of strolling players. Returning home, Arany found his mother dying and his father losing his sight. He reconciled himself to life at home and secured an appointment first as an assistant teacher, then as a village notary. He married an orphan Julianna Ercsey, and they lived happily with their two children. After a preliminary success, with a mediocre comic epic, in a Kisfaludy society competition, Arany made his real advent on the literary scene in 1847 with his popular epic, *Toldi* (which won him another prize from the same society). *Toldi* was received with enthusiasm by a public craving for a national literature of artistic quality in a language all could grasp. Sándar Petőfi wrote a poem in its praise, and this was the beginning of a friendship to which Arany remained loyal even after Petőfi's death. The influence of Petőfi's blazing temperament on Arany's more restrained personality was marked.

In 1848 Arany took part in the Hungarian war of independence, and for a short period edited a government newspaper for peasants. With the crushing of the revolution he lost his job and took to teaching. In 1858 he was elected a member of the Hungarian Academy and in 1860 became director of the Kisfaludy society. He moved then from Nagykörös to Pest, where he edited a literary periodical, the *Szépirodalmi Figyelő* (later the *Koszorú*), and was elected first secretary and in 1870 secretary-general of the academy. He was, however, indifferent to official recognition and reluctant to accept the honours offered him. With his "wise old peasant" mentality he found it difficult to settle down in the capital. He resigned because of ill-health in 1879 and died in Budapest, Oct. 22, 1882, an embittered man.

Arany's main epic work is the trilogy *Toldi* (1847), *Toldi szerelme* ("Toldi's Love"; 1848–79), *Toldi estéje* ("Toldi's Evening"; 1854). Its hero, a youth of great physical strength, is taken from an arid verse chronicle written by Péter Ilosvai Selymes in the 16th century. The story is set in the 14th century. In the first part of the trilogy *Toldi*, after a series of adventures recalling those of the youngest sons of folk tales, reaches the royal court. The second part tells of his tragic love and the third of his conflicts with the king, his last feat of arms and his death. Another epic poem, *Bolond Istók* ("Steven the Fool"; 1850), is a strange mixture of humour and bitterness. Though only a fragment, it is valuable for the few moments of self-revelation which Arany—usually the most reserved of authors—permits himself in it. Arany started work on a Hun trilogy, connected with Hungarian prehistory, but finished only the first part of it, *Buda halála* ("Death of Buda"; 1864). In plot and style it is reminiscent of the *Nibelungenlied*, but the characterization of the heroes is almost like that of a modern novel. The atmosphere is lowering. Archaic and folk expressions are freely used, and Arany carries language to its heights.

Arany's ballads, mostly concerned with some terrible crime and its punishment, are unparalleled in virtuosity in Hungarian literature. The poems of his two great lyrical periods are fraught with melancholy. The earlier poems, written in the 1850s, are overshadowed by the loss of Petőfi and by his despair for the Hungarian nation and for himself. The *Őszikék*, his beautiful swan songs, written just before his death, are poignant in their bitterness and sense of unfulfillment and solitude. He never published a love poem.

Arany's genius is not a loud, rebellious one. He was essentially an epic poet with a style combining exceptional lucidity and density. Even his grimmest works are relieved by his sense of humour, and his vocabulary is enriched with unusual peasant expressions. He was an infinitely painstaking worker; it would be hard to find a line in his poetical legacy which is not perfectly expressed.

Arany wrote also several essays on literature and translated Shakespeare's *King John*, *Hamlet* and *A Midsummer Night's Dream*. For his translations of Aristophanes' comedies he was awarded the Karátsonyi prize of the academy.

The best edition of Arany's collected works is by Géza Voinovich, six volumes (1951–52). (N. KI.)

ARAPAHO, an Algonkian Plains tribe, bison hunting, and tepee dwelling, on the upper Platte and Arkansas rivers at the time of the first white settlement. In the 1960s about 2,500 lived on reservations in Wyoming and Oklahoma. In addition to the northern and southern divisions now recognized, there are submerged remnants of two or three other groups—once perhaps tribally independent, since they spoke distinct dialects—and the Atsina or Gros Ventre, close to the Arapaho in speech, but chiefly associated with the Blackfoot during the 19th century. Arapaho is one of the most divergent Algonkian languages, suggesting that its speakers have been long separated from the body of the stock, presumably on or at the edge of the Plains. They were nonagricultural and clanless, kept a bundle containing a tubular pipe as tribal fetish and were divided into seven age-graded ritual societies for men and one for women, besides practising the Sun

dance in elaborate form. Their ceremonial system, decorative art and other traits indicate them as one of the nuclear or typical tribes participating in Plains culture.

They adhered vigorously to the Ghost Dance (*q.v.*), the messianic religion of 1889–91. *See* also ALGONKIAN TRIBES; PLAINS INDIANS.

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ARARAT, a municipal city in Ripon county, Victoria, Austr., is about 1,030 ft. above sea level and 127 mi. W.N.W. of Melbourne by road. Pop. (1960) 7,934. Situated toward the western end of the western Victorian highlands, it is flanked on the south and east by a range of hills, the Pyrenees. Extensive lava flows (basalt) have occurred in this area and the soils derived from them are fertile. Ararat, with an average annual rainfall of 23–24 in., is the centre of a flourishing agricultural and pastoral area (wheat, vines, sheep, cattle). The excellent local timber resources have been exploited.

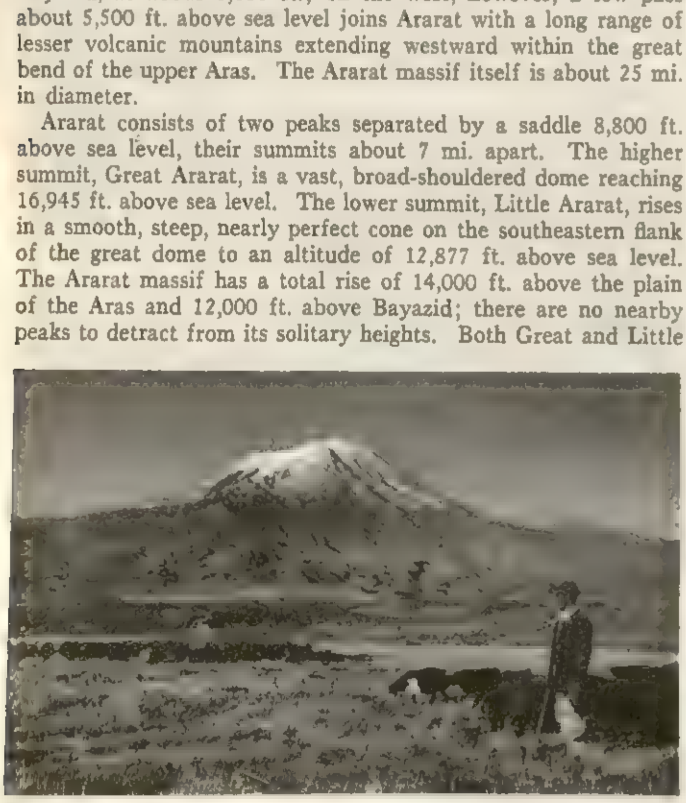
Ararat lies on the main Adelaide-Melbourne railway line and is a junction for other lines, including one to Hamilton and the rising ports of Portland and Warrnambool. Besides the railway workshops and marshalling (freight) yards important sources of employment are a fabric-weaving and hosiery-finishing mill, a psychiatric hospital and a large postal relay centre.

Ararat derives its name from Mt. Ararat (2,020 ft.), about 5 mi. S.E., so called in 1840 by the pioneer sheep-farmer H. S. Wills because, like the Ark on Mt. Ararat in Armenia, he had come to rest there. Its history began with the discovery of gold by Chinese during 1854–55, which started a big gold rush.

(J. I. GR.)

ARARAT, an extinct volcanic massif dominating the Armenian plateau, stands in Turkish territory overlooking the point where the frontiers of Turkey, Iran and Soviet Armenia converge. Its northern and eastern slopes rise from the broad alluvial plain of the Aras (Araxes) river (*q.v.*), which is there about 3,000 ft. above sea level; its southwestern slope rises from the plain of Bayazid, at about 5,000 ft.; on the west, however, a low pass about 5,500 ft. above sea level joins Ararat with a long range of lesser volcanic mountains extending westward within the great bend of the upper Aras. The Ararat massif itself is about 25 mi. in diameter.

Ararat consists of two peaks separated by a saddle 8,800 ft. above sea level, their summits about 7 mi. apart. The higher summit, Great Ararat, is a vast, broad-shouldered dome reaching 16,945 ft. above sea level. The lower summit, Little Ararat, rises in a smooth, steep, nearly perfect cone on the southeastern flank of the great dome to an altitude of 12,877 ft. above sea level. The Ararat massif has a total rise of 14,000 ft. above the plain of the Aras and 12,000 ft. above Bayazid; there are no nearby peaks to detract from its solitary heights. Both Great and Little Ararat are a result of eruptive volcanic activity, although no eruption is known to have occurred in historical times. Both consist entirely of volcanic rocks, chiefly varieties of andesite with some obsidian, and are covered with scoria and lava. Neither retains any evidence of a crater, but well-formed parasitic cones and fissures exist upon their flanks.



EITZ—PIX FROM PUBLIX

THE PEAK OF GREAT ARARAT AS SEEN FROM TURKEY

The heights of Ararat lie in the zone of perpetual snow. The snow line varies according to the season, descending in winter, the season of colder temperatures and greater precipitation, to 8,000 ft. above sea level. Both Great and Little Ararat are covered with snow as late as May. By the end of the warmer and drier summer the snow line retreats to approximately 14,000 ft. above sea level, and the snow cap occurs only on Great Ararat. The only true glacier is found on the northern side of Great Ararat, descending into the head of the great Aghuri (Akhury) chasm, a cleft in the side of the mountain extending nearly from summit to base. The middle zone of Ararat, from 5,000 to 11,500 ft., is covered with good pasture grass and some juniper, where Kurds of the area graze their sheep. Above it is sterile, black volcanic detritus, while below it is the wide sweep of thorny steppe. Most of Great Ararat is devoid of trees, but Little Ararat has a few groves of birches.

History and Legend.—The name Ararat, as it appears in the Bible ("the mountains of Ararat," Gen. viii, 4), is the Hebrew equivalent of Urardhu, or Urartu (*q.v.*), the Assyro-Babylonian name of the kingdom which flourished between the Aras (Araxes) and the upper Tigris rivers from the 9th to the 7th century B.C. The name Urartu was explained by the Babylonians as meaning "highlands," aptly referring to the mountainous character of the region. To the Armenians, Ararat refers to the province around Mount Ararat, although it was applied to the mountain itself in early Armenian literature. Today the mountain is locally known as Masis to the Armenians and Aghri Dagh to the Turks.

Mount Ararat is sacred to the Armenians, venerated by them as the Mother of the World. It is the symbol of their unity and the focal point of their traditions. Great Ararat is perhaps most celebrated as the legendary site upon which Noah's Ark came to rest as the waters of the flood subsided. The story of the Ark is still a living tradition among the Armenians, who believe themselves to be the first race of men to appear in the world after the deluge. Local legend maintains that the remains of the Ark were long visible on the mountain. Near the foot of the Aghuri chasm stood the village of Aghuri, where, according to tradition, Noah built his altar and made sacrifice after his safe deliverance from the Ark, and where he also planted his vineyard. The monastery of St. Jacob, 2,300 ft. above the village in the chasm, commemorated the monk who repeatedly tried and failed to reach the summit of the holy mountain. Both the village of Aghuri and the monastery of St. Jacob were totally destroyed by a devastating earthquake and avalanche in 1840. A Persian legend refers to Ararat as the Cradle of the Human race; the Persian name for it is Koh-i-Nuh, meaning Noah's Mountain.

In keeping with the legend of St. Jacob, the Armenians believed that God forbade anyone from reaching the top of Ararat and viewing the remains of the Ark. But on Sept. 27, 1829, Johann Jacob von Parrot (1792–1840), a German in the Russian service, made what is believed to be the first successful ascent. His accounts describe the Aghuri chasm, the village of Aghuri, and St Jacob's monastery before the great landslide. Professor Hermann Abich, a German geologist, climbed Ararat in 1845 and described the immediate effects of the Aghuri avalanche. Since then the mountain has been climbed many times by Europeans. From a mountaineering point of view the ascent is said not to be difficult, requiring only considerable endurance. (D. D. CR.)

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ARAS (Russian ARAKS, Persian RUD-E ARAS, Turkish ARAS NEHRI, anc. ARAXES), a river which rises south of Erzurum (*q.v.*)

in the Bingol Daglari of Turkish Armenia. It flows eastward, forming between longitude 41° 20′ E. and 48° E., or approximately 280 mi., the international boundary between the U.S.S.R. on the north and Turkey and Iran on the south. Approximately 568 mi. long, it joins the Kura river in Azerbaijhan S.S.R. about 75 mi. from its mouth on the Caspian sea. Since a flood in 1897 a separate distributary of the Aras also empties into the Caspian. The swift-flowing Aras accounts for most of the sediment comprising the Kura-Aras delta. The principal tributaries of the Aras are the Zanga, draining Lake Sevan (Gokcha), and the Qara Su, which flows off the Kuh-i-Savalan in northeastern Iranian Azerbaijan. On an island in the river, in the shadow of Ararat (*q.v.*), stood Artaxata, the capital of Armenia from 180 B.C. to A.D. 50. (D. D. Cr.)

ARASON, JÓN (*c.* 1484–1550), last Roman Catholic bishop in Iceland, is remembered as a national, no less than as a religious, hero. The son of poor parents, he rose quickly to eminence in the church and was consecrated bishop of Hólar, the northern diocese of Iceland, in 1524. He administered his diocese prosperously until Christian III of Denmark began to impose Lutheranism on all his subjects. The two Icelandic bishops, Jón in the north and Ögmundr in the south, protested (1537). Ögmundr was deported by the Danes in 1541, but Jón continued his resistance. He captured the Lutheran bishop Marteinn and seized his see (1549–50), but was soon afterward taken by the king's agents and beheaded with two of his sons in Nov. 1550.

Jón was the author of splendid religious and satirical poetry and brought the first printing press to Iceland.

See Knut Gjerset, *History of Iceland* (1922). (G. T.-P.)

ARATUS (*c.* 315–*c.* 245 B.C.), Greek poet of Soli in Cilicia, is best remembered for his poem on astronomy, *Phaenomena.* He resided at the courts of Antigonus Gonatas, king of Macedonia, and Antiochus I of Syria, and died in Macedonia about 245 B.C. The *Phaenomena,* a didactic poem in hexameters is his only completely extant work. Lines 1–757 versify a prose work on astronomy by Eudoxus of Cnidos (*c.* 390–337) while lines 758–1154 treat of weather signs and show much likeness to Pseudo-Theophrastus' *De Signis Tempestatum.* The poem became immediately popular and provoked many commentaries, the most important of these being that by Hipparchus (*c.* 150 B.C.), still extant. In form the *Phaenomena* belongs to the Alexandrian school, but the author's Stoicism adds a strong note of seriousness. It enjoyed a high reputation among the Romans. Cicero, Caesar Germanicus and Avienus translated it; the two last versions and fragments of Cicero's survive. One verse from the opening invocation to Zeus has become famous from being quoted by St. Paul (Acts xvii, 28).

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ARATUS OF SICYON (271–213 B.C.), Greek statesman, who for many years was the leading spirit of the Achaean league (*q.v.*). From Argos, his home after his father's murder (264 B.C.), he liberated Sicyon (251), established a democracy there and united it with the Achaean league for defense against Macedonia. He solved its economic difficulties with subsidies from Ptolemy II of Egypt. As general of the league (a post he normally held each alternate year after 245), he captured Acrocorinth (243), defeated the Aetolians at Pellene (241) and pursued a policy of establishing democracies in the Peloponnese. With Aetolia as ally from 239, he repeatedly attacked Athens and Argos. He brought Megalopolis (235) and Argos (229) into the league and helped to liberate Athens from Macedonian rule (229). Spartan aggression threatened these gains. Twice defeated by Cleomenes III, Aratus sought help from Macedonia, and the league was saved by Antigonus Doson's arrival (224). In 222 Cleomenes was defeated and dethroned. On the accession of Philip V of Macedonia, Aratus countered Aetolian aggression by appealing to Antigonus Doson's new Greek league; in the subsequent war (the "Social War") he successfully defeated the anti-Achaean policy of the court cabal led by Apelles. After the peace of Naupactus (217) he resisted Philip's anti-Roman policy and his interference in Messene. His death (213), probably from consumption, was popularly laid at Philip's door. Aratus' memoirs no longer survive; they formed an important source for Polybius' *History.* Aratus sometimes indulged personal rancour against his rivals, but his general policy was statesmanlike. He failed to build up a strong army; but his main decisions were almost invariably right, and as a diplomatist and guerrilla fighter he achieved greatness through adapting himself to circumstances.

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ARAUCA, a western tributary of the Orinoco river (*q.v.*). It rises in the eastern cordillera of the Andes near the Venezuelan-Colombian border and empties into the Orinoco about 60 mi. southeast of San Fernando de Apure. Its course is about 430 mi. long and forms part of the Venezuela-Colombia boundary for approximately 135 mi. in the upper course.

The Arauca takes a relatively straight, almost direct east-west course across the llanos (plains) and flows nearly parallel to the Apure and the Meta. The level nature of the vast plains, combined with the seasonal rainfall, result in such widespread flooding during the rainy season (April to November) that the waters of the Arauca and the Apure sometimes mingle. Since the flow of the rivers down the gentle slope of the llanos is relatively straight, the Arauca has few tributaries.

The river is navigable by small craft but is little used. (D. R. D.)

ARAUCANÍA, an area of southern Chile between the Bío-Bío and Toltén rivers within which Araucanian (*q.v.*), or Mapuche, Indians maintained independence of Spanish and Chilean authority until late in the 19th century, despite periodic methodical campaigns of reduction. During one of the final operations Temuco (*q.v.*) was founded (Feb. 23, 1881) on a strategic site ceded in the treaty signed on Cerro Ñielol. Settlement of the conquered area by Chileans and Europeans was encouraged by the government. Land was reserved for the Indians, a people whose process of incorporation into national life continues. Arauco, Bío-Bío, Malleco and Cautín (*q.v.*) provinces occupy Araucanía. (J. T.)

ARAUCANIAN is a language group of the Andean Equatorial phylum and the generic name given to Indians speaking any of its several mutually-intelligible dialects and living in southern middle Chile and Argentina. Most is known about Chilean Araucanians who are traditionally described as belonging to three major geographical and cultural divisions, *Picunche* (*picun* "north," *che* "people"), *Mapuche* (*mapu* "land"), and *Huilliche* (*huilli* "south"). The Picunche were defeated and assimilated by the Spaniards before the end of the 17th century and the Huilliche, for the most part, are now culturally indistinguishable from rural mestizos among whom they live. It is the approximately 200,000 Mapuche, who inhabit the central valley and the Andean foothills from the Bío-Bío river to an ill-defined zone south of the Toltén river, who represent contemporary Araucanian society in Chile. The Argentine Araucanians are descendants of *émigrés* from Chile who crossed the Andes in great numbers at certain periods during more than 400 years of troubled relationships with white colonists and soldiers. Today, social contacts are still sustained between these two Araucanian populations who share a common culture and a similar social organization.

The Mapuche defended their territory against white invaders until their final defeat in the War of 1880–82, after which they were forced to settle on several thousand small, family-based reservations in southern middle Chile, where they are found today. During the centuries of hostilities the Mapuche were desultory horticulturalists and herders of horses, sheep and cattle. They shifted their small settlements frequently, according to the exigencies of warfare. With the establishment of the present reservation system the Mapuche population has become sedentary, and agriculture has taken on greater importance as new crops (wheat, barley, oats) have been added to the traditional inventory (maize,

potatoes, quinoa, beans) and as ox-traction plowing has spread throughout their territory. The Mapuche have become increasingly dependent on Chilean regional markets for sales, purchases and the establishment of credit. Young men and women continually leave the reservations to find work or attend schools in Chilean and Argentine towns. Many cultural changes have taken place. (*See* also CHILE: *The People and Population.*) Nevertheless, Chilean as well as Argentine Araucanians comprise one of the largest functioning indigenous societies in South America. They are culturally and socially distinctive from peoples who surround them. They maintain characteristic kin and marriage relationships, based on patrilineal organization. Their traditional religion, influenced by Christianity, is still practiced and involves beliefs in ancestral spirits and a hierarchy of mythological deities.

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ARAUCARIA, a genus of coniferous trees included in the tribe *Araucarineae.* They are magnificent evergreen trees, with apparently whorled branches, and stiff, flattened, pointed leaves, found in Brazil and Chile, the Phoenix Islands and Australia. The name of the genus is derived from Arauco, the name of the district in southern Chile where the trees were first discovered. *Araucaria araucana,* the Chile pine, or "monkey puzzle" as it was called because it was hard to climb, was introduced into Britain in 1796. It is largely cultivated, and usually stands the winter of Britain; but in some years, when the temperature has fallen very low, the trees have suffered much. Care should be taken in planting to select a spot somewhat elevated and well drained. The tree grows to the height of 150 ft. in the Cordilleras of Chile. The cones are from eight to eight and one-half inches broad, and seven to seven and one-half inches long. The wood of the tree is hard and durable.

This, as well as other members of the genus, is cultivated on the Pacific coast of the U.S., particularly in California, and also in some cases in southern Florida. They are valued for the conspicuous growth habits which set them apart from nearly all other conifers commonly grown. *Araucaria excelsa,* the Norfolk Island pine, a native of Norfolk Island and New Caledonia, was discovered during Captain James Cook's second voyage and introduced into Britain by Sir Joseph Banks in 1793. It is tender but finds some use as a house plant during its sapling stage, because of the beauty of its symmetrically tiered growth. It is not often found out of doors in the United States, where *A. cunninghamii,* the Moreton Bay pine, *A. bidwillii,* the bunya-bunya pine and *A. angustifolia* are more frequently met.

E. AUBERT DE LA RÜE

PARANA PINE (ARAUCARIA ANGUSTIFOLIA) OF BRAZIL

ARAUCARIACEAE. This family of conifers (*q.v.*) has only two genera and about 32 species; it includes some of the largest gymnosperms, and is restricted to the southern hemisphere. They are extremely important as timber trees, are used in the manufacture of paper pulp, and are the source of important resins (obtained often in fossilized condition) such as kauri gum and copal. The genus *Agathis* includes about 20 species of the Australasian area, while *Araucaria,* with about 12 species, ranges from this area to South America. Four species of *Araucaria* are cultivated commonly in temperate regions: *A. excelsa* (Norfolk Island pine) *A. cunninghamii* (Moreton Bay pine), *A. araucana* (monkey puzzle tree), *A. bidwillii* (bunya-bunya).

The Araucariaceae are large, monoecious or dioecious trees with needlelike or broad leaves. The large, cylindrical staminate, or pollen-bearing, cones are borne on the ends of short axillary branches. The numerous scales bear 5 to 20 pendent sporangia. The ovulate, or seed-bearing, cones are often extremely large and heavy and are borne on the ends of short branches. The numerous cone scales are composed of a bract and an ovule-bearing scale fused their entire length. Each cone scale bears a single, inverted ovule. Only simple polyembryony occurs in the Araucariaceae. The single surviving embryo has two to four cotyledons. (R. W. H.)

ARAUCO, a small coastal range province of southern Chile, approximately bisected by latitude 37° 30′ S. Area 2,023 sq.mi.; pop. (1960) 89,504. Created in 1852, the province sustained various areal changes before being merged with Concepción province in 1928. It regained provincial status in 1934. There are three departments: Arauco, which includes Santa María Island; Lebu; and Cañete, which includes Mocha Island. The provinces adjoining are Concepción (north), Bío-Bío and Malleco (east) and Cautín (south). Arauco's hilly terrain culminates in the forested Cordillera de Nahuelbuta, the divide marking both the eastern boundary of the province and the headwaters of most of Arauco's streams. The area receives abundant rainfall; the maximum occurs in winter but no month is rainless. Winters are cold and summers cool.

At the time of the Spanish conquest this area was skilfully defended by the Araucanian Indians (*q.v.*). The fierce fighting between Spaniards and Indians near Cañete in the 16th century cost the lives of two of Chile's most famous warriors, Pedro de Valdivia (*q.v.*) and the Araucanian chieftain Caupolicán (*q.v.*). Indians overwhelmed the fort at Arauco three times before 1662; they remained strong enough to attack again in 1723, 1766 and 1817. It was not until well after Chile had gained its independence that the Chilean army pacified (1861–67) most of this part of Araucanía (*q.v.*). Thereafter agriculture and coal mining were developed, although with limited economic benefits to the province. Arauco's soil and mineral wealth are of modest importance. A fair acreage of wheat, potatoes, oats and peas is grown; cattle and sheep are common in the open brush and forest range; and the forests produce lumber and tanning materials. Husbandry supports about half of the gainfully employed, coal mining about 10%. The province produces about 15% of Chile's coal. The mines of Colico, Curanilahue and Arauco are served by rail from Concepción (*q.v.*). Lebu, a lesser mining centre, minor port and provincial capital since 1875 (pop., [1960] 6,248), has rail communication with Cañete (5,487) and the longitudinal railway. All-year roads are maintained from the capital to Curanilahue, Cañete and Quidico. Lebu, Arauco and Lake Lanalhue, southeast of Cañete, attract summer vacationers. (J. T.)

ARAUSIO, BATTLE OF, the defeat of a Roman army by Germanic tribes on Oct. 6, 105 B.C., near Arausio (the modern Orange in southern France). The Cimbri and the Teutones, Germanic peoples from north of the Alps, had invaded the Roman province of Gallia Narbonensis (*see* GAUL) *c.* 110 B.C. The consul Gnaeus Mallius Maximus, sent from Italy in 105 with an army to reinforce that of Q. Servilius Caepio (Roman proconsul in Gaul from 106), began negotiations with the invaders, but during the negotiations Caepio attacked the Cimbri. Caepio was over-

whelmed, and the consul's army, drawn into the fighting, also was destroyed. Instead of advancing into Italy, however, the Cimbri went into Spain and the Teutones wandered in Gaul. The disaster and the urgent need to raise new forces accelerated the process whereby the Romans replaced their traditional citizen soldiery with a long-service professional army.

ARAVALLI RANGE, an Indian hill system running for 300 mi. in a northeasterly direction through Rajasthan state, is situated between 24° and 27° N., and between 72° and 75° E. The series of ridges and peaks, with breadth varying from 6 to 60 mi., are generally from 1,000 to 3,000 ft. in elevation, the highest point, Mount Abu (5,650 ft.), being in the extreme southwest. Geologically the Aravalli range is built up of Pre-Cambrian metamorphic rocks, especially gneisses, schists and slates. Masses of rose-coloured quartzite give a dazzling snowlike appearance to some of the peaks.

The Luni and Sakhi rivers from the steep northwestern slopes turn southwest to the Gulf of Kutch. Two distinct river systems drain the southeastern slopes; one debouches in small streams on the Gulf of Cambay, while the other unites to form the Chambal river, a tributary of the Jumna and the Ganges system. The Aravalli hills are for the most part bare and thinly populated, with large areas of sand and stone, or huge masses of quartz. The valleys are generally sandy deserts, with sparse oases of cultivation. Occasionally, however, a fertile tract marks a natural drainage line, *e.g.*, that of Ajmer (*q.v.*) city, with its lake. The Aravalli hills send off rocky ridges northeast through the state of Rajasthan, which reappear in the form of isolated hills near Delhi.

(L. D. S.)

ARAWAK, a name applied by the Spanish to various groups of Indians in the West Indies and in South America who spoke related languages. The term is now used to refer to a major family of South American Indian languages which were spoken not only in the Caribbean and in northern South America but as far south as the Gran Chaco.

The Arawakan-speaking Indians whom Columbus met in Hispaniola and the other islands of the Greater Antilles were a peaceful agricultural people who granted their chiefs great deference and were organized into fairly large political units. In spite of their superior organization, however, they seem to have been unable to withstand the attacks of the Carib, who had driven the Arawak out of the Lesser Antilles shortly before the arrival of the Spanish (*see* CARIB).

In South America, Arawakan-speaking tribes occupied large areas in the northern and western parts of the Amazon basin, where they shared many traits with the other peoples of the tropical forest. Sedentary farmers who did considerable hunting and fishing, they lived in small settlements in large thatched houses, made baskets and pottery, wove hammocks, and traveled in dugout canoes. Their chiefs had little authority and each village was independent of all others. Religion centred around curing individuals, although some ceremonies were held for the benefit of the whole community. A few of the Arawakan tribes in the Guianas were cannibals, but this practice was more characteristic of their neighbours and traditional enemies, the Carib.

The most western Arawak, the Campa and neighbouring tribes, lived in the foothills of the Andes but do not seem to have been much influenced by the Andean civilizations. To the south, in eastern Bolivia, the Mojo had a political organization similar to that of the Antillean Arawak, with several communities being under the control of a paramount chief.

For Arawakan languages, *see* INDIAN, LATIN-AMERICAN.

See also references under "Arawak" in the Index.

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(SE. L.)

ARBELA: *see* IRBIL; GAUGAMELA, BATTLE OF.

ARBENZ GUZMÁN, JACOBO (1913–), president of Guatemala, under whom the Communists reached positions of national influence, was born in Quezaltenango on Sept. 14, 1913, and graduated from the military academy at Guatemala City in 1935 at the top of his class. María Cristina Vilanova Castro, whom he married in 1939, is generally credited with leading Arbenz toward the acceptance of Marxism. After playing a major role in the revolution of Oct. 20, 1944, which opened the way for the establishment of a democratic government in Guatemala, he became a member of the triumvirate that governed until the inauguration of Juan José Arévalo as president in March 1945. As Arévalo's minister of defense, Arbenz became the presidential candidate of the leftist forces. His road cleared by the assassination of his chief rival, Francisco Arana, he was elected president in Nov. 1950 and assumed office the following March. Organized labour soon came completely under the control of the Communists, several of whom occupied important positions in the government. Following the enactment of a program of agrarian reform in July 1952, Guatemala moved rapidly toward open class warfare and became the centre of international controversy. The situation continued to deteriorate until finally on June 18, 1954, civil war broke out. After a week of indecisive fighting, the army withdrew its support; Arbenz resigned on June 27 and shortly thereafter went into exile. Following an extended visit to eastern Europe, the Soviet Union and Communist China, Arbenz moved to Uruguay in 1957 and later to Cuba. *See* GUATEMALA: *History*.

(R. M. Sc.)

ARBER, EDWARD (1836–1912), English man of letters, whose editing of Elizabethan and Restoration literary texts first made detailed study of them possible to the ordinary student, was born in London, Dec. 4, 1836. He became a clerk in the admiralty office in 1854 but used his leisure to study literature and in 1878 was appointed lecturer in English at University college, London. He was professor of English at Birmingham, 1881–94, and a fellow of King's college, London, from 1880. He was knocked down and killed by a taxicab in London, Nov. 23, 1912.

Arber's publication at a reasonable price of rare texts opened up new opportunities for scholars and students. His editions of many texts remain the only ones easily accessible. His *English Reprints*, 30 vol. (1868–71), began with a 6*d*. edition of Milton's *Areopagitica*. Later series were *An English Garner*, 8 vol. (1877–96); *The English Scholar's Library*, 16 vol. (1878–84); and *British Anthologies*, 10 vol. (1899–1901). Equally valuable were his bibliographical *A Transcript of the Registers of the Company of Stationers of London, 1554–1640*, 5 vol. (1875–94), and *The Term Catalogues, 1668–1709*, 3 vol. (1903–06), edited from the booksellers' quarterly lists.

ARBITRAGE, a business operation in which funds, gold, commodities or securities are sent from one place to another to take advantage of temporary price differences that exceed transfer costs. Undertaken only for virtually certain profit with practically no risk, it is not a form of speculation. The operation, however, is impossible without some freedom of movement of the means of arbitrage. When they move unrestrictedly, the price disparity can be only temporary—unless the knowledge of market conditions remains imperfect or the supply of the means of arbitrage continues to be limited. Opportunities for arbitrage may keep recurring because of the working of the supply-and-demand forces in the market.

In less developed countries a common arbitrage activity consists in the buying and selling activities of the peasant or traveling merchant plying between nearby village markets. He is able to profit when a price disparity persists due to the difficulty of communication, the lack of sufficient supply, and the nonstandardization of weights and measures. Equally common in these countries is the shifting of funds from one city to another in the same country to take advantage of substantial differentials in interest rates. In highly developed countries, however, opportunities for arbitrage at home are far less extensive, and the term is generally used to refer to international operations in respect of foreign exchange rates, short-term interest rates, prices of gold and prices of securities.

Foreign-exchange arbitrage proper is confined to spot exchange markets where exchanges are bought and sold for immediate de-

livery. For purposes of illustration, the differential between buying and selling rates, fees and commissions, the possible loss of one day's interest and the cost of cables and telephones are ignored. Assume that at a given time the New York rate for sterling is \$2.80 while the London rate is \$2.81. Under the circumstances a New York operator will instruct his banking correspondent in London by telephone to use a specified amount of his sterling balance to buy dollars immediately for cable transfer to New York, and simultaneously buy sterling in New York to replenish his London account. By so doing, he will make one cent on every \$2.80. This opportunity for sure profit, known to many operators in New York, London and other money centres, will disappear in a matter of minutes. The increase in demand for dollars in London and the increase in demand for sterling in New York will harden the sterling value sufficiently to make the rates in both markets identical at a new level of, say, \$2.80½.

The example above is known as a two-point arbitrage, involving simultaneous purchase and sale in two exchange centres. The same principle applies to three-point or multiple-point arbitrages when three or more centres are involved. Given the rates of \$2.80 to a British pound and \$2.04 to 1,000 French francs in New York, operational parity means not only identical rates for the American dollar in London or Paris, but a cross-rate of £1 to 1,372.55 francs ($= 2.8 \times 1000 \div 2.04$) between them. Now suppose the franc rate in New York and Paris suddenly drops to \$2.00, with the sterling rate in New York and the cross-rate between Paris and London unchanged at the moment. A New York operator, with \$100,000 at his disposal, may then make three moves: (1) buy 50,000,000 francs in New York in the form of a cable transfer to his Paris account; (2) instruct his correspondent in Paris by telephone to use a similar amount of francs to buy at the current rate £36,428.11*s*.5*d*. in the form of a cable transfer to his London account; and (3) sell the same amount of sterling in New York at \$2.80 for a total of \$102,000. Thus, within a few minutes the original amount of working funds is returned with a profit of \$2,000. The heavy demand for francs in New York may push the rate back to \$2.04, restoring the old operational parity. Should the franc continue to weaken in the New York market, arbitrage will go on until the franc depreciates equally in all exchange centres and the new cross-rate between London and Paris becomes £1 to 1,400 francs ($= 2.80 \div 2.00$).

Pure arbitrage in foreign exchange has been curtailed by the establishment of equalization funds in various countries. The administrators of such funds may "peg" the exchanges so effectively that arbitrage profits are eliminated.

The opportunity for a different type of arbitrage, interest arbitrage, arises when, say, the three-month money rate in London is 3% per annum compared with 2% in New York. To take advantage of this differential, a New York operator will either purchase three-month sterling bankers' acceptances in the market at a discount of close to 3% and hold them until maturity, or transfer funds to London to invest in prime papers. (The price of sterling acceptances and the spot sterling rate will rise.) Simultaneously, hedging against unfavourable exchange fluctuations at the end of three months when the proceeds will be brought back, he sells sterling in New York for three-month delivery. Heavy sales of forward sterling will carry the forward rates to a growing discount against the spot rate, which may soon wipe out the profit margin. Meanwhile the flow of funds will stiffen the money rate in New York and soften that in London. The new equilibrium will be found in a combination of a narrowing interest differential between the two centres and a falling price of forward sterling which eliminates any incentive to arbitrage.

Gold arbitrage and securities arbitrage operate, in principle, very much like commodity arbitrage in the domestic market, except that in the two former cases exchange rates are important either because funds have to be remitted abroad for the operation or because the proceeds have to be brought home at the end of the operation. (CH.-M. L.)

ARBITRATION, in law, an arrangement for settling a dispute by calling upon the judgment of a selected person or persons rather than taking the matter into the established courts of justice. This article is restricted to the use of arbitration in commercial matters; the arbitration of labour disputes is discussed in INDUSTRIAL RELATIONS, while methods of settling disputes between nations are described in ARBITRATION, INTERNATIONAL.

United States.—Arbitration generally followed the pattern of the English common law until 1920, when New York adopted the first modern arbitration statute. Previously, agreements to arbitrate disputes that might arise in the future could be revoked at any time prior to an actual settlement. Such agreements were held nonenforceable, although not illegal, on the theory that they would deprive the courts of jurisdiction. Following adoption of the New York statute, the federal government (in 1925) and 15 states enacted similar statutes. The federal act does not prescribe a rule of decision for all cases in the federal courts but is confined to subjects within federal legislative control, namely, maritime transactions and those involving interstate commerce. In other cases that may be litigated in the federal courts, *e.g.*, in suits between citizens of different states, the law of the state in which the federal court sits either provides the controlling law on arbitration or points to the law of the appropriate state.

In the early 1960s all states with the exception of Oklahoma and South Dakota had some statutory provisions for arbitration. Not all, however, provided for enforcing an agreement to arbitrate future disputes; many followed the rule that none but existing controversies could be made the subject of an agreement to arbitrate. A Uniform Arbitration act that would validate agreements regarding both existing and future disputes was adopted in 1955 by the Commissioners on Uniform State Laws and approved by the American Bar association. This act, if adopted generally, would bring into conformity those state laws not providing for future disputes. It also would simplify arbitration proceedings and the enforcement of awards.

Although individuals frequently agree, either by contract or after a dispute has arisen, that a dispute will be arbitrated by some specific procedure, the majority of arbitrations are held under the auspices of organizations that have procedures for arbitration as an explicit part of their trading rules, bylaws or constitutions. Such institutional arbitration has a long history. The New York Chamber of Commerce had arbitration facilities from at least 1761 to 1920, and the New York Stock exchange provided for arbitration of members' disputes in its 1817 constitution. Trade associations frequently provide the machinery for settling disputes among members, and occasionally such facilities are available to nonmembers as well. In some instances an association has joined several others to provide joint arbitration machinery. Additional facilities for handling disputes by arbitration were made available through the auspices of the American Arbitration association, a nonprofit-making organization that maintained panels of arbitrators and provided administrative services for judging both labour and commercial disputes. (S. M.; X.)

England.—The Arbitration act of 1950 (which consolidated the Arbitration acts, 1889 to 1934) provided a code regulating all arbitrations made as a result of written agreements between the disputing parties, as well as certain arbitrations conducted under statutory provisions; however, if the parties to a dispute so agree, many provisions of the 1950 act need not be observed.

Apart from the Arbitration act itself, there are many statutes providing for the arbitration of special classes of disputes. Arbitration is made compulsory in statutes dealing with agricultural holdings, housing and the acquisition of land. Disputes in connection with building societies, companies, compulsory purchase of land, public health and rent restriction may be arbitrated at the option of the parties involved.

An arbitration agreement is defined as a written agreement to submit existing or future disputes to arbitration; it may or may not specifically name an arbitrator. Unless the agreement provides otherwise, the authority of the arbitrator is irrevocable except by order of the court or a judge. For example, if an arbitrator has misconducted himself by showing partiality, the court has the power to remove him or to set aside his decision.

The court has two ways in which it may compel parties to carry out an arbitration: directly, by appointing an arbitrator or by

allowing one appointed by one of the parties to proceed alone with the arbitration; and indirectly, by staying any proceedings before the legal tribunals to determine matters within the scope of arbitration. However, the court will refuse to stay proceedings where the subject matter of the litigation falls outside the scope of the arbitration, where there is some serious objection to the fitness of the arbitrator, or where some other good reason of the kind exists, such as there being an important question of law involved.

When two arbitrators and an umpire are to be appointed, the umpire must be named by the arbitrators (in order to make an award should the arbitrators fail to agree) immediately after they are appointed; in cases of disagreement, the court may appoint an umpire.

An arbitrator or umpire has the power to administer oaths to, and take the affirmations of, the parties to the dispute and their witnesses, and the customary penalties for perjury apply to such proceedings.

An award in an arbitration case may be made at any time, if no specific time limit has been provided for in the arbitration agreement. However, if the arbitrator or umpire delays unduly in making an award, the court has the power to remove him. Where the time for making an award has been fixed in the agreement, that time may be extended by the court or judge. In cases where the court may remit an award to the arbitrators or umpire for reconsideration, the reconsidered award must be made within three months.

An award must dispose of all the points referred to the arbitrators and it must be final, except as regards certain matters of valuation. However, an award may be set aside in cases where the arbitrator has misconducted himself, where he has been willfully deceived by one of the parties or where there is a prima-facie error of law. An award may be enforced, by leave of the court, in the same manner as a judgment or decree to the same effect. An arbitrator may, and shall if required by the court, state in the form of a special case for the opinion of the court any question of law arising in the arbitration.

(A. W. R.; H. Sle.; X.)

Other Countries.—Commercial arbitration procedures are much the same in all countries, differing locally in matters of detail. In countries that have felt British influence, legislation generally follows the pattern of English law. However, in Scotland, the law on arbitration is almost wholly common law. There is no statutory code, although contracts for arbitration always have been enforced by the courts.

In France, a distinction is made between the formal submission of an existing dispute and an agreement to submit future disputes that arise out of a definite legal relationship between the parties, the latter being most common. The French code excludes arbitration that is not based on a formal submission; hence, an arbitration clause is construed as a promise to sign a submission when a dispute arises.

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ARBITRATION, INTERNATIONAL. Arbitration is a process for the settlement of disputes based on the consent of the parties in conflict. By their agreement, the controversy is referred to a third party for a final decision or award. It is to be contrasted with conciliation or mediation (*q.v.*), in which the role of the third party is to persuade the parties to the dispute to accept a settlement, rather than to impose upon them a binding decision.

International arbitration contemplates the final settlement of disputes between states or bodies having legal personality in international law. It implies the reference of such a dispute by the consent of the parties to a tribunal of their own selection for a decision which will be binding upon them. As defined in the Hague convention of 1907, international arbitration has for its object the settlement of disputes between states by judges of their own choice on the basis of respect for law.

Arbitration between states differs from arbitration between private persons in a number of respects. The differences basically stem from a difference in attitudes toward the two processes. International arbitration although distinguished from international judicial settlement (*see* League of Nations covenant, art. 13; United Nations charter, art. 33) is a process of adjudication. The international arbitral tribunal proceeds "on the basis of respect for law." International law governs its creation, its functioning and the binding force of its judgments. On the other hand, private arbitration is regarded as a mechanism or device for the settlement of controversy. Private arbitrators are not perceived as judges.

As a consequence, an arbitration treaty may not lawfully be revoked by the act of one of the parties whereas a private agreement to arbitrate may be. An international tribunal may determine its own jurisdiction, subject to no superior body. A decision on jurisdiction by private arbitrators is subject to review by the courts. A domestic arbitration award need not be supported by reasons; an international award must be. An international award is itself binding and, unlike a domestic award, needs no court order to render it enforceable.

International arbitration may look to the settlement of existing disputes (*ad hoc* arbitration) or of future disputes. States have rarely entered into agreements to settle all their future disputes by arbitration or judicial means. Usually such agreements are subject to limitations, such as the requirement that resort to arbitration cannot be had unless diplomatic negotiation or conciliation shall have failed to settle the dispute. Other agreements limit arbitration of future disputes to those which involve rights, are of a legal nature or are capable of decision by the application of legal principles. Still other agreements specifically exclude disputes of a political nature or those which involve matters of domestic jurisdiction, sovereign rights or vital interests.

International law assures states that when they decide to arbitrate their differences, the terms of their agreement will be respected by each of them and by the arbitral tribunal, that the tribunal will observe the minimum procedural standards observed by courts of law generally, that the award of the tribunal will be confined to the matters submitted to it and that the tribunal will apply the law laid down for it.

The extension of the arbitral process to the settlement of political, as well as legal, disputes is in part a problem in reconciling conflicting values or viewpoints of nations and in part a problem in the growth of international law. When national feelings run high, the parties may accept mediation but refuse arbitration, since mediation is not binding whereas arbitration is. Yet even if the necessary readiness to accept arbitration should exist, there is still the problem of the basis upon which the tribunal shall decide the dispute. If the dispute is of a legal character, it is susceptible to decision by international law. If, however, it is of a political character, international law may not provide applicable rules for decision. International law represents a limited body of rules growing out of the practice of states and based on their consent. In many areas, such as economic relations, no rules were developed to limit the exercise of state power. These are termed the sphere of sovereignty or of domestic jurisdiction. If a dispute arising in such an area were to be decided on the basis of international law, the result would always be in favour of complete state freedom. Yet this very freedom from restraint by law is the ultimate source of the dispute.

To some extent, the lag in the growth of international law, as compared with the growth of international society, is met by treaty regulation. Treaties not only provide new rules or create new agencies to deal with new international problems but often include provisions for the arbitration or judicial settlement of disputes arising under them. Illustrative of this development are the Convention on International Civil Aviation, the constitution of the Food and Agriculture organization and the agreement of the In-

ternational Bank for Reconstruction and Development.

When, however, states desirous of settling their disputes peacefully are faced with the lack or inadequacy of customary rules of international law, they must give the tribunal greater freedom than merely the resort to international law as a basis for decision. One approach in such circumstances is to provide for a decision *ex aequo et bono* or on the basis of equity. In international practice, this means a decision consistent with the general principles of justice, faithful to the spirit of the law and supplementing and filling in its gaps in an objective manner. Another approach is to provide for a decision in accordance with the "general principles of law recognized by civilized nations," a term first used in international jurisprudence in the statute of the Permanent Court of International Justice and continued in the statute of the International Court of Justice.

In support of the latter approach, it has been asserted that the principles evolved by the legal systems of civilized states are of a maturity and breadth which would make it possible for all conflicts between states to be decided on a basis of law, even in areas where customary international law has not developed rules. On the other hand, others have contended that it is fallacious to assume that international arbitration can be relied upon to settle basic conflicts of power in the international sphere. They say that in such conflicts the issue is not who is right and who is wrong but what ought to be done to combine the particular interests of individual nations with the general interest in peace and order. Such a question, they say, cannot be answered by a lawyer but only by a statesman.

Arbitration has been used for settling international claims, such as claims of a state on behalf of its nationals based on denial of justice by another state. Cases in this field, known as the responsibility of states, have probably occupied the largest volume of litigation before international tribunals; there are literally thousands of such decisions. A number of diplomatic episodes of importance have been decided by arbitration, notably by the Permanent Court of Arbitration established under the Hague conventions of 1899 and 1907. Boundary disputes, many with a stormy diplomatic history, have been frequently resolved by arbitration.

History of Arbitration.—The history of arbitration goes back to antiquity. It was practised occasionally between the various city-states of ancient Greece. It was resorted to between the 12th and the 15th centuries in the relations of the various political units of western Europe, the Italian cities and the cantons of Switzerland. Modern international arbitration, conceived as a procedure based on the application of rules of law, may be said to have begun with the Jay treaty of Nov. 19, 1794, between Great Britain and the U.S. In that treaty the parties submitted to adjudication by mixed commissions matters of considerable importance, such as determination of boundary disputes relating to vast stretches of territory, as well as acute controversies bearing upon the exercise of belligerent rights at sea by Great Britain during its war with France and the fulfillment by the U.S., in the same war, of its obligations of neutrality.

While in the 19th century a number of arbitrations between other states took place, much of arbitral practice in that century was due to agreements between the U.S. and Great Britain. These covered not only mixed commissions, sitting over long periods, for the determination of boundary disputes and pecuniary claims such as those established by the treaty of Ghent of 1814, by the treaty of 1853 and by the treaty of Washington of 1871; they also revealed the political and legal potentialities of international arbitration by submitting successfully to legal determination complex and delicate political issues. Thus, in 1870 the two states ended a prolonged and embittered controversy by agreeing on arbitration with regard to the claims of the U.S., based on alleged violations of neutral obligations by Great Britain in the American Civil War, in the matter of the "Alabama" and other vessels. The U.S. claim for arbitration was originally rejected by Great Britain on the ground that it would have been contrary to the honour of the government to submit to arbitration the question whether it had acted in good faith in the fulfillment of its neutral duties (*see* "ALABAMA" ARBITRATION).

The British Guiana arbitration of 1897 was between Great Britain and Venezuela, but it was an arbitration in which U.S. counsel and U.S. arbitrators played prominent parts. It was brought about largely as the result of extreme political pressure on the part of the United States, which invoked the Monroe Doctrine on the ground that any European state refusing to submit to arbitration a territorial dispute with an American state in fact attempts to annex American territory in disregard of the Monroe Doctrine.

The Bering sea arbitration of 1893 involved, in an acute form the question of the freedom of the sea. The awards in all these arbitrations were preceded by an elaborate written and oral argument—the latter lasting in some cases for weeks. They more than any other factor, were responsible for raising the prestige and revealing the possibilities of international arbitration.

The Permanent Court of Arbitration.—The success of international arbitration during the 19th century and considerations of international peace prompted the adoption, at the first Hague conference, of the convention (Convention no. I) on the pacific settlement of international disputes. That convention apart from short chapters on mediation and commissions of inquiry, was concerned exclusively with international arbitration In approaching that question, the conference was confronted with two problems: (1) that of the machinery of international arbitration, namely, of setting up an international arbitral tribunal; and (2) that of obligatory arbitral settlement. With regard to the latter the progress achieved by the conference was purely nominal. With regard to the former, the convention adopted detailed provisions for the establishment of the Permanent Court of Arbitration.

In a sense, the expressions "court" and "permanent" were misnomers, for it was provided that the Permanent Court of Arbitration should consist of a panel of arbitrators appointed by the contracting parties, each party appointing not more than four members. In case of a dispute which the parties were willing to submit to arbitration, they could—though they were not obliged to—select a number of arbitrators from the panel thus set up. In addition, the convention established the International bureau which was to serve as the registry for the court, to have the custody of its archives and to control its administrative business. Finally, the convention established the Permanent council of the court to consist of the diplomatic representatives of the contracting parties accredited to the Netherlands and the Dutch minister for foreign affairs, who was to act as president of the council. Its task was to control the International bureau of the court and to decide on questions of administration relating to the business of the court.

At the second Hague conference in 1907 an attempt was made to set up a body—an arbitral court of justice—in the nature of a permanent international tribunal as distinguished from a panel of arbitrators. That attempt failed, largely because of the insistence of Latin-American states, ably led by Ruy Barbosa, the delegate of Brazil, on the full observance of the principle of equality in the composition of the court. (*See* also HAGUE CONFERENCES. Between 1902 and 1914, 14 cases were decided by tribunals acting under the aegis of the Permanent Court of Arbitration. Between 1914 and 1932, six cases were submitted to the tribunals of the Permanent Court of Arbitration. No case came before it after 1932. But the Permanent Court of Arbitration was formally still in existence at mid-century and the national groups on the panel of arbitrators had been assigned a—somewhat nominal—function in the procedure of the election of the judges of the International Court of Justice.

Among the notable cases decided by the Permanent Court of Arbitration were the Venezuelan Preferential case (1904), which grew out of the pacific blockade of the ports of Venezuela by Great Britain, Germany and Italy in 1902, the Casablanca case (1909), which resolved a ticklish diplomatic episode between France and Germany, the famous North Atlantic Coast Fisheries case (1910), which resolved a century-old dispute between Great

Britain and the United States concerning fishing rights off the Canadian coast, the Norwegian shipowners' claims (1922), which grew out of the requisition by the United States of ships and shipbuilding contracts in World War I, and the Island of Palmas case (1928), between the United States and the Netherlands.

The Permanent Court of Arbitration is an institution of long history and great prestige. It is flexible in character and enables parties to select their own judges for the settlement of their disputes and to determine the law which such judges shall apply. Proposals have been made that its procedures be re-examined with a view to strengthening and revitalizing it.

Other notable arbitrations which took place in the 20th century included the Venezuelan arbitrations of 1903, the British-American claims arbitrations under the convention of 1910, the numerous cases decided by the mixed arbitral tribunals established under the peace treaties following World War I, the several claims arbitrations against Mexico growing largely out of the revolutionary disturbances of 1914–20, though also including other types of claims, as well as a number of territorial disputes; *e.g.*, between Colombia and Venezuela (1922), Chile and Peru (1925), Mexico and France (1933) and Guatemala and Honduras (1933). A post-World War II arbitration involved the Italian-United States Conciliation commission under the treaty of peace of 1947, which was created to settle, among other things, disputes in connection with the restitution or restoration of the property of U.S. nationals in Italy.

International Judicial Settlement.—Before and during World War I there was a widespread feeling that considerations of international peace, of the development of international law and of a proper administration of international justice required the establishment of a permanent international tribunal. The development of international judicial settlement as a process distinct from international arbitration is discussed in the article INTERNATIONAL COURT OF JUSTICE. A statute for such court was approved by the council and assembly of the League of Nations and was opened for acceptance by states on Dec. 16, 1920.

Obligatory Arbitration and Obligatory Judicial Settlement.—It is a rule of international law that, in the absence of any express undertaking to the contrary, no state is obliged to submit its disputes with other states to arbitral or judicial determination. The relevant articles of the Hague conventions on the pacific settlement of international disputes of 1899 and 1907 are clearly, though indirectly, expressive of that legal position. They provided as follows: "In questions of a legal nature, and especially in the interpretation or application of international conventions, arbitration is recognized by the signatory Powers as the most effective, and at the same time the most equitable, means of settling disputes which diplomacy has failed to settle." It was not until 1903 that international practice registered a treaty of obligatory arbitration—a treaty substantially qualified by far-reaching reservations. This was the treaty between Great Britain and France which provided, in article 1, as follows: "Differences which may arise of a legal nature, or relating to the interpretation of treaties existing between the two contracting Parties, and which it may not have been possible to settle by diplomacy, shall be referred to the Permanent Court of Arbitration established at The Hague by the Convention of 29 July 1899, provided, nevertheless, that they do not affect the vital interests, the independence, or the honour of the two contracting States, and do not concern the interests of third Parties." Before World War I more than 100 treaties of that type had been concluded. Attempts to introduce a more substantial measure of obligatory arbitration as between Great Britain and the U.S. failed because of the insistence of the senate that, notwithstanding the treaty of obligatory arbitration, the submission of any particular dispute to arbitration should depend on the affirmative advice and consent of the senate.

With the creation of the Permanent Court of International Justice, however, essentially a new process was introduced into international jurisprudence. This was the process of international adjudication characterized by a permanent or established court, whose membership was determined by the parties to the statute instead of the parties to each dispute, an administrative secretariat known as the registry, a fixed body of procedural rules, as well as rules for decision, and, finally, as a result of numerous decisions, a jurisprudence. The obligatory jurisdiction of the court under article 36 of its statute meant that for the first time in international practice a court had jurisdiction; that is to say, disputes of a fixed character could be unilaterally submitted by one party to the court for decision, even if the other party were unwilling. Such a unilateral power existed whenever both parties had adhered to the optional clause of article 36, reading as follows:

> The states parties to the present Statute may at any time declare that they recognize as compulsory *ipso facto* and without special agreement, in relation to any other state accepting the same obligation, the jurisdiction of the Court in all legal disputes concerning:
> (a) the interpretation of a treaty;
> (b) any question of international law;
> (c) the existence of any fact which, if established, would constitute a breach of an international obligation;
> (d) the nature or extent of the reparation to be made for the breach of an international obligation.

Development of the Process of Arbitration.—The growth of the process of international arbitration, apart from the process of international judicial settlement, proceeded along two principal lines:

First, as a result of the numerous arbitrations, there developed a technique of procedure consisting of the formulation of procedural rules governing the submission and argument of cases. These were increasingly of a flexible character, varying in accordance with the needs of the particular case or cases. These also developed a considerable body of case law relating to procedure and evidence.

Second, a certain body of obligatory jurisdiction developed, at first along the lines indicated at the outset of this article, by distinguishing legal from political disputes and providing for the obligatory settlement of legal differences or claims of right as distinguished from differences involving vital interests or matters of domestic jurisdiction. The difficulties of interpretation involved in such clauses led to a new approach in the General Act for the Pacific Settlement of International Disputes of Sept. 26, 1928, readopted in the Revised General Act for the Pacific Settlement of International Disputes of April 28, 1949. The General act extended to "disputes of every kind." Arbitration of a dispute, however, was not required until it had been proved impossible of settlement by diplomacy or by the procedure of conciliation outlined in the General act. The General act made it possible for a tribunal to be created even where one of the parties did not co-operate in its constitution.

Notwithstanding these developments, states proved reluctant to submit differences of major importance to arbitration. Even where they had previously agreed in principle to arbitrate, there was the difficulty of implementing such an agreement. The weaknesses implicit in the consensual nature of the arbitral process were dramatized in the dispute between the United States, on the one hand, and Bulgaria, Rumania and Hungary, on the other, arising out of the treaties of peace of 1947. By these treaties disputes arising thereunder, which had not previously been settled as provided therein, were to be referred to an arbitral tribunal composed of one representative of each party and a third member selected by mutual agreement, or, failing such selection by mutual agreement, designated by the secretary-general of the United Nations. A dispute arose between the parties but Bulgaria, Hungary and Rumania each refused to appoint their respective representatives to the arbitral tribunals. The matter was referred to the International Court of Justice for an advisory opinion which decided, in 1950, among other things, that the failure of said countries to name their representatives did not create a power in the secretary-general to nominate the third member. Hence, a two-member tribunal, composed of the representative of the United States and the member to be appointed by the secretary-general, could not be created to hear the dispute. The International Court of Justice held that the defaulting parties were without legal justification in asserting that no dispute under the treaties of peace existed, yet their failure to carry out their legal obligation

to arbitrate the dispute blocked any settlement.

The above incident concerned a failure to carry out an agreement to arbitrate. In other instances, as, for example, in the famous Chamizal arbitration award of 1911 between the United States and Mexico, states have refused to carry out awards finally rendered, on the ground they were void. Such a failure to carry out an award is a matter which should itself be arbitrated rather than be left to constitute an impasse between the parties. The Orinoco Steamship Company case (1910), between the United States and Venezuela, decided by the Permanent Court of Arbitration, was an illustration of the arbitration of a difference as to the binding character of an award. Yet there were a number of instances in which states refused to accept awards as binding and there let the matter stand. The foregoing and other weaknesses of the process of arbitration led the International Law commission of the United Nations, in its Draft Convention on Arbitral Procedure, to endeavour to make the international arbitral tribunal a truly judicial institution.

The Draft convention insisted that once a written undertaking to arbitrate a dispute shall have been made, nothing shall impede the carrying out of the agreement. The Draft convention remedied the defect which led to the above-noted dispute between the United States and Bulgaria, Hungary and Rumania by providing that, if a party shall fail to make the necessary appointments of arbitrators, the tribunal shall be constituted by other means. If a party shall agree to arbitrate but fail to enter into an agreement containing the necessary provisions for the creation of a tribunal to decide the dispute, such an agreement or *compromis* may be drafted by others and will be binding. Proceedings may be held in the absence of a party and a default judgment or award rendered. The tribunal may not refuse to give an award on the ground of "the silence or obscurity of international law or of the *compromis*." Claims of nullity of an award may be referred to the International Court of Justice, subject to time limitations.

The reception of the Draft convention by governments and the general assembly of the United Nations indicated a general tendency to reject the draft. States still generally adhered to the view that arbitration should not be recast into a mold approximating international adjudication and that it should be flexible. States should still remain masters of the agreement, the procedure and the selection of judges.

Other Types of Arbitration.—The arbitration of disputes between states and foreign subjects or between subjects of different states in the sphere of foreign investment or international trade also has been termed international arbitration, though the more usual term is international commercial arbitration. Such arbitration has often been administered through the International Chamber of Commerce or the American Arbitration association. It represents a means for a quick, efficient and economical solution of controversy in the field of international business. Some of such arbitrations even have a place in international jurisprudence, such as the Lena Goldfields arbitration with the U.S.S.R. (1930) and the Trucial Coast arbitration with the sheikh of Abu Dhabi (1952). A United Nations Conference on International Commercial Arbitration was held in 1958 on means for increasing the effectiveness of this form of arbitration.

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ARBOGAST (d. A.D. 394), barbarian soldier of the Roman empire, the first to establish a Roman nominee of his own as puppet emperor, was perhaps of Frankish nationality. Having risen to the rank of *magister equitum* ("master of the horse") in the Western Roman army, in 380 he was sent by the emperor Gratian to assist the Eastern emperor Theodosius (*q.v.*) against the Goths in Thrace. He remained with Theodosius, who in 388 sent him to help the child Valentinian II (*q.v.*) against Magnus Maximus in Italy. On the defeat of Maximus, Arbogast was sent to Gaul to remove Maximus' son Flavius Victor and his adherents. In 389 he pacified the Rhenish frontier, imposing a treaty on the Frankish leaders Marcomer and Sunno, who had invaded Gaul in 384.

By 391 Arbogast was all-powerful in Gaul as *comes* (count) or regent; and when Valentinian, on a visit there, tried to dismiss him Arbogast declared that only Theodosius had power to do so. Shortly after this, on May 15, 392, Valentinian died at Vienne in circumstances indicative of suicide but suggestive of murder at Arbogast's behest. Arbogast then proclaimed the rhetorician Eugenius as emperor in the west and set about the restoration of paganism. Arbogast conducted a successful campaign against the Ripuarian Franks, the Chamavi and the Chatti on the right bank of the Rhine in the winter of 392–393; but in May 394 Theodosius marched against him to suppress the pagan revolution. The battle of the Frigidus river (the Vipacco or Wippach, a tributary of the Isonzo) began on Sept. 5 and ended next day in victory for Theodosius. Eugenius was killed, and Arbogast fled to the mountains, where he committed suicide two days later (Sept. 8, 394). Arbogast was a great general and an energetic statesman. His pagan revival was inspired by admiration for the Roman republic and by contempt for the quarrels of Catholic and Arian Christians.

ARBOR DAY, an annual tree-planting day generally observed throughout the United States. It originated in Nebraska, where it was first observed on April 10, 1872. The plan of devoting a certain day each year to the public planting of trees and the name Arbor day were proposed by J. Sterling Morton, then a member of the state board of agriculture and later U.S. secretary of agriculture. In 1885 Arbor day was made a legal holiday in Nebraska, and thereafter a number of states made similar enactments. At first the efforts to extend its celebration were made chiefly through agricultural associations and town authorities, but about 1882 the plan of making it a school festival was inaugurated. As such, the observance of Arbor day spread throughout the United States and far beyond its borders. Moreover, its scope and purpose were greatly broadened. From simple exercises and the planting of single trees to beautify public grounds, it became the occasion for impressing upon the minds of school children the importance of forestry and for the planting of seedling trees to reforest otherwise waste lands.

The time of celebration varies in different states, sometimes even in different localities in the same state. An effort was made by the National Arbor Day commission to establish a unified national observance on the last Friday in April, and a number of states observe this date. Another organization, the Arbor Day association, incorporated in 1956, performed extensive Arbor day promotion throughout the United States.

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ARBORETUM, a place where trees and shrubs are cultivated for ornamental, scientific or other educational purposes; it is that portion of a botanical garden devoted to woody plants. An important characteristic of an arboretum is that all plants are adequately labeled, with at least common and scientific names and continent of origin. Thus an arboretum is a living dictionary of trees and shrubs, referring to where the species were originally found growing wild. In the 20th century practically all botanical gardens are also arboretums, so the names are commonly used interchangeably. Arboretums are sometimes maintained by individuals on private property, or they may be publicly owned, occasionally being developed within an existing city park. More frequently they are set up as independent institutions with or without municipal or other governmental support. Some high schools, colleges and universities have developed their grounds as arbore-

tums for the general public as well as for student use.

The trees and shrubs are usually arranged by plant families, *i.e.*, all members of the pine family are placed in one section of the tract, the maple, oak, willow, rose, linden, heath, olive and other families are grown in their own special areas. Some arboretums arrange their collections ecologically, others according to geographic origin of the species—so one may see miniature landscapes of plants representing different parts of the world. Others arrange plants according to economic or aesthetic use. In the second category, for example, are hedge displays, where many different kinds of shrubs and trees are planted in separate rows and clipped to demonstrate hedges for all tastes and locations.

Europe.—As early as the middle of the 16th century René du Bellay of Touvoys, in co-operation with Pierre Belon, made a fine collection of trees and brought into France seeds of exotic species from western Asia. This collection long remained the richest and most beautiful in France and perhaps in the world. About 1720, Duhamel du Monçeau, head of the French marine and a scientist, gathered plants from all over Europe and North America to set out on his two estates. The plants were arranged systematically in what might be called the first arboretum made for scientific purposes. From his experience with the collection, Monçeau published in 1755 a book on characteristics and cultivation of trees and shrubs which had a great influence on study and early distribution of imported plant species.

One of the most complete arboretums in the world is that at Kew, Eng., in the Royal Botanic gardens. It traces its origin (1759) to a 9-ac. private garden on the estate of Princess Augusta. This garden, together with the adjoining garden of Richmond lodge, occupied by her son George III, was turned over to the nation in 1841. Other tracts were added later. The first director was Sir William Hooker, who was succeeded by his son, Sir Joseph. The arboretum occupies a large portion of the entire tract, with trees and shrubs representing about 10,000 species and varieties. In addition to the arboretum at Kew, other important collections of trees and shrubs in the British Isles are to be found at the Royal Botanic garden in Edinburgh, the gardens of the Royal Horticultural society at Wisley, and the Irish National Botanic gardens at Glasnevin, Dublin. On the continent of Europe the classical example is the formally designed Jardin des Plantes in Paris.

North America.—Most arboretums in the United States were founded by amateurs. For example, Henry Shaw, a businessman, in 1859 founded and endowed what later became the Missouri Botanical garden in St. Louis. The special arboretum section of this institution is 38 mi. from St. Louis, at Gray Summit. In 1922 Joy Morton, then president of the Morton Salt company, founded and endowed the Morton arboretum in the Chicago suburb of Lisle. Similarly, Pierre S. du Pont founded and developed Longwood as his private estate near Wilmington, Del. Upon his death in 1955 it was left, richly endowed, as a public garden and arboretum.

Among other better-known arboretums in North America are the Arnold arboretum, Jamaica Plain, near Boston, Mass. (1872); Boyce Thompson Southwestern arboretum, Superior, Ariz. (1924); Brooklyn Botanic garden, Brooklyn, N.Y. (1910); Dominion Arboretum and Botanic garden, Ottawa, Can. (1886); Highland and Durand-Eastman Park arboretum, a part of the park system of Rochester, N.Y. (1890); Montreal Botanical garden, Montreal, Can. (1932); National arboretum, Washington, D.C. (1927); New York Botanical garden, New York city (1895).

In temperate climates many arboretums offer a series of dramatic floral displays during the flowering season with forsythia, flowering cherry, flowering crab apple, dogwood, lilac and other beautiful ornamentals. In the fall and winter, unusual species such as witch hazel, franklinia, heather, etc. are often featured.

Function in Scientific Research.—In addition to their role in public education, arboretums may have such objectives as follow, a number of which involve scientific research:

1. To grow as wide a selection of plants of quality as is possible in a particular climate. This often means the introduction and testing of plants not previously known or grown in a certain area. If space is limited, only the most ornamental and reliable plants are given preference. For instance, the major objective of the Arnold arboretum for many decades was to introduce and test new species of trees and shrubs from temperate climates all over the world. The best of these were released to nurserymen for propagation and ultimate sale to the public.

2. To breed new types of trees and shrubs, using the basic collection as parent stock. Objectives in such breeding work might include resistance to pests and diseases, greater hardiness, earlier or later flowering, double flowers, dwarfness, better foliage quality, etc. Breeding trees of economic importance may lead to more rapidly growing and disease-resistant varieties.

3. To study and taxonomically describe and classify species and varieties of ornamental trees and shrubs. This means building up a technical reference collection of dried plants, called an herbarium. From this, books such as Alfred Rehder's *Manual of Cultivated Trees and Shrubs* are written, so that persons everywhere may have ready access to authoritative works.

To carry on these programs, arboretums need experienced plant propagators, gardeners, botanists and horticulturists. Adequate funds are needed; as mentioned, some arboretums are supported by endowment income. Others are membership societies supported by payment of dues; still others are supported entirely from tax funds. In the case of the New York and Brooklyn botanic gardens, annual appropriations by the city of New York supply part of the funds, and the balance comes from membership dues, special gifts and income from endowment.

The public generally looks upon an arboretum as a fine park, a place to go for recreation and to increase one's knowledge about nature. The aesthetic role has gradually assumed greater importance. In addition to special lectures and conducted tours through the plant collections, many arboretums have excellent reference libraries and act as centres of plant information, identifying plants sent in by amateurs, answering questions and publishing bulletins.

See also ARBORICULTURE; BOTANICAL GARDENS; FORESTS AND FORESTRY; HORTICULTURE.

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ARBORICULTURE is the cultivation and care of woody plants, particularly trees and shrubs used for decorative, shade and ornamental purposes. In arboriculture the welfare of the individual plant is given prime consideration, in contrast to such related fields as silviculture and agriculture where the well-being of a group of plants as a whole is the major concern. (*See* FORESTS AND FORESTRY; FRUIT FARMING; ARBORETUM.)

Early Egyptians are credited with being the first people to transplant trees with a ball of earth and originating the practice of shaping the soil around the newly planted tree to form a saucer to retain water. The Greek philosopher Theophrastus about 302 B.C. wrote *On the History of Plants*, in which he discussed transplanting of trees and treatment of tree wounds. Roman knowledge of tree culture is portrayed in Virgil's *Georgics*. In his *Sylva, or a Discourse of Forest Trees*, dated 1664, the English horticulturist John Evelyn (*q.v.*) offered advice on pruning, insect control, wound treatment and transplanting. Arboricultural principles and objectives are of ancient origin; only techniques, materials and methods of application have changed.

Essential to success in the practice of arboriculture is a clear understanding of tree growth processes, and of the role played in a tree's development by climate, soil conditions and other external influences. The arborist (one who practices arboriculture) must have a good working knowledge of plant physiology, soil science, insects and diseases that affect woody plants, chemistry insofar as it pertains to the use of fertilizers, growth regulators, antibiotics, insecticides, fungicides and other chemical compounds applied to plants and proficiency in the mechanical arts. Skill in selecting plants and grouping them for their ornamental values as well as for their hardiness and pest-resistant qualities certainly

is desirable. (*See* also Landscape Architecture.)

The arborist's work includes transplanting, pruning, applying fertilizer, spraying to control insects and diseases, cabling and bracing, tree wound treatment, tree removal, cavity treatment,

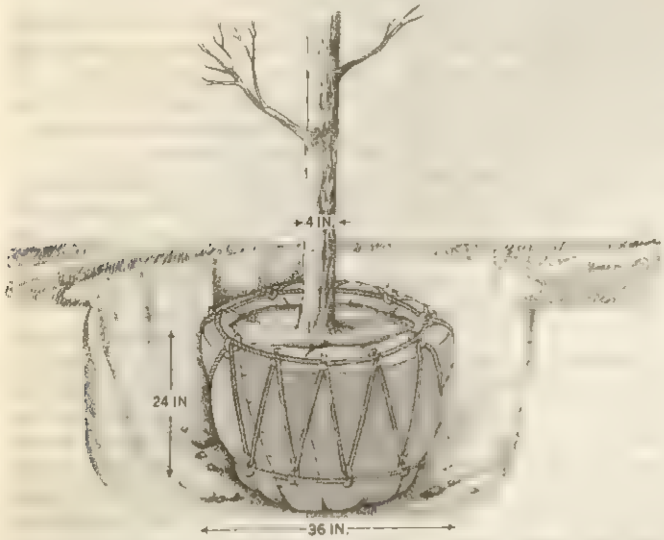


FIG. 1.—TRANSPLANTING DECIDUOUS TREE WITH ROOTS BALLED AND BURLAPPED. SURFACE MEASUREMENT OF BALL VARIES WITH THE SPECIES BUT IS ROUGHLY NINE TIMES THE DIAMETER OF TRUNK OF TREE MEASURED AT ONE FOOT ABOVE GROUND LINE; DEPTH OF BALL IS ROUGHLY SIX TIMES THE DIAMETER OF TRUNK

identification of plants, diagnoses of tree ailments, tree damage appraisals and numerous miscellaneous activities which relate to trees and shrubs.

Transplanting.—Deciduous trees (those that drop their leaves annually) usually are transplanted during the period that extends from the time they drop their leaves in the fall until new leaves appear in the spring. The spring period for planting evergreens usually begins about the time deciduous trees are coming into leaf and continues for a month; evergreens may be planted also in late summer or early fall. Most small deciduous trees may be moved "bare root," with no soil attached to the root system; those greater than about three inches in trunk diameter are best moved as "balled and burlapped" stock in which a ball of earth, held in place with burlap, encloses the roots. Evergreens of size suitable for home planting are balled and burlapped before moving.

Holes for planting should be dug of sufficient depth and width to permit natural spread of the roots, or to receive the ball in the case of balled and burlapped stock. The tree should be planted to approximately the same depth it stood at the time of digging. Planting should be done as quickly as possible after digging; meanwhile, the roots should be kept moist and protected from the sun and wind. The planting hole should be backfilled with fertile soil of good texture; it should be worked in around the roots and tamped to eliminate air pockets. A shallow saucerlike depression should be formed around the tree to retain water. After planting is completed the tree should be thoroughly watered. Usually it is good practice to guy the tree to prevent wind sway, and to wrap the trunk with burlap or similar material to prevent sun scald.

Pruning.—The pruning of a shade or ornamental tree is done to protect its health, improve its appearance and remove hazards to life and property. Pruning includes removal of old branch stubs and broken, dead or diseased branches; cutting back of limbs that interfere with traffic, impede electric service, obstruct desirable views or mar the tree's characteristic symmetrical shape; thinning to permit air circulation and secure more light; removal of branches that rub against other limbs to prevent wounding and possible future decay problems; judicious cutting to compensate for root loss, promote blossom formation, restore a storm-damaged or unshapely tree to its normal form and, occasionally, heading back to revitalize an aged tree. Each tree normally assumes a shape and form characteristic of the species; care should be used in pruning to avoid destroying the natural growth pattern.

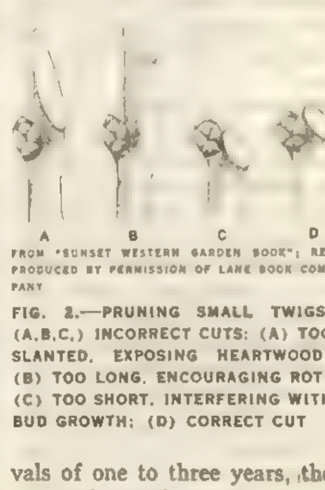
Pruning of most deciduous trees may be done at any time of the year. Maple, birch and a few other species may "bleed" (exude sap) copiously if pruned in late winter or spring; this is unsightly though it causes little or no harm to the tree. Pruning of evergreen trees that bear needlelike leaves usually should be confined to removal of dead wood. In evergreen shrubs the tips of branches are clipped back to induce compact growth. In pruning back the branches of shrubs or young trees, the cut generally is made just above a healthy bud or immediately beyond a lateral branch. In mature trees long unpruned, two or more moderate prunings usually are better for the health of the tree than a single severe pruning.

No branch stubs should be left in pruning. Even a short stub seldom, if ever, is healed over with new wood growth before it decays and by that time the wood-rotting fungi may have penetrated deep into the tissues of the tree. The pruning cut should be made flush with, and parallel to, the stem from which the branch is being removed.

The removal of large, heavy branches is a three-step operation. First, an undercut is made with the pruning saw a foot or more beyond the point of the final cut. Next, the limb is severed with an overcut and usually lowered to the ground by means of ropes. Finally, the stub is removed. Removal of heavy branches with a single cut is likely to result in bark and wood being stripped from the stem below the cut as the branch falls. Tree wound dressing, available at most horticultural or garden supply stores, should be applied to all cuts greater than one inch in diameter.

Use of Fertilizers.—Different trees vary in their responses to fertilizers. Fertilizer is used beneficially to maintain or restore soils to a high level of fertility, or to stimulate new growth and vigour after a tree has suffered injury from insect or disease attack, drought, severance of roots, lightning strike, wind and ice storms.

Commonly, fertilizer used for trees contains nitrogen, phosphorus and potash in proportions of 12-6-4, 10-8-6 or a similar mixture. Frequently used is a 10-8-6 mixture in powder form. Generally recommended rates of application are three to five pounds per inch of trunk diameter for deciduous trees above six inches in diameter and one-half that amount for smaller trees and evergreens. The fertilizer is introduced into the soil that surrounds the roots by means of a punch bar, air pressure or water jet. Following application the area is watered to carry the material to the roots. Completely soluble fertilizers are available for foliage spraying, and these are used with good results. Shade trees generally benefit from applications made at intervals of one to three years, the time varying with the species of tree and growth response.



FROM "SUNSET WESTERN GARDEN BOOK"; REPRODUCED BY PERMISSION OF LANE BOOK COMPANY

FIG. 2.—PRUNING SMALL TWIGS: (A,B,C,) INCORRECT CUTS: (A) TOO SLANTED, EXPOSING HEARTWOOD, (B) TOO LONG, ENCOURAGING ROT; (C) TOO SHORT, INTERFERING WITH BUD GROWTH; (D) CORRECT CUT

Spraying to Control Diseases and Insects.—Leaf-spotting fungi, which cause unsightliness or defoliation of shade and ornamental trees, often make spraying or dusting necessary. Sycamore, elm, ash, juniper, spruce, hawthorn and mountain ash are but a few of the ornamental trees that are sprayed to prevent disease. In general, there is less need for spraying shade trees as a protection from fungus attack than there is for insect control. Numerous fungicidal materials are available for use in spraying.

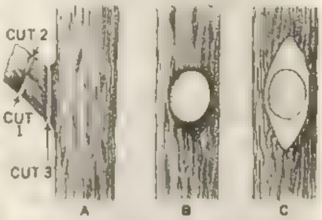
Insects may be classified according to the type of damage they cause—leaf-eating, sap-sucking and burrowing. Leaf-eaters may be controlled by use of stomach poisons, such as the arsenicals, or with such materials as DDT which may serve as both a stomach and a contact poison. Sap-sucking insects, of which aphids, scale insects and plant lice are examples, are controlled only with contact insecticides such as miscible oils, nicotine sulfate or certain

of the organic compounds developed after World War II. A number of the organic compounds are quite effective in control of leaf miners and stem or trunk borers.

On the containers of insecticides available at retail stores are given directions for use, rate of application and usually a list of the insects the material will control. In all insect control, it is of the utmost importance that the insecticide be applied at the time in the life cycle of the insect when it is most vulnerable. This necessitates a broad knowledge of entomology.

Preventing and Repairing Damage.—Under certain conditions artificial support is of distinct benefit to shade trees. Such support, supplied in the form of flexible cables or rigid braces, is needed when trees develop narrow, structurally weak V-shaped branch crotches; when splitting occurs at branch forks; and when unduly long, pendulous branches develop. Cables or guys also may be used to lessen the danger of a mature tree with a weakened root system being blown over by wind, and to support recently planted trees until the roots become established.

In trees with structurally weak, but unsplit crotches, cables are installed as a means of protection against storm damage. Location of the cables is based on the principles of the lever and fulcrum; they are placed as high in the tree as practicable, usually about two-thirds of the distance from the crotch to the branch tips. The cables are attached to the branches by means of lag screw hooks, hook bolts or eyebolts. Cables should never be wrapped around a branch since this restricts the sap flow and may cause death of the limb.



FROM P. P. PIRONE, "TREE MAINTENANCE"; OXFORD UNIVERSITY PRESS, NEW YORK (1959)

FIG. 3.—PRUNING LARGE BRANCH OF TREE OR SHRUB: (A) POSITION AND SEQUENCE OF CUTS; (B) FRONT VIEW AFTER FINAL CUT; (C) CUT WITH BARK TRIMMED AND TAPERED TO FACILITATE PROPER HEALING

In repairing split crotches, a block and tackle is used to pull the branches together until the split closes. Then holes are drilled through the split parts and a screw rod, or sometimes bolts and nuts, are installed. Usually, additional support is provided by installation of cables as described above. Screw rods or bolts and nuts are used to fasten together two major branches that rub against each other. A single rod through the branches at the point of contact will hold them rigidly together thereby eliminating rubbing and consequent wound formation.

Trees may be invaded by fungi that cause decay of the heartwood and the development of large cavities in the trunk. This results in a weakening of the structural strength of the tree and it becomes vulnerable to the twisting strains of wind storms. To compensate, in some measure at least, for the strength of the internal woody tissues lost through decay and to hold the cavity walls in position, rigid cross braces are installed. Difference of opinion exists concerning the filling of cavities. Many arborists favour open cavity treatment in which the decayed wood is removed, the inner walls treated with antiseptic dressing materials and drains installed at the bottom of the cavity. Other arborists favour filling the cavity with concrete or other materials after removal of the decayed wood. Cavity filling seldom is advocated in short-lived or weak-wooded tree species.

Treatment of Tree Trunk Wounds.—Damage to tree trunks in the form of large areas of bark torn away through impact is of frequent occurrence. In treatment of such wounds, loosened bark along the sides of the wound is trimmed back to the sound tissue. To facilitate healing, the bark at the top and bottom of the injury also is trimmed back forming a pointed ellipse of the wound area. The exposed wood is then covered with wound dressing material to protect the tree from invasion by wood decay fungi.

Tree Propagation.—In a broad sense the term arboriculture includes not only care of established trees and shrubs, but also propagation of plant materials. This is the process by which plants are reproduced from the parent stock by means of seeds, layering, cuttings, grafting or budding. Such work usually is performed by nurserymen, plant propagators or specialists skilled in this phase of plant culture.

Seeding.—Sometimes direct seeding is practiced in which the seed is planted on the site desired for the tree. This method is especially suited to such trees as hickory, walnut and other taprooted species which may be injured by ordinary transplanting techniques. More often, however, seeds are planted in either a commercial or a home nursery where intensive care can be given the young plants for several years or until they attain a size suitable for transplanting. Seedbeds are prepared as carefully as in gardening and the seeds sown by broadcasting or with a seed drill. A mulch of leaves, straw or marsh hay may be used to protect newly sown seedbeds, especially if the seeds remain in the ground a long period before germinating or if the young plants are of a species that grows slowly. Shading evergreens and some deciduous species from the sun during the summer months is often necessary. The amount of shade needed depends upon the species and local weather conditions.

Layering.—The shoots or lower branches of many plants when partially covered with soil will form roots while still attached to the parent plant. Propagation by this method is known as layering. The stem is bent down so that a section rests in a previously dug shallow trench with the branch tip extending beyond the trench. The section in the trench is then covered with moist soil of good quality. A brick or other weight may be used to hold the soil-covered branch section in place. When roots have developed, which may require from several months to a year or more, the branch is severed from the parent and transplanted. The new plant retains all the characteristics of the parent. This method is used frequently to obtain independent plants from a tree with historical associations.

Air Layering.—In this method of propagation a branch is slit deeply or girdled, and the wounded section enclosed in a ball of earth, moss or similar material which must be kept constantly moist. This rooting medium may be held in place by a divided pot supported from below, stout paper shaped in the form of a cone or other means. As in soil layering, the branch is severed and transplanted after roots have developed.

Root Cuttings.—Some trees rarely produce roots from stems, but can be propagated by root cuttings. Roots are cut into pieces several inches long and planted horizontally in moist soil, moss or sand flats. When tops and roots develop they are lifted and transplanted.

Stem Cuttings.—Cuttings from stems are made from both deciduous trees and evergreens, although it is usual to reproduce most conifers and many hardwoods from seed. Pines, for example, do not ordinarily grow from cuttings, but can be made to do so by the use of growth-promoting substances. Untreated cuttings of arborvitae and juniper usually root satisfactorily. Tree species that tend to sucker or send up shoots readily, such as willow and poplar, frequently are propagated from stem cuttings. Privet and the evergreen species of holly often are propagated in this manner.

Stem cuttings are made from deciduous plants during dormancy and, preferably, from the terminal growing shoots of the current season. Pieces usually are cut six to ten inches in length, generally with two or more buds on each piece. The cuttings are tied in bundles, stored in damp sand or moss for callus formation, and then planted in prepared beds. Abundant watering is necessary. In cuttings made from conifers, two- to five-inch shoots are obtained and the foliage removed from the lower part. Usually they are planted at once in flats of moist sand under cover, often in a cool greenhouse, where they remain until roots form sufficiently for transplanting.

As mentioned, root formation may be stimulated by the application of certain chemicals, known as growth-promoting substances or growth hormones. Indoleacetic and indolebutyric acids, for example, are employed for this purpose.

Grafting.—There are certain trees which, if grown on their own roots, are especially susceptible to root diseases, insect attack or adverse soil conditions. Rootstocks of different species therefore are used to propagate these plants, as well as to produce generic variations (mutations and bud sports) with peculiar characteristics which may not root readily.

Grafting is the introduction of a part of one plant into or onto the living part of another plant in such a manner that the two will unite and continue their growth as a composite individual. A woody shoot bearing one or more buds (scion grafting) may be used or, in budding, one bud only with a small area of bark is inserted in contact with the cambium (growing layer) of the "stock." If the top of a plant is replaced by shoots or buds from another plant, the tree is said to be "top-worked." In general, plants must be botanically related for successful grafting (*see* GRAFTING [IN PLANTS]).

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ARBORVITAE (TREE OF LIFE), the common name for evergreen trees or shrubs of the genus *Thuja*. *Thuja* comprises a genus of four to six species belonging to the cedar or cypress family (Cupressaceae).

Thuja occidentalis is the eastern arborvitae or northern white cedar of eastern North America and ranges from Canada to the mountains of North Carolina and Tennessee. The tree attains a height of 40 to 50 ft. and features scalelike leaves borne in flattened sprays; when bruised they exhale an aromatic odour. In its many dwarf horticultural varieties the eastern arborvitae finds wide use as an ornamental in rock gardens, foundation plantings and borders.

BY COURTESY OF U.S. FOREST SERVICE

EASTERN ARBORVITAE (THUJA OCCIDENTALIS), BRANCH WITH CONES

The giant arborvitae or western red cedar (*Thuja plicata*), is a native of western North America. It attains gigantic proportions in the forests along the Pacific slope, where it is often 150 to 200 ft. tall and 5 to 10 ft. in diameter. The wood is exceedingly durable and is used for shingles, siding, poles, posts and mine props.

Another species of arborvitae is *Thuja orientalis*, known also as *Biota orientalis*. The latter generic name is derived from the Greek adjective *biotos*, formed from *bios*, "life," probably in connection with the name "tree of life." This is the Japanese hiba or Chinese arborvitae. It was cultivated in the Chelsea Physic garden in 1752, and was believed to have been sent to Europe by French missionaries. It has roundish cones, with numerous scales and wingless seeds. The leaves, which have a pungent aromatic odour, yield a yellow dye. There are numerous varieties of this plant in cultivation, one of the most remarkable being *pendula*, with long, flexible, hanging, cordlike branches. The variety *pygmaea* forms a small bush of only a few inches in height. (E. S. HR.)

ARBROATH, a royal burgh and seaport of Angus, Scot., 17 mi. N.E. of Dundee by road or rail, lies at the mouth of Brothock water (the old name of the town was Aberbrothock). Pop. (1961) 19,533. Area 2.3 sq.mi. The ruins of the red sandstone abbey, once the richest in Scotland, stand in High street. It was founded by William the Lion in 1178 for Tironensian Benedictines from Kelso, and consecrated in 1197, being dedicated to St. Thomas (à) Becket. It was William's only personal foundation and he was buried within its precincts in 1214. There the Scottish parliament met on April 6, 1320, to send the pope the notable letter asserting the independence of their country and reciting in eloquent terms the services which their "lord and sovereign" Robert the Bruce had rendered to Scotland. An annual historical pageant is held in the abbey. Arbroath was created a royal burgh in 1186 and its charter of 1599 is preserved. The harbour, originally constructed and maintained by the abbots, by an agreement in 1394 between the burgesses and John Gedy the abbot, was enlarged in 1725 and 1844 and the old part made into a wet dock in 1877 when the entrance to the new harbour was deepened. There is a lifeboat station and the lighthouse on the Bell rock (*q.v.*) or Inchcape lies 12 mi. S.E. in the North sea.

Arbroath is the "Fairport" of Sir Walter Scott's *The Antiquary*. Hospitalfield, ½ mi. W., once the abbey hospice, and the "Monkbarns" of the novel, is an art school with a collection of Scottish art. The parish church dates from 1570. The Old Red Sandstone cliffs, weathered into weird shapes and caves, form part of the coastline and were once used by smugglers; the beaches are sandy. Auchmithie, 3 mi. N.E. ("Mussel-crag" of *The Antiquary*), is a picturesque old fishing village. At church St. Vigeans, 1 mi. N. of Arbroath, is the Drosten stone, thought to be the only sculptured stone in Scotland with a legible Pictish inscription. The church, founded in the 11th century and restored, contains Celtic sculptured stones, some of which were incorporated into the walls. Arbroath's main industries are textiles, flax spinning, the making of canvas, sailcloth and bleaches, engineering and ironworks, shipbuilding, fishing and canning, and tourism.

ARBUTHNOT, JOHN (1667–1735), Scottish mathematician and physician chiefly remembered as a friend of Jonathan Swift, Alexander Pope and John Gay. He was born at Inverbervie, Kincardineshire, in April 1667, and, after the death of his father in 1691, went to London where he taught mathematics. He entered University college, Oxford, in 1692, and in 1696 became M.D. at St. Andrews. He published *An Essay on the Usefulness of Mathematical Learning* (1701)—a plea for greater emphasis upon mathematics in the university curriculum—became a fellow of the Royal society in 1704 and was one of Queen Anne's physicians from 1705 until her death in 1714. After the queen's death he continued to have a distinguished practice and to publish essays on medical topics. He also published an important work on numismatics, *Tables of Ancient Coins, Weights and Measures* (1727). He died in London on Feb. 27, 1735.

With the exception of a meditative poem, *Know Yourself* (published anonymously in 1734 and later as *Know Thyself*) Arbuthnot's literary works are all satirical. The most important fall into two groups. The first consists of five pamphlets first published separately and later under the composite title *The History of John Bull* in 1712. This is an extended political allegory somewhat in the manner of Swift's *Tale of a Tub* although without Swift's elaborate digressions and complexity of irony. The chief actors in the events which led up to the treaty of Utrecht are caricatured as Lord Strutt (Charles II of Spain), Lewis Baboon (Louis XIV), Nicolas Frog (the Dutch) and John Bull (the English). John Bull, "in the main . . . an honest plain dealing fellow, choleric, bold, and of a very unconstant temper," is a national hero here clearly defined for the first time. In the simple but effective action he is very nearly tricked by the duplicities of the other national heroes and by the self-centredness of Humphrey Hocus the attorney (the duke of Marlborough).

The other satire in which Arbuthnot had an important share was *The Memoirs of . . . Martinus Scriblerus*, first published in the 1741 edition of Pope's works, but largely written as early as 1713–14 by the members of the Scriblerus club, whose most important members were Arbuthnot, Swift, Pope and Gay, and which aimed to ridicule bad literature and false learning. The *Memoirs* were designed, in Pope's words, "to have ridiculed all the false tastes in learning, under the character of a man of capacity enough, that had dipped into every art and science, but injudiciously in each." The result is a biography which gives full scope for a mocking exposure of pedantry and false learning. The work was consistently undervalued, largely because of a lack of suitable editions until 1950 when it was edited by C. Kerby-Miller. *The History of John Bull* was edited by H. Teerink in 1925.

See G. A. Aitken, *The Life and Works of John Arbuthnot* (1892); L. M. Beattie, *John Arbuthnot, Mathematician and Satirist* (1935). (JN. C.)

ARBUTUS, a genus of evergreen trees and shrubs of the heath family (Ericaceae) characterized by smooth, red, exfoliating bark, handsome foliage, showy flowers in terminal clusters and attractive, red, berrylike fruits. There are about 12 species, found chiefly in the Mediterranean region, Central America and western North America. In mild climates several species of *Arbutus* are planted for their beautiful foliage, flowers and fruit. Of these, the best known is the strawberry tree (*A. unedo*), a native of southern Europe and Ireland. The Pacific madrone (*A. menziesii*), a handsome tree of the west coast of North America, is sparingly transplanted. The trailing arbutus or Mayflower (*see* ARBUTUS, TRAILING) of eastern North America belongs to a different genus (*Epigaea*), also of the heath family. (E. S. HR.)

ARBUTUS, TRAILING (*Epigaea repens*), a fragrant flowering plant of the heath family (Ericaceae), also called Mayflower, common in rocky woods and on hillsides from the Maritime provinces in Canada to Florida and westward to Minnesota. The flowers appear as early as April, while the snow still lingers, and are eagerly sought as one of the first signs of spring. In regions near towns they are often stripped from the woods by ruthless persons and also sold on street corners. The plant stems are tough and sturdy, rough-hairy, and creep close to the ground under the dead leaves of the preceding season. The old leaves are rusty, dull green and heavily midveined. New leaves develop in June, rough in texture with fine netted veins and paler on the lower surface than on the upper. The small nectar-bearing flowers, which exist in four forms, are white to pale pink and delicately scented, five-lobed and tubular, and grow on stems 6 to 12 in. in length.

ROCHE

TRAILING ARBUTUS OR MAYFLOWER (EPIGAEA REPENS)

ARC, ELECTRIC: *see* ELECTRICITY, CONDUCTION OF: *The Arc;* LIGHTING: *Electric Lamps, Electric Discharge Lamps, Arc Lamps, Gaseous Vapour Lamps;* FURNACE, ELECTRIC: *Arc Furnaces;* WELDING: *Arc Welding.*

ARCADE, in architecture, a series of arches assembled in a single composition, particularly when the arches are of approximately the same size and placed upon the same level. Arcades are used structurally as in the arcade between the nave and aisles of a church, which supports the clerestory wall and the nave roof. They are also used, purely decoratively, where a band of horizontal decoration is required. Although the arch was known to many of the peoples of antiquity, it was the Romans who first appreciated its decorative possibilities and who made it, again and again, a dominant feature of great architectural importance, as in the Tabularium and in any Roman amphitheatre. An arcade, such as those used by the Romans, with the front face of each pier ornamented by a pilaster or engaged column that carries an entablature running over the tops of the arches, is known as a Roman arcade, and was a favourite motive of the Renaissance. During the late Empire, the Romans started to build arcades whose arches were carried directly upon the capitals of a range of columns (*e.g.*, the great court of the palace of Diocletian at Spalatro), and during the Romanesque and Gothic periods this became the normal type, although in the Byzantine work of the eastern empire, spreading blocks, known as impost blocks, were often placed between the capitals and the arches.

Arcades were used decoratively, to a great extent, in north Italian Romanesque. Some fronts, such as that of the cathedral at Pisa, consist entirely of rows of freestanding arcades. In the medieval architecture outside Italy (except for the Romanesque churches on the Rhine, where Italian influence is strong) decorative arcades were almost always actual parts of the wall and are known as wall arcades. The word arcade is also used, at the present time, to designate any covered passageway on which shops open. (T. F. H.; H. MN.)

ARCADELT, JAKOB (*c.* 1500–*c.* 1570), an early master of the madrigal, was a native of Flanders. His first publication dates from 1532 (Lyons). He probably went to Italy about 1538, and became a singer and later choirmaster at the Sistine chapel in Rome in 1539, resigning in 1545. In 1547 he returned after a year's absence in France, leaving again before 1552. He was serving Charles, duke of Guise, in 1555, and by 1557 he was a member of the French chapel royal. He vanishes from the records about 1567, and died before 1572.

Arcadelt's fame rests on about 120 chansons and over 200 Italian madrigals. With Costanzo Festa and Philippe Verdelot, he set the style for a generation of madrigal-composers. He favoured four-voiced composition, and his secular music owes much to the simple declamation and tuneful treble of the *frottola*. Cipriano da Rore and Palestrina both learned much from Arcadelt's limpid clarity. He published about 20 motets, three Masses, six books of madrigals and a collection of chansons.

BIBLIOGRAPHY.—Modern editions of his music, largely secular, may be found in R. van Maldeghem's *Trésor Musical* (1874, 1884 and especially 1889–92; madrigals); *Publikationen der Gesellschaft für Musikgeschichte*, ed. by R. Eitner, vol. 23 (chansons); A. Einstein, *The Italian Madrigal*, vol. 3 (1949); E. B. Helm, *The Chansons of Jacques Arcadelt*, vol. i, in *Smith College Archives*, no. V (1942) (42 chansons). The well-known *Ave Maria* is a near-forgery dating from 1845, when P. C. P. Dietsch arranged the top part of a three-voiced chanson of 1554 as a sacred piece. *See* also R. Eitner, "Jakob Archadelt," in *Monatshefte für Musikgeschichte* (1887); W. Klefisch, *Arcadelt als Madrigalist* (1938). (B. L. TR.)

ARCADIA (mod. Gr. ARKADHÍA), in ancient Greece, was the central district of the Peloponnesus, bounded on the north by Achaea, on the south by Messenia and Laconia, on the east by Argolis and on the west by Elis. Ancient Arcadia was thus cut off from the coast on all sides, and is therefore not exactly coextensive with the modern *nomos* (department) of Arkadhía (area 1,664 sq.mi., capital Tripolis) which extends on the east to the Gulf of Argolis (formerly Nauplia). The inland plateau of Arcadia is bounded in the north by the Erymanthus (Erimanthos) and Cyllene (Killíni) mountains and is itself divided by numerous subsidiary ranges. In eastern Arcadia these enclose a series of plains drained only by underground channels. The western country is more open, with isolated mountain groups and the winding valleys of the Alpheus (*q.v.*) river and its tributaries the Ladon (Ládhon), which is harnessed for electric power, and Erymanthus (Erímanthos). Isolated geographically from the rest of Greece, Arcadia was not occupied by the Dorians when they invaded Greece in the 12th century B.C., and retained a dialect strongly resembling that of the Greeks who had settled in Cyprus. When, however, the power of Sparta grew, the Spartans could not neglect Arcadia. Unable to force their way through Argolis, they needed to control Tegea (*q.v.*) and the other Arcadian towns to secure their passage to the isthmus of Corinth. By 550 B.C. the Arcadians had all accepted Spartan leadership and alliance but whenever Sparta showed weakness there was potential danger from Arcadia. At some date during the period 475–460 when their influence was on the wane, the Spartans had to fight a combination of Arcadians at Dipaea and from 420 to 418 Athens was allied with Argos, Mantinea and Elis. However, the rivalry of Tegea and Mantinea normally prevented concerted action.

After the battle of Leuctra (371) (*q.v.*), a political league grew out of an old religious synod, and a federal capital was founded in a commanding strategic position at Megalopolis (*q.v.*). But a severe defeat by Sparta in 367 (the "tearless battle" in which no Spartan lives were lost) and internal discord paralyzed this movement. During the Hellenistic age Megalopolis stood staunchly by Macedonia; the rest of Arcadia rebelled against Antipater (331, 323) and Antigonus II Gonatas (266). Thereafter the cities divided their allegiance between the Achaean and the Aetolian leagues, and submitted, some to Spartan and others to Macedonian influence. In Roman times Arcadia fell into decay. An influx of Slavonic settlers in the 8th century A.D. checked depopulation, but Arcadia suffered severely from the constant quar-

rels of its Frankish barons (1205–1460). Turkish rule combined with Albanian immigration raised the prosperity of the land, but in the War of Greek Independence the strategic importance of Arcadia once more made it a centre of conflict.

The pastoral character of Arcadian life together with its isolation partly explains why it came to be represented as a paradise in Greek and Roman bucolic poetry and later in the literature of the Renaissance.

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ARCADIA, a residential city of southern California, U.S., within the metropolitan area of Los Angeles, is near the eastern end of the San Gabriel valley. Once part of Rancho Santa Anita, Arcadia was developed by Elias J. ("Lucky") Baldwin in the 1880s and became a boom town like its neighbours, Monrovia and Sierra Madre. Incorporated in 1903, Arcadia was noticed early for its live oak, eucalyptus and pepper trees, and its orange and lemon groves. Tourists often visited the 54,000 ac. Baldwin estate with its rare shrubs and artificial lakes. Later reduced in size, the estate (Los Angeles State and County arboretum) is maintained as a public park. Santa Anita race track is in the western part of the city. For comparative population figures *see* table in California: *Population.* (J. A. Sz.)

ARCADIUS (Flavius Arcadius) (*c.* 377–408), Roman emperor from 383 to 408, was the elder son of Theodosius I and Aelia Flaccilla. Born before his father became emperor, he was still a child when Theodosius proclaimed him as emperor in the Hebdomon at Constantinople on Jan. 16, 383. When Theodosius left for Italy in 394 to engage the pagan usurper Eugenius, Arcadius remained in Constantinople as ruler of the east; and when Theodosius died in the west in 395, Arcadius became sole emperor of the east. A small, weak, irritable and stupid youth, he rarely exercised any influence, and the history of his reign is largely the history of the ministers who dominated him in turn. The first of these was the prefect Rufinus, in whom Theodosius had had full confidence and whom he left in the east in 394 to advise and guide Arcadius; but Rufinus was murdered late in 395, probably at the instigation of Stilicho (*q.v.*). The second of Arcadius' ministers was the eunuch Eutropius, on whose advice he had married Eudoxia (on April 27, 395, before his father was buried). She bore him Flaccilla in 397, Pulcheria in 399, Arcadia in 400 and, on April 10, 401, his only son, Theodosius, whom he proclaimed as the emperor Theodosius II on Jan. 10, 402, to rule the east jointly with himself. Eutropius was executed at the end of 399; and Arcadius' next powerful minister was Anthemius, an able administrator of whom little is known. The reign was marked by the devastation of Greece by Alaric (*q.v.*) in 395–396; by the revolt of the Gothic troops under Gainas in Asia Minor in 399–400, crushed only after Gainas had held control of Constantinople for six months; and by the banishment of the patriarch of Constantinople, John Chrysostom. Throughout most of the reign relations with the Western empire were strained because of the competing claims of both governments for the possession of the prefecture of Illyricum.

See J. B. Bury, *History of the Later Roman Empire*, vol. i (1923); E. Demougeot, *De l'Unité à la division de l'empire romain, 395–410* (1951). (E. A. T.)

ARCESILAUS (315/314–241/240 b.c.), Greek philosopher, from Pitane in Aeolia, succeeded Crates as head of the academy in Athens, to which he, with obvious preference for Plato's early dialogues, gave an antidogmatic turn, thus revolutionizing or, as others assert, restoring genuine Platonism (*see* Academy, Greek). Criticizing the Stoics, he denied the existence of sense-presentations evidently and adequately "grasping" reality, to which alone the ideal wise man would unfailingly assent. Consequently, he advocated the "withholding of assent" (*epoche*) in all cases; whether as an ultimate goal, is controversial. His profession of ignorance ("I am ignorant even of my ignorance") exceeded that of Socrates. In matters of conduct, he said, the wise man will be satisfied if he can defend his action as having been "reasonable" (*eulogon*). Arcesilaus left no writings. (Pr. M.)

ARCHAEOLOGY (ARTICLES ON). Interest in archaeology ranges widely; at one extreme is the amateur relic hunter or antiquarian; at the other lie a humanistically oriented concern with the material traces of man, especially the Greek, Roman and Bible-land civilizations, and a more general anthropologically oriented concern with the course of cultural evolution. The article Archaeology summarizes the history, changing methods and goals of the field itself and presents a survey of the results of archaeological research in the various regions of the world, beginning with an account of human cultural evolution during prehistoric times. Before recorded history, in most parts of the world, various means of food-producing through the domestication of plants and animals had been achieved (*see* Agriculture: *World Agriculture;* Animals, Domestication of) and the technological and economic foundations for civilizations had been set. Urban civilization was first to appear in southwestern Asia about 3500 b.c., and various starts were made, subsequently, in other parts of the world (*see* City).

The archaeology of various areas of the world, where it is significantly understood, is given in separate articles (*e.g.*, Indonesian Archaeology and Art; Babylonia and Assyria; Andean Civilization) or in the archaeological sections of articles on continents, regions (*e.g.*, Oceania; Asia Minor) and nations (*e.g.*, Egypt; Iran; Greece; Rome). Again, where there is sufficient clarity in understanding, the more important of the extinct cultures are given separate entries (*e.g.*, Aegean Civilization; Anasazi; Hallstatt; La Tène; Indus Civilization; Hopewell; Etruscans; Maya Indians; Aztec; Sarmatians).

Finally, various specific types of archaeological artifacts or monuments (*e.g.*, Flint and Other Stone Tools; Lake Dwellings; Obelisk; Mummy; Pyramid), and of arts and technologies that first appeared in the archaeological past (*e.g.*, Metalwork, Decorative; Pottery and Porcelain; Primitive Art; Astronomy) should be studied.

Archaeology deals with the reclamation and interpretation of the material traces of man's past. Since man is intractable and often disorderly, his traces are bound to turn up in odd places and under peculiar headings. Reference to the Index is thus advised. Archaeologists have much in common with anthropologists, art historians, general historians, and philologists; and are aided by (and often aid) such natural scientists as agronomists, botanists, chemists, geologists, paleontologists, nuclear physicists, and zoologists (*e.g.*, *see* Radiocarbon Dating; Geochronology; Monuments, Preservation of). The generalizations of anthropology and particularly of social anthropology (*qq.v.*) are of increasing interest to modern archaeologists. For other areas of major concern to archaeological science *see* Alphabet; Ecology; Jewelry; Man, Evolution of; Music, Primitive; Music in Ancient Civilizations; Numismatics; Paleography; Papyrology; Medicine and Surgery, History of.

Ancient man was quite like his modern counterpart. Had he not involved himself in so many different activities, it would be much easier to categorize his traces. (R. J. B.)

ARCHAEOLOGY. Archaeology is that science or art—it can be maintained that it is both—which is concerned with the material remains of man's past. There are two aspects to the archaeologist's concern. The first of these is the discovery and reclamation of the ancient remains; this usually involves field excavation or at least surface collecting. The second concern is the analysis, interpretation and publication of the findings.

To the lay mind, the archaeologist is often a romantic figure who spends his time discovering hidden cities or royal tombs full of gold and precious stones. In actuality, the professional archaeologist spends most of his time in the classification and interpretation of unspectacular and repetitious objects of little or no aesthetic appeal or monetary value. But without the analysis and, especially, the interpretation of his recoveries, the archaeologist's work is without real meaning or reason.

The materials of archaeology are both the things made by man and the things used by man. The things made by man are the settlements, buildings, utensils, tools, weapons, objects of ornament

or pure artistic expression—the sum total of things fashioned in some way for human purposes. A general term for any one of the things made by man is artifact. The nonartifactual materials which were used—but not made or fashioned—by man are the unworked bones of the animals which he ate, the traces of the plants either grown or collected for food, the charcoal from ancient hearths—all the things utilized by man as given by nature.

Both the artifactual and the nonartifactual materials have their important roles in archaeological interpretation.

Strictly speaking, archaeology is not concerned with the analysis and interpretation of the bones of ancient man himself—whether fossilized or not. The study of the skulls and skeletons of ancient man is the concern of the physical anthropologist or human paleontologist. Neither is the archaeologist normally prepared to decipher or interpret the writings of ancient man—this is the specialty of the epigraphist and philologist.

The present article is divided into the following sections:

I. INTRODUCTION

General History and Development.—The ancients themselves—when digging holes in the ground for one reason or another—sometimes encountered the traces of preceding cultures and made observations and deductions which might be called archaeological. Up to about the 18th century, however, artifacts were more usually thought to be the tools of dwarfs and witches, if the artifacts were noticed at all. Only a few rare minds, such as that of Leonardo da Vinci, can have had any notion as to the natural human origin of artifacts. It is curious that Thomas Jefferson may be called the first scientific digger. He excavated Indian mounds in Virginia, kept careful notes of his observations and drew conclusions from them.

In terms of the history of ideas, it would appear that one of the two major approaches to archaeological thought arose within the great humanistic tradition of the Renaissance. Part of the reviving interest in classical Greece and Rome was a concern with the art and architecture of the Greeks and Romans. Sculpture, pottery and coins were collected, and excavation was undertaken (albeit primarily for the purpose of sales to private collectors). With the creation of the great national museums of Europe—for example, the Louvre as a public institution at the time of the French Revolution—a need for materials to fill their exhibition halls came into being.

At this point it is convenient to see the humanistic approach to archaeology as composed of two branches: a fine arts or museums branch and an academic or scholarly branch. In actuality, the early practitioners did not make such an explicit subdivision. The early British and French expeditions to Mesopotamia were frankly collecting enterprises, but Napoleon's even earlier scientific commission in Egypt had both collecting and scholarly interests.

Given the philosophical orientation of its initiators, the humanistic approach to archaeology has tended to restrict itself to Greece, Rome and, by natural extension, to their provinces and to the Bible lands. With rare exceptions (generally concerned with an artistic expression comprehensible or exciting to the western mind) the humanistic approach has concerned itself only with the earlier manifestations of the western cultural tradition. The exceptions may also include—especially in the countries of western Europe—interest in national origins: of France with the Gauls, Great Britain with the Britons, Germany with the early Germanic tribes, etc.

The second of the two major approaches to archaeology appeared about the middle of the 19th century. It might be called the approach of the social sciences—most characteristically, of anthropology. It arose as part of the magnificent burst of activity in the natural sciences, of Charles Darwin, Thomas Henry Huxley and the great geologists. Stimulated by the thought of such men as Lewis Henry Morgan and Sir Edward Tylor, the early anthropologists reasoned that if there were a process of biological evolution, then why not a process of social evolution as well? Hence the concern of the early ethnologists with finding "living fossils" among the isolated societies of remote places, and of the anthropological archaeologists with the recovery of traces of extinct societies which would fit into a developmental scheme of social evolution.

The matter did not prove to be as simple as the early social evolutionists anticipated. However, part of their importance is that they gave rise to an approach and a way of thinking with which the humanists had no interest. The "exotic," the "peripheral," the very remote peoples—whether living or dead—were of little or no concern to the humanists but a delight to the anthropologists. Anthropological archaeology, too, developed both museum and research scholarly branches in its approach.

In their extremes, the attitudes of the two main approaches have been harmful to what must be their common goal—a fuller understanding of mankind. Both the humanistically and the scientifically oriented archaeologists developed a kind of professional snobbishness, which tended even to discourage their curiosity about what was being learned in the other camp. Fortunately—especially from about 1930—this snobbishness has been disappearing.

The present article is a case in point: with the world of the past as a stage for the article, the contributors necessarily represent scholars from both the humanistic and the anthropological approaches. It will be obvious that their interests (and what they stress as important in their respective sections) are often different. By and large, however, there is either explicit or implicit in their writings a concern with the man behind the artifact.

The Great Problems Approached by Archaeology.—If it is agreed that archaeology's major concern is an understanding of mankind in the past, that archaeology is the only means of examining extinct human cultures and achievements until written records become both profuse and meaningful, then certain problems come into focus. Whether oriented toward the humanities or the sciences, the colour of the museum man's interest in these problems tends to differ somewhat from that of his research-scholar colleague. It will also be understandable, in terms of the philosophical history of its interest, that humanistic archaeology is concerned mainly with the fourth and fifth of the six general problems listed below. These six general problems, which probably encompass all of the legitimate interest of archaeology, are:

1. How may we understand the emergence and development of man, or, more properly, of a toolmaking and culture-bearing manlike being?
2. How may we understand the appearance of anatomically modern man and the cultural florescence which seems to attend his appearance?
3. How are we to understand the origins of food production and the rise of an effective village-farming community?
4. How did civilization, manifesting itself archaeologically as a more

or less urbanized and politically formalized society, with public projects and monumentality in art and architecture and usually with writing, make its appearance; how shall we understand certain apparent regularities held in common by the independent original civilizations?

5. How are we to understand the nature of the early (not so profusely literate) civilizations as they differ from or resemble the later historical or modern civilizations, and what were the mechanics of cultural transmission and of cultural change in their time?

6. Given the enormous time depth with which only archaeology is prepared to deal, what can we learn of the changing relation between man, society and culture on the one hand and environment on the other; what of the generalized cultural processes (diffusion, invention, acceptance, rejection, etc.), which, because of the bearing of this time factor, can be examined in no other way? For the related set of problems within this general heading, it would not matter whether civilization proper ultimately had been achieved or not.

It goes without saying that we take "understand," as used above, also to mean "to appreciate the meaning of, and thereby to benefit in, human understanding."

Order of Incompleteness of the Archaeological Record.—The sections which follow suggest the state of understanding on the six general problems of archaeological concern early in the second half of the 20th century. A serious hindrance to full understanding is, of course, the incompleteness of the archaeological record. The archaeological record would be fully complete only if every artifact, and all nonartifactual material, used by man since his beginning was already recovered in a well-preserved condition and was ready for interpretation. There being no possibility of such completeness, it is wise to inquire into the relative order of incompleteness of the record.

A primary notion in archaeology is that of context, *i.e.*, the original find spot of an artifact, ideally the place in which the artifact was last used by man. Context also has implications of an association of artifacts, from simple objects of daily use clustered about their original hearth to the vast complex of associations at, for example, Pompeii. The context is as much a part of the archaeological record as is the artifact itself. If precise observations as to horizontal and vertical (stratigraphic) position and associationship are not made, the artifact is contextless. Thousands of contextless artifacts exist, some having been separated from their original find spots by natural agencies—usually geological weathering or erosion—but many also being contextless because of the depredations of amateurish or avaricious "relic hunters." A large part of the exacting mechanics of professional archaeological field excavation in surveying, photography and notation is above all an attempt to record context.

An associationship of artifacts and nonartifactual materials, from a given context, suggests the notion of the archaeological assemblage. The assemblage consists, ideally, of everything made and used by an extinct culture; it is the mail-order house catalogue plus, the entire physical manifestation of a way of life and the true basis for an archaeological interpretation of an extinct culture. The difficulty is, of course, that so many items in any assemblage have a low survival value. Objects of baked clay, stone, bone and some of the metals preserve well; the softer materials usually disappear in large part, save under very favourable natural conditions (as, for instance, in Egypt or coastal Peru). It is with the preservation of any possible trace of the more perishable categories that more of the exacting mechanics of professional field techniques are concerned, and there is a heartening increase in new methods for the reclamation of materials once thought to have been completely perishable.

The human element itself also modifies the relative completeness of the record in two ways. First, some ancient cultures seem to have been—unwittingly, of course—more considerate of archaeology than were others. The elaborate funerary interests of the Egyptians played into archaeologists' hands; so, for example, did the Swiss lake dwellers' habit of building their houses on piles in a lake where anything dropped overboard became waterlogged and well preserved.

The second human element is the archaeologist himself. The discipline in the latter half of the 20th century was still new, and field techniques were only beginning to become professionally exacting. Archaeology, unfortunately, from its beginning tended to attract dilettantes and sensation seekers as well as true culture historians; some of the former have been intelligent but others bumbling and even actually destructive. Different from the physical and biological sciences, an experiment in archaeological excavation can never be repeated or even very exactingly checked by professional colleagues. Charlatans—and there have been a few—can probably continue unexposed for a longer time in archaeology than in any other profession. Also to be accounted for within the human element category are some of the extremes of both the humanistic and the social science branches of the profession, the extremes of some of the national "schools" of archaeology, and inadequate and subjective publication of results.

In sum, while the archaeological record is incomplete, it is not discouragingly so. As the discipline grows in professional stature, and as new techniques in observation and reclamation are developed and utilized, the trend is toward greater completeness of the record. It is unfortunate that the early pioneers chose the best available sites—one could learn more from these sites now, even more in the future—but archaeology has had to learn from past mistakes in more ways than one.

Archaeological Classification and Terminology.—Artifacts of archaeological interest are available in the hundreds of thousands and nonartifactual specimens certainly in the thousands. It has proved necessary to develop schemes of classifying these materials for convenience in study and interpretation. Once detailed classificatory schemes involving objects from proper archaeological contexts are made, it is sometimes possible to introduce contextless materials into the scheme on the basis of analogy alone.

Classifications based on the materials of which artifacts were made, and on the techniques of manufacture, are probably less useful in detail than are those based on form and imputed use. However, gross subdivisions of archaeological assemblages are usually made in terms of materials; *e.g.*, clay, stone, bone, metal, wood and so on. With the aid of various analytical techniques (chemical, petrological, etc.) such gross classifications most closely approach objectivity, and the same is true to a somewhat lesser extent of classifications based on original technique of manufacture. In fact, these two kinds of schemes blend together, as technique of manufacture was generally adapted to a particular type of material. It is in these categories that the archaeologist is most dependent on the natural scientist and his analytic procedures.

For purposes of drawing cultural interpretations from a given assemblage, classifications based on form and imputed use of materials are more interesting. They are also, usually, more subjective. It is one thing to have a metallurgist make an exact assay of the metal in a bronze tool, but quite another thing to describe, on the basis of the form of the tool, exactly what its original use may have been. This kind of difficulty becomes even more acute as technology grows more complex and exotic forms become possible. For example, as objects of supposedly religious or other nonutilitarian significance begin to be manufactured, their exact interpretation may become less certain. This is even true of essentially utilitarian forms which become culturally significant. A modern example would be a gold-plated trowel used in laying the cornerstone of a public building; it is simply a trowel in form, but its real function is loaded with overtones of cultural tradition which would not be immediately apparent to the archaeologist.

A further complication, especially with classifications based on form and imputed use, is the idea of the type object. With hundreds or even thousands of roughly similar objects to classify and describe, the archaeologist usually must select a type to represent a whole class of objects. The choice of this type or model or representative of a whole class is conditioned by the relative completeness of the record (how large a series does the class contain?), by preservation factors and by the discernment and interests of the typologist. It is obvious that the selection of a type object must always be more or less subjective.

Terminology in archaeology never has been (and probably never will be) completely standardized. Difference in interests

generally leads individual archaeologists to idiosyncratic preferences in the terminologies they use. By and large, four factors enter into terminological usage: locality, time, description and interpretation. Such a phrase as "the Old Stone Age of Britain" (or substitute for "Old Stone" "Paleolithic," which is simply its Grecized form) indicates locality, "Britain"; time, "Age," with an imputation of a time long ago when only stone tools were made or used; description, "Old Stone," with an imputation of crude stone tools alone; and interpretation, which is rather implied than expressed in the total phrase, which carries the general meaning of a stage of cave-dwelling savagery.

Unfortunately, in much of the archaeological literature up to the 1940s, and even in some thereafter, the four factors are more often confused than clearly delineated by the terminology. The use of the Grecized forms—Paleolithic, Mesolithic, Neolithic, Chalcolithic, etc.—has often allowed archaeologists to appear to write learnedly but without precision in meaning. The words are not necessary. Robert J. Braidwood, for example, did a little book on *Prehistoric Men* without the use of any of the Grecized terms, and no reviewer even commented on the fact.

It is usually easy enough for an archaeologist to express the notion of locality, although the original area of distribution of an assemblage may not yet be fully known. Precision as to the time factor in years before the present becomes increasingly possible as detailed understanding of geological and radiocarbon chronologies increases. General descriptive names for assemblages of artifacts tend to be simply the adjectival form of the place name of the site where the assemblage was first examined; for example, the well-made flint hand ax or bifacial tool first noted at St. Acheul in France is generally referred to as "Acheulean," regardless of where it is now found. Interpretative terminology tends to reflect general stages of culture—a stage of cave-dwelling savagery, a stage of simple village-farming communities, a stage of incipiently urban market-town communities, a stage of an essentially urban political state.

Professional Archaeology.—Most of the great European and American universities are prepared to offer higher degrees in professional archaeology. It is rare that the archaeologist is considered professionally "finished" without the Ph.D. degree; curriculums leading to such a degree in archaeology exist in both the humanistic and the social science disciplines. A sound general education and ability to operate in the languages of scholarly communication (English, French, German; if necessary, Spanish or Russian) are the basis for the graduate curriculums. Since the concern of archaeology is with man and his works, the breadth of an archaeologist's general education is of the greatest importance.

Professional archaeologists hold posts in the larger universities and museums and in the establishments of the various national schools abroad—for example, the British School of Archaeology in Athens. In the United States, archaeologists are also employed by the national park service, by the state museums and historical societies in some of the states, and in some of the river basin reclamation programs. Other countries also have archaeologists in their own equivalent services.

As a general rule, archaeology in Great Britain and in Europe has tended to be supported by the state. In the United States, some government and state support is available within the boundaries and territories of the country only, and most archaeology has been privately supported, with private grants being made to interested universities and museums. With the tax structure as it existed during and after World War II, private support tended to diminish, though it was supplemented to a degree by support from the learned foundations. (*See* ARCHAEOLOGY, SOCIETIES OF.)

Archaeology and Society.—There is no practical justification for archaeology which would have immediately satisfied Sinclair Lewis' George Babbitt. It can be justified on a philosophical level, as can history, as part of man's apparently natural curiosity about his own past. It can also be justified, as can anthropology, as an attempt to gain an objective and scientific understanding about mankind itself.

Both the philosophical and the scientific factors do suggest, however, in what ways concern with the past may be quite practical. In his book, *Archaeology and Society*, Grahame Clark has examined the way in which in some countries man's curiosity about his past has been consciously manipulated to further national and political ideologies. It could be maintained that it is the responsibility of the intelligent citizen to understand the nature of the archaeological record, its relative order of completeness and the basis for the drawing of archaeological interpretations.

In the latter half of the 20th century, while there was an enormous amount still to be learned about the past, it could be comfortably asserted that there were no longer any grand archaeological rabbits still to be pulled from the hat of time. One might be suspicious of assertions about mysterious but otherwise unspecified movements of "peoples from the north," about still hidden "cradles" of mankind (or of "civilization"), about lost continents of Atlantis or Mu. Modern archaeology had passed beyond this stage; it already knew that such things as "pure races" or "pure cultures" are myths. It had passed its pioneer stage, and was settling down to the very difficult and detailed task of understanding a very complex and very interesting being—man himself.

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II. THE MATERIALS OF ARCHAEOLOGY

Excavation.—Archaeology or prehistory, the science that studies the history of human culture through its material remains, is limited to analysis of those items (and inferences drawn therefrom) which have escaped the destructive forces of decay. Wherever man has altered the natural surface of the earth, as at a site where people have lived, some evidence will remain, and with the proper method of detection such spots can be identified. Usually the archaeologist concentrates his field activity at a spot where intensive or long-term human activity has occurred, for there is the location most productive of the information for which he is searching.

Archaeological sites may be of several sorts. Closed sites such as caves may on occasion be so well protected from the weather that otherwise perishable objects made of wood, basketry or leather may be perfectly preserved. In the western United States, for example, are numbers of such dry caves which have produced large quantities of well-preserved organic materials, and the complete preservation of some tomb contents of dynastic Egypt are well known. In northwestern Europe a large number of remains, either of individual objects or burials or of whole sites, have been found in peat deposits. Organic materials tend to be preserved nearly as effectively in the moist, acid conditions of peat as in completely dry caves. Most prehistoric sites are in the open and consequently are subject to the influences of climatic and geologic forces which cause the disintegration, covering or erosion of evidences of former occupation. Trash mounds, formed by the gradual accumulation of refuse, occur very generally where man has settled for any length of time. In coastal regions such sites so commonly take the form of shell mounds (kitchen middens), so named because their bulk is largely composed of shells of mollusks once used for food. Fire hearths, floors of houses, storage pits, lost and discarded tools, bones of food animals and all the miscellaneous by-products of living commonly occur in such trash heaps. Cemeteries where the dead were buried usually occur in the proximity of occupation sites. Megalithic or other stone or earth structures such as temples, dolmens, barrows, fortifications, ditches, roads and pyramids may be particularly obvious remains of man's former presence. Other sites may be in the form of cave walls bearing pecked petroglyphs or painted petroglyphs (petrographs) such as the famous Upper Paleolithic (Magdalenian) caves at Altamira, Spain, and Lascaux, France. This general type of aesthetic expression occurs widely in all continents. Mines and quarries where flint or obsidian, soapstone, building stone, coloured pigments, iron or copper ore, etc., were extracted are widespread and are evidence of early industrial pursuits. Even ancient garden plots can be located, as proved by aerial surveys

in the British Isles.

In addition to material objects made by man, food remains in site deposits may enable a reconstruction of economic pursuits and provide some indication of the relative importance of fishing, hunting, gathering or farming. Trade, travel and intergroup contacts can often be reconstructed by identifying the material or forms of certain objects as made in some region far distant from the spot where they are recovered by the archaeologist.

The aim of the field archaeologist is to recover as much material as possible or necessary for the interpretation or reconstruction of the former culture pattern. Since archaeology means systematic excavation for the recovery of buried materials, the excavator must be acquainted with the techniques of map making, methods of preserving materials which he uncovers and correct procedure in actual digging.

Discovery of archaeological remains may come about through several means. Materials may be exposed through natural erosion, as in the banks of rivers or streams, or by human disturbance, as in ditching, plowing or digging of building foundations. Commonly the field archaeologist is an expert in recognizing surface evidences of man's former presence in the form of a distinctive dark soil colour due to charcoal from fires, irregularities in the normal surface relief, unusual vegetation which is a function of the different soil chemistry of occupation sites, or the presence of exposed artifacts as a result of erosion of the surface.

Once having searched for and found the sites, the archaeologist selects the site to be excavated. Excavation entails careful attention to the placement and association of each object or feature uncovered. Most or all portable objects are saved and removed to the laboratory or museum for study. Nonportable remains such as house floors, stone constructions and the like are recorded in notes and documented in photographs. Bones of animals in refuse layers are collected and identified, and this information may indicate foods used as well as give evidence of the local environmental conditions when the culture was in operation. The association of items in the deposit may assist in determining their original functions; thus, objects found in a ceremonial chamber, in a refuse pit or in a cache of tools may indicate, respectively, that the various items were used for religious, culinary or industrial activities. Full photographic and notebook records of finds and observations are made, and these are utilized in preparing the final report. Some excavations, especially in the Mediterranean and Central American areas, where monumental architecture is notably characteristic, may be performed primarily for the purpose of reconstructing ancient temples or pyramids. In the eastern Mediterranean area extensive digging has been performed for the purpose of identifying sites, structures and cultures mentioned in the Bible. In every case, the particular problem which the archaeologist is attempting to solve determines his choice of sites and method of approach in excavation.

Methods of Dating.—Since archaeology is a historical discipline and concerns the development and succession of human cultures, the problem of dating finds is of fundamental importance. Age assignments may be of two orders: (1) direct or absolute dates; and (2) indirect or relative dates.

Direct or absolute dates can be expressed in numbers of years. Calendrical records in the old world do not carry beyond the last 5,000 years and in the new world not past the beginning of the Christian era. The absolute dating method known as dendrochronology (*q.v.*) works by counting annual rings of trees. Beginning with living trees, the pattern of wide and narrow rings, which reflect conditions of temperature and rainfall experienced during the life of the tree, can be extended backward in time with the use of prehistoric wood samples. This method was developed and carried to its highest point in the southwestern United States, where the tree-ring chronology extends back about 2,000 years. Elsewhere, as in Alaska and the eastern United States, the method has been applied to advantage but without such striking results. The astronomical chronology of F. E. Zeuner, which gives the Pleistocene epoch a duration of about 600,000 years, is based upon calculating the dates of periodic changes in the earth's orbit and axis which are presumed, but not proved, to have affected the amount of solar radiation received by the earth's atmosphere and to have been the cause of Pleistocene glaciation. The Zeuner chronology thus gives "dates" for the four main periods of glacial ice advance and intervening periods of ice retreat (interglacials). Paleolithic implements and fossil human remains which occur in identifiable glacial or interglacial deposits can thus be dated approximately with reference to the Zeuner chronology. It should be noted, however, that extensive criticism has been directed toward the Zeuner chronology. An alternative theory of causes for Pleistocene glaciation has been proposed by M. Ewing and W. L. Donn. Counts of annual sediment layers (varves) deposited by retreating glaciers in northwestern Europe and northeastern North America have yielded a chronology, to which archaeological finds can often be correlated, for the last 15,000 years. (*See* PLEISTOCENE EPOCH.)

Another method of absolute dating is the radiocarbon technique. Mildly radioactive carbon (carbon with an atomic weight of 14) is formed in the atmosphere and is contained in the bodies of all organisms (plants and animals). C^{14} decays or disintegrates at a constant rate, its half life being 5,700 years. Thus, in 5,700 years one-half of the original amount of C^{14} is left, in another 5,700 years one-quarter of the original amount remains and so on until the amount becomes too small to be measurable. The method can be used to date unaltered carbon-containing organic materials such as peat, pollen, wood, ancient charcoal, burned bone, etc., back to about 45,000 years ago. It has not, however, been perfected beyond possibility of error. (*See* RADIOCARBON DATING.)

Relative or indirect dates are expressed relative to some other chronological event. The Pleistocene glacial chronology and paleontological succession of animal forms furnish convenient sequences of events to which Paleolithic culture finds may be referred for relative age determination. The primary chronological tool of the archaeologist is stratigraphy (*q.v.*) or superposition. Unless disturbances of deposits has occurred, the oldest objects will lie near the bottom and the most recent ones near the top. Within any archaeological deposit laid down over a long period of time it is usually possible to indicate changes in type or styles of artifacts from bottom to top. Analysis of stratigraphic series of pollens contained in postglacial lakes or bogs has yielded surprisingly complete information on the sequence of ancient climates and flora which can often be of aid in assigning ages of prehistoric archaeological materials. A method of deriving chronology or sequence from surface materials where stratification is lacking is called seriation. The method was devised in the Zuñi region of the southwestern United States by A. L. Kroeber, who made potsherd collections from the surface of a number of sites. The pottery types showed overlap, so that types A and B at one site could be correlated with B and C at another, and this in turn with C and D at a third site. The seriation from type A to D was clear, and direction of the sequence (either A to D or D to A) was determined by identifying type D with the early historic Zuñi type. The potsherd seriation method of determining space-time relationships was carried further by James A. Ford in the southeastern United States and by workers in Peru.

Typology.—While much of the information derived from excavation can be presented by simple description and illustrated by drawings or photographs, this is not always convenient, since there may be large numbers of specimens which show important individual differences. The usual means of treating large bodies of artifacts is by means of typology (*q.v.*) or classification into classes and types. Classes consist of groups of objects segregated according to material (*e.g.*, artifacts of stone, bone, shell, wood, antler, clay, etc.) and then further segregated into subclasses or types based upon differences of form, function, decoration or technique of manufacture. Classification may be based upon the methods of manufacture, as in the case of Paleolithic stone implements, where shape may have been incidental and the flaking process was the primary concern of the maker. In an effort to make dead archaeological data more significant, some workers employ a functional method of classification, organizing all objects recovered according to their presumed original purpose, so that categories of

the warfare complex, economic and handicraft complex, etc., are established. Within classes of artifacts may be distinguished types such as pottery types which are recognized on the basis of particular combinations of kind of clay, method of firing, colour and style of decoration, shape of pots and the like. Chipped stone projectile points are often typed on the basis of size and form.

When the prehistorian is engaged in analyzing the materials from a single occupation period which may comprise the deposits of an entire site or derive from one stratigraphic level of a site which has been occupied by successive culture groups, he may establish a "culture type." Such culture types are usually named and serve as datum points for comparison with other culture types. Prehistoric cultures may sometimes be associated with an ethnic group, but usually their bearers are anonymous, and cultures are thought of in terms of a characteristic aggregate or constellation of specific artifact types. European prehistorians often use the term industry, by which they mean all the implements found in archaeological context or association in one layer and made of one material (as stone or bone).

Man is a tradition-bound animal. He learns to do things by being taught by the older generation and therefore tends to reproduce the same material or social forms. Changes in evolution and degeneration do occur, but in simpler societies, whose remains are generally those with which the archaeologist is concerned, these changes are more slowly paced and less abrupt than in modern society, in which technological change proceeds at a rapid rate. Through the Paleolithic period a limited number of forms of stone tools were manufactured by the same technique for tens of thousands of years. With the passage of time since man's emergence from the brute state as a toolmaking and fire-using animal, and with the increase of numbers of mankind and consequent growth or elaboration of cultural equipment, the tempo of culture change has also accelerated. The basic assumptions underlying systematic typology are that cultural change will be evidenced in the material objects and that this change is evidenced both in terms of space (geographic spread) and time (chronology).

By mapping the location of sites and determining the geographic distribution of cultures it is often possible to find correlations of culture areas with natural environmental areas, to determine settlement patterns and shifts of population centres through time, and by comparing the local or regional culture sequences to gain insight into culture-historical processes over wider areas. Classification must be meaningful to the archaeologist, for it furnishes him with a scheme for drawing conclusions, and, according to the materials being analyzed and his aims, the prehistorian will elect one or the other of the various methods available.

Cultural Inferences.—Once having performed the labour of excavation and the task of classification, it remains for the archaeologist to treat the historical problem of how the culture he is studying came to constitute the particular aggregation of traits which it displays. Such explanations, which are rarely complete and precise, entail reference to what are called culture processes, the factors operating toward the change, growth or stabilization of cultures. Culture types which are geographically widespread may be assumed to have diffused from one generative centre in the course of time, and the point of origin can often be indicated as the locus where it occurs earliest or in most complex form. Cultural traits or trait complexes are often observed to have discontinuous distributions. If the spatial discontinuity is very large and diffusion from one source is judged improbable, or the temporal placement of the occurrences is markedly different, the archaeologist may conclude that independent or parallel invention explains the multiple occurrences. The cultural parallels occurring on either side of the Pacific have been judged by some anthropologists to indicate transpacific cultural diffusion and by others as explainable in terms of parallel or independent development. Proofs of such alternative explanations can rarely be adduced, and the decision to support one or the other usually rests upon that one on which the student believes the weight of probability to bear most heavily.

Some culture-historical facts or situations can be explained with reference to ecological factors, so that types of culture are sometimes noted to correspond in their distribution to natural or ecological zones. This was well illustrated by Kroeber in his study of late American Indian cultures, where types of native culture are shown not only to conform to climatic, biotic and physiographic factors but also in many instances to have a considerable historical (chronological) depth. American archaeologists who employ the direct historical approach begin by excavating sites known to have been occupied in the historic period by a particular tribe, and from this historic datum then work backward in time through a series of prehistoric sites by means of identifying the specific culture complex in order to trace the historical development of the culture. Clark studied the economic basis of prehistoric European cultures from a historical viewpoint and demonstrated that the various economies, such as sea hunting, land hunting and farming, are conformable to specific biological and physical environments of the past.

Walter W. Taylor argued that space-time problems are not so important as what he termed the "conjunctive approach" or functional interpretation of archaeological data, in which the excavation results are written up in the manner of an ethnography of a living culture by identifying the function of each object, noting intrasite associations and relationships and reconstructing the prehistoric data in terms of function and culture processes. Taylor's argument was effective, and deeper anthropological insight resulted.

The historical-geographic-temporal distribution of prehistoric cultures are sometimes graphically presented in the form of phylogenetic or taxonomic charts, the assumption being that cultures develop in the manner of biological evolutionary radiation. This approach was critically reviewed by John O. Brew in 1946. The synthesization of prehistory into schemes of evolutionary culture stages was attempted by V. Gordon Childe, and a sequential "culture epoch" formulation of wide application was advanced by Julian H. Steward.

The discipline of modern archaeology has been developing from about 1850. During most of this period it was preoccupied with the collection of materials and descriptive reporting of finds. Partly through the stimulus of the strong emphasis on theory in modern social anthropology, archaeologists were beginning to accumulate a systematic body of archaeological theory. Notable contributions to this subject have been made by C. F. C. Hawkes, E. MacWhite and G. R. Willey, among others.

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III. PREHISTORY

This section provides a general account of the long period of man's cultural-historical development during the Pleistocene ice age and the early Holocene or Recent epoch. During this approximately 500,000 years of prehistoric human development the climates and environments of the world fluctuated considerably, and there were, of course, no national boundaries or ethnological re-

gions that conformed in any meaningful way to those of the present. It would be impossible to maintain, on the basis of the archaeological evidence, that the inhabitants of what is now France were already Frenchmen 25,000 years ago or that the inhabitants of what is now Rhodesia were already Bantu-speaking Negroes 250,000 years ago. Hence the approach of this section is one of an overview of vast regions and of the great, general steps forward that human culture made from earliest times until the civilizations of the conventional ancient historians were well established. The rest of the article takes up the story in late pre- and protohistoric times, region by region, as the archaeological evidence begins to provide glimpses of a world that is presently to become as it is now known.

A. Culture History of the Pleistocene

Paleolithic archaeology is concerned with the origins and development of early human culture between the first appearance of man as a tool-using mammal, which is believed to have occurred about 600,000 or 700,000 years ago, and the beginning of the Recent geologic era, about 8000 B.C. It is included in the time span of the Pleistocene, or glacial, epoch—an interval of about 1,000,000 years. Although it cannot be proved, modern evidence suggests that the earliest protohuman forms had diverged from the ancestral primate stock by the beginning of the Pleistocene. In any case, the oldest recognizable tools are found in horizons of Lower Pleistocene Age. During the Pleistocene a series of momentous climatic events occurred. The northern latitudes and mountainous areas were subjected on four successive occasions to the advances and retreats of ice sheets (known as Günz, Mindel, Riss and Würm in the Alps), river valleys and terraces were formed, the present coast lines were established, and great changes were induced in the fauna and flora of the globe. In large measure, the development of culture during Paleolithic times seems to have been profoundly influenced by the environmental factors that characterize the successive stages of the Pleistocene epoch.

Throughout the Paleolithic, man was a food gatherer, depending for his subsistence on hunting wild animals and birds, fishing and collecting wild fruits, nuts and berries. The artifactual record of this exceedingly long interval is very incomplete; it can be studied from such imperishable objects of now-extinct cultures as were made of flint, stone, bone and antler. These alone have withstood the ravages of time and, together with the remains of contemporary animals hunted by our prehistoric forerunners, they are all that scholars have to guide them in attempting to reconstruct human activity throughout this vast interval—approximately 98% of the time span since the appearance of the first true hominid stock. In general, these materials develop gradually from single, all-purpose tools to an assemblage of varied and highly specialized types of artifacts, each designed to serve in connection with a specific function. Indeed, it is a process of increasingly more complex technologies, each founded on a specific tradition, that characterizes the cultural development of Paleolithic times. In other words, the trend was from simple to complex, from a stage of nonspecialization to stages of relatively high degrees of specialization, just as has been the case during historic times.

In the manufacture of stone implements, four fundamental traditions were developed by our Paleolithic ancestors: (1) pebble-tool traditions; (2) bifacial-tool or hand-ax traditions; (3) flake-tool traditions; and (4) blade-tool traditions. Only rarely are any of these found in "pure" form, and this fact has led to mistaken notions in many instances concerning the significance of various assemblages. Indeed, though a certain tradition might be superseded in a given region by a more advanced method of producing tools, the older technique persisted as long as it was needed for a given purpose. In general, however, there is an over-all trend in the order as given above, starting with simple pebble tools that have a single edge sharpened for cutting or chopping. But no true pebble-tool horizons had yet, by the second half of the 20th century, been recognized in Europe. In southern and eastern Asia, on the other hand, pebble tools of primitive type continued in use throughout Paleolithic times.

French place names have long been used to designate the various Paleolithic subdivisions, since many of the earliest discoveries were made in France. This terminology has been widely applied in other countries, notwithstanding the very great regional differences that do in fact exist. But the French sequence still serves as the foundation of Paleolithic studies in other parts of the old world, and it will be adhered to here.

Europe.—Three major subdivisions—Lower, Middle and Upper Paleolithic—are recognized in Europe. Although the dividing line between the lower and middle stages is not so clearly defined as that separating the middle and upper subdivisions, this system is still used by most workers.

Lower Paleolithic.—On the basis of the very rich materials from the Somme valley in the north of France and the Thames valley in the south of England, two main Lower Paleolithic traditions have been recognized in western Europe. These are as follows: (1) bifacial-tool or hand-ax traditions (Abbevillian and Acheulian); and (2) flake-tool traditions (Clactonian and Levalloisian).

The type tools of the Abbevillian (formerly Chellean), which takes its name from the town of Abbeville, France, on the 45-m. terrace of the Somme valley, consist of pointed, bifacial implements or hand axes. Their forms vary and the flaking is generally irregular; it is probable that they were manufactured either with a stone hammer or on a stone anvil. Associated with these crude types of hand axes, simple flake tools are found, but they lack definite form. The Abbevillian has been reported from deposits of Lower Pleistocene (first interglacial) Age.

The Acheulian, which begins in the second interglacial and persists to the close of the third interglacial, covers by far the longest time span of any of the Paleolithic traditions found in western Europe. The type site is on the 30-m. terrace of the Somme valley at St. Acheul, near Amiens, in northern France. Acheulian hand axes, which display a marked technological refinement over their Abbevillian precursors, were apparently made by employing a wooden or bone billet rather than the more primitive stone-on-stone technique. But, except at the very end of the Acheulian cycle of development, there is very little typological difference in the types of hand axes found in the various layers.

The Micoquian, or Final (Upper) Acheulian, is characterized by elongated hand axes that exhibit very straight and finely chipped edges, in marked contrast with the Lower Acheulian, in which ovate forms predominate. Flake tools occur in all Acheulian levels, the side scrapers being the predominant type. Many of these tools were made from trimming flakes produced during the process of hand-ax manufacture. In general, flake tools, including points with a triangular cross section, are found in greater quantities in Micoquian deposits than in the older horizons.

The evidence from Clacton-on-Sea, Essex, and Swanscombe, Kent, in the Thames valley of southeastern England clearly shows that the main development of the Clactonian occurred during early second interglacial times. The type artifacts are flakes, although core tools—single-edged choppers and chopping tools—do in fact occur. The flakes, which have large, high angle (greater than 90°), plain striking platforms and prominent bulbs of percussion, were detached from roughly prepared, discoidal cores by the stone-hammer or stone-anvil technique. Actual retouching or secondary working of the edge is found in some instances, but for the most part it is crude, and edge chipping resulting from use is far more characteristic.

Named after a locality at Levallois, a suburb of Paris, the Levalloisian is primarily a flake tradition, although hand axes are found in certain of the Middle and Upper Levalloisian stages. It first appears in deposits of the late second interglacial in association with hand axes of Middle Acheulian type, and persists into fourth-glacial (Würm) times. It is characterized by a new and improved method of producing flakes, which previously had been obtained in a more or less haphazard manner. This involves the careful shaping of the core by the removal of centrally directed flakes, and the preparation of an extremity for the detachment of a symmetrical oval flake. Since unstruck cores of this type exhibit a plano-convex section suggesting the form of a tortoise,

they are known as tortoise cores. On the striking platforms of typical Levallois flakes, small vertical flake scars, called facets, may be observed, and the scars of the converging core preparation flakes are present on the upper surface. The use of this technique resulted in the production not only of symmetrical flakes but also of larger ones in proportion to the size of the core. In the Middle and Upper Levalloisian a variation of this same basic technique was developed whereby it was possible to produce either triangular flakes (or points) or rectangular flakes (or flake blades) by modifying the method of core preparation.

Middle Paleolithic.—The Middle Paleolithic comprises the Mousterian, a portion of the Levalloisian and the Tayacian, all of which are complexes based on the production of flakes, although survivals of the old hand-ax tradition are manifest in many instances. These Middle Paleolithic assemblages first appear in deposits of the third interglacial and persist during the first major oscillation of the fourth-glacial (Würm) stage. Associated with the Tayacian, in which the artifacts consist of very crude flakes, remains of modern man (*Homo sapiens*) have been found. Mousterian man, on the other hand, is of the Neanderthal race. By the 1960s no human remains had yet been found associated with the Levalloisian. It is in the Mousterian levels of the caves and rock shelters of central and southern France that the earliest evidence of the use of fire and the first definite burials have been discovered in western Europe. The cave of Le Moustier, near Les Eyzies in the classic Dordogne region of France, is the type site of the Mousterian. The typology of the artifacts is complex; it consists of three distinct increments: (1) the prepared striking platform-tortoise core (Levalloisian) tradition; (2) the plain striking platform-discoidal core technique of ultimate Clactonian tradition; and (3) a persistence of the bifacial core tool or Acheulian tradition. The type artifacts from the Mousterian consist of points and side scrapers, in addition to a few hand axes (especially heart- or triangular-shaped forms), and the secondary working is coarse. A crude bone industry appears here for the first time. Judging by what is known concerning modern hunting groups, small bands or tribes of people already had developed simple social institutions, even at this early level of development.

Upper Paleolithic.—The Upper Paleolithic, which occupies only approximately one-tenth of the time span of the period as a whole, first appears in horizons referable to the Würm I–II interstadial, and it persists to the very end of late glacial times. Early man made his greatest cultural progress at this time. The hand axes and flake tools of the earlier assemblages were replaced by diversified and specialized tools made on blades struck from specially prepared cores. Many important inventions appeared, such as needles and thread, skin clothing, hafted stone and bone tools, the harpoon, the spear thrower and special fishing equipment. Bone, ivory and antler, in addition to flint, were extensively used. The earliest man-made dwellings are found, consisting of semisubterranean pit houses. Of prime importance and interest is the beginning of the basic techniques of drawing, modeling, sculpture and painting, as well as the earliest manifestations of dancing, music, the use of masks, ceremonies and the organization of society into patterns that were apparently fairly complex. Indeed, the location of certain settlements suggests a more complex social life, including perhaps collective hunting. There is evidence for fertility magic, private property and possible social stratification. Furthermore, primitive types of early man disappeared, and the remains of men of modern type (*Homo sapiens*) alone are found in Upper Paleolithic sites.

The chronology of this interval in western Europe shows a succession of cultures known as Lower Périgordian (or Châtelperronian; formerly Lower Aurignacian), Aurignacian, Upper Périgordian (or Gravettian; formerly Upper Aurignacian), Solutrean and Magdalenian, each characterized by its distinctive types of artifacts. These latter occur, together with gravers (or burins), end scrapers, points, etc., which are common to all levels. The graver itself is a very important tool, for its invention made possible the extensive working of bone and facilitated the development of art. The climate of the Upper Paleolithic varied from cold steppe, or even arctic tundra, to north temperate (taiga), similar to parts of Siberia and Canada of the present day.

In the Périgordian, named after a region in south-central France, blades with steeply retouched backs are typical. The Lower Périgordian is characterized by large curved points with blunted backs that are known as Châtelperron points. These first appear, together with other types of blade tools, in horizons immediately overlying Upper Mousterian levels. It is believed that the straight points with blunted backs, called Gravette points and characteristic of the Upper Périgordian, were evolved from the Châtelperron type. In the final stage of the Upper Périgordian, tanged Font Robert points and diminutive multiangle gravers, known as the Noailles burin, are found. A number of small sculptured human torsos depicting the female form have been found at Upper Périgordian sites.

The type site of the Aurignacian is near the village of Aurignac (Haute-Garonne) in southern France. At many sites it is found intervening between horizons referable to the Lower and the Upper Périgordian, a fact that is considered to indicate that more than one cultural element was present in western Europe at the beginning of Upper Paleolithic times. The tool types include various kinds of steep-ended scrapers, nose scrapers, blades with heavy marginal retouch, strangulated blades, busked gravers or burins and split-base bone points. Bone was extensively used, mainly for javelin points, chisels, perforators and *bâtons de commandement* or arrow straighteners. Articles of personal adornment, probably worn as necklaces, such as pierced teeth and shells as well as decorated bits of bone and ivory, appear for the first time in the Aurignacian.

The oldest manifestations of art were produced during the Aurignacian, and the development continued during Upper Périgordian times. In general, Upper Paleolithic art falls into two closely related categories: mural art and portable art. The former includes finger tracings, paintings, engravings, bas-reliefs and sculptures on the walls of caves and rock shelters; the latter is characterized by small engravings and sculptures on stone and bone found in the occupation layers. The whole development almost certainly owes its inspiration to the magico-religious idea, especially the custom of hunting magic as practised today by living primitive peoples.

The Solutrean, which is named after the site of Solutré, near Mâcon (Saône-et-Loire), is noted for the beautifully made, symmetrical, bifacially flaked, laurel-leaf and shouldered points, the finest examples of flint workmanship of the Paleolithic in western Europe. In addition, the usual types of gravers, end scrapers, points, perforators, etc., are present. Examples of Solutrean art are comparatively rare; they consist of sculpture in low relief and incised stone slabs. The fauna indicates that this culture flourished under conditions of a relatively cold climate.

The rock shelter of La Madeleine, near Les Eyzies (Dordogne), is the type Magdalenian locality. This final culture of the Upper Paleolithic is noted for the dominance of bone and antler tools over those of flint and stone, and for the very remarkable works of art that were produced at this time. The wide variety of bone tools include javelin points, barbed bone points (or harpoons), eyed needles, *bâtons de commandement* (often elaborately decorated), perforators, spear throwers, chisels, etc. The flint and stone tools include a variety of special forms, among which small geometric forms, denticulated blades, scrapers with steeply retouched edges and the parrot-beak graver are especially distinctive. The six phases of the Magdalenian have been established stratigraphically and are characterized mainly by the contained bone and antler implements. But the heights attained by the people responsible for this culture can best be evaluated on the basis of the art objects they produced. Magdalenian sites have yielded countless fine examples of both mural and portable art. Animals of the period, the usual subject matter, are portrayed in paintings (often polychrome), engravings and sculptures. The fauna from the various Magdalenian horizons demonstrates that cold conditions prevailed in western Europe at the end of Paleolithic times.

Africa.—The Paleolithic of Africa is characterized by a variety of stone-tool assemblages, some of which represent purely local

developments while others are practically identical with materials from corresponding horizons in Europe. Geological investigations of the Late Cenozoic deposits of this continent indicate that, as the result of fluctuations in rainfall, the Pleistocene epoch throughout most of Africa can be subdivided on the basis of a succession of pluvial and interpluvial stages. The pluvials, known as Kageran, Kamasian, Kanjeran and Gamblian, are believed to represent the tropical and subtropical equivalents of the four major glacial stages of the northern hemisphere, but this has not yet been proved. The archaeological succession is well established in certain areas, although not in the continent as a whole.

North Africa.—In this area, very crudely worked pebble tools have been reported from one site in Algeria in direct association with a Lower Pleistocene (Villafranchian) mammalian assemblage. Throughout Tunisia, Algeria, Morocco and the Sahara region, Lower Paleolithic hand axes of both Abbevillian and Acheulian type, together with flake tools, have been found in great numbers. The geological evidence shows that the Sahara region was far less arid during Pleistocene times than it is at present. The Middle Paleolithic of both Levalloisian and Mousterian facies is very widespread in north Africa, and it apparently persisted as late as the second maximum of the Würm glaciation in terms of the European sequence. A specialized Middle Paleolithic development, known as the Aterian, occurred there; it is characterized by tanged points made on flakes and flake blades. This was succeeded by two distinctive blade-tool complexes—the Capsian and Oranian—which are more or less contemporary. Their main development took place during the time span of the European Mesolithic. The Capsian sites are all inland, whereas the Oranian has a coastal distribution. Both are microlithic tool complexes which persisted after the introduction of Neolithic traits into the area.

Egypt.—The Pleistocene terrace gravels of the Nile valley in Egypt have produced a wealth of Paleolithic materials. The 30-m. terrace contains typical Abbevillian and early Acheulian hand axes, including a special form with a triangular section known as the Chalossian type. These are associated with primitive flake implements. In the 15-m. terrace, developed Acheulian has been recorded, while the 9-m. terrace yields large flakes and cores of Levalloisian type. In the low terrace, which occurs at a height of three metres above river level, developed Levalloisian (originally called Mousterian) has been reported. Overlying the low terrace, a local development known as the Sebilian is found. It contains very highly evolved flake implements of Levallois type and, in its later phases, a definite microlithic industry. Of approximately the same age as the Sebilian are several Epi-Levalloisian sites in the lower Nile drainage, including the Fayum depression and the Kharga oasis. In the latter area, where the specialized Levalloisian development is called the Khargan, an Egyptian version of the Aterian has been discovered.

East Africa.—In Kenya, Tanganyika and Uganda, very simple types of pebble tools, roughly chipped to an edge on one side only, occur in deposits of Lower Pleistocene Age. This development is known as the Kafuan, and it apparently evolved into an industry characterized by implements made on pebbles chipped to an edge on both sides, called the Oldowan. Overlying the latter are beds containing true Lower Paleolithic hand axes of Abbevillian and Acheulian type, together with flake tools. Associated with the Middle and Late Acheulian are cleavers made on flakes, as well as evidence of the use of the prepared striking platform-tortoise core (Levallois) technique in the production of flakes. In the next younger horizon, two distinct toolmaking traditions are found: (1) the Kenya Stillbay, a Levalloisian derivative characterized by small- to medium-sized, bifacially flaked points or minute hand axes; and (2) the Kenya Fauresmith, which is basically of Acheulian inspiration and very similar to the true Fauresmith of southern Africa. Carefully shaped round stone balls, believed to have been used as bola weights in hunting, constitute part of the Fauresmith assemblage. In the post-Gamblian dry phase, microlithic tools appear for the first time in an assemblage known as the Magosian. This was followed by the introduction into the area of a true blade technique, called the Kenya Capsian, together with the art of pottery making. More or less contemporary with the localities where the earliest pottery is found in east Africa, a series of sites has been discovered yielding typical microlithic assemblages and referable to the Kenya Wilton, also found in South Africa and the Rhodesias.

South Africa.—The sequence in southern Africa is well established on the basis of the terrace stratigraphy of the Vaal valley. Just as in north and east Africa, the succession begins in the basal Pleistocene with the occurrence of simple pebble tools of Kafuan type. These develop into what is called the pre-Stellenbosch which is found in the oldest gravels of the Vaal and which includes artifacts made on pebbles that recall both the Kafuan and the Oldowan. The true Stellenbosch complex occurs in the next younger series of deposits; it is simply a south African version of the Abbevillian and Acheulian of other parts of Africa and Europe. Typical are hand axes, cleavers, flakes struck from Victoria West cores and (in its later phases) various sorts of flakes produced by the prepared striking platform-tortoise core technique. The Stellenbosch was followed by the Fauresmith, which is characterized by evolved hand axes and Levalloistype flakes. The Stellenbosch and Fauresmith together comprise what is called the South African Older Stone Age, a period roughly corresponding to the Lower and Middle Paleolithic stages of Europe. On the other hand, the South African Middle Stone Age belongs to the later part of the Upper Pleistocene. It is characterized by a series of more or less contemporary flake tool assemblages, each of which displays local features. These are known as Mossel Bay, Pietersburg, Howieson's Poort, Bambata Cave, Stillbay, etc.; Stillbay which occurs in Kenya and Uganda, is the only one of these found outside south Africa. The characteristic tools are made on flakes produced by a developed Levalloisian technique, including slender unifacial and bifacial lances or spear points for stabbing or throwing. In the final stages of the Middle Stone Age, known as the South African Magosian, microlithic elements appear, just as in the case of east Africa. The Later Stone Age cultures of this region—the Smithfield and the Wilton—developed during post-Pleistocene times. These are closely related and, in their later stages, reveal varying degrees of influence as the result of contact with the culture introduced by the Bantu-speaking peoples. Both were extant at the time the first Europeans arrived in south Africa, and there is little doubt that the Wilton, which is a typical microlithic assemblage, is to be associated with the modern Bushmen. There are many paintings in the rock shelters and engravings on stones in the open-air sites of south Africa, the oldest of which belong to the Later Stone Age. The naturalistic style of art revealed at these sites persisted until well into historic times.

Central Africa.—The Lower Paleolithic sequence of central or equatorial Africa is essentially a repetition of what has already been outlined for east and south Africa. At the beginning of Middle Stone Age times, however, a special development took place known as the Sangoan (formerly Tumbian). This is characterized by picks and adzes made on bifacially flaked cores, the tranchet type of ax, hand axes of developed Acheulian form, massive side scrapers and many elongated, bifacially flaked points that probably served as lances or spearheads. The Sangoan seems to represent a response to the environmental conditions of this tropical rain-forest region. Its main development took place during Upper Pleistocene times, but it persisted after the introduction of Neolithic traits into the area.

Asia.—During the Paleolithic, two major culture provinces can be recognized in Asia, each of which has yielded a distinctive sequence. The first of these includes the near east, Russian Turkistan, central Siberia and India; throughout this vast region a developmental sequence has been reported which, in all its essential respects, is related to that of Europe as well as to that of Africa in the early stages. The second of these provinces is in the south and east, and it embraces Pakistan, Burma, Java, Malaya, Thailand and China. There the characteristic implement types consist of choppers and chopping tools that are often made on pebbles. In Africa such pebble-tool assemblages as the Kafuan, Oldowan and pre-Stellenbosch are widely distributed, as stated above, and they first appear in beds laid down in Lower Pleis-

tocene times, but by the Middle Pleistocene they were replaced (or superseded) by hand-ax industries of Abbevilleo-Acheulian type. The latter are missing in southern and eastern Asia, together with the intimately associated prepared striking platform-tortoise core, or Levallois, technique. There the pebble-tool tradition persisted to the very end of Paleolithic times uninfluenced by contemporary innovations characteristic of the western portion of the continent.

Near East.—In this area, especially in Israel, Jordan, Lebanon and Syria, a Lower Paleolithic development closely paralleling that of Europe is indicated by the widespread distribution of hand axes of Abbevillian and Acheulian type. Unfortunately, the majority of these finds are from open-air, unstratified sites that cannot be dated. A crude flake industry, reminiscent of the Tayacian of western Europe, has been reported from several cave sites. This is followed by a typical Upper Acheulian horizon in which there occur many developed hand axes of Micoquian type, a wide variety of flake implements and the prepared striking platform-tortoise core technique. The Levalloiso-Mousterian found in the next younger horizon is associated with a series of Neanderthaloid burials at one of the Mt. Carmel caves of Israel and at Shanidar cave in northern Iraq. Next in the sequence comes an early Upper Paleolithic development, which is characterized by various types of blade and flake-blade tools, including points that recall the Châtelperron type. This is overlain by the Antelian (formerly Middle Aurignacian), which in turn is followed by the Atlitian and the Kebarian. These assemblages, together with the recently discovered Baradostian of northern Iraq, constitute specialized late Upper Paleolithic industries which preceded various Mesolithic developments in the middle east.

Central Asia.—In the central Asiatic parts of the U.S.S.R. (formerly Russian Turkistan), few investigations of Paleolithic sites have been conducted. Surface finds of Acheulian-type hand axes have been reported from the Turkmen republic, and several Mousterian localities have been excavated in the southeastern Uzbek republic. At the most important of these—the cave of Teshik-Tash—the burial of a Neanderthal child surrounded by horns of the Siberian mountain goat was discovered. Up to the early 1960s no convincing evidence had been reported showing that this region was occupied during Upper Paleolithic times.

India and Pakistan.—Certain of the Paleolithic assemblages from India and Pakistan demonstrate that during Pleistocene times the region played an intermediate role between western Asia and the far east. In the Punjab province of Pakistan, assemblages of implements characteristic of both the chopper-chopping tool and the hand ax-Levallois flake complexes are found. The former, called the Sohanian, or Sohan, has been reported from five successive horizons, each of which yields pebble tools associated with flake implements. Massive and crude in the earliest phases of the Sohanian, these reveal a progressive refinement in the younger horizons, where the evolved pebble tools are associated with flakes produced by the prepared striking platform-tortoise core technique. In part contemporary with the Early Sohanian is a series of hand axes of Abbevilleo-Acheulian affinities, which occur in profusion at many sites in India from the Gujarat region in the north to the Madras in the south. These sites yield hand axes, cleavers and flake tools that are very reminiscent of assemblages from south and east Africa. As in the latter areas, the oldest materials are of Abbevillian type, and this is followed by the entire Acheulian cycle of development, just as in the case of the Stellenbosch of the Vaal valley. The occurrence of choppers and chopping tools of Sohanian affinities and made on pebbles throughout peninsular India in deposits of Middle Pleistocene Age suggests the probability that Lower Pleistocene horizons will ultimately be found in this area containing only pebble tools, as in the case of Africa.

As of the early 1960s, no convincing evidence had been reported to indicate that a blade-burin complex was introduced into India before the close of Paleolithic times.

Far East.—Pebble tools, including choppers and chopping tools, are found in the Pleistocene terrace deposits of the Irrawaddy valley of upper Burma. This complex is known as the Anyathian. The Early Anyathian is characterized by single-edged core implements made on natural fragments of fossil wood and silicified tuff, and these are associated with crude flake implements. In the Late Anyathian, a direct development from the earlier stage, smaller and better-made core and flake artifacts are found. No hand axes or flakes produced by the prepared striking platform-tortoise core technique have been found in Burma.

Elsewhere in the far east, pebble tools have been reported from deposits apparently of Middle Pleistocene Age in western Thailand, for which the name Fingnoian has been proposed. In northern Malaya a large series of choppers and chopping tools made on quartzite pebbles and found in Middle Pleistocene tin-bearing gravels have been referred to collectively as the Tampanian, since they come from a place called Kota Tampan in Perak. Still another late Middle Pleistocene assemblage, called the Patjitanian, is known from a very prolific site in south-central Java. In both the Tampanian and Patjitanian the main types of implements consist of single-edged choppers and chopping tools that occur in association with primitive flakes with unprepared, high-angle striking platforms. Also in both assemblages is an interesting series of pointed, bifacial implements that have been described as crude hand axes. Since these tools are very rare in each instance and are absent in Burma, it is probable that they were developed in southeastern Asia independently of influences from the west. Several sites of Upper Pleistocene Age in central Java have produced artifacts made on small- to medium-sized flakes and flake blades. Antler and bone implements belong to this complex, known as the Ngandongian, which has also been reported from the Celebes and from the Philippines.

One of the oldest Lower Paleolithic occupation sites ever discovered is near the village of Chou-k'ou-tien, about 30 mi. S.W. of Peking in northern China. Associated with the remains of Peking man (*Sinanthropus pekinensis*), pebble tools, together with quartz flake implements, occur in quantity. This assemblage, known as the Choukoutienian, is of Middle Pleistocene Age; it forms an integral part of the chopper-chopping tool tradition of the far east.

Also in north China several Upper Paleolithic sites are known in the provinces of Shansi, Shensi and northern Kansu, in the region encompassed by the great bend of the Yellow river (Huang Ho). Collectively known as the Ordosian, these materials are of Upper Pleistocene Age. Typical of the Ordosian are blade implements of various types, points and scrapers of Mousterian-like appearance and pebble tools of Choukoutienian tradition. Originally classified as Moustero-Aurignacian, it later became apparent that this development had much in common with that of the Yenisei-Baikal region to the north in central Siberia.

The archaeological materials from the loess sites of Siberia between the Yenisei valley and the Lake Baikal area is an interesting mixture of (1) blade tools, together with antler, bone and ivory artifacts of classic Upper Paleolithic type; (2) points and scrapers made on flakes of Mousterian aspect; and (3) pebble tools representing a survival of the ancient chopper-chopping tool tradition of eastern Asia. Remains of semisubterranean dwellings with centrally located hearths occur at certain of these stations, together with female statuettes in bone. One of the most striking features of this Siberian Upper Paleolithic is the fact of its comparatively late survival: in terms of the European sequence, it seems to have persisted as late as Early Mesolithic times. Indeed, in several instances it actually occurs in the uppermost layer of loess immediately below a horizon of humus containing Neolithic camp sites. The problems of the Siberian Upper Paleolithic are of obvious importance to students of new-world archaeology, since they have an intimate and direct bearing on the question of the peopling of the Americas.

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(H. L. Ms.)

B. The Old World of the Recent Period

There is reasonable agreement that the Paleolithic ended with the beginning of the Recent (Holocene) geologic and climatic era about 8000 B.C. It is also increasingly clear that a developmental bifurcation in man's culture history took place at about this time. In most of the world, especially in the temperate or tropical woodland environments or along the southern fringes of arctic tundra, the older Upper Paleolithic traditions of life were simply readapted toward more-or-less increasingly intensified levels of food collection. These cultural readaptations of older food procedures to the variety and succession of post-Pleistocene environments are generally referred to as the Mesolithic stage. But also by 8000 B.C. (if not even somewhat earlier) in certain semiarid environments of the world's middle latitudes, traces of a quite different course of development began to appear. These traces indicate a movement toward incipient agriculture and (in one or two instances) animal domestication. In the case of southwestern Asia, this movement had already culminated in a level of effective village-farming communities by 7000 B.C. In Mesoamerica, a comparable development—somewhat different in its details and without animal domestication—was taking place almost as early. It may thus be maintained that in the environmentally favourable portions of southwestern Asia, Mesoamerica, the coastal slopes below the Andes, and perhaps in southeastern Asia (for which little evidence is available), little if any trace of the Mesolithic stage need be anticipated. The general level of culture probably shifted directly from that of the Upper Paleolithic to that of incipient cultivation and domestication.

The picture presented by the culture history of the earlier portion of the Recent period is thus one of two generalized developmental patterns: (1) the cultural readaptations to post-Pleistocene environments on a more-or-less intensified level of food collection; and (2) the appearance and development of an effective level of food production. It is generally agreed that this latter appearance and development was achieved quite independently in various localities in both the old and new worlds. As the procedures and the plant or animal domesticates of this new food-producing level gained effectiveness and flexibility to adapt to new environments, the new level expanded at the expense of the older, more conservative one. Finally, it is only within the matrix of a level of food production that any of the world's civilizations have been achieved (see *Civilizations*, below).

The Level of Intensified Food Collecting.—In the Upper Paleolithic of Europe, certain evidence exists for what must have already been well-organized collective-hunting activities, such as the horse-stampede traces at Solutré, France, and the great concentrations of mammoth bones of the Gravettian hut settlements of Czechoslovakia and Russia. Cultural adaptations appear to have been made to restricted local areas or niches and to the fluctuations of climate and environment during the changing phases at the end of the Pleistocene range of time. In fact, it could be maintained generally that Upper Paleolithic traditions flowed rather smoothly into the Mesolithic, with no more significant indication of cultural development than further environmental readaptations. The people of the Mesolithic stage or level of development "changed just enough so that they would not have to change."

The Maglemosian.—The level of intensified food-collecting cultures of the early Recent period in the old world is best known from northwestern Europe, and it is with regard to this area that the term Mesolithic has greatest currency to denominate archaeological traces. A classic example of such traces comes from the Maglemose bog site of Denmark, although there are comparable materials ranging from England to the eastern Baltic lands. These bogs were probably more-or-less swampy lakes. At about 6000 B.C., when the Maglemosian culture flourished, traces of primitive huts with bark-covered floors have been found. Flint axes for felling trees and adzes for working wood have appeared, as well as a variety of smaller flint tools, including many of microlithic scale. These were mounted as points or barbs in arrows and harpoons and were also used in other composite tools. There were adzes and chisels of antler or bone, besides needles and pins, fish hooks, harpoons and several-pronged fish spears. Some larger tools, of ground stone; *e.g.*, club heads, have appeared. Wooden implements also have survived because of the unusually favourable preservative qualities of the bogs; bows, arrow shafts, ax handles, paddles and even a dugout canoe have been discovered. Fish nets were made of bark fibre. There is good evidence that the Maglemosian sites were only seasonally occupied. Deer were successfully hunted and fish and waterfowl were taken, and it appears possible that several varieties of marsh plants were utilized. At Star Carr, in northern England, there are indications that four or five huts existed in the settlement, with a population of about 25 people.

This description of the Maglemosian must suffice to represent a considerable variety of European manifestations of the level of intensified post-Pleistocene food collecting. The catalogues of the Azilian and Tardenoisian industries of western Europe, of the Ahrensburgian of north Germany, of the Asturian of Spain, etc., would each differ in detail, but all would point in the same general

direction as regards cultural-historical interpretation.

The Nachikufan.—As a further and far-distant example, the Nachikufan culture of southern Rhodesia might be cited. Here again, microlithic flint bladelet tools, with certain types mounted as projectile points or in composite tools, existed. The Nachikufan cave walls show a few seminaturalistic drawings, and the caves also contain "pencils" of red and black pigment. Ground stone axes and adzes, bored stones (digging-stick weights?) and normal-sized chopping and scraping tools of chipped stone also occurred. Grindstones of various types indicate a degree of dependence on collected vegetable foods, and the animal bones suggest specialization in the hunting of zebras, wildebeeste, hartebeeste and wild pig. These Nachikufan materials date back to at least 4500 B.C. Again, an intensified level of food collecting is implied.

The General Picture.—Though there are vast gaps in our knowledge of the Recent period in many parts of the old world, enough is known to see the general cultural level of this range of time. Outside of the regions where food production was establishing itself, the period was one of a gradual settling-in and of an increasingly intensive utilization of all the resources of restricted regional niches. At first, the level seems nowhere to have achieved a climax of artistic expression, such as that for example, of upper Périgordian-Magdalenian times. But, as time went on, certain climaxes within the matrix of an intensified level of food collection did occur. An often-cited example might be the complex art and social organization of the cultures of the northwest coast of British Columbia.

More often, however, as the culture history of the Recent period proceeded, cultures at the level of intensified food collecting were "captured" by being absorbed within an expanding matrix of the new elements, procedures and traditions of food production or—subsequent to its appearance—by the expansion of civilized societies.

The Rise of Village-Farming Communities in the Near East.—There is little question that a level of an effective food-producing, village-farming-community way of life had been achieved in certain portions of southwestern Asia by at least 7000 B.C. Furthermore, increasing evidence indicated that the effective village-farming level was preceded by one of cultivation and animal domestication and that this incipient level was at least under way by about 9000 B.C.

Incipient Cultivation and Domestication.—Recent research suggests that the level of incipient cultivation and domestication was essentially restricted to the piedmont and intermontane valley zone which flanks the Zagros-Taurus-Lebanon chain of highlands about the great basin of the upper Tigris-Euphrates and Karkheh-Karun rivers and their tributaries. There are even hints that the zone extended to parts of the Iranian and Anatolian plateaus and that it may possibly have fingered northwest toward European Thrace. The significant point is that the zone appears to have formed a natural habitat for the cluster of plants and animals which were potentially domesticable. These subsequent domesticates—wheat, barley, sheep, goat, cattle and pig, plus a possible wolf dog—still exist in their wild state in those parts of the zone which have been examined by prehistoric archaeologists and natural scientists. An exact definition of the boundaries of this zone during the period from 10000 to 8000 B.C. was not available, however, in the 1960s.

The level of incipient cultivation and domestication is best manifested by the archaeological materials of the Natufian group in the Palestine-Syro-Lebanese littoral and parts of its hinterland, and by the Karim Shahir group in Iraqi and Iranian Kurdistan. The possibility of a continuation of the level into the northern Syrian and southern Turkish portions of the natural-habitat zone has been essentially untested by modern field research. Both of the available complexes of materials, the Natufian and the Karim Shahirian, appear to have been established by about 9000 B.C.

The Natufian and Karim Shahirian.—In both, there are clear indications of open settlements of modest size, with some traces of round huts, some of which were built on stone foundations, although caves are also known to have still been inhabited. Both groups yield traces of normal developments of flint industries based essentially upon local Upper Paleolithic antecedents, and both must have been influenced in their food getting by the already intensified food-collecting practices of their immediate predecessors. It is freely admitted that the postulation of this incipient level rests considerably on a judgment based on the materials of the succeeding level of effective village-farming communities. Nevertheless, it has been demonstrated that sheep were already being used at the incipient level, and there are such hints as flint sickles, ground stone mullers, mortars and pestles, and probable hoe blades to suggest that food plants were also receiving marked attention. Claims for the domesticated dog in the Natufian are not universally accepted, however. It has been rightly stressed that the materials of this level will be exceedingly difficult to interpret, since the earliest plant and animal domesticates will show little morphological difference from their wild contemporaries and since the procedures and artifacts of the new food-getting and food-preparation techniques will have taken considerable time to develop.

The Effective Village-Farming Community.—The next level, that of the effective village-farming community, yields, even in its earliest available phase (at Jarmo, in Iraqi Kurdistan, *c.* 7000 B.C.), materials which leave little doubt about the presence of food production. In the Jarmo phase, wheat, barley, a pea, goats, sheep, and—before the phase is completed—pigs and probably dogs all appear. The Jarmo settlement suggests a permanent village of about 20 rectangular several-roomed huts, which probably had a population of at least 150 people. Several other variants of the Jarmo phase have been excavated or at least located in Kurdistan. One of these, Sarab, near Kermanshah in Iran, suggests a seasonal encampment of herdsmen. Sarab yields pottery throughout its shallow deposit; at Jarmo itself, similar pottery appeared only in the upper third of a much thicker deposit.

"Preceramic" village sites were recovered in the 1950s in the Dead sea valley, along the Syro-Palestinian littoral, on Cyprus, in the southwestern Turkish highlands and even in Thessalian Greece. Controversy exists regarding the very spectacular architectural remains of the Dead sea valley site of Tall as Sultan (reputedly also the site of the later Jericho), with disagreement about its "town" or even "urban" nature in view of the normal small-object assemblage there, the radiocarbon determinations now available for it, and the relative lack of firm evidence for cultivation. These disagreements will certainly be resolved as more sites in the time range of about 9000 to 6000 B.C. are excavated in the Syro-Palestinian littoral and in parts of its hinterland. Further understanding should result as excavations proceed at Ras Shamra (north Syria) and at Hacilar and Catalhuyuk in southwestern Turkey.

Fully Established Village Sequences in the Near East.—By, or soon after, 6000 B.C., a variety of more-or-less complete regional cultural sequences developed in the near east. In Iran, two sequences appeared. That beginning at the site of Sialk developed most characteristically in the northern and northeastern parts of the country and evidently extended into the Turkmen Soviet Socialist Republic and northern Baluchistan and perhaps beyond to the Indus. A somewhat different tradition developed in southwestern and southern Iran, early traces of which may be seen at Ja'farabad in Susiana (Elam) and at Bakun B near Persepolis. This tradition exhibited a closer proximity to the earlier sites in Iraq; its eastern extension may also be traced as far as Baluchistan, if not beyond into the Indus valley.

The earliest full-bodied assemblage in northern Iraq, following that of Jarmo, is the Hassunan of the Mosul-Kirkuk piedmont. Next—either as elements in the developed Hassunan phases or alone at the mid-Euphrates site of Baghouz or at the mid-Tigris site of Samarra—comes the Samarran phase. Then, with further overlap, comes the Halafian phase of the upper (Syro-Turkish-Iraqi) piedmont. The overlapping of these three assemblages is indicated by the availability of a radiocarbon determination for an early Halafian level, which is as early as either of the two determinations of the Hassunan—about 5750 B.C. The beginning of the food-producing sequence in classic southern Mesopotamia comes after this time and is, perhaps, partly an amalgam of (1) a south-

ward extension of Hassuna-Samarra-Halaf traits; (2) the westward extension of early Susiana traits from southwestern Iran; and (3) the probable presence of indigenous riverine-oriented food collectors.

Another local tradition, at least contemporary with that of Hassuna (and perhaps earlier than that of Sialk), appears to have its focus in the Syro-Cilician corner of the eastern Mediterranean; its preceramic antecedents may be seen in the basal levels of coastal Ras Shamra. Later, this Syro-Cilician tradition appears to have been affected by the Halafian and later inland developments. To the north of Syro-Cilicia the early materials of Hacilar and of Catalhuyuk must be given place, including the possibility of their implications for the early developments in the Aegean. To the south, the Syro-Cilician tradition merged gradually into a somewhat related coastal Palestinian tradition. But in the more arid reaches of inland Palestine, a somewhat different tradition developed that appears to have culminated in the sites of semi-nomadic traders such as that at Beersheba.

Food production appears to have reached Egypt (and northern Africa generally) relatively late, perhaps not much before 4500 B.C. Such northern Egyptian occurrences as Merimde (on the western flank of the Nile delta) and the Fayum A pit sites might argue for an expansion directly (by boats?) from the Asian coast. But some authorities favour the idea of a way into middle Egypt via the Red sea and the Wadi Rawd 'Aid to account for the available developments there.

General Cultural Level of the Early Villages.—This very compressed sketch is meant only to suggest the variety of regional variations and adjustments within the general development of the effective village-farming level in the near east, from about 6000 to 4500 B.C. Wheat and barley were the staple crops; cattle join sheep, goats and pigs as major food animals at least by the Halafian phase. Villages—except the Tall as Sultan fortified establishment—seldom have a proved area of more than four or five square meters; an informed guess would put their limit of population at about 500 people. Again, except for some dubious interpretations of certain rather modest buildings as "shrines," the architecture appears to be entirely domestic in nature. Aesthetic expression also took the form of an almost bewildering variety of regionalized and successive painted-pottery styles. The modeling of clay figurines—already well attested in the phase of Jarmo and its contemporaries—continues, with both animals and stylized human females being rendered. The latter, especially, may be suspected as having represented some magico-religious aspect of concern with fertility, upon which the livelihood of the communities depended. Flint tools were gradually replaced by copper and, eventually, by bronze implements, and the early trade routes in obsidian (a volcanic glass of restricted occurrence) were doubtless taken over by the metallurgists. Certain artifacts indicate the presence of weaving; in addition to their local utility, woven fabrics may also have served as media of exchange. It would be difficult to maintain that there was a strict subdivision of labour on a full-time scale (except perhaps on a basis of sex or age), but such a trend must have been setting in.

It should be emphasized that the complexity of this picture cannot readily be conceived apart from a system of effective food production. It may also be noted that an older trend was not being reversed. The intensified food collecting at the close of the Pleistocene was apparently accompanied by increasing regional specialization and a tendency toward full utilization of a rather restricted environmental niche. Now—with the establishment and spread of the effective village-farming community, its expansion beyond the confines of the natural-habitat zone, and the beginnings of trade—the horizon began to widen again. The *oikoumenē*, or known world of these first effective village farmers, became an ever expanding one. Hence, just as it is probably not very fruitful to ask exactly where any particular element was "invented" or first discovered within the level of incipient cultivation and domestication in the natural-habitat zone, it is probably most useful to view the development of the way of life of the effective village-farming community as a general regional phenomenon of cultural interrelationships and stimulations. It might be further suggested that this general development took place over a broad area which had certain localized environmental variables and natural resources. These environmental conditions, however, had been there, just as the natural-habitat zone itself had been, long before incipient and effective food production came into being. The latter were human, cultural achievements; favourable environment, though it enabled them to come into being, did not cause them.

The Threshold of Town and City Life in the Near East.—The end of prehistory and the threshold of urban civilization are first seen in classic southern Mesopotamia about 4500 B.C. The materials of the Ubaidian assemblage make their appearance after a still rather poorly delineated phase in the basal levels of the mound of Eridu. Whatever elements combined in the earliest amalgam (northern Iraqian, Susianan or indigenous), the resultant traits of the Ubaidian tradition are revealed in their greatest clarity, consistency and variety in southern Mesopotamia by 4000 B.C.

There are mound accumulations and at least one large cemetery which suggest a scale of communities well beyond that of the simple village. Buildings sufficiently large, formal in design and size, monumental in concept and decoration to be judged as temples were present. Great quantities of painted pottery of high quality appear in the excavations. This pottery, by its very uniformity and the somewhat cursive nature of its decoration, may already have been the product of specialized craftsmen. No unquestionable instances of metal tools were available by the early 1960s from Ubaidian contexts in southern Mesopotamia (although metal was available by that time in the north), but quantities of very highly fired clay tools (axes, adzes, sickles) had been found. These were useful for cutting the pithy woods, reeds and grain of the southern alluvial environment or for dressing sun-baked bricks. The female clay figurines continued, but in a unique and highly characteristic stylization.

General Cultural Level of the Ubaidian Phase.—A Ubaidian town supplied itself from fields of wheat and barley and its animal herds. However, the agricultural regime in the hot, dry alluvium of southern Mesopotamia depended upon the utilization of the braided lower channels of the Tigris and especially of the Euphrates. Though elaborate irrigation works did not exist, the management of even quite informal ditches, with necessary shifts when the natural channels of the rivers shifted, added a new dimension to the sociopolitical necessities of Ubaidian culture. This system of irrigation may have been one of the factors which contributed to the expansion of society in late prehistoric Mesopotamia. Given the proper management and water, the yield of the rich alluvial soil was magnificent (until salinity became a problem several centuries later). There were also important dietary additions, such as dates from the groves of date palms and fish from the river channels and ditches.

With southern Mesopotamia as its focus, the Ubaidian tradition "exported" some of its elements at least as far as the Mediterranean coast and throughout the great upper drainage basin of the Tigris-Euphrates and Kakheh-Karun rivers. These exported traits doubtless reflect the growth of another *oikoumenē*, and one much more explicitly southern Mesopotamian in character. In southern Mesopotamia itself, the Ubaidian phase was followed (after a "Warkan" interval) by the proto-Literate period, in which the usual criteria of civilization are manifest.

Other Possible Origins of Food Production.—Some authors maintain that at least one important, quite independent and perhaps even earlier centre of cultivation and domestication lay well to the east of the southwestern Asiatic one. Southeastern Asia—under the circumstances, exactly where cannot be made explicit—is often suggested. There are also one or two champions for sub-Saharan Africa. It is, indeed, quite possible (perhaps even probable) that a southeastern Asiatic focus of domestication for certain tropical plants,—*e.g.*, the taro, the breadfruit, the yam, the banana—did in fact exist. Again, an independent domestication of wild pig, water buffalo and other animals, along with the chicken, may also have occurred in the area. The history of these domesticates as well as that of rice and certain other Indian plants, is not at all clearly understood. In Africa, the case is made on the grounds

of reputedly early (5th millennium B.C.) domestications of certain species of millet, sorghum, a pea, several tubers and root crops, and the watermelon.

The difficulty in deciding about such origins is that nowhere in either southeastern or southern Asia, nor in sub-Saharan Africa, is there any direct archaeological evidence bearing on these possible achievements. But, based on a judgment of what ought to have happened because of the later developments actually known to have occurred in areas, it is not unreasonable to conclude that early cultivation and animal domestication very likely took place there. The issue of how completely independent these achievements may have been is a much more troublesome problem, for it can equally well be maintained that the southeast Asian and sub-Saharan developments depended on the borrowing of ideas, or stimulus diffusion, from southwestern Asia. Even if this were the case, however, an important element of independence would still be involved in the application of borrowed ideas to quite different environmental scenes with their different potential domesticates, and the development of procedures and tools to assure effective food production on the basis of these new possibilities. The resultant complexion of the cultures which utilized these regional domesticates through tools and procedures they themselves had produced need hardly be thought of as simply pale reflections of the focus from which the original (and doubtless very generalized) idea was borrowed.

East of Southwestern Asia.—It is known, however, that village-farming communities existed in the Indus valley as early as 3000 B.C., if not earlier. The original complexion of their assemblages resembled those of Iran (and perhaps those of the Ubaidian imprint on southwestern Iran), but this complexion gradually changed to something characteristic of the Indus valley itself and evidently culminated in the Harappan urban civilization. Some degree of contact between the cities of the Indus and of Mesopotamia certainly continued to exist, however. It is becoming evident that the Harappan complex was not restricted to the Indus valley alluvium but extended into the adjacent semitropical portions of India as well.

Knowledge of the developmental sequence in China is obviously incomplete. Except for a few snatches of typologically more simple materials, the first evidence of food production in China appears to pertain to a well-advanced phase of the effective village-farming-community level. This is the Yangshao complex, focused in the basin about the confluence of the Yellow river (Huang Ho), Fen Ho and Kuei Shui rivers. Characterized by a handsome painted-pottery style, the Yangshao catalogue also includes cultivated millet, rice, kaoling and possibly soybeans, as well as domesticated pig, cattle, sheep, dog, chicken and possibly the horse and silkworm. The village houses were built of tamped earth; there was a flourish of "ceremonial" pottery vessels and of elaborately worked objects in jade, as well as flint, bone and ground stone objects of daily use. The Yangshao phase is followed by that called Lungshan, after which comes the Yin or Shang early dynastic complex of about 1500 B.C. The date for the beginning of the Yangshao is unknown; 3500 B.C. is probably much too early. Our comprehension of China is approximately comparable to what our knowledge of Iraq would be if we knew nothing earlier there than the Halaf phase.

Even less is known of southern China and southeastern Asia; the former seems to have been affected by the expansion of the makers of the Lungshan black pottery and perhaps was also stimulated from the south. The rather amorphous Hoabinhian and Bacsonian sequence in Indochina, with ground stone axes and adzes, appears to be quite late—perhaps of the 1st millennium B.C. In Japan, on the other hand, the first appearance of pottery of early Jōmon type (evidently all of the Jōmon development lies before effective cultivation had begun) has several radiocarbon determinations at about 7000 B.C., but some authorities suspect contamination of the samples. Positive cultivation (wet rice) appears in Japan about 300 B.C., in the Yayoi phase.

Sub-Saharan Africa.—The case of sub-Saharan Africa is complicated by the fact that the elements and procedures of food production are known to have spread southward along the Nile and across the Sahara from northern Africa. The wheat-barley and sheep-goat complex is not native to Africa, but cattle could have been domesticated there if the native north African *Bos opisthonomous* was utilized. An interesting development in Kenya and northern Tanganyika is the so-called stone-bowl culture, which must extend back to 1000 B.C. and probably somewhat earlier. Here, sheep and cattle were kept, and it seems very probable that certain millets were cultivated. Less is known of the area west of the Kenya-Tanganyika highlands; lack of excavation, poor preservation conditions in the tropical-forest environment, and the unlikelihood that stock raising could have been practised there, are factors which contribute to our ignorance. It is certainly not impossible that local plants were used—probably as the result of the diffusion of ideas from the north or east—but this is not known to have occurred until quite late.

Diffusion From the Near East to Europe.—The appearance of an effective village-farming-community way of life in Europe depended upon a combination of direct and stimulus types of diffusion from southwestern Asia. The plant and animal domesticates which reached Europe were those of the southwestern Asiatic complex, but it is very important to visualize their adaptive adjustments to the new, more temperate environments of Europe, and the changes in the procedures and tools which were also necessary to make food production effective in the new environments. Moreover, the new pattern of life did not move into a vacuum but into an area already occupied by intensive food collectors. It is unlikely that many people or ideas were carried directly from southwestern Asia to Europe; it appears, rather, that the spread was relatively slow (about 3000 years from, *e.g.*, Syro-Cilicia to the Rhine delta), with necessary adjustments and adaptations along the way.

Hence, it has been rightly maintained that the peoples of Europe were not slavish imitators and that they took "the gifts of the East" and molded them into a new, organic whole capable of developing along its own lines. This was the final achievement of prehistoric Europe and the basis upon which its subsequent civilizations were to arise.

See R. J. Braidwood and G. R. Willey (eds.), *Courses Towards Urban Life: Archeological Considerations of Some Cultural Alternates*, Viking Fund Publications in Anthropology no. 31 (1962), which contains a detailed treatment of the subject matter of this article, together with a full bibliography. (R. J. B.)

C. The New World Prior to Urban Civilization

The prehistoric sequence in the new world shares many essential developmental features with the old world and provides a test for generalizations about cultural development based upon old-world materials. In the new world there is evidence for an early horizon of primitive food collectors, followed by an increasing specialization of food collecting based primarily upon differences in localized resources. These specialized collectors were followed by a tradition of food production independent of the old world.

With food production came gradual increases in centres of population; villages were succeeded by towns and finally by centres of urban civilizations, which at the time of European contact were comparable to the ancient civilizations of the near east.

The absence of a suitable fossil record and of cultural remains from Early and Middle Pleistocene deposits in the new world have led prehistorians to look to the old world as the ultimate source of the diverse populations of American Indians found in the western hemisphere by the early European explorers. Present knowledge of Pleistocene glaciations and of accompanying alterations in sea level indicates that the most probable route of entry for man from the old world was via a land bridge between Alaska and Siberia, crossing what is now the Bering strait. It appears that a dry-land crossing of this area was possible during periods of continental glaciation, until about 10,000 years ago. The subsequent flooding of this region has hidden whatever traces these early migrants may have left of their arrival on the threshold of the American continents, and it is necessary to look to the interior of North America for evidence of their presence. While these early horizons of American prehistory are little known, a

few sites from western North America have cultural remains or other possible evidences of man in a context suggesting occupation as early as 30,000 years ago. The best known of these is the Tule Springs site in southern Nevada, where crude chopper tools and scrapers appear to be associated with hearths and the burned and broken bones of extinct mammoth, camel, horse, sloth and a large bison (*Bison alleni*) nowhere else known to be associated with man. Radiocarbon samples from this site indicate a probable age of 28,000 to 32,000 years. At no site in this early context are there any types of implements distinctive enough to be recognized in a context of crudely chipped stone tools from later horizons.

The earliest well-defined cultures in the new world have been placed by radiocarbon dating at about 9000 to 10000 B.C. At this period, two distinct traditions in North America are known: the Paleo-Indian big-game hunters of the Great Plains and eastern North America, and the Desert culture peoples of the western basin-range region.

The oldest remains of the Paleo-Indian tradition are found on sites where large Pleistocene mammals were killed and butchered. The most distinctive artifact type of this horizon is the Clovis Fluted projectile point, a lanceolate point of chipped stone which has had one or more longitudinal flakes struck from the base of each flat face. These points are accompanied by side scrapers and, in one instance, by long cylindrical shafts of ivory. They are most frequently associated with mammoth, although associations with extinct species of bison, horse and camel have also been reported.

A second Paleo-Indian horizon, which seems in part to be contemporary with the Clovis material and partially to postdate it, is the Folsom phase of the central high plains. It is characterized by lanceolate points of more careful manufacture (including broader fluted surfaces) than Clovis, associated with the remains of extinct *Bison antiquus*. The Lindenmeier site, a Folsom camp site in northeastern Colorado, has yielded a wide variety of end and side scrapers, gravers and miscellaneous bone artifacts. Both Clovis and Folsom sites have been dated at about 9000 B.C. by radiocarbon. Fluted points similar to western Clovis specimens have been found over most of the eastern United States south of the limits of the last major glacial advance. A single series of radiocarbon dates from the Bull Brook site in Massachusetts places the age of points of this type at about 7000 B.C. in that area. However, the distribution of this artifact type with respect to glacial events dated by C^{14} suggests an appearance as early as 11000 B.C. and a terminal date near that of the Bull Brook site. In the east several specialized varieties of fluted points may replace Clovis-type points toward the end of the Paleo-Indian occupation. While there is no instance of the discovery of eastern fluted points in association with an extinct fauna, the similarity of the accompanying assemblages of scrapers and gravers to those of the western industries suggests a similar economic orientation in the east. Outside of the United States fluted points have been reported at scattered sites from Alaska to Ecuador; but no certain temporal context has been established for any of these finds, and faunal associations are not clear.

Another variety of Paleo-Indian culture which appears to be contemporary with the Clovis and Folsom phases is characterized in its early horizons by rather crudely flaked lanceolate points which have been found associated with the bones of mammoth at two sites near Ixtapan in the Valley of Mexico and between the Clovis and Folsom horizons in a gravel pit near Portales, N.M. Similar points in circumstances suggesting comparable age have been found at San Jon, N.M., and Lime Creek, Neb. It appears that by about 7000 B.C. the fluted-point industries were replaced by a succession of lanceolate point-using phases, which continued the Paleo-Indian hunting tradition, concentrating primarily on large, now extinct, species of bison until the onset of the Altithermal dry period about 5000 B.C. The eastern limit of these cultures is in the vicinity of the western Great Lakes, while the most intensive occupation was on the western plains.

The Desert culture tradition, an adaptation of food-collecting peoples to the impoverished habitats of the basin-range area of western North America, seems to have been well established by about 9000 B.C. The most extensive knowledge of this way of life comes from cave or rock-shelter sites, such as Danger cave in western Utah, in which the desiccated remains of vegetal and animal materials have been discovered with stone tools. The Desert peoples made intensive use of virtually all aspects of their habitat, specializing in the use of vegetable fibres for a wide variety of implements, including twine, nets, baskets, sandals and snares. Projectile points appear to have been mostly leaf- or lozenge-shaped or lanceolate in earlier phases, with a greater use of notching for hafting in later phases. An essential feature of Desert assemblages is the milling stone for use in grinding wild seeds. In earlier sites this is likely to be a small, thin portable slab of stone used with a small pebble handstone, while later in the sequence large basin-shaped milling stones are more characteristic. Large choppers and scrapers similar to artifacts from the early Tule Springs assemblage are common in Desert sites and appear to have been used for the processing of plant materials.

Although the southern limits of the Desert culture are not yet clearly defined, it is known that it extended into northeastern Mexico, where, in the state of Tamaulipas, Desert materials have been found associated with the earliest-known cultivated plants in the new world. Here, in the Infernillo phase, it appears that native American squash, peppers and perhaps beans were being cultivated as early as 6500 B.C. At this time domesticates formed only a small portion of the total diet, the bulk of which was derived from wild animals and, to a lesser extent, wild plants. At about 2500 B.C. a primitive variety of corn (maize) first appeared in the Tamaulipas area in the La Perra phase. It appears, however, that corn was first domesticated elsewhere, probably in the puebla area of south central Mexico, where a carbon-14 date of 3600 B.C. is reported from materials associated with early corn in a cave near the town of Tehuacan. Even in the La Perra phase, cultivated species formed only a small part of the total diet, the majority of foodstuffs being wild plants. Thus, there is evidence in the new world for plant domestication comparable in age to that of the old world but for many years this was unattended by the sequence of complex social developments that closely followed domestication there.

While the earliest cultivation was under way in Middle America, other areas of the new world also show evidence of interesting developments. At the site of Palli Aike, on the Strait of Magellan the earliest cultural horizon has yielded a radiocarbon date of about 8000 B.C., indicating that man reached the southern extremity of the new world well before 10,000 years ago. In the northern hemisphere, food-collecting cultures were well adapted to several specialized ways of life by about 4000 B.C. In the eastern United States, two basic traditions utilizing the woodland areas appear to have grown from an earlier culture which was present in that area by 6000 or 7000 B.C. This early Archaic tradition is best known from the Modoc Rock Shelter in southern Illinois and from Graham cave in Missouri and Russel cave in Alabama. It differs from preceding Paleo-Indian horizons in its orientation toward a broad range of resources, including plant foods, as evidenced by the frequent use of milling stones. While some projectile points from these sites suggest Paleo-Indian varieties, the majority are stemmed or notched and differ in flaking technique from contemporary western Paleo-Indian specimens. By 2500 B.C. the Archaic cultures of eastern North America had separated into several distinct phases. There appears to have been a major division between peoples adapted to a riverine environment in the south and those adapted to the lacustrine resources of the north. Both depended, to a large extent, on the forest resources bordering these aquatic habitats. The Middle Atlantic coast area appears to have supported another type of Archaic culture, and the boreal forests of the north yet another. In areas without concentrations of particularly favourable resources, a generalized Archaic culture similar to the earlier pattern seems to have persisted. Most Archaic cultures are characterized by a rather extensive use of ground-stone implements, both woodworking tools and other categories, such as bowls, knives, net sinkers and elaborate weights for spear throwers. Projectile points vary widely,

but are usually rather large and crude and are stemmed or broadly notched for hafting. Perhaps the most interesting of the late Archaic manifestations is the Old Copper culture of the northern Great Lakes area. Here, exposures of native copper were quarried and cold-hammered into implements, such as projectile points, knives, awls and axes; and highly valued copper from this region was traded over much of eastern North America.

In western North America, similar developments were under way during this same period. It appears that the more arid regions of the basin-range country were largely depopulated during the Altithermal dry period (from about 5600 to 2500 B.C.) and that in surrounding regions diversification and specialization took place. In the drainages of the major rivers of the northwest, such as the Columbia and the Fraser, the annual abundance of salmon was the basis of a cultural adjustment as early as 7000 B.C. Implements of this horizon are similar to those found earlier in the Desert culture with projectile points, the most diagnostic artifact types, tending to be long and leaf-shaped or slightly stemmed, with a few notched forms also present. Following the Altithermal drought, a broad horizon characterized by the use of indented-based points with serrate-edged blades (generally termed "Pinto-like" after the type locality in the Pinto basin of California) is found over much of the southern portion of western North America. In at least one of the phases representing this horizon, the Chiricahua of southern Arizona and New Mexico, it appears that primitive maize cultivation was practised. The site of Bat cave in western New Mexico has produced specimens of a type of primitive corn which is also known from the Flacco phase in Tamaulipas at 2000 B.C. but which is here in association with a Chiricahua assemblage from which materials have been dated at about 1000 B.C.

By 2500 B.C., techniques of cultivation had also reached the north coast of Peru where, at such sites as Huaca Prieta at the mouth of the Chicama valley, there was a mixed dependence upon marine foods such as sea urchins, mollusks and fish; upon wild plants, mostly tubers and roots; and upon cultivated plants, including beans, peppers and a different genus of squash than that cultivated in the early horizons in Tamaulipas. Gourds and cotton were also grown, the gourds for use as containers and net floats, and the cotton for twined fabric and cordage. The use of stone at Huaca Prieta is interesting in its simplicity. Crude flakes and shattered pebbles compose the entire chipped-stone industry, while pecked and ground-stone artifacts are chiefly perforated net sinkers. In the upper levels of the site are architectural remains consisting of one- or two-room, small cobble-walled subterranean houses. The absence of ceramics at the Huaca Prieta site poses a number of interesting problems. From the Valdivia site in Ecuador, several hundred miles to the north, C^{14} samples indicate that ceramics may have been present there as early as 2500 B.C., and another date from Panamá indicates that the ceramics of the Monagrillo phase were manufactured by about 2000 B.C. Our present knowledge of the north coast of Peru does not reveal ceramics before about 1200 B.C., indicating an isolation of this area from cultural developments to the north. With ceramics, maize and other indications of Middle-American influence appear in Peru.

The appearance of village farming in the upper levels at Huaca Prieta and in the immediately succeeding Guannape phase in surrounding areas is roughly contemporaneous with the first appearance of this way of life in the Valley of Mexico at such sites as Zacatenco and El Arbolillo. Here a relatively sophisticated ceramic tradition (clearly derived from elsewhere) appears in the earliest levels. While evidence for architecture is not completely clear, it appears that by about 1500 B.C. there were small villages of wattle and daub huts scattered along the shores of the lakes of the Valley of Mexico, with inhabitants subsisting largely on maize-bean-squash cultivation, supplemented by the meat of game animals and various aquatic resources.

Earliest evidences for the next cultural advances are apparent by about 800 B.C. in changes in architecture and settlement pattern in several areas of Middle America and Peru. At this time, fairly extensive public works are represented by temple structures and large sculptured monuments, which occupy a central position in towns and villages. Phases as widely separated as the Olmec of Veracruz and the Cupisnique of coastal Peru appear to be linked not only in time and patterns of basic subsistence but in specific ritual practices involving a jaguar or feline deity. Throughout Middle America and in the Andean area, this appears to have been a time of consolidation and establishment of the basic traditions which dominated the development of high cultures in the new world up to European contact.

The spread of cultivation into North America seems to have proceeded along two separate courses, one from northern Mexico into the southwest and the other from an unknown Middle-American source into the Mississippi valley. One of the earliest known phases in eastern North America in which maize cultivation appears to have had a role in subsistence is the Adena, which occupied the middle Ohio river valley by about 800 B.C. The stimulus of the Adena farmers was apparently instrumental in bringing about the spectacular Hopewell culture in the Illinois and Ohio valleys. The success of the Hopewell peoples (400 B.C. to A.D. 400) seems to have been due largely to their combining elements of the preceding Archaic cultures with elements of the Adena culture and perhaps with some features of a local cultivating tradition. It is evident that the Hopewell culture included a well-organized village-based society in which surplus resources were used in the construction of elaborate earthworks and were concentrated as wealth in a restricted group of individuals. The most outstanding feature of Hopewell culture is a burial complex which called for the deposition of concentrations of wealth in tombs of one or several deceased individuals. The interment procedure was elaborate and involved the construction of a large log tomb, later burned and covered by an earth mound. Artifacts found within these burial mounds indicate that the Hopewell were able to obtain goods from widespread localities in North America. Obsidian and grizzly-bear teeth were apparently derived from the Rocky mountain region; copper from the northern Great Lakes; and conch shells and other exotic objects from the southeast and along the coast of the Gulf of Mexico. The ceramics of the Hopewell appear to be based in two major traditions, one derived from northern Asia, which reached eastern North America by about 1000 B.C., and the other from Middle America, where the decorative technique of rocker-stamping, characteristic of finer Hopewell pottery, existed several hundred years prior to the earliest appearance of the Hopewell culture. In less favourable areas of eastern North America, a "generalized Woodland" culture paralleled the Hopewell in time, probably based more on collecting than on cultivation for subsistence.

The period of the Hopewell culture was followed by relative decline in social cohesion in the northern Mississippi and Ohio valleys, evidenced by the absence of unifying features comparable to the Hopewell in the succeeding generalized Woodland culture. At about A.D. 800 a new tradition, with much stronger and more specific Middle-American elements, moved up the Mississippi valley. This Mississippi culture was based on more intensive cultivating techniques than the Hopewell and resulted in impressive concentrations of population in large towns through the south and central Mississippi valley and in several areas of the southeastern United States. A central ceremonial plaza provided the nucleus of a Mississippi town, and each settlement had one or more pyramidal or oval earth mounds, surmounted by a temple or chief's residence, grouped around the plaza. This settlement pattern is typical of most of Middle America after about 850 B.C., but is not found in North America until the Mississippi culture appears. The scale of public works in the Mississippi culture can be estimated from the largest of the Mississippi earthworks, Monk's Mound near Cahokia, Ill., which measures 1,000 ft. in length, over 700 ft. in width and still retains a height of 100 ft. The first European explorers in the southern Mississippi valley in the early 16th century found the Mississippi culture still flourishing as warring alliances of towns, each ruled through an elaborate theocratic system based on kin ties.

In the southwest, the earliest villages of farmers appeared by about A.D. 200, and this initial development in southern New

Mexico and Arizona was succeeded by a gradual spread of this way of life as far north as southwestern Colorado, east to the Pecos river, and west into the lower valley of the Colorado river. The maximum expansion of the Puebloan culture of the eastern and northern portions of the southwest appears to have taken place by A.D. 1150 or 1200 and was followed by the gradual abandonment of much of the area by farming peoples. This decline seems to have been due to a combination of factors, including drought, deforestation and lack of social cohesion within the villages. At the time of historic contact the Puebloan peoples were restricted to the Rio Grande valley and adjacent localities and to scattered settlements in west-central New Mexico and on the Hopi mesas of Arizona. The early explorers encountered other less well-organized farming groups, descended from the Hohokam and Patayan traditions of the southwest, in scattered localities along the Gila, Salt and Colorado rivers.

In South America, little is known of cultural development outside the Andean area, where, as in Middle America, urban civilization was well under way by the first few centuries A.D. From a sequence near the mouth of the Orinoco, it appears that manioc cultivation, which formed the subsistence base for stable villages in the tropical forest, had been developed by about 1000 B.C. Peripheral to the Andean area numerous cultures are known, particularly in Colombia and northern Argentina and Chile, which show marked influence from Andean urban centres and yet preserve distinct local traditions throughout the late prehistoric period.

An over-all view of the prehistory of the new world prior to the development of urban civilization reveals several general trends. The outline above follows the forefront of cultural development as it took place in several well-known areas. In localities less favourable to primary or intensive cultivation, the level of cultural development tended to stabilize at the point at which maximum food production was possible with the techniques at hand. Thus, in the arctic and in the boreal forests of the north, as well as through most of the southern South America and various other regions unfavourable for cultivation, cultural activity remained at an Archaic food-collecting level through the entire prehistoric period. In the tropical forests of South America and the woodlands of the northeastern United States, farming villages were the apex of cultural development under prehistoric conditions. In relatively favourable areas, such as the Mississippi valley, the oasis regions of the southwestern United States, and several other regions peripheral to the South and Middle American high-culture centres, temple-centred towns were the climactic development. A general appraisal of cultural complexity reveals a trend from a single, or few early cultural phases of uniform composition covering the entire new world, to the extremely diversified cultures of the last two millenniums of the prehistoric period. Within the sequence of cultural development it appears that the greatest diversity is present at the village-farming level, with hundreds of distinct phases indicating essentially locally oriented social groups which gradually united into larger units as communication and political pressures from more successful centres submerged the cultures of the weaker local phases.

When compared with the old-world sequence, a similar succession of cultural levels can be distinguished in the new world, but there are differences in such basic qualities as the lack of economically important domestic animals in the new world and the much greater diversity of habitats and forms in which the various cultivated plants originated. These factors seem basic in explaining the wide discrepancy in rapidity of cultural development between the old and the new world once the idea of cultivation was present. It was not until several cultivated crops (corn, beans and squash for most of the new world) were fully developed and assembled that higher cultural levels were possible.

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D. CIVILIZATIONS

It is customary to regard the time span of western civilization as immensely long, extending back through medieval Europe to the Greco-Roman world and to still earlier oriental forerunners. But the length of time for this development is probably no greater than that which had elapsed between the prior introduction of agriculture and the rise of the first civilized states. And both of these intervals together probably constitute only about one-fiftieth or less of the time since two-legged, tool-using creatures made their first appearance. Furthermore, the extensive spread of civilization is much more recent still. Civilizations have prevailed over uncivilized food collectors, nomads and primitive farmers across most of the world only within recent centuries. Thus, it must be stressed that civilization is a late condition in the human record.

Since at least the days of L. H. Morgan (1818–81), the achievement of civilization has been widely recognized as a major stage in man's social and cultural evolution. Coming ultimately as a consequence of the attainment of settled food production, its main attributes were substantial, qualitative increases in the scale and complexity of the limited number of societies which were its initial representatives. As there is civilization, so there are civilizations. And at least until well after the end of prehistory by any definition, the early civilizations must be regarded as very limited enclaves in a largely uncivilized world.

The earliest civilizations of the old world occupied the great alluvial valleys of the near east by around 3000 B.C. There is some evidence that Egyptian developments were stimulated by Mesopotamian influences, but the beginnings of civilization in the two areas were nonetheless essentially independent of one another and more or less contemporaneous. Farther to the east, civilization made its appearance in the valley of the Indus river a half millennium or so later. Here it was also essentially independent in at least its stylistic manifestations, but the time lag and the apparently abrupt inception of urban life—abrupt, that is, relative to that in Mesopotamia—suggest that stimulus from the latter area played a considerable part in its origin. The civilization of north China, still farther afield, did not cross the same threshold until after the middle of the 2nd millennium B.C., and controversies continue regarding the role of the already well-established near eastern civilizations in its formation. From these four primary centres, lesser and later centres naturally developed across the Eurasiatic hinterland. However, this process of consolidation and expansion is a part of the historic and not the prehistoric record.

A direct comparison of the old-world sequence with that of the new world is complicated by somewhat different cultural emphases. But while criteria for the identification of early civilization in the two hemispheres are not entirely the same, most authorities would concur in assigning the first appearance of a civilized way of life in the new world to the final centuries of the pre-Christian era. In view of the evident delay in this achievement, the possibility that it was prompted by influences from eastern Asiatic centres has long been debated. Apart from a few isolated and somewhat dubious cultural elements, however, the general course of development was sufficiently different in the new world to indicate that it was essentially independent of external stimuli.

Two centres or focuses of early civilization in the new world came into existence roughly at the same time, in Middle America and in the central Andes. Stylistic affinities suggest the possibility of a brief period of interconnection between them at the outset, perhaps the result of the southward spread of an early Mesoamerican cult. As in the case of Egypt and Mesopotamia, however, the subsequent development of the two major focuses proceeded along substantially independent lines. As late as the time of the Spanish conquest in the 16th century, the powerful Mexican and Inca empires had little or no direct knowledge of one another.

Civilization is of concern in the present context, of course, only as the terminus of the long prehistoric record. In most areas the rise of civilization coincided at least roughly with the development of writing, so that the later courses of civilization are illuminated by historical sources. In the absence of documents, the limitations of purely archaeological sources entail a stress on certain aspects of the rise of early civilizations—primarily those

involving formal governmental or religious institutions, and the material-technical facets of culture more generally. To be sure, a comparison with civilizations which have left written records, and with nonwestern civilizations of today, suggests many other dimensions in which the early civilized societies must have diverged from their predecessors and noncivilized contemporaries. Robert Redfield, for example, has identified the rise of civilization primarily with the formation of great traditions which systematized and redirected the cultural and moral order as it had been previously conceived in scattered folk communities. But except as indirectly inferred from objects associated with ritual, or from tenuous parallels with modern nonwestern societies, such a dimension of change as this is virtually irrecoverable by the prehistorian.

The possibility of attaining a civilized way of life rested ultimately on conditions which only intensive agriculture made possible. Among these were storable food supplies permitting permanent residence, agricultural surpluses supporting the proliferation of full-time administrators and specialists freed from primary subsistence activities, and a sufficient intensity of production within a given area to encourage the formation of urban centres. Recognizing these as prerequisites for civilization, V. Gordon Childe has formulated the growth of civilization as the consequence of two successive revolutions. The first, or neolithic revolution, has been dealt with in a preceding section; it encompassed the domestication of the plants and animals essential for an agricultural mode of subsistence, as well as the formation and spread of settled village communities. For the second, or urban revolution, a number of criteria have been proposed. Most importantly, these include: (1) cities, or large, dense settlements; (2) the differentiation of the population into specialized occupational groups; (3) social classes, including a ruling stratum exempt from primary subsistence tasks; (4) mechanisms for extracting a "social surplus," such as taxes or tribute; (5) monumental public buildings and other enterprises; (6) writing.

It is important to note that these two proposed revolutions differ fundamentally in character. The first represented most importantly an advance in man's control of his environment and consisted of a series of discoveries permitting its vastly fuller exploitation. The urban revolution, on the other hand, affected man's relation to his environment only secondarily and much more slowly. As agricultural techniques became stabilized, the crucial changes increasingly were those in community size and composition, in the appearance of new institutions and in the vastly greater complexity of patterns of social organization. These are changes less in man's interaction with his habitat than in that with his fellows. Hence, different interpretive skills are required to elucidate them than to explain the changes which accompanied the beginnings of agriculture, skills rooted more in the social sciences and humanities than in the natural sciences. Moreover, because of the increasing diversity of the social and cultural scene, our understanding of these changes is increasingly subject to distortions arising from the accidents of preservation or the unrepresentativeness of evidence so far obtained. The preoccupation of archaeologists with late pre- and protohistoric temple furnishings and architecture, for example, probably has exaggerated the importance of temples and certainly has left us with disappointingly little information on the nature of contemporary secular life in neighbouring precincts of the same towns. By contrast, it can be (or at least, has been) generally assumed that the relative absence of social and cultural differentiation in early villages permits them to be adequately sampled by random small-scale soundings.

If we accept the general descriptive validity of the criteria for civilization given above, the identification of the rise of civilization with the sequence of a neolithic and an urban revolution is still subject to three important qualifications. In the first place, to say that civilization depends on agricultural surpluses is not the same as saying that agricultural surpluses were all that was necessary to bring civilization into being in any given area. There is simply not enough known of the productivity of prehistoric agriculture to indicate whether increasing surpluses might have triggered subsequent changes in other aspects of culture. In fact, on the basis of present evidence it seems at least as likely that it was primarily through changes in social organization which civilizations brought about that there were advances in agricultural productivity. Second, it must be stressed again that the criteria given above are only those that are in some way accessible to the archaeologist. The tendency to regard them as a self-contained list which somehow defines civilization, or even which somehow embraces its primary causes and consequences, must be avoided. Third, the term "revolution" implies sudden and violent change. Yet, if the rise of civilization was undoubtedly rapid as compared with the hundreds of thousands of years of preagricultural life, it is equally clear that it was spread over many generations and probably never was as apparent to its participants as the Industrial Revolution has been to recent generations. Authorities are not even agreed, moreover, that the neolithic and urban revolutions were events separable in time. It remains only a hypothesis that one was consummated before the other began, and an equally plausible hypothesis might see a single, rising tempo of change that began with incipient agriculture and culminated in the appearance of oriental Bronze Age monarchies.

There remains a further difficulty with the criteria mentioned earlier: they apply most usefully to the earliest or "type" sequence in Mesopotamia, and elsewhere diverge to a greater or lesser degree from the observed archaeological data. The Maya area of Mesoamerica, for example, lacked true cities yet exhibits the other elements in the list to such a degree that its status as a civilization seems indisputable. According to some scholars, cities were also absent in Egypt during the Old Kingdom, although the other appurtenances of a civilized state are unusually well represented there. Similarly, the highly organized Inca empire got along entirely without writing, while in the Mayan and Mexican areas the much earlier invention of writing was only applied to economic and administrative tasks in the centuries immediately preceding the Spanish conquest.

To phrase the problem more broadly, the separate focuses of early civilization tended to crystallize into patterns which in some respects are quite different. Mesopotamia was characterized by extensive irrigation agriculture, by fairly rapid technological progress (though hardly rapid enough to "explain" the more profound social changes that took place concomitantly), by emphasis on urban settlement, and by an early separation between the temple cults and the political leaders. In Egypt, we find irrigation agriculture again and an even more precocious elaboration of a state administrative apparatus, but there is an absence of the trends toward rapid technological advance, urbanization and secularization that are so evident in Mesopotamia. A further variation on this pattern is found in the Maya area, where agriculture was largely of a nonintensive slash-and-burn variety, where the bureaucracy of a centralized state was entirely absent and where primary cultural emphasis seems to have been placed on the elaboration of esoteric cults by hierarchies of priests for whom important nonreligious functions in the society are not apparent. Peruvian civilization, on the other hand, was somewhat closer to the Mesopotamian model, except perhaps in its greater emphasis on an ethnically distinguished ruling stratum. In both new-world civilizations, but in neither of those of the old world, it might be added, there are indications that monumental temple architecture long preceded the other criteria of civilization—and in fact may be as old as the earliest village settlements based on agriculture.

These divergences should not be taken to deny the regularities that are implied by Childe's criteria for the urban revolution. Given a sufficient level of abstraction, the early civilizations of both hemispheres shared most of their essential features. And certainly they constitute a distinctive sociocultural type when contrasted with all earlier folk societies. They form the culminating stage of the prehistoric record, and it is worth noting in conclusion that their essential attributes never subsequently disappear. In fact, in one sense the world's written history is the documenting of their spread: gradually and irregularly, based on a succession of different focuses (of which western Europe and the United States are only the most recent), but ultimately ir-

resistible.

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IV. EGYPT AND WESTERN ASIA

A. EGYPT

The scholars who accompanied Napoleon to Egypt began the modern archaeological study of that country, although hampered by the fact that they did not understand the ancient language. When Jean François Champollion succeeded in deciphering the hieroglyphic text of the Rosetta stone in 1821–22, rapid advances were soon made in the translation of Egyptian texts. The 19th century also saw the formation of collections of antiquities and the first accurate copying of the monuments. Some excavation was undertaken by Auguste Mariette, who founded the antiquities service and the Cairo museum. However, scientific excavation was a development of the 20th century, based on methods devised by Sir Flinders Petrie and developed by such men as Ludwig Borchardt, George Andrew Reisner and Herbert Winlock. In conjunction with this field work immense contributions were made by the philologists Adolf Erman, Kurt Sethe, F. L. Griffith and Sir Alan Gardiner and by the historians Gaston Maspero, Eduard Meyer and James Henry Breasted.

Historic Egypt emerged in the 1st dynasty with a developed hieroglyphic writing and a brilliant display of technical skill. The magnificent objects excavated by Walter B. Emery and Zaki Saad in the Sakkara (Saqqara) and Helwan cemeteries of the Memphis district lend a new meaning to the fragmentary material known earlier from the shrine at Hierakonpolis and the Abydos royal cemetery in upper Egypt. Skill in the minor arts was accompanied by a dexterity in the working of large blocks of stone to line the burial chambers at Helwan which shows that tradition was correct in attributing this craft to Memphis. Certainly the first great building of stone was erected at Sakkara. There, in the temples of the Step Pyramid which Imhotep built for King Zoser in the 3rd dynasty, the excavations of C. Firth and J. P. Lauer show that an earlier architecture of light materials was literally translated into stone forms. This building was, in turn, a step in the development of Old Kingdom architecture.

The chronological divisions of Egyptian history are taken from the dynastic Lists of the Ptolemaic historian Manetho. These were based on earlier king lists such as the Turin papyrus of the 19th dynasty. Fixed dates have been calculated from records of astronomical observations and give 1991 B.C. for the beginning of the 12th dynasty and 1570 B.C. for the commencement of the 18th. The Turin papyrus states that the 11th dynasty lasted 142 years and that 955 years elapsed between Menes, the first king of the 1st dynasty, and Aba, the last king of the 8th. The length of the 9th and 10th dynasties remains uncertain, but a date of about 3200 B.C. can be estimated for the beginning of the 1st dynasty, with the possibility that this may have to be lowered.

The Archaic period (1st to 3rd dynasties, 3200–2680 B.C.) was followed by the Old Kingdom or Pyramid Age (4th to 6th dynasties, 2680–2258 B.C.). The First Intermediate period (2258–2052 B.C.) included the 9th, 10th and part of the 11th dynasties. The Middle Kingdom began in the 11th dynasty with the uniting of Egypt under Thebes in 2052 B.C. and ended with the 12th dynasty in 1786 B.C. It was followed by the Second Intermediate period (13th to 17th dynasties). The New Empire commenced with the 18th dynasty in 1570 B.C. and closed with the 20th about 1085 B.C. Then came a late period (21st to 31st dynasties), which was interrupted by the conquest of Alexander in 332 B.C.

Annual Nile floods have produced conditions which militate against the kind of stratified excavation of a city mound practised in other countries. Excavation has mostly been confined to the cemeteries on the edge of the desert. House architecture has survived at a few sites, such as Ikhnaton's city at Amarna, which lay beyond the reach of the floodwaters. So much material from tombs might have produced a distorted picture were it not for the Egyptians' belief in the continuance of life after death. This led them to bury with the dead their personal possessions, to represent different phases of daily life on the chapel walls and to make statues of the owner of the tomb.

Old Kingdom.—A wonderful picture of the Old Kingdom at its height in the 4th dynasty has been gained from the excavations at Gizeh of Reisner and Hermann Junker. That a vital formative period lay between the Step Pyramid of Zoser and the Great Pyramid of Cheops (Khufu) at Gizeh was long evident from the pyramids at Medum and Dahshur and the private tombs with reliefs and statues such as those of Rahotep and Nefert or paintings like the famous Medum geese. This transition from the 3rd to the 4th dynasty was clarified by Ahmed Fakhry's excavations at Dahshur, where royal statues and reliefs were finally found in the temples of the Bent Pyramid built by Snefru, the first king of the 4th dynasty. It is possible, then, to follow the steps by which the Old Kingdom achieved a truly monumental style in architecture and to obtain an impression of how the sculptor realized a noble conception of the human figure through a particularly happy blend of naturalism, mastery of simplified form and sensitive feeling for material. The finest 4th-dynasty sculpture reveals an interest in portraiture that was rivaled only by certain 12th-dynasty royal heads and a few statues of the late period. The fine cutting of the reliefs had a parallel only in the royal work at the beginning of the 5th dynasty. The gold-cased furniture of Hetepheres, wife of Snefru and mother of Cheops, shows that the same superlative craftsmanship was lavished on the dwellings

The large number of workmen trained in the vast projects of the 4th dynasty made technical skill more widely available in the 5th and 6th dynasties, as is abundantly illustrated by the work of the German expedition at Abusir and that of the Egyptian antiquities service at Sakkara. Royal monuments decreased in size but were more extensively decorated. The simple severity of earlier representation gave way to a more descriptive style which illustrates delightfully the life of the Old Kingdom. Even the lesser official could command a surprisingly high standard of craftsmanship. However, the brilliance of the Memphite court begins gradually to be dimmed by the rise of a provincial nobility whose rock-cut tombs appear near their capitals as far south as Aswan.

Written records remained somewhat laconic in the Old Kingdom, although the magical spells of the pyramid texts inscribed on the walls of royal burial chambers furnish a wealth of information concerning early religion. There were brief biographical inscriptions, royal decrees and records of expeditions to the stone quarries or for foreign trade. Notations of certain historical events survived in the fragmentary annals of the Palermo stone and its related pieces. A few letters on papyrus have been recovered, while the precepts of wise men such as Hordedef and Kagemni were repeated in later literature.

Middle Kingdom.—The collapse of the centralized administration brought an end to this prosperous civilization based essentially upon an agricultural economy. The ensuing chaos is reflected in a pessimistic literature that looks back upon this troubled time from the renewed stability of the Middle Kingdom. The poverty of the disunited segments of the country is clear from the poor craftsmanship and clumsy inscriptions of the tombs found in upper Egypt at sites such as Dendera and Naga-ed-Der. The growth of Theban power in the 11th dynasty is richly illustrated by H. E. Winlock's excavation of the Mentuhotep cemetery at Deir el Bahri. Inscriptions there and at Asyut tell of the struggle between the south and the north from which Mentuhotep II emerged triumphant over Heracleopolis to rule a newly united kingdom.

The strong rulers of the 12th dynasty established their capital in the north and, imitating Memphite custom, were buried in a series of pyramid fields stretching from a little south of Sakkara to the mouth of the Fayum, at Dahshur, Lisht, Lahun (Illahun) and Hawara. The excavations of the Metropolitan Museum of Art (New York city) at Lisht have built up a series of archaeological material comparable in completeness with that supplied

by Gizeh and Sakkara for the Old Kingdom. The craftsmen of the court drew upon Memphite models, but elsewhere in the country there is a regional diversity which stems from the feudal character of the First Intermediate period. The great men of the provinces decorated imposing tombs in the neighbourhoods of their chief towns. There appeared a variety of styles, both in wall decoration and sculpture in the round, unknown in the Pyramid Age. In these provincial tombs the painter developed an increased facility. The same delicacy and technical skill entered into the making of jewelry for the court at Dahshur and Lahun. Such pieces were imitated at Byblos on the Syrian coast, where there appeared a skilled metalworking industry that was to have a long tradition. Somehow related to the Syrian crafts and the importation into Egypt of Cretan painted pottery is a use of new decorative patterns in Egypt employing interweaving spirals and the palmette.

New forms appeared in architecture, as in the Theban temple of Mentuhotep II, which combined terraced colonnades with the pyramid form. Some traces have also survived of temples of a nonfunerary character. Sculpture in the round seldom attempted the harmonious forms of the Old Kingdom. It is as though the sculptor, like the writer, could not regain the calm confidence of the Pyramid Age. The careworn faces of Sesostris III (Senusret) and Amenemhet III reflect the bitter disillusionment seen in the literature. This tentative effort to portray inner feeling is one aspect of an advance in social consciousness which is evidenced in literature by a new concern for the rights of the individual man. These ideas are more fully expressed in writing than were the simple precepts of an earlier time. Similarly, the more flexible language of the *Tale of Sinuhe* lends colour to the background of the story. There is evidence, too, of a wider interest in foreign lands, supported by material excavated in Syria, Palestine and Crete, as well as the trading post at Kerma in the Sudan.

New Empire.—A disintegration of central power in the Second Intermediate period was complicated by the invasion of the Hyksos, who entered Egypt from Palestine. Except that they introduced the use of the horse and chariot, there is still more conjecture than conclusive fact concerning this people, in spite of the excavation of their encampments in Syria, Palestine and the Egyptian delta. Inscriptional evidence is very scanty. A strong Theban family again began the liberation of the country in the 17th dynasty. The New Empire inherited an aggressive foreign policy which resulted in an extensive empire. As this empire declined there came a shift to defensive measures. In the 19th and 20th dynasties Merenptah and Rameses III drove off the "peoples of the sea," but later invasions succeeded, first from Kush in the south and then by the Assyrians, Persians and Greeks.

Until the conquests of Tuthmosis III, the early 18th dynasty showed at Thebes a clear continuance of old tradition. Its finest monument, the terraced temple of Queen Hatshepsut at Deir el Bahri, was reconstituted by Edouard Naville, Winlock and the architects of the antiquities service. The early buildings of the Karnak temple and the paintings in the tombs of the Theban nobles complete this picture of a renewal of old forms, as yet unaffected by the complexity of new currents. The effect upon the Egyptian of his dominant position in a greater world can be traced through changes in subject matter and style in the tomb paintings and in the increasing size and ostentation of the temples. The altered spirit is vividly displayed in the painted decorations of the palace of Amenhotep III at Thebes and in his son's new town at Amarna. A delight in curving lines and luxurious decorative detail was combined with a love of precious small objects for their charm alone. This is fully illustrated by the amazing tomb equipment of the young king Tutenkhamon. The art of the Amarna period, although powerfully affected by the monotheistic tendencies of Ikhnaton's brief religious revolution, is an equally true reflection of the spirit fostered by the empire. The rich finds made by Petrie, Borchardt and John Pendlebury at Amarna show also that Ikhnaton's artists produced the only true portrait sculpture of the New Empire. In general, though, painting seems to have been the most congenial medium of expression and reaches the height of its development in the 18th dynasty.

All the complexity of New Empire life is documented by written evidence. Accounts of military campaigns, foreign office archives, legal and administrational records are supplemented by biographical inscriptions, popular tales, poetical compositions, treatises on mathematics and medicine and a vast religious literature. These can be brought into relation with an increasing body of such material from neighbouring countries.

Later Empire.—The funeral customs at Thebes in the later empire can be studied in detail as the result of the excavations of Bernard Bruyère at Deir el Medineh, while the royal burials of the 21st and 22nd dynasties found by Pierre Montet at Tanis in the delta rival in splendour those of an earlier time. That the craftsman had lost little of his old skill is clear from these Tanis objects and those found by Reisner in the tombs of the 25th-dynasty Kushite kings and their successors in the thoroughly Egyptianized Sudan. On the other hand, Theban painting declined sharply in the 19th dynasty and soon virtually disappeared. There was a renewal of creative effort under Rameses III which is evident in the reliefs of the Medinet Habu temple. From the 20th dynasty onward, accounts of criminal investigations illustrate the corruption creeping into civil life, while the drawings of satirical papyri mock the manners of the period. The contemptuous treatment of Egyptians abroad is evident from Wenamon's account of his attempt to fetch timber from Syria early in the 21st dynasty.

The increasing importance of the delta encouraged the division of the country, which split into small sections under struggling petty dynasts in the 22nd to 24th dynasties. The success of one of these men, Tefnakht of Sais, seems to have provoked the invasion of the Kushite king Piankhi. The Kushite 25th dynasty brought a renaissance of Egyptian spirit which survived Assyrian attack to continue under the Saite 26th dynasty. A vigorous school of portrait sculpture appeared and a new freshness is felt in the tomb reliefs. Simultaneously there was an archaizing return to ancient forms in writing and in art. Egypt preserved its old ways with remarkable tenacity in spite of close political contact with the Mediterranean world and western Asia. Assyrian and Persian rule left scarcely a perceptible mark, while the new spirit carried abroad from Greece by traders and mercenaries in Saite times met with a stout resistance which continued even after the time of Alexander the Great.

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B. Mesopotamia

In contemporary archaeological usage the name Mesopotamia is generally applied to the region of western Asia which is dominated by the river valleys of the Tigris and the Euphrates. This region is bordered on the east by the Zagros mountains, on the west by the north Syrian desert plateau, on the north by the Kurdish mountains and on the south by the Persian gulf. Its boundaries roughly coincide with those of the modern kingdom of Iraq. Geographically, as well as historically, Mesopotamia falls into two distinct parts: the north, which is geologically the older, consists of rolling country that extends south as far as Hit and Samarra; the south, geologically the more recent, is the flat alluvial plain which extends down to the Persian gulf. As in the tradition of the Old Testament, north and south Mesopotamia are often referred to as Assyria and Babylonia, respectively.

Exploration.—The Old Testament was, indeed, for many centuries the main source of information about ancient Mesopotamia available to the western, European, world and the main stimulant for interest in that region. Biblical associations dominated the interest of early European travelers and explorers in

Mesopotamia. During the middle ages, few Europeans ventured into this relatively remote, inaccessible and inhospitable region. One of these was a Spanish-Jewish traveler of the 12th century, Benjamin of Tudela. Though his main interest was the status of the Jewish communities in the countries that he visited, he mentions the ruins of Babylon and correctly places the ruins of Nineveh across the Tigris from Mosul. Not until after the Renaissance with its awakened interest in classical antiquity did Europeans begin to take interest in the antiquities of Mesopotamia, and even then the interest was biblical rather than historical and archaeological.

From the end of the 16th century onward, the number of Europeans who visited Mesopotamia increased steadily. The Roman nobleman Pietro della Valle seems to have been the first to bring samples of cuneiform writing to Europe. These were stamped bricks which he collected in 1616 and 1625 in the vicinity of Babylon and Ur. The majority of travelers during the 17th and 18th centuries seem to have been British, followed in number by French, but Scandinavian and other European countries were also represented. The travelers included scholars, clergymen, merchants, government officials and diplomats. In the 18th century an increasing number were more than casual visitors. Several spent many years in Mesopotamia, sometimes on repeated visits and often pursuing definite scientific, commercial or political objectives. More and more came equipped with a knowledge of oriental languages and with experience gained during sojourns in other parts of the orient.

The establishment of offices of the British East India company in Basra and Baghdad, with their permanent representatives, and the establishment of British and French consulates in Mesopotamia played an important part in the archaeological exploration of the country. One of the residents of the East India company in Baghdad, Claudius James Rich, was in many respects the pioneer of methodical antiquarian exploration of the region.

Early in the 19th century, a point had been reached when explorers were no longer satisfied with a topographical study of the ruins which they visited nor with collections of antiquities which could be gathered on the surface or obtained from local inhabitants. Occasionally trenches were dug into the ruins in the hope of enriching these collections. Most of these activities took place in the south. The sporadic diggings were usually on a small scale and did no great damage except as setting an example for the local inhabitants, who then gradually became aware of the monetary value of the antiquities which lay buried in the ruins.

Excavations.—The era of regular archaeological excavations was opened in 1842 by the French consul in Mosul, Paul Émile Botta, who began his activities at Nineveh but soon transferred them to Khorsabad, where he discovered and began the excavations of the palace of Sargon II (722–705 B.C.). Hampered by local Turkish officials, he appealed to the French minister in Constantinople and obtained a royal permit—a firman—from the sultan for the continuation of his dig. Thus the precedent was established for the official permit or concession that is needed for archaeological excavations in near eastern countries. After a short interval, excavations were resumed at Khorsabad under the direction of Victor Place with Félix Thomas as architect and artist. The British followed almost at once with excavations at Nineveh and Nimrud under the direction of Sir A. H. Layard.

The results of both enterprises far exceeded all expectations. During the first decade of regular excavations, the French and the British discovered palaces of Assyrian kings, which were decorated with thousands of bas-reliefs depicting the daily life of the Assyrian court, with coloured glazed bricks and paintings, and which contained innumerable small objects. These finds laid the foundations for the magnificent collections of Mesopotamian antiquities in the British Museum and in the Louvre. Less spectacular but no less important was the discovery of a wealth of inscribed material, especially the library of Assur-bani-pal at Nineveh. At the same time, efforts to decipher cuneiform (*q.v.*) script were crowned with success as a result of the perseverance and ingenuity of scholars of several nationalities. Thus, when the magnificent results of the first decade of regular excavations became available, a new branch of scholarship, Assyriology, was ready with scholars to take over the study of the inscriptions.

The first outburst of archaeological activity in the north soon subsided, though exploration and excavation on a smaller scale continued. Gradually the centre of interest shifted back to the south, where both the British and the French undertook small-scale investigations. In the south too the French were the first to establish a regular expedition, when the French consul at Basra, E. Chocquin de Sarzec, in 1877 identified Telloh (ancient Lagash) as the source of statues of a hitherto unknown type. Work at Telloh continued intermittently until 1935.

Toward the end of the 19th century, German and U.S. scholars joined the British and the French in the field. The U.S. effort was on a relatively small scale and of short duration. The Germans, on the other hand, developed their activities to include several sites, in both the north and the south, among them the famous sites of Ashur and Babylon (*qq.v.*). Indeed, early in the 20th century, in the years preceding World War I, the Germans were in the fore of archaeological activities in Mesopotamia.

World War I caused an interruption of archaeological activity, but with the British occupation of Mesopotamia work was soon resumed. The British organized and guided a department of antiquities and a national museum in the newly established kingdom of Iraq, which was under their mandate.

In the years between World Wars I and II archaeological excavations in Mesopotamia were conducted by British, French, U.S., German and Italian institutions. During that period the U.S. activities gained first place in terms of number of sites excavated and results obtained. Because of the magnitude of the task, often too large for a single institution to undertake, the Americans introduced joint expeditions, in which excavations were sponsored by two or more institutions. Participants were either U.S. or U.S. and British institutions. Interest extended beyond the periods of classical Mesopotamian civilization to prehistoric periods.

The peak of archaeological activities in Mesopotamia was reached in the middle 1930s. Political tensions in Europe and the near east combined with the effects of the economic depression in the United States caused a gradual decline of these activities, which finally came to a standstill. When World War II broke out, not a single foreign expedition was active in Iraq.

During World War II, excavations in Mesopotamia did not cease completely. The department of antiquities, organized and developed by the British during the period of the mandate, was able to undertake a number of important excavations on its own. After the war, excavations in Mesopotamia were resumed on a relatively small scale. U.S. and British institutions were the first in the field and were followed by the Germans in 1953. The principle of joint expeditions was maintained, and the effort was again divided between historical and prehistoric sites. It was significant that, except for new prehistoric sites, archaeological activity was concentrated on previously excavated sites. The British returned to Nimrud, the very first site on which they undertook regular excavations more than a century before, the Americans were digging at Nippur, the first site dug by a U.S. expedition more than 50 years earlier, and the Germans had returned to Erech (modern Warka), where small-scale digs were undertaken by W. K. Loftus in 1849 and 1854 and where a regular German expedition was established in 1912. This was not only a striking reminder of the seldom realized fact that not a single ancient site of any importance had as yet been completely excavated but also a reflection of the progress which archaeology had made as a scholarly discipline.

Stratigraphy and Relative Chronology.—In contrast with Egypt, where ancient sites often contain remains of various periods at the same level near the surface, and where many monuments, such as the pyramids and the great temples, have never disappeared from sight, the ancient sites of Mesopotamia usually consist of accumulations of superimposed ruins of consecutive occupations, and all the ancient monuments have to be uncovered by means of excavations. This contrast is due to differences both in building material and in geographic and climatic conditions.

In Egypt a great variety of hard stone suitable for monumental

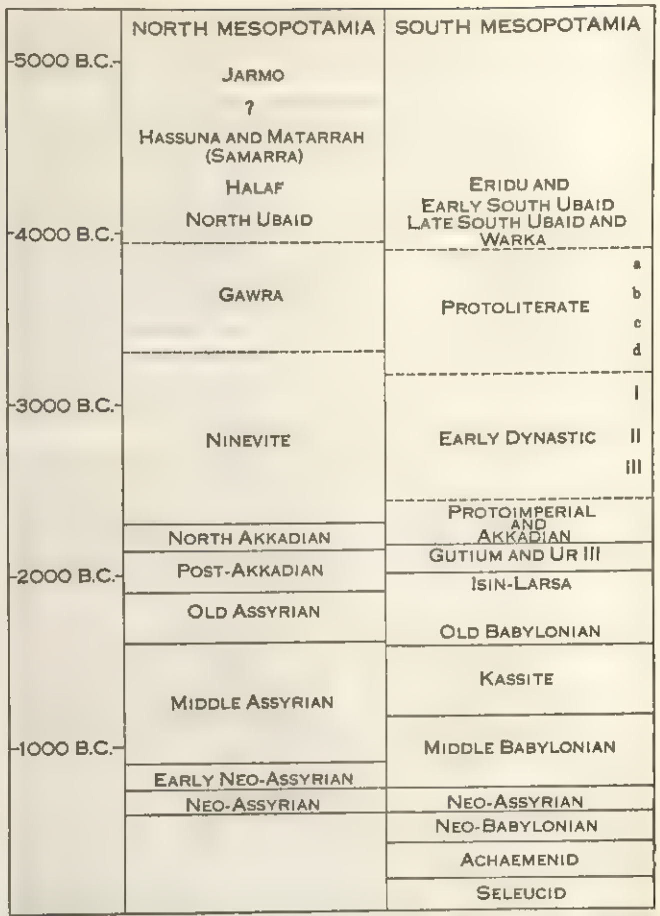
building always was available. In Mesopotamia, on the other hand, stone had to be imported from relatively great distances, and the universal building material in all periods was the indigenous and ubiquitous alluvial clay. Adobe, then, was the prevailing building material in Mesopotamia at all times and for all purposes, from the humblest private dwelling to temples, palaces and colossal city walls many yards thick. Adobe structures crumble easily when exposed to the elements. This feature and the cheapness of the material were conducive to relatively frequent repairs and rebuildings. In the process of rebuilding, earlier debris was simply leveled off and new buildings were erected on top of it. The results of such accumulation are the artificial mounds for which the Semitic languages from earliest times have had a specific name—"tell." Most of the tells are thus stratified, with, generally speaking, the lower strata being earlier than those above them. One of the preoccupations of the modern excavator is to distinguish between the strata and to attribute the finds to their proper strata in order to establish the relative chronology.

Not all ancient sites were occupied continuously and during the same periods, and consequently gaps in cultural sequence may be encountered in the course of excavations. Such gaps in one site may be filled through information obtained on others. Synchronization of archaeological strata on different sites is based largely on typological comparisons of finds in them.

The development and changes in the various classes of archaeological material in the course of time serve as the bases for distinguishing and defining the various earlier archaeological periods. For later, historical, times, periods are defined chiefly on the basis of written documents, and the archaeological materials must be co-ordinated with historical evidence. A summary of the main archaeological and historical periods in Mesopotamia is given in the accompanying chronological chart. An attempt has been made also to correlate these periods in terms of absolute chronology.

Absolute Chronology.—Absolute chronology can be established in various ways, the most widely used being direct reckoning from a previous dated event. This method is valid in Mesopotamia only for the Seleucid era, at the end of the 1st millennium B.C. For earlier periods, absolute chronology depends on chronological lists such as king lists which give regnal years or on lists of eponymous officials (limmu lists). The reliability of a chronology established on the basis of such lists depends on their accuracy and continuity as well as on the possibility of establishing certain absolute dates within them. The latter can be achieved either by means of synchronization with dated events in other regions or through astronomical calculations. The astronomical method depends on a specific astronomical event having been accurately observed and recorded in ancient times. Such is the case of the eclipse of the sun which was recorded in an Assyrian limmu list and which has been calculated to have occurred on June 15, 763 B.C. This astronomical synchronization is the basis for the absolute chronology of the first half of the 1st millennium B.C. and, with a certain margin of error because of discontinuity in the list, of the second half of the 2nd millennium B.C.

The absolute chronology of the first half of the 2nd millennium B.C. depends largely on another recorded astronomical event, namely the heliacal setting and rising of the planet Venus. Since astronomical events are periodical in character, additional criteria must be used for determining the particular event recorded. The efforts of many scholars have been concentrated on establishing such criteria. No astronomical synchronization is yet available for events before the 2nd millennium B.C. The estimates of the duration of archaeological periods in this range of time and their absolute chronology depend largely on fragmentary historical information and on archaeological evaluation of the time that it took the various cultures to develop and the debris that represents them to accumulate. Results obtained from the valuable contribution of W. F. Libby and his associates at The University of Chicago, who developed a method for dating organic remains by their content of the radioactive isotope of carbon (C^{14}), seemingly are not greatly at variance with those obtained through archaeological estimates. The number of well-stratified specimens from Mesopotamia tested by this method was still too small in the mid-1950s, however, for decisive conclusions.



COMPARATIVE CHRONOLOGY, NORTH AND SOUTH MESOPOTAMIA. DASHED LINES INDICATE APPROXIMATE DATING

All archaeological material from Mesopotamia can be divided into two major groups. The first represents all the phases of prehistoric cultures; the second contains the products of the distinctive Mesopotamian civilization.

Mesopotamian Civilization.—During the last stage of Mesopotamian prehistory, a number of distinctive regional cultures were submerged by a relatively widespread and homogeneous, if somewhat monotonous, material culture known as the Ubaid. It extended over a large area of western Asia, from the Iranian highlands to the Mediterranean coast in northwest Syria and from the southern borders of Anatolia to the Persian gulf. Sometime during the first half of the 4th millennium B.C. the trend was reversed, the homogeneous material culture being replaced by a number of differentiated cultures in smaller areas. This development in one of these areas—the southern plain of Mesopotamia—is especially noteworthy, for there emerged, apparently for the first time in human history, a civilized society.

Cultural traits that distinguish a civilized society are many and vary in character and degree for different civilizations. One trait that is common to most civilized societies is literacy. The invention of writing in the Protoliterate period is therefore an important landmark in the history of Mesopotamian culture. Moreover, concurrent with the appearance of writing there emerged a number of new traits which remained characteristic of Mesopotamian civilization throughout its history. One of the major tasks of Mesopotamian archaeology consists of the discovery of such distinctive traits, the tracing of their development and changes and their interpretation in terms of cultural history.

Archaeological material from Mesopotamia is often divided into the following classes: architectural remains, art products, written documents, tools and weapons, utensils, personal ornaments, etc. Architecture includes temples, palaces, fortifications, private dwellings and even building materials. Art includes sculp-

ture in the round, bas-reliefs, glyptic, painting, etc. Out of the tremendous mass of material remains might be mentioned some that represent best the distinctive character of Mesopotamian civilization: its writing, its architecture and its glyptic.

The distinctive method of writing is known in its fully developed form as cuneiform. Its development from earlier, pictographic writing can now be traced. It was apparently invented by Sumerian-speaking people, later adopted for a totally different family of Semitic languages and in turn borrowed from them for non-Semitic languages in later times. The architecture, unlike the writing, derived some of its elements from prehistoric periods. Some features are undoubtedly attributable to the building material of Mesopotamia. However, it is not necessary to assume that its main characteristic features were predetermined by this material. Its outstanding feature is the temple, often combined with an artificially raised platform. Mesopotamian architecture, too, was adopted in other periods in other regions.

A distinctive form of glyptic, the cylinder seal, is, as it were, a hallmark of Mesopotamian material culture. This form of art, like the writing, appeared for the first time in the Protoliterate period and had a continuous history of development and change for 3,000 years. Like the writing and the architecture it was adopted by other regions, where it often underwent an independent evolution. Cylinder seals, being small and valuable objects, were often exported from one region to another and thus serve as an important guide for archaeological synchronization. The stylistic development of cylinder seals is one of the main bases for the distinction of the various cultural periods, and iconographic study of their subject matter is an invaluable source for the understanding of Mesopotamian religion.

The picture of ancient Mesopotamian civilization that emerges from the study of the archaeological material, though far from complete, is of interest in many respects. Not only was it the first civilization in human history, with all the freshness and vigour of an original achievement, but the emergence and persistence of its distinctive individual "form" merits close scrutiny. Less isolated and sheltered than Egypt, Mesopotamia was from the beginning a meeting ground for various ethnic and linguistic groups and their cultural tendencies, with all the implied mutual influences and conflicts. At the very beginning of this civilization, at least two distinctive linguistic groups were on the scene as partners in its creation. The writing was apparently invented by the Sumerians, but even in the earliest texts loan words from the Semitic Akkadian have been recognized. The writing itself was eventually taken over by the Semites, whose language—Akkadian—was in turn influenced by its long association with Sumerian. Not only the writing but many other distinctive traits of Mesopotamian civilization appeared as early as the Protoliterate period, survived and developed throughout the Early Dynastic period with its predominantly Sumerian character and continued without a perceptible break after the Sumerians had disappeared. Subsequent political changes, ethnic movements, wars and conquests did not succeed in destroying the distinctive character of this civilization, though the influences of these events are often reflected in the material culture. The full history of this civilization, which preserved its individuality for more than three millenniums through language barriers, ethnic changes and political and economic vicissitudes, is the subject of Mesopotamian archaeology.

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C. East Mediterranean Littoral

By the term "east Mediterranean littoral" is meant the areas of Syria and Palestine along the eastern coast of the Mediterranean. Following the first village cultures of the 5th millennium B.C., the Chalcolithic period in Palestine is designated as the Ghassulian from the type site, Teleilat el-Ghassul, in the Jordan valley. Copper smelting was known by this time, though the most astonishing discoveries have been the remains of elaborate, multicoloured paintings on house walls. One which depicts a star is about six feet in height. This, together with a number of grotesque masks and other items, indicates a high degree of imaginative activity. Since its discovery in 1929 this culture has been found widely distributed in Palestinian valleys and plains; discoveries were made by the Israeli department of antiquities in 1954 near Beersheba, where a subterranean village was found tunneled beneath the surface of a field.

In Syria the Chalcolithic period consists of cultural phases in which the contemporary painted pottery of the Halaf and Ubaid periods of northern Mesopotamia is represented by importation and native imitation. No significant architecture comparable with that in Palestine at the time had been discovered by the mid-1950s.

Bronze Age.—During the last two or three centuries of the 4th millennium a new cultural epoch was introduced which is labeled the early Bronze Age. In Syria and Palestine it is known to begin before the first dynasties in Egypt and Babylonia by the artifacts found in early Bronze I (*e.g.*, Protoliterate seal impressions of Mesopotamian origin in both countries and a late predynastic Egyptian slate palette at Jericho), while imported Syro-Palestinian jars and pitchers in tombs of the Egyptian 1st dynasty inaugurate early Bronze II. About the turn of the 3rd millennium B.C. Syria and Palestine shared with Egypt and Mesopotamia in a sudden burst of new cultural energy. Judging from the depth and spread of the deposits, population must have increased greatly and social organization become more complex. Massive city walls were erected at Jericho, Ai, Megiddo, Dothan and elsewhere in Palestine. In fact, Jericho exhibits during the 3rd millennium no fewer than 14 successive city walls or wall components. Temples have been found at Megiddo, Jericho and Ai, while in Syria Byblos by about 2700 B.C. appears to have become a crown colony of Egypt. The importance of this age in the cultural history of Syria-Palestine has only become clear from a number of excavations from about 1935; it is the first period of extensive city-state development and expansion.

In Syria the middle and end of the 3rd millennium are marked by the succession of the Khirbet Kerak and caliciform pottery cultures. In Palestine major disturbances during this time brought an end to the early Bronze civilization, and no city excavated by the mid-1950s showed a continuous occupation between 2500 and 2000 B.C. Only the end of the caliciform period is represented in a brief revival of early Bronze traditions in middle Bronze I (2100–1900 B.C.), at which time Jordan exhibits the first signs of extensive urban installations.

Between 1900 and 1200 B.C. (middle Bronze II to late Bronze II) Syria and Palestine for the first time show a striking unity in material culture. Perhaps the type site in Syria is Ras Shamra on the coast south of Antioch. This city was excavated by a French expedition in successive seasons in 1929 and following years, interrupted only by World War II. There, as at Byblos, Megiddo and Gezer, imported objects of the Egyptian 12th dynasty establish the chronology. The cultural revival about 1900 B.C., illustrated so vividly by the rich tombs of the princes of Byblos, brought with it a fine new pottery, characterized especially by beautiful carinated bowls made from metallic prototypes. During the Hyksos period (*c.* 1700–1550) the introduction of the horse and chariot was accompanied by the construction of large beaten-earth enclosures, the most notable of which have been found at Qatna in Syria and Hazor in Palestine. High ramparts also came into being around many citadels; in Palestine they were typically of cyclopean masonry at the bottom with a brick superstructure. Perhaps the climax in the Syro-Palestinian artistic development came between the 17th and the 14th centuries B.C., as shown

especially by the jewelry, faïence, ivory carving and glyptics.

The most important architectural monuments of the period are the temples and palaces found in the royal cities; that is, in the capitals of the city-states. Most important is the temple of Baal at Ras Shamra, near which the scribal archives were discovered, beginning in 1929. The clay tablets of this library (*c.* 14th century B.C.) were written in a specially developed cuneiform alphabet script, and they were found to contain a portion of the long-lost Canaanite religious literature. The elaborate palace of the same site contained many more documents of a business and diplomatic nature. An earlier palace at Atchana (Alalakh), east of Antioch on the Orontes, was uncovered by a British expedition between 1936 and 1949. It dates from the 18th century and contained numerous tablets which revealed something of the political history of this city in the time of the Mari archives on the middle Euphrates. Even more elaborate was the 15th-century palace at the same site, together with the statue of one of its kings, Idrimi, who had inscribed his autobiography on it.

Iron Age.—During the late 13th and early 12th centuries the Bronze Age culture of Syria and Palestine was brought to an end by successive waves of invaders, especially Israelites, Aramaeans and "peoples of the sea."

In Syria insufficient excavation has been done in the Iron Age which followed these events to enable us to gain a clear picture of the cultural sequence. The excavations of the Oriental institute of The University of Chicago at Chatal Huyuk and Tell Judeidah in the Amuq plain (1933–36), and Sir Leonard Woolley's work at El-Mina (1936–49), promised much in filling the gaps in our knowledge. The latter site was an important port at the mouth of the Orontes river for the Aegean trade between the 8th and 4th centuries B.C. At Chatal Huyuk a fine palace with adjoining temple of about the 8th century was unearthed. The temple is particularly interesting because it is the only Iron Age temple excavated in Syria by the mid-1950s; its plan is similar to that of the Solomonic temple in Jerusalem.

In Palestine, knowledge of the Iron Age is much more detailed. The type sites are Tell Beit Mirsim, excavated by the American Schools of Oriental Research and the Pittsburgh-Xenia Theological seminary (1926–32), and Megiddo, excavated by the Oriental institute (1925–39). During the 12th and 11th centuries B.C., iron was introduced by the Philistines for weapons and jewelry. Thereafter it came into common use for agricultural tools as well. The greatest density of population and cultural vigour appeared between the 10th and 8th centuries B.C., from which time excellent architecture, the work of Israelite kings, has been recovered at Megiddo and Samaria. The economic and cultural centre was then in the hill country, and the changes in ceramic styles were so gradual that a fairly stable life until the third quarter of the 8th century B.C. was presumed. Then the country became a province of Assyria, after which rapid decline and violent destruction occurred. The devastation of Judah by the Babylonians in 587 B.C. was so severe that town after town was abandoned. Two centuries at least passed before full recovery was made.

During the Persian period of the late 6th through the 4th centuries, the ceramic culture is in general a continuation of that of the preceding period, but three things among others are particularly notable: (1) The first coins appear in the 5th century; these were the Persian empire's adaptation of Greek coinage. (2) Beautiful silver vessels indicate the new industry created by Phoenicians after the decline of their ivory carving. (3) Syria and Palestine were being flooded with pottery from Greece. By the 4th century, for example, the Greek style of lamp had replaced the native type which had been in use for over 1.000 years. Greek influence on the material culture, at least, was thus much earlier than the conquest of Alexander the Great.

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(G. E. WT.)

D. ANATOLIA

Anatolia, the peninsula called Asia Minor and the region east of it, all in present Turkey, was in the 2nd millennium B.C. the main part of the Hittite empire. Information about the history and civilization of the Hittites comes from the archives of their capital, Hattusa, modern Boghaz Keui, about 100 mi. E. of Ankara. The site has been known since 1834 (Charles Texier); the archives were excavated in 1906–12 and again in 1931 and after. Only the central plateau of Anatolia was really settled by Hittites, a people whose language belongs to the Indo-European group, whereas outlying territories were linked to the empire as vassal kingdoms. Also archaeologically, Anatolia is divided into zones which show different cultures from the earliest times on. Type sites for the central area are Boghaz Keui, Alisar Huyuk near Alaca, and Kultepe. After the Chalcolithic Age (4th millennium), with a village culture characterized by mud-brick houses and handmade pottery, an accumulation of wealth, probably indicating concentration of political power, appears in the tombs of Huyuk toward the end of the early Bronze Age (end of 3rd millennium). The introduction of the potter's wheel, around 2000, marks a new type of pottery which remains in use, though with changes, throughout the middle and late Bronze Ages (2000–1200), corresponding to the historical periods of the Assyrian merchant colonies (20th–19th centuries) when the first Hittites are attested by proper names, the old (*c.* 1700–1400) and new Hittite kingdoms (1400–1200); it is therefore called Hittite pottery.

The type site in the northwest is Troy, whose Level I corresponds roughly to the central Chalcolithic, whereas Troy II with its famous treasure is similar to the early Bronze Age tombs of Huyuk. In shape and technique, however, the material culture of Troy is different from that of the central plateau. The finds of Troy III–VII and British excavations at Beycesultan in Caria (1954) show that the west used a pottery different from that of the Hittites even at the time of the Hittite empire when part of this region, the Arzawa countries, were Hittite vassals.

South of the Taurus range, in Cilicia and north Syria, a separate material culture was found at Mersin, Tarsus, Sakchagozu, mounds in the plain of Antioch, Carchemish on the Euphrates, etc. Artifacts in this region go back to the Neolithic Age. In the Chalcolithic Age, pottery of the Halaf type links it to north Mesopotamia (Tell Halaf on the source of the Habur river). The potter's wheel was introduced there much earlier than on the plateau, and Hittite types remain sporadic even during the new kingdom when this region belonged to the Hittite empire.

The northeastern highlands of Turkey are still little explored; early Bronze Age finds at Tilkitepe near Van and Karaz near Erzerum remain isolated, although the latter seem to form a link with the Caucasus region. After the downfall of the Hittite empire (*c.* 1200) the western part of the plateau became the Phrygian kingdom. Around Lake Van the kingdom of Urartu produced rock architecture and refined bronze objects. Small Hittite states lived on in the region from Kayseri (Caesarea Mazaca) southward into north Syria. The establishment of Greek colonies along the coasts hardly affected the culture of the interior.

What is generally known as Hittite art must be divided into the Anatolian art of the Hittite empire and the late Hittite art of the southeast. Monuments of both are often inscribed in Hittite hieroglyphs, a system of writing developed in Anatolia in the 2nd millennium and used to write a language different from Hittite but also of Indo-European stock and closely related to Luwian, another language attested in the Hittite archives. Imperial Hittite monuments centre around Boghaz Keui and in the Taurus range, with outlying examples in the south (Cilicia, north Syria) and west (near Smyrna and Konya); they are rock carvings and stone reliefs. Of stone monuments older than the empire only a few fragments survive (Boghaz Keui, Kultepe); the main source for preimperial Anatolian art are the numerous seals (mostly stamps, rarely cylinders) and seal impressions. The subjects of monuments and small art objects alike are religious, representations of gods and worship. The stone monuments are architectural, carved slabs adorning gates and temples. The creation of long series of relief orthostates is characteristic of this

art (Huyuk). The late Hittite states of the southeast carry on this tradition of religious architectural sculpture; main find spots are Malatya, Carchemish, Marash, Zinjirli, Sakchagozu and Karatepe. Some of the motifs and stylistic elements of this late Hittite art are believed to have influenced the "orientalizing" style of Greece. The Phrygian rock monuments, found between Afyon Karahisar and Eski-Shehr (Eskisehir), show, in turn, the impact of early Greek art on the Anatolian plateau around 700 B.C.

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V. NEOLITHIC AND BRONZE AGES IN EUROPE

A. Neolithic Age

Origins of European Neolithic.—Europe received from southwestern Asia the material bases of the Neolithic economy—cultivated wheats (*Triticum monococcum*, *T. dicoccum* and *T. spelta*) and barleys and, among domestic stock, probably sheep—together presumably with the techniques of husbandry. But in Europe Neolithic farming was developed on novel and original lines imposed by environments that differed radically from those of the cradle of farming in the near east.

Europe falls into four distinct ecological zones: the Mediterranean zone of evergreen forest and winter rains; north of the Pyrenees, the Alps and the Balkans, the temperate zone of deciduous forest and evenly distributed annual rainfall; still farther north the circumpolar taiga or coniferous forest; and to the southeast the western end of the Eurasiatic steppes. Each zone itself is subdivided into natural regions by physiographic boundaries and peculiarities of climate or soil. Only the three major divisions of the temperate zone are not obvious from every map. We may distinguish: western Europe, from the Atlantic to the Vosges and Alps and including the British Isles; the loesslands of central Europe, including the Ukraine and limited by the Balkans and the Harz; and the northern province, that portion of the Eurasiatic plain lying between the Rhine and the Vistula and including Denmark and southern Sweden.

While the cereals and sheep were presumably introduced by an actual infiltration or immigration of Neolithic peasants from Asia, the substantial Neolithic communities that arose by 3000 B.C. must have been largely recruited from indigenous Mesolithic hunters and fishers, attested so abundantly in western and northern Europe by the remains described in section III above. (Some communities indeed seem to be composed entirely of such Mesolithic stocks, though they had adopted a Neolithic equipment from immigrant farmers; such are termed "Secondary Neolithic" by British prehistorians.) From these Mesolithic survivors too must be derived much of the science and equipment applied in Neolithic times to adapting societies to European environments, though here again contributions from the orient may be admitted. Upon the resultant distinctively European technology and economy was reared a no less original ideological superstructure expressed in distinctive sepulchral monuments, styles of ceramic decoration and fashions in personal ornaments.

Rural Economy.—In each of the above-mentioned provinces the archaeological record opens with fully developed and individualized Neolithic cultures, divergently adapted to the peculiarities of their several environments. The period of immigration and formation had already passed—unnoticed—in the Mesolithic Age. Still some common features justify the adjective "Neolithic."

Save in the taiga, where a Mesolithic economy persisted until the end of the Bronze Age, the basis of life everywhere was subsistence farming supplemented by some measure of hunting and fishing—fish being a source of food curiously neglected in western and central Europe during the earlier phases of the Neolithic. Everywhere the same cereals were cultivated together with beans, peas and lentils. In the Mediterranean zone orchard husbandry may already have begun, while round the Alps apples were eventually cultivated and utilized for the preparation of a sort of cider. The balance between cultivation and stock breeding varied. Throughout the temperate zone sheep, though bred even in Britain and Denmark, were at first rare. The damp temperate forests were uncongenial to these animals, and only toward the end of the Neolithic Age, when the greater dryness of the subboreal climatic phase and incipient clearing for plow cultivation were leaving their mark on the landscape, did flocks begin to multiply. On the loesslands in early Neolithic times animal husbandry may have played a subordinate role as compared with agriculture. But in the sequel, cattle raising combined with hunting proved to be the most productive pursuit among the deciduous forests with a Neolithic equipment; cultivation was relegated to an increasingly secondary place until in the late Bronze Age more efficient tools for clearing land became generally available. The rural economy permitted the continuous occupation of permanent villages round the Aegean and in the Balkan peninsula, perhaps also in south Italy and the Iberian peninsula. In the temperate zone, however, shifting cultivation based on slash-and-burn clearance was the rule and involved the periodical removal of the complete village. Under this extravagant system plots were presumably tilled with hoes, as in parts of Africa today. But by the beginning of the Bronze Age the ox-drawn plow was beginning to replace the hoe.

Houses.—Dwelling houses in Greece, Sicily and the Iberian peninsula were built, as in the near east, of pisé or mud brick on stone foundations. But in the Balkans and throughout the temperate zone, wood was used for the construction of gabled houses, stout posts serving to support the ridgepole and the walls of split saplings or wattle and daub. The earliest houses on the loessland of central Europe were very large, up to 42 m. (135 ft.) in length and large enough to accommodate a whole lineage or small clan together with stalled cattle and grain stores. In the sequel these communal houses gave place to smaller two-roomed dwellings, 7.5 to 10 m. (24½ to 33 ft.) long, but still entered through one end. Finally in late Neolithic times clusters of one-roomed huts became the most widespread fashion. Round the Alps such two-roomed houses and, less often, one-roomed huts were raised on piles above the shores of lakes or on platforms laid on peat mosses. These are the world-famous Swiss lake dwellings that have yielded such precious collections of the organic substances from wood to bread that are otherwise missing from the archaeological record. In northern Europe too the earliest villages consisted of two parallel long communal houses, but these were subdivided by cross walls into 20 or more apartments, each with a separate door. But here again the communal houses eventually broke up into free-standing one-roomed huts. Finally Skara Brae (*q.v.*) on the treeless island of Orkney illustrates an ingenious adaptation of the one-roomed wooden hut to an inhospitable environment, but shows how commodiously such huts must always have been furnished.

Stone Tools.—Carpenters used celts (ax or adz heads) edged by grinding and polishing of fine-grained rock or of flint where that material was available in large nodules. In Greece and the Balkans, all over central Europe and the Ukraine and throughout the taiga, adzes were used exclusively as in the earlier Baltic Mesolithic; in northern and western Europe axes were preferred. In the Iberian peninsula axes and adzes occur in equal numbers in early Neolithic graves, but the proportion of axes increased later. Often in western Europe and occasionally in Greece and Cyprus celts were mounted with the aid of antler sleeves inserted between the stone head and the wooden handle—a device already employed in the north European Mesolithic. In Spain, the British Isles and northern Europe axheads were simply stuck into or through straight wooden shafts, but adz heads must always have been mounted on a knee shaft (a crooked stick), a method regularly used for axheads too by the Bronze Age. Axheads like those in modern use, with a hole for the shaft, were rarely used for tools, but the Danubian peasants on the loesslands may sometimes have mounted adzes in this manner. They certainly knew how to perforate stone, using a tubular borer (a reed or bone with sand as an abrasive). From them the technique was adopted by various secondary Neolithic tribes in northern Europe for the manufacture

of so-called battle-axes. The latter seem to derive their form from Mesolithic weapons of antler, but their splayed blades disclose the influence of metal forms.

Ax Factories and Flint Mines.—Celts were manufactured in factories where specially suitable rock outcrops occurred and were traded over great distances. Products of the factories at Graig Lwyd, Penmaenmawr, north Wales, were transported to Wiltshire and Anglesey, those of Tievebulliagh on the Antrim coast to Limerick, Kent, Aberdeenshire and the Hebrides. Similarly, large nodules of good flint were secured by mining in Poland, Denmark, the Netherlands, England, Belgium, France, Portugal and Sicily. The mine shafts, cut through solid chalk sometimes to a depth of 20 ft. with the aid only of antler picks and bone shovels, may be simple pits, but often regular galleries branching from them follow the seams of big nodules. Though the ancient miners appreciated the necessity of leaving pillars to support the roof, skeletons of workers killed by falls have been discovered at Cissbury, Spiennes and elsewhere. In the British Isles and Denmark at least there is evidence that the ax factories and flint mines were exploited, and the products distributed, by men of Secondary Neolithic stocks. Still the operators and distributors need nowhere be regarded as full-time specialists.

Weapons.—The sling and the bow and arrow were of course employed in Neolithic times. The sling was used apparently to the exclusion of the bow in Greece, the Balkans and central Europe; arrowheads were common from the start in the Iberian peninsula, western and northern Europe and the taiga but appeared in central Europe only in late Neolithic times, in Greece first in the Bronze Age. These missiles might be huntsmen's tools as well as weapons of war. Indeed there is little evidence for war in early Neolithic Europe save in the northern province and the Iberian peninsula. By late Neolithic times, on the contrary, settlements are often fortified everywhere and martial weapons are prominent. The most unmistakable of the latter are the battle-axes described above. They are distinctive of a series of pastoral tribes—"Battle-Ax folk"—who emerged in late Neolithic times in central Russia, round the Baltic, in the Saale-Elbe valleys and round the Alps.

Burial Rites and Megalithic Tombs.—Neolithic farmers were generally buried in a flexed or contracted position on the side, except in northern Europe, where the corpse lay extended on its back, as was the custom also among the surviving hunter-fishers of the taiga and Russia. In Britain Secondary Neolithic folk practised cremation, burying the ashes in circular enclosures, one of which was destined in the Bronze Age to become the world-famous sanctuary of Stonehenge (*q.v.*). But the most celebrated and imposing funerary monuments of the European Neolithic are collective tombs or family vaults, some built of huge undressed stones and so rightly called megalithic, others walled with dry stone masonry and roofed by corbeling, others simply cut in the rock. Save for a cluster on the northern slopes of the Caucasus, such tombs are virtually confined to the Mediterranean coasts, the Iberian peninsula and western and northern Europe and are most densely concentrated near the coasts. The simplest, but not necessarily the oldest, type of megalithic tomb, the true dolmen, is confined to northern Europe and was originally designed to contain a single extended skeleton. Passage graves, consisting of a polygonal chamber entered by a distinct passage and covered with a round tumulus, probably originated in Portugal and spread thence by seaways to Brittany, Britain and Denmark. A corbeled version of the same plan, termed a tholos, perhaps started in southeast Spain and was thence diffused on the one hand as far as Orkney and on the other to Greece. Finally, gallery graves—long, narrow chambers with no distinct entrance passage, often covered by a long cairn with a crescentic forecourt at one end—are distributed from the Gulf of Lyons across France to Scotland and northern Ireland. A special variant, generally subterranean, was developed in the Seine-Oise-Marne basin and carried with a distinctive assemblage of pots, weapons and personal ornaments by migrating bands to the Channel Islands and across Belgium and Westphalia to southern Sweden.

Art.—Neolithic art, save among the hunter-fishers of the taiga, was geometric and not representational. It is best illustrated by the decoration of pottery. Pots, always handmade, were painted in southeastern Europe, south Italy and Sicily; elsewhere they were adorned with incised, impressed or stamped patterns. Many designs are skeuomorphic, *i.e.*, enhance the pot's similarity to vessels of basketry, skin or other material. But on the loesslands of central Europe and the Ukraine and in the Balkans spirals and meanders were favourite motifs.

Trade.—While Neolithic societies could be completely self-sufficing, growing their own food and making all essential equipment from local materials, luxury objects were transmitted quite long distances by some sort of trade. So ornaments made of the shells of the Mediterranean mussel, *Spondylus gaederopi*, are found all across the Balkans, up the Danube valley and even on the Saale and the Main. Products of factories and flint mines were, as stated, traded widely throughout a single province, such as the British Isles, and some specially valued raw materials—the yellow flint of Grande Pressigny (France), the obsidian of Melos and the Lipari Islands—became objects of "international trade" as much as shells. But the most prized object of such commerce was the amber of Jutland and East Prussia, whose electrical properties seemed evidence of potent mana. Eventually the amber trade, extended to Greece, provided the distributive machinery that made a Bronze Age possible in central Europe.

B. Bronze Age

Origins of Metallurgy in Europe.—The term Bronze Age is misleading, since in many parts of Europe, as in Egypt and the near east, most of the metal objects used to define the "age" were made of copper unalloyed with tin, but the usage is too well established to be changed here. It now seems highly probable that native copper was discovered in Hungary, methods of working it cold and perhaps even by fusion were independently devised there, and the curious implement termed an ax-adz was invented by local artisans. An equally independent centre of metallurgy in the Iberian peninsula is likewise possible though less likely. Still, in general, the knowledge of copper smelting and of alloying copper with tin was almost certainly brought to Europe from southwestern Asia.

Aegean Bronze Age.—In Greece and Crete the Bronze Age seems to have been initiated soon after 3000 B.C. by immigrants from Asia Minor who founded little townships on the coasts and islands, introduced the plow as well as metallurgical techniques and developed maritime trade with the near east, Egypt and perhaps also with south Italy and Sicily. Soon after 2000 B.C. in Crete Early Aegean culture developed, through the concentration of wealth and power in the hands of princes or priest-kings, into a genuine civilization, known as Minoan. The princes built themselves palaces, the potter's wheel was introduced and a system of writing was devised. About the same time the Early Helladic townships of mainland Greece were sacked by warlike invaders, probably speaking Greek, but were immediately rebuilt as Middle Helladic townships. Among these, Mycenae (*q.v.*) rose to a position of hegemony about 1600 B.C. Its kings, who were buried in the six shaft graves excavated by Heinrich Schliemann and in another group of nine discovered in 1951, attracted to their courts Minoan-trained armourers and artist craftsmen from Crete; they also imported amber from Jutland. Then between 1550 and 1500 B.C. there was a change of dynasty and of burial rites at Mycenae. Tholos tombs replaced shaft graves as royal sepulchres. The erection of similar tholos tombs at many other cities in Greece must indicate the rise in them too of local kings. By 1400 B.C., if not before, Crete too was conquered by mainland Greeks and became a province of Mycenaean culture.

Bronze Age I in Spain and Portugal.—In the Iberian peninsula too it is likely that intelligent metallurgy was introduced by colonists from the east Mediterranean. In any case settlements such as Los Millares in Almería, Alcalá in southern Portugal and Palmella near the Tagus estuary are remarkably like the Early Helladic townships of Greece. But there, though copper from local ores was used for weapons (daggers) and craftsmen's tools (adzes and saws), it was not alloyed with tin and did not, as it had in

Greece, oust stone even for weapons. Indeed flintworking now reached its highest peak of excellence. The corbeled and megalithic passage graves were still used as family vaults; the finest were actually first built in this period, termed Bronze I. Only in the succeeding Bronze II, when Los Millares had been replaced by El Argar, did single graves among the houses take the place of collective tombs and was copper alloyed with tin from Galicia and north Portugal.

Early Bronze Age in the Temperate Zone.—In the temperate zone, apart from Hungary, the Bronze Age begins with the arrival of a warlike brachycephalic stock, termed by archaeologists the Beaker folk because of the very distinctive vase regularly buried in their graves. The Beaker folk were primarily bowmen but were armed also with a flat, tanged dagger or spearhead of copper (not bronze) and wore ornaments of gold, copper, amber, jet or callaïs. They may have begun the exploitation of local ores and the organization of the distribution of metal. But in central Europe the systematic production and distribution of bronze was initiated by metallurgists from north Syria who have been termed Torque Bearers from a distinctive sort of neck ring with recoiled ends that was worn by their patron deity in north Syria (as shown by a small idol found there) and that in Europe served as an ingot and perhaps as currency. By 1600 B.C. copper from the Austrian Alps and Slovakia, alloyed with tin from Bohemia and Saxony, was being distributed in connection with the trade in amber. This fossil resin was being conveyed from Jutland up the Elbe, across the Brenner pass and down the Adriatic to Mycenaean Greece and Crete. Commerce along this transcontinental route was linked up in southern England with an ill-defined "long-sea" route that by 1450 B.C. at latest was conveying to the Aegean markets Cornish tin, Irish gold and even crescentic amber necklaces and other articles made in England. "International trade" along these routes supplied raw materials to local bronzesmiths who manufactured diverse types of weapons and ornaments to suit the divergent tastes of local purchasers in north Italy, Hungary, Austria, Bavaria, Czechoslovakia, Saxo-Thuringia, Silesia and the British Isles. No local smiths yet worked for the north European market, and the rest of the temperate zone as well as the taiga remained virtually Neolithic.

In the foregoing regions (and by Bronze II in Spain), despite local divergences, certain common types of tools and weapons—flat, triangular knife-daggers, halberds, flat or flanged axes—were current for some time. Since they were later replaced by more efficient types, the period of their currency is termed the early Bronze Age. Then the consumers of bronzeware in central Europe were peasant farmers settled in the fertile, loess-clad valleys, the intervening uplands and heaths being grazed by pastoral tribes, still almost without metal gear. In the British Isles, on the contrary, it was the more pastoral groups, the builders of round barrows, who used bronze weapons. The graziers of the Wiltshire downs were the most prosperous and soon grew so rich and numerous that they could erect the gigantic sanctuary of Avebury and the still more celebrated lintel circles at Stonehenge. Their Irish counterparts' kings were buried in the sculptured tholos tombs of the Boyne. Characteristic ornaments of the British early Bronze Age—crescentic necklaces formed of strings of jet or amber beads and gold collars of similar pattern—were exported to the continent and even to Greece. Finally on the south Russian steppes other pastoral tribes developed an independent Bronze Age province inspired from Transcaucasian centres of metallurgy. The south Russian "Bronze Age"—actually unalloyed copper alone was used—is known only from barrows (kurgans) covering skeletons thickly strewn with red ochre. Save round the Caucasus, these graves are poor in metal gear, but one contained the oldest wheeled vehicle yet known from Europe.

Middle Bronze Age.—Toward 1500 B.C. in central Europe the previously Neolithic pastoralists of the uplands, expanding at the expense of lowland farmers, became the chief purchasers of metal arms. At the same time in northern Europe local smiths began to manufacture ornate bronze weapons and toilet articles to meet the tastes of big ranchers whose burial mounds, covering rich interments in oak tree coffins, still line every ridge in Denmark. Now the flat and flanged celts of the early Bronze Age grew into winged axes and palstaves, while ogival daggers, rapiers and two-edged swords replaced flat, triangular knife-daggers. These innovations serve to define what is termed the middle Bronze Age in central and northern Europe, in Italy and also in the British Isles, but in the rest of western Europe and in south Russia these characteristic types are missing. That does not of course mean a depopulation of either province.

Late Bronze Age.—During the late Bronze Age socketed celts replaced palstaves, winged axes and even shaft-hole axes, while warriors came to prefer slashing to thrusting so that sword blades tended to become leaf-shaped. Though both new types were eventually adopted throughout western Europe and in the Iberian peninsula, and socketed celts even in eastern Russia too, their adoption was far from simultaneous everywhere. The late Bronze could also and more significantly be defined by a great increase in the use of metal, which was now employed freely even in agriculture and for rough work. Such use means that bronze must have become much cheaper than ever before. One cause for this was certainly a considerable extension of mining. In the Austrian Alps survive old mine shafts with timbered galleries still containing bronze gads and other tools employed by the miners, who knew how to break up the rock by the method of fire setting. At the same time the distribution of metal and metalware was reorganized and extended into new fields. Large objects such as bronze shields, helmets, buckets and cups were exported, for instance, from the Carpathian basin to Italy, the Ukraine, Norway and England or from Ireland to Denmark, Brittany and Spain. Cheap metal tools and above all the socketed ax, the first really cheap and efficient implement for tree felling, allowed an immense expansion of plow cultivation and also of sheep breeding, a proportionate increase in the food supply and consequent growth in population.

Urn Fields.—This growth is attested by the number and size of the flourishing villages and still more of the cremation cemeteries, termed urn fields. For a feature of the late Bronze Age was the general adoption of cremation with inurnment of the ashes, first in central Europe and north Italy, but spreading to the Ukraine, to Sicily, to Scandinavia and across France to the Iberian peninsula, in some cases at least as a result of folk movements. The late Bronze Age certainly witnessed an intensification of warlike behaviour. Settlements were normally fortified, often by quite monumental works. The enlarged supplies of bronze were largely devoted to armaments. Besides many offensive weapons, helmets, shields and even cuirasses were made of beaten bronze. At the same time the horse-drawn chariot began to play in European warfare the part that it had in the near east since 1700 B.C.

End of the Mycenaean Age.—The foregoing events in temperate Europe and the western Mediterranean partly coincide with a Dark Age in the eastern Mediterranean and are not unconnected therewith. Between 1225 and 1150 B.C. the near east was ravaged by barbarian invaders, some of whom may have come from Europe. As a result the Mycenaean Greeks were cut off from the markets and supplies of Asia. Perhaps they sought compensation for the loss of Asiatic supplies of metal in central Europe and thus initiated the mining activity described above. But about 1100 B.C. the Mycenaean civilization itself collapsed as a result of complex disturbances traditionally termed the Dorian invasion. With the consequent loss of the Mycenaean market, the miners and smiths of temperate Europe had to produce for local consumption. Though in the near east and Greece the Bronze Age had ended by 1100 B.C., it certainly lasted much longer in the temperate zone and in the western Mediterranean. How long is hard to say, because of the drying up of written records in the Dark Age, but at least till 700 B.C. in central Europe, till 400 B.C. in England and much longer still in Scotland and Ireland. So too in Russia, while the socketed celt was adopted round the Urals about 1300 B.C. it was not replaced by iron tools till 700 or even 500 B.C.

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more or less out of date and must be supplemented and corrected by various articles in *Antiquity* and *Proceedings* of the Prehistoric society.
(V. G. C.)

VI. CLASSICAL ARCHAEOLOGY

Classical archaeology is concerned with the study and interpretation of the material remains of the civilizations of Greece and Rome. Thus, its area is coextensive in time and space with these civilizations: from their beginnings in the early Iron Age (9th and 8th centuries B.C.), when the city-states were developing their typical institutions, to the gradual transformation into the medieval world of western Europe and Byzantium in the 4th century A.D. Greek civilization, however, shared the heritage of the Bronze Age in the Aegean, of the Minoan-Mycenaean culture, so that the problem of filiation is also of importance. While classical archaeology is primarily concerned with the centres of Greece and Italy, its study is necessary in understanding the expansion and influence of Greek and Roman culture throughout the Mediterranean area, from Spain and Great Britain to south Russia and the near east and from the Sahara to the Baltic. With the better-known remains of Greece and Italy as a guide, an important phase of the history of all those regions which participated in the western tradition of civilization through the colonial activity of Greece and the imperial expansion of Rome may be illuminated.

Branches of Study.—It is obvious that the quantity and complexity of the remains of more than 1,000 years of human activity in the Mediterranean area have necessarily led to a great degree of specialization in the study. The mature civilization of Greece and Rome was a highly developed, wealthy, urban culture, so that its most obvious remains are those of the thousands of cities and towns which came into existence during its history. The names of many of them, like those of Athens and Rome, have remained firmly attached to their proper locality by continuous inhabitation. Many, however, have to be identified; the siting and physical growth of each is significant for its history. Thus, topography is a primary branch of archaeological study. In the Mediterranean area the builders of these cities usually found good supplies of building stone at hand, so that the important structures of the cities were built of limestone and marble and. in the case of Rome, of brick and mortar. From the mere accident of durable materials, architecture is an important branch of classical archaeology; it is concerned not only with the formal development of the various styles employed (Doric, Ionic, Corinthian and their variants) but also with the types of buildings developed to satisfy the needs of a complex society: temples, houses, theatres, porticoes, great bathing establishments, meeting places, fortifications. The buildings were decorated with sculpture in stone and bronze (occasionally of ivory, gold and silver), while in the houses, shrines and graves terra-cotta figurines or statuettes of bronze were appropriate; free-standing statues of marble and bronze embellished both public and private buildings. Thus, sculpture forms another branch of study. Local and central governments recorded their decrees and regulations on stone and bronze tablets, while private individuals and groups inscribed their dedications to the gods, epitaphs, etc. The study of these documents is the function of epigraphy. From every excavated city come the ubiquitous remains of pottery vessels and small objects which were used in the household for the storage of food and drink or were dedicated in the shrines and graves. The study of these ceramic remains not only constitutes a special branch of classical archaeology but also offers a chronological guide to the excavator and, in many cases, a clue to the trading connections of the region in which they are found. A somewhat similar role is played by the coins, the object of study of the numismatist. They afford information for political and economic history from their legends and from the quality and kind of metals employed in their manufacture. Painting, too, constitutes an important branch of study; for Greece its history is traced mainly from the vase decoration, but for Rome there are the frescoes on the walls of houses, as at Pompeii, and on tombs. These various branches of study, topography, architecture, sculpture, ceramics, numismatics and painting, are not only special fields in themselves, but the particular material of one period or area may constitute a special field of study from its very complexity.

The material of these special branches of study is arranged in major chronological divisions which reflect the historical development of Greek and Roman civilization: the "Dark Ages" (*c.* 1100–750 B.C.) in which growth started again following the dormant period resulting from the collapse of the Mycenaean culture; the Archaic period, a vigorous and rapid development from *c.* 750 B.C. to the Persian Wars (early 5th century B.C.), which owed much to the renewal of contacts with the near east; the Classical period, in which the Greek city-states attained to maturity, in the 5th and 4th centuries B.C.; the Hellenistic period, when Greek culture was spread in the near east by the successors of Alexander and was eagerly adopted by the growing power of Rome (323–27 B.C.). Roman development is usually divided into two periods: that of the republic (*c.* 509–27 B.C.) and that of the empire, which represents the fusion of Greco-Roman culture.

Role of Classical Archaeology.—In its task of interpretation classical archaeology has an ancillary role for certain of these periods, for others a primary one. It supplements and illuminates the literature and history of the great creative periods of Greece and Rome, from the 5th century B.C. to the 2nd century A.D. The paintings on a Greek vase, for example, may illustrate a festival mentioned in the literature. In this it has somewhat the value of a lively commentary. For these same periods, however, important works of art, such as the Parthenon of Athens or the Column of Trajan in Rome, made comprehensible by archaeology, can illuminate the age as directly as a play of Sophocles or the *Aeneid* of Virgil. The minor objects of a region —the pottery, lamps and coins—may reveal in their totality an economic trend or a social habit not mentioned in the literary tradition. At times, however, classical archaeology goes beyond this ancillary role to provide almost the only key. For example, in Greece the Dark Age period is given a chronology and a material background, however uncertain, through archaeological discoveries. Much the same is true for understanding the effect of Greek and Roman cultural influences on "native" areas as in southern Russia, France or Spain. Thus, we can see the relationship of Greek and Scythian art and can realize that Italian traders were busy in the Alpine districts before Julius Caesar found it expedient to subdue the Helvetians. Classical archaeology, then, is many things to many persons: to the excavators and specialists, first of all an exercise in classification by which its material may be made available and comprehensible to the students of literature, history and religion; to them and to the nonprofessional an activity which can provide objects for aesthetic pleasure and afford a fuller understanding of the civilization which created them.

Throughout its history these two main objectives have characterized classical archaeology: the acquisition of art objects for their own sake and their use for the better understanding of classical culture. In antiquity itself these are casually recognized. Thucydides, in his account of the early development of Greece, states that Carians once inhabited most of the Aegean islands, pointing to the type of armour and burial found in the graves on Delos when the Athenians purified the island in 426 B.C. One could ask little more, except for a catalogue and photographs of the contents of the graves, from a modern archaeologist. Strabo recounts that at the refounding of Corinth by Caesar in 44 B.C. the new settlers happened upon tombs of the old city, destroyed in 146 B.C. They promptly went into the antique business and "filled" Rome with the pottery and bronzes from the graves. Thucydides' attitude, however, was the exception, and, generally speaking, it was this desire for precious objects which characterized excavation from the time of the Renaissance until well into the 19th century. The objects so obtained found their way into private collections and eventually into the museums of western Europe and America. Their importance for the study of art is great, but the information which they might have afforded by proper excavation is irrecoverably lost. Before the early 19th century only sporadic instances of scientific treatment of the remains of antiquity can be pointed out. At that time several factors contributed to the practice of classical archaeology as a means to knowledge, with a proper technique of excavation, rather than as a treasure hunt without rules

or control. The intellectual impetus was given by the application of a more scientific method, as by G. B. Vico and B. G. Niebuhr, to the study of human history; the opportunity was afforded by the improvement of conditions of travel in the Mediterranean countries and, in Greece, in particular, by liberation from Turkish rule. An additional factor, both there and in Italy, has been the growth of national consciousness. This was naturally accompanied by pride in the past and a desire to seek out and safeguard its monuments.

A. Excavation in Greece

Early Period.—While excavation was organized in Greece only after its liberation (1828), much useful information about monuments was recorded and the basis of its classical topography worked out by travelers from the time of the early Renaissance onward. The awakening curiosity of that period was exemplified by Cyriacus of Ancona (1391–*c.* 1457), a merchant, who traversed southern Italy, Illyria and Greece copying inscriptions and making drawings of monuments. Other travelers followed his lead, but the most important work of this type was not done until the 17th and 18th centuries. In 1675–76 Jacques (Jacob or James) Spon and George Wheler traveled through parts of Greece and Asia Minor describing and drawing what they saw in the main centres; before 1687 drawings were made of the sculpture in the pediments of the Parthenon by a French draftsman in the ambassador's suite (the Carrey drawings). Their importance lies in the fact that they record the condition of the pediments before these were largely destroyed by an explosion during the siege of Athens by the Venetians in 1686–87. Other monuments of Athens were more fully delineated by James Stuart and Nicholas Revett, whose fine drawings were published in a series of four volumes between 1762 and 1814, while a similar service was performed for some of the Greek and Roman cities of Asia Minor by Richard Chandler, whose *Ionian Antiquities* was published in 1769. The sponsor of these activities was the Society of Dilettanti in London, whose interest thus made original Greek monuments known in western Europe despite the inaccessibility of Greece to travelers. Their interest was a connoisseurship of the antique, but their service to archaeology was very real in that the details of many structures subsequently destroyed were preserved. Another service of equal value was in the field of topography in the late 18th and early 19th centuries. Here the name of William Leake, whose *Travels in the Morea* (1830) and *Travels in Northern Greece* (1835) are still of value for their accurate observation and judicious resolution of problems, is to be singled out. They have the additional merit of being a very vivid and readable account of the condition of Greece in the last years of the Turkish regime. In its totality the work of Leake and other travelers, mainly British, laid the basis for the more detailed reporting and excavation which were to follow. During this same period the publication of J. J. Winckelmann's *History of Ancient Art* (1764) and of the private collections of antiquities in western Europe offered a chronological framework soon to be modified and enlarged by the results of excavation. In Greece the government established after its liberation proceeded to organize archaeological work, the first regulation of this kind.

One of the first acts of the new regime was the removal of Turkish structures from the ancient buildings on the Acropolis of Athens (1832–36) under the direction of Ludwig Ross, the Bavarian scholar, who acted in the capacity of conservator of antiquities to the government. In 1837 the Greek Archaeological society was founded and, since that time, excavation has been under the general supervision and licence of Greek authorities, with strict control of the export of antiquities. The liberation and early growth of Greece, however, were aided by foreign powers, and from the outset archaeological activity has been generously shared. Foreign schools were encouraged to establish themselves in Athens. These have become centres of study for students and archaeologists from the respective countries, and a large part of the excavation in Greece has been carried out under their auspices and at their expense. Some, such as the French, are supported by their governments, others, such as the American, by private endowment. The oldest of the foreign schools is the French, founded in 1846; the German institute was organized in 1874; the American School of Classical Studies began operations in 1882, the British school in 1885. Other such institutions were the Austrian, Italian and finally the Swedish school in 1948. Thus, from the outset, the practice of archaeology has been an international activity, reflecting the interest of western Europe and America in its own cultural tradition and disseminating the results in the publications of the various schools as well as those of Greece itself.

A consequence of the foundation of the foreign schools and of the growth of Greece was the inception of large-scale excavation on the major sites. It was wholly natural, of course, that religious centres and important cities should be the objects of attention, but unfortunate that they formed the necessary training ground for the development of excavational techniques. The uncovering of large buildings and the discovery of important groups of sculpture such as that of the Temple of Zeus at Olympia and the Acropolis "Maidens" naturally held the focus of interest; the realization that the careful recording of pottery and minor objects for the stratification and history of a site was necessary grew slowly; it was rarely demonstrated until after 1900, as in Sir Arthur Evans' excavation of Knossos and David Hogarth's work at Ephesus. In the first era of large-scale excavation the lead was taken by German archaeologists, for by the 1870s archaeology had become a branch of classical studies in German universities. Thus, between 1875 and 1900 the Germans excavated at Olympia in Greece and at Pergamum, Magnesia, Priene and Miletus in Asia Minor; the Austrians at Samothrace (1873) and Ephesus (1894). Other very important excavations started in this period were those of the French at Delos (1877) and Delphi (1892), of the Americans at Corinth (1896) and of the British at Sparta (1906). The Greeks, too, were active: at the healing sanctuary of Epidaurus (1881), at Eleusis (1882) and, most important, on the Acropolis at Athens (1885). From this latter shrine came the wealth of archaic material used as filling after the Persian destruction of its monuments in 480 B.C. Very important discoveries, too, were made outside the field of strictly classical archaeology: the revelation of Mycenaean Greece by Heinrich Schliemann at Troy, Mycenae and Tiryns and of the Minoan culture on Crete by Sir Arthur Evans at Knossos. The complexity of many of these sites still held, in the 1950s, the major attention of the schools located there, but, in addition, a large number of smaller and less well-known places were excavated in the following generation. From these has come important information, for they have frequently been less disturbed by continuous inhabitation and the search for building materials. Generally speaking, the material provided for archaeological studies by the 50 years of activity from 1875 to 1925 enabled the basic outlines of its various branches to be established and much of the detail of classification to be filled in. Thereafter, however, new and ambitious projects were undertaken and a clearer insight was obtained into the problems whose difficulties were revealed by the wholesale excavation of the preceding era.

Later Activity.—A somewhat better understanding of the "Dark Ages" was secured by the correlation of material from small excavations and, in particular, from the German excavation in the Ceramicus (cemetery) of Athens. The latter established the fact that in Athens there was a cultural continuity from Mycenaean times and provided a chronology from the pottery found in the graves. Knowledge of the Archaic period was supplemented by British excavations at Perachora, the site of a small sanctuary near Corinth, and by an Anglo-Turkish dig at Old Smyrna in Asia Minor; this latter promised to provide the first substantial picture of an early settlement of the Greek migrants to Asia Minor—the environment of Homer. Useful information for this period also came from German excavations on Samos, Aegina and Olympia, where much early metalwork has been found. U.S. excavation of the potters' quarter at Corinth and of one of the early cemeteries, overlooked by Julius Caesar's settlers, has thrown light on the pottery industry there at the height of Corinth's commercial activity in the 7th and 6th centuries B.C. The mature periods of Greek and Roman civilization have been clarified by large-

scale U.S. excavation in the market places (agorae) of Athens and of Corinth and by the clearing of the residential quarter of the small Greek city of Olynthus in Macedonia. The Agora excavation in Athens enabled the restoration of the social and political centre of Greece's most famous city and yielded thousands of inscriptions to amplify the details of its history. Scrupulous care in excavation and recording made an elaborate classification of the pottery and figurines of the Hellenistic and Roman periods possible. The continuance of the excavations in Corinth brought the centre of a great Roman city to light, while the town of Olynthus revealed the planning of a classical Greek city and provided much material for a reconstruction of its daily life. Perhaps as an antidote to this understandable affinity for urban centres, U.S. excavators also cleared the exotic sanctuary of the Cabeiri on Samothrace, begun by the Austrians in 1873, and started work on the Isthmian sanctuary near Corinth. Important material for the study of Greek religion was found by the Greeks at Eleusis. Both French and Italians were active at many points in the Aegean area, particularly on the islands of Thasos and of Rhodes and Cos, where large areas of the ancient cities were revealed, while in Asia Minor Swedish archaeologists excavated Labraunda.

B. Excavation in Italy

Early Period.—In Italy the cultural problems of classical archaeology are rather more complicated than in Greece, for Roman civilization was a blend of native Italian, Etruscan and Greek colonial influences in its early period; these fused into Rome of the republic and met the mature civilization of Greece from Hellenistic times onward. In addition, both the colonial Greek area in Sicily and southern Italy and the Etruscan area of central Italy are of extreme interest in their own right. The interrelation of these areas, however, was only realized in the 19th century. At first, of course, it was the visible remains in the city of Rome itself that roused archaeological interest. Unlike Greece, which for centuries was inaccessible to travelers from western Europe, Italy played a leading role in medieval and early modern times so that its monuments profited or suffered accordingly.

An early indication of curiosity about the structures in Rome surviving from the empire was the production of a guidebook for pilgrims, the *Mirabilia urbis Romae*, even before the time of printing. The period of the Renaissance, of course, was characterized by a passionate interest in antiquity. Leaving aside the question of the influence of Roman architecture and sculpture on Renaissance artists, this interest resulted in very material gains for archaeology: the drawings of ancient buildings by architects not only made their principles of construction a part of common knowledge but also preserved on paper buildings which later were destroyed; the interest of sculptors and painters and their patrons preserved many statues from the lime kilns in the search for building materials from the ruins. From the 15th century to the 17th the structures in Rome became literally quarries for building stone, particularly marble. The buildings which had survived the medieval period fell into masses of rubble from this activity, which exported its products as far afield as Westminster abbey in England. While the architecture of ancient Rome thus suffered, its sculpture was treasured, and throughout this period the large collections of the princely families in Italy were formed, partly by excavation on their private estates and partly by purchase. Inscriptions, too, were preserved or copied by the interest of scholars, but excavation remained essentially for the purpose of acquiring precious objects for collection or sale; this motive, rather than any desire for knowledge, led to the excavation of Herculaneum, started in 1738, and to that of Pompeii shortly afterward. Scholarly interest, however, was soon kindled so that the Accademia Ercolanese was founded in 1755. It tried to record the material from the excavation of Herculaneum and published eight volumes of antiquities between 1775 and 1792.

The first landmark in a more scientific approach to excavation was in the work of Carlo Fea in the Forum in 1803 and again in 1813–20. He worked systematically to bring some order out of the rubble heaps left by the search for building stone, recording his findings properly. Similar aims were advocated by the Istituto di Corrispondenza Archeologica, founded in 1829 with an international membership of scholars interested in Roman studies. While this effort had a wholesome effect on excavation, yet such activity was still carried out by private individuals for their own delectation or profit, so that many potentially important finds went unrecorded and large groups of objects were dispersed. It was unfortunately in these circumstances that the archaeological discovery of Etruscan civilization was made. In 1827 the first tombs were opened at Tarquinia and in 1828 at Vulci. These chamber tombs with their vivid wall paintings of Etruscan funeral banquets, games and scenes of religious and daily life were a revelation, as were the rich offerings of vases, ivories and metalwork found in them. Since there was no regulation of their excavation, exploitation was rapid; the tomb groups were frequently broken up and objects dispersed throughout Europe. By 1848 the Etruscan cities were so fully known that G. Dennis' *Cities and Cemeteries of Etruria* could be written and remain the best survey of their monuments. It was not until after the unification of Italy that a firm hand was taken with excavation and antiquities. At that time governmental supervision and conduct of archaeological activity were established. By this time the Istituto di Corrispondenza Archeologica had developed into the German Archaeological institute (1871), and other schools soon followed: the French in 1873, the American academy in 1894 and the British school in 1901. These schools and those founded subsequently, Belgian, Dutch and Swedish, unlike their counterparts in Greece, have seldom been licensed to engage in excavation. Thus, their work has been mainly one of study and interpretation, while excavation has been the task of the Italian governmental departments concerned. From 1876 these activities were duly reported by the official publication of excavations in the *Notizie degli scavi di antichità* of the Royal Academy (Accademia Nazionale dei Lincei). In the two generations which followed, a great amount was accomplished, as in Greece during the same period. In Rome itself the Forum was steadily cleared, and in 1899 excavation began to go below the level of the imperial pavement to investigate the primitive city. The famous *lapis niger* with its archaic inscription was found in 1899. More systematic excavation of the two show places of Italy, Pompeii and Herculaneum, was carried out, as well as major excavations in the Greek colonial sites and on the small towns of the native Italian peoples. In short, the structure of classical archaeology in Italy was worked out and its various problems more clearly formulated.

Later Activity.—The fascist regime in Italy, with its emphasis on the continuity of Roman imperialism, promoted a somewhat flamboyant but very effective archaeological program, particularly in Rome itself. There the Roman Forum and the forums of the emperors were systematically cleared and partially restored as part of the general monumental reorganization of the heart of the city. Elsewhere much work of a similar nature was carried on and new discoveries were made as the result of building activity and clearing the old buildings of accretions. The buildings on the Palatine and Capitoline hills, the Tabularium and the Mausoleum of Hadrian were all made intelligible. Museum collections were reorganized and exhibited to better advantage. Large-scale excavation and restoration were carried out at Pompeii and Herculaneum so that their development was better understood, while their streets and houses were made an almost living monument of the past. Considerable knowledge of the Republican period in Italy was gained by the investigation of such Roman colonies as Ardea, Minturnae and Cumae and by investigation of monuments in Turin and Milan. In the Greek colonies work continued on the known sites and an important new discovery was made on the Silarus (Sele) river, where the Heraion of Lucania was excavated. It brought to light the sculptured metopes, in excellent preservation, of the archaic temples, thus setting a new group of early sculpture alongside that of Selinus, long known. The great cities of north Africa, such as Leptis Magna and Cyrene, were also cleared. This ambitious program was curtailed by World War II, but archaeological activity was quick to revive. In 1945 the International Association for Classical Archaeology was founded in Rome

and in 1946 began the publication of *Fasti Archaeologici*, a complete annual bibliography for classical archaeology as a whole. This international flavour also characterized post-World War II excavation, with the French institute sharing in the digging of Etruscan Bolsena and the Greek colony of Megara Hyblaea, the Belgian school in that of Alba Fucens, a Roman colony, and the American academy in that of Cosa (Ansedonia), a Roman colony on the Etruscan coast. Italian efforts were directed partly to the routine work of restoration and preservation, but on an increasing scale to excavation.

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VII. GREEK AND ROMAN ORIENT (INCLUDING EGYPT-INDUS)

Before Alexander the Great.—Greek influence in the orient is very old, going back to the Egyptian Old Kingdom (2680–2258 B.C.) if Pierre Montet is right in identifying the Helou-Nebout with Hellenes. This is doubtful, but in any case, Greek trade with Egypt of the empire became very active in the period of Late Helladic I and II (1560–1300 B.C.). Greek pottery and art patterns are found in Egypt at that time, and such tombs as those of Senmut and Rekhmara at Thebes are decorated with representations of tribute bearers from the Aegean. In Late Helladic III (1300–1200 B.C.) similar finds occur also in the Levant and Mesopotamia.

Following the period of the migrations, about 1200 B.C., in which such Grecian tribes as the Danaans took part, Greeks began to settle on the southern edge of the old Hittite empire in Asia Minor, and the Aeolic and Ionian cities were founded on the eastern shores of the Aegean. In the case of Miletus, there is evidence that Greek occupation goes back to Mycenaean times (before 1200 B.C.). The great Greek colonial movement of the 8th and 7th centuries B.C. added further settlements on the northern and southern shores of the Anatolian peninsula.

Early buildings of this time have been found at Old Smyrna and especially at Ephesus, where the great temple of Artemis was excavated. A few Greek trading posts were established on the Levant coast also. Poseideion (the present Al-Mina) flourished from 800 B.C. until its destruction by Nebuchadrezzar and was refounded as an Attic colony in 520 B.C. The work of Greek artists from Ionia has been detected at Pasargadae and Persepolis, under the early Persian empire (550–500 B.C.). The Lycian tombs of the 5th century B.C., such as the Nereid tomb from Xanthus (in the British museum) and the Harpy tomb from Tyrsa (in Vienna), show the work of Greek sculptors. The Mausoleum at Halicarnassus, one of the Seven Wonders of the World, built about 350 B.C. as a tomb for Prince Maussollus (Mausolus) by his wife Artemisia, was decorated by the Greek sculptors Scopas, Bryaxis, Timotheus and Leochares. In Egypt, Greek artistic influence shows itself a little later, notably in the tomb of Petosiris at Hermopolis Magna (modern El Ashmunein).

Alexander the Great.—Between 334 and 323 B.C., the conquests of Alexander the Great opened the territory of the Persian empire as far east as India to Greek settlement and Greek influence. In consequence of his early death, his immediate archaeological influence is confined to the cities which he founded, usually named "Alexandria." Several of these lay on the sites of later cities in Iran, Afghanistan and the U.S.S.R.: Chodjend, Ghazni, Kandahar, Herat and Merv. Two of those in the west retain their names: Alexandria in Egypt and Alexandretta in Turkey. In addition, Alexander minted a plentiful silver coinage which was to continue for centuries after his death. The common types show Alexander's head with ram's horns in imitation of the god Amon, with a lion headdress as a reminder of Heracles or with an elephant skin in token of his victory over Porus' war elephants in the Indus valley (326 B.C.). In sculpture, Alexander set the fashion of royal portraiture, the rendering of the sculptor Lysippus being especially popular. The famous Alexander mosaic at Pompeii is a copy of a painting by Philoxenus of Eretria.

Hellenistic Period.—Under the Hellenistic states (323–30 B.C.) which succeeded Alexander's unified empire, the process of Hellenization of the orient proceeded methodically. The kings of the Ptolemaic (in Egypt) and the Seleucid (in Asia) dynasties were Macedonian generals; foreigners in the territories which they ruled. They needed Macedonian and Greek soldiers and Greek technicians, executives, artists, businessmen and settlers in order to administer and to maintain their kingdoms. These collected at the royal courts and populated new cities or new quarters of old cities, forming islands of Greeks loyal to the ruling dynasties amid a sea of hostile or indifferent natives. The same situation prevailed in the minor kingdoms of the Attalids of Pergamum in northwest Asia Minor, near the Greek motherland, and of the Greek kings of Bactria and India on both sides of the Hindu Kush, who certainly attracted very few Greek immigrants.

It is probable that none of the kings attempted to Hellenize his native subjects as a policy, except perhaps Antiochus IV of Syria (175–163 B.C.), best known for his conflict with the Jews (and he was thought to be mad), but their use of the Greek language and their encouragement of Greek culture had an inevitable effect. An Egyptian complains about the year 255 B.C. that he met discrimination in his employment "because he did not know how to act like a Greek." For the same reason, Greek ways spread to the Hellenistic states which were Iranian in nationality, such as that of the Parthians, who dated their kingdom from 248 B.C. and officially described themselves as philhellene (pro-Greek), and to those with Iranian ruling families: the kingdoms of Bithynia, Pontus and Cappadocia in Asia Minor. Even the cantonal state of the invading Galatians with its capital at Ankara was gradually Hellenized, and the Maccabean movement in 2nd-century Judaea began as a protest against Hellenizing tendencies among the Jews. This Hellenistic process gives a unifying quality to the whole period. The Hellenistic peoples shared a common culture as they shared a common dialect, the so-called Koine, in which the Greek New Testament is written.

In the field of architecture and town planning, the finest remains of this period are found in Asia Minor. The little town of Priene, perched on the slope of a steep ridge north of the Maeander river not far from its mouth, was built largely with the support of the kings Alexander the Great and Lysimachus of Thrace (301–281 B.C.). The construction is of stone throughout, and the city is laid out according to the plan popularized by the architect Hippodamus of Miletus (5th century B.C.) in rectangular blocks, each containing typically four private houses. The streets are straight and intersect at right angles, opening out at times for a beautiful little theatre and Ionic temple of Athena, for a market place with colonnades and a public meeting hall, and, at the lowest part of the town, for a gymnasium and stadium, the whole being inclosed within a city wall of finely fitted stone.

More spectacular is the site of Pergamum. This was the Attalid capital and fortress, built on the top of a high and isolated hill. Its buildings belong to the period 250–170 B.C. and, as excavated by the German Archaeological institute, are principally of a public character. The palace of the kings has been discovered, standing with extensive storehouses and arsenals on the crest of the hill. The slopes are occupied by temples, a library, gymnasium, a large theatre and the so-called Great Altar, the reliefs of which constitute the most remarkable examples of Hellenistic sculpture. They represent the battle of the gods and giants, expressed with great vigour and emotion, and were formerly on exhibition in the Pergamum museum in Berlin.

Elsewhere in Asia Minor, extensive Hellenistic remains exist at Miletus, at Heraclea on Mt. Latmus (famous for its well-preserved fortifications), at Aezani in Phrygia, at Attaleia (Adalia) in Pamphylia and at such hill towns as Theangela in Caria.

In Egypt and the east, the only Hellenistic city to have been excavated systematically is Doura-Europos on the middle Euphrates, a garrison town built about 300 B.C. of poor stone, rubble and mud brick, which had little importance in the Hellenistic period. It was laid out according to the Hippodamian plan, with a rectangular market place in the centre. The same was probably true also of such great Seleucid cities as Laodicea (Latakia) in Syria, Antioch in southern Turkey, Seleucia on the Tigris near Baghdad and Susa on the Eulaeus (Karun) in Khuzistan (Iran), but little of the Hellenistic period has been found in these cities.

The same city plan is still visible in Alexandria, Egy., built on the coast west of the Nile delta at a point where an island and connecting causeway made a double harbor. The island was the site of the lighthouse or Pharos, and the city itself, long and narrow, included quarters for the Greek, Egyptian and Jewish inhabitants and a royal quarter, the site of the museum and library. The Serapeum or temple of the god Serapis, who had been created by Ptolemy I (323–285 B.C.) for his Greek and Egyptian subjects, has been found in the southern part of the city, at a place called Pompey's Pillar. Little remains except the underground rooms and vaults, but the gold foundation tablet has been found, dating the construction to the times of Ptolemy III (246–221 B.C.). Elsewhere in Egypt, the Ptolemies continued to build temples in the traditional Egyptian manner. That at Edfu in upper Egypt is almost completely preserved and is covered with accounts of the temple ritual in hieroglyphic writing. Of the cities and villages built for immigrant Greeks, little remains except along the edge of the Fayum oasis, near Cairo, where several settlements with stone temples and crowded houses of mud brick have been partially excavated.

It is to archaeological materials that we owe much of our knowledge of the Hellenistic orient, especially to the inscriptions on stone which have preserved laws and decrees of the cities or letters of the kings, and to the papyrus documents from Egypt comprising laws, royal edicts, court decisions and official papers of all sorts, as well as private letters, accounts, contracts and deeds and memorandums, with substantial fragments of Greek literature, preserved in large numbers by the dry climate.

The silver coinage of the Hellenistic rulers was plentiful and artistic, and supplies much useful historical information. Some of the coins, especially those of the Bactrian kings, contain royal portraits of great beauty. Pottery of the period is of no special interest, except for the fine red bowls of the so-called Samian and Megarian ware, decorated with bizarre scenes in relief. Similar metalwork was popular but has disappeared for the most part. Gem cutting and polychrome jewelry became popular. The standard containers of the period were large, five-gallon clay amphorae, the handles of which were often stamped with dates or indications of origin; these serve as indexes of the flow of trade in grain, wine and olive oil. Glass blowing was discovered in the Hellenistic period, and many fine bottles and bowls were made in Syria and Egypt.

In the field of engineering, the Hellenistic period saw such improvements in irrigation as the Archimedean screw for raising water, and made great advances in the production of large ships of war and of siege engines and artillery.

In the field of fine arts, paintings, mosaics and frescoes have perished except rarely in Egypt, where the painted mummy portraits preserve fine likenesses of men and women, but Hellenistic sculpture survives, directly or in the form of Roman copies. Among the latter are many portraits of Alexander and the kings, of famous philosophers and men of literature. There are Venuses of various types, Muses, Dying Gauls, copies of the head of Serapis designed by the Rhodian school, and city Fortunes based on Eutychides' Antioch with turreted crown or Sophilus' Alexandria with headdress in the likeness of the prow of a ship. Notable originals which have survived, in addition to the reliefs of the Great Altar at Pergamum, are such Venuses as those from Melos (in the Louvre) and from Cyrene (Museo delle Terme in Rome), and the great Laocoön group made in Rome by Rhodian artists toward the end of the Hellenistic period. As a smaller equivalent of the large statuary in marble and bronze, little clay figurines were very popular and have survived in large numbers. They represent fashionable ladies and gentlemen, children, slaves, animals and grotesque subjects of many kinds. The centres of manufacture were Tanagra in Greece, Myrina in Asia Minor and Alexandria in Egypt.

The Roman Empire.—The period of the Roman empire (27 B.C.–A.D. 476) is marked in the orient by recovery and expansion followed by stagnation and decay. The Roman civil wars of the 1st century B.C. had caused terrible damage in the east, and after Octavian's final victory before Alexandria in Aug., 30 B.C. the Hellenistic orient was prostrate. The Iranian kingdom of Parthia had benefited by the collapse of the Seleucid state to expand as far west as the Euphrates river, and small native kingdoms had established themselves in the buffer zone between the Roman west and the Iranian east: Commagene in the Amanus mountains, famous for the funeral monument of King Antiochus on Nimrud-Dagh; Judaea under the Herods of Idumaea, well known from the Bible, the writings of Flavius Josephus and the papyri and parchments found between 1948 and 1952 in the Dead sea caves; and Arabia under the Nabataean Arabs, with their spectacular capital at Petra in the modern kingdom of Jordan. The caravan city of Palmyra flourished in the Syrian desert.

With Augustus' settlement with the Parthians in 20 B.C., a state of peace prevailed between Rome and the Iranians for almost 250 years, interrupted by brief border wars under the emperors Nero, Trajan, Marcus Aurelius and Septimius Severus. Trajan added to the empire the province of Arabia (modern Jordan) in A.D. 106 and Septimius that of Mesopotamia (the Syrian Jazira) in A.D. 198–199, and Armenia as a client kingdom was sometimes under Roman, sometimes under Parthian control. About A.D. 224, the philhellene Parthian dynasty was superseded by the fanatical Sassanian Persians of Fars, and Rome's wars with its eastern neighbour became more serious, the Sassanians entering Antioch more than once about the middle of the 3rd century and capturing the emperor Valerian about A.D. 260. Nevertheless these were limited wars which did not affect seriously the Greco-Roman population of Asia Minor, the Levant and Egypt, which were free to prosper from manufacturing, trade and commerce, troubled only by the growing burden of Roman taxation and Roman bureaucracy. Even the Gothic raid in Asia Minor in A.D. 267 did little damage, while the central part of the peninsula benefited from the activity of the great military road from Byzantium to Antioch. These were the centuries of great building activity in the orient. Existing cities were expanded and new ones were built, especially in central and southern Asia Minor, Mesopotamia, Jordan and southern Palestine. In all of the orient, remains of buildings, walls, bridges and aqueducts built of rubble, stone or baked brick illustrate the Roman fondness for massive construction with arch and vault, while the traces of Roman paved roads and frontier military posts are found commonly along the frontier.

In the field of art, on the other hand, the Roman period in the east is less distinguished. Mass production of metal objects, glass and pottery, cloth and jewelry meant that artistic excellence was sacrificed for cheapness and plenty. Roman figurines are dull compared with the earlier Hellenistic product. Roman coins cannot compare in artistic quality with those of the Hellenistic kingdoms, and in the 2nd century began a process of depreciation in silver content which led to the enormous price inflation of the period following A.D. 270. In the plastic arts, the popular subjects are those connected with the oriental religions of Egyptian, Syrian and Iranian character which now began to spread to the west. Figurines and sculptures represent the oriental deities, principally Isis, Osiris and Serapis of Egypt, with such mixed Greco-Egyptian conceptions as the popular Harpocrates; the Levantine Baal, Astarte and Atargatis, Adonis, Dusares, Bel, Jupiter Heliopolitanus and Jupiter Dolichenus; the Iranian Mithras; and the Anatolian Great Mother and Attis. The one great artistic creation was that of the god Mithras slaying a bull, which became the Mithraic central cult image and which has been found in numerous renderings throughout the many centres of worship of this god in the west. Farther east, the old Hellenistic creativeness showed itself in Iranian clothing, in the royal Sassanian rock reliefs and in the

service of native religious ideas in India, where the portrait of the Buddha of the so-called Gandhara art became standard for centuries to come.

The general mediocrity of art in the Roman orient is brightened by the artistic excellence of the mosaic pavements found in Antioch, with their geometric and floral polychrome patterns and their rendering of religious and rural scenes. Of even greater interest are the frescoes found at Doura-Europos, small and primitive ones from a Christian chapel and large and elaborate ones from a Jewish synagogue, both belonging to the period about A.D. 250. The Christian scenes portray the Good Shepherd, the healing of the paralytic, Christ walking on the water and some other subjects. The Jewish frescoes cover the entire walls of a large room and present numerous scenes from the Old Testament, especially those connected with Moses, Esther and the Ark of the Covenant. The Christian chapel has been re-erected in the Art gallery of Yale university, the synagogue in the museum of Damascus.

Roman building in the east reached its height in the 2nd century but was matched under the Byzantine emperors in the 5th and 6th centuries, when many monumental structures were converted into churches. This is true at Ephesus, on the Aegean coast of Asia Minor, and at Gerasa (Jerash) in Jordan, two of the finest sites of the Roman east. At Baalbek in Lebanon, the citadel of the Roman city was preserved largely by the Christian buildings erected in it, and the smaller temple of Bacchus, as well as the great temple of Zeus with its large court and lofty altar, remain to impress us with their magnificent proportions and the richness of their sculptured decoration. Scenically, however, the finest ruins of the Roman orient lie in the desert, the little-visited Hatra in Iraq and especially Palmyra, "the Bride of the Desert," on the road between Damascus and the Euphrates. There the remains of temples, colonnaded streets, theatre, council chamber, forum and caravanserai, and the great temple complex of the god Bel, in their colourful desert setting, linger in the memories of all visitors.

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(C. B. Ws.)

VIII. THE IRON AGE IN EUROPE

The Chronological Framework.—Outside pre-Classical Greece the first use of iron occurred in the late Urn Field culture of Italy and central Europe (Reinecke phase B). The iron was imported and used to imitate or decorate traditional bronze types. Only in the next phase does it come into regular use. Its use spread only slowly across Europe, an important factor being the rate of production of separate mining centres.

Since the commencing date of the Iron Age varies from place to place, the division into an early and a late period also varies. The central European early Iron Age is contemporary with the late Bronze Age of northern Europe. Absolute dating in Italy is therefore calculated in relation to the foundation there of the Greek colonies (after 750 B.C.). By correlating other cultures to this, the end of the Urn Field culture and the beginning of the Iron Age is established at about 800–750 B.C.

The end of the prehistoric Iron Age is marked by the Roman expansion in the Alpine zone as far as the Danube (16–15 B.C.), bringing Italy, France and southeastern Spain into the period of written history.

The Celtic migration about 400 B.C., spreading the La Tène culture, marks the division between early and late Iron Age.

Origin and Production of Iron in Prehistoric Europe.—A letter of Chattusil III to Amenhotep II shows that during the 15th century B.C. iron was mined and used to make implements in southeast Asia Minor. The use of iron may therefore have diffused from there into early classical Greece and thence to the neighbouring nonliterate peoples. W. Witter, however, showed that the copper mines which were in use from the early Bronze Age in central Europe also contained (sparry) iron ores, which the miners may have tried to process separately; but this has not yet been proved. All known examples of central European iron mining belong to the end of the Iron Age; *e.g.*, eastern Alps (Burgenland), Bavaria (Kelheimer Forst, Donaumoos near Augsburg and the west German Siegerland. Furnaces in north Germany and Scandinavia show the use of bog ore (limonite). Roman mines in the eastern Alps (Erzberg, or Ore mountain, near Eisenerz and Hüttenberg) may have been used already in the Iron Age. Iron was bloomed in bowl furnaces, producing a very impure iron. The iron was marketed in the late Iron Age as biconical bars with drawn out ends or as flat bars.

Significance of the Urn Field Culture.—The character of the Urn Field culture was influential on the history of early Iron Age Europe. The core of the Urn Field culture extended from central Germany to the Alps and from eastern France to western Hungary. Its marginal areas covered north and central Italy, southeastern France, northeastern Spain, Belgium, the Netherlands, eastern England, northern Germany, Denmark, southern Sweden, Poland, Hungary and Macedonia. Traditional forms in pottery and metal persisted into the early Iron Age in these areas. The uniformity of the Urn Field culture suggests that it represents the extent of migration of one people.

Early Iron Age and Its Different Cultures.—The two most important centres in the early Iron Age are central and northern Italy and central Europe, where a culture based on iron became established while the rest of Europe was using bronze. Archaeological evidence suggests that the early Iron Age peoples of Italy developed their characteristic cultures on the spot and were not immigrant groups as has been suggested on linguistic grounds.

Etruscans.—The Etruscans were a mixed stock derived from the native Mediterranean non-Indo-European element existing from Neolithic times, blended with Indo-Europeans who reached middle Italy in the wake of the Urn Field culture; their language reflects this. From the mid-8th century B.C. the culture of central

Italy is enriched by Phoenician-Egyptian imports, particularly on the west coast. The transition stage is seen in cemeteries at Timmari, Tolfa and Allumiere and Pianello di Genga (cremations with Urn Field pottery). The earliest Etruscan element is found in cremation burials in shaftlike pits (*pozzi*) from Tarquinia (Corneto), Veii and Vetulonia. Later inhumations in rectangular ditches (fosses) also occur, from which the typical Etruscan tomb develops, based on chambered tombs, which allow mural decoration (Tomba dei Tori, degli Auguri, delle Vasi Dipinti, dei Leopardi, del Letto Funebre, dell Orco). Cremations in figure-shaped urns (canopi) continue well into the 6th century in the Etruscan hinterland, but simple rock-cut chamber tombs were also used. The chronology is related to a series of standard tombs, beginning with the Tomba del Guerriero (Tarquinia), a late fosse, with geometric pottery (*c.* 720–710 B.C.). Then follow: the Bocchoris (Bokenranf) tomb (Tarquinia), an early chambered tomb containing an Egyptian faïence vase (700–690 B.C.); the Tomba del Duce (Vetulonia) (*c.* 680 B.C.), from which the grave goods show the beginnings of orientalizing decoration. This decoration is continued (675–625 B.C.) in the chambered tombs Regolini-Galassi (Caere), Barbarini and Bernardini (Praeneste), which were lavishly furnished; *e.g.*, with Phoenician silver bowls. The figural motifs from them were copied by the Etruscans on ivories (Pania tomb in Clusium). As Etruscan supremacy spread northward this art reached the Villanovans and Atestines, who used it on situlae.

Villanovans.—Villanova, a small suburb of Bologna, yielded the first north Italian early Iron Age burials and thus gave its name to the culture in the provinces of Bologna, Faienza, Forli and Ravenna, as far as the Reno and Panaro rivers. The Villanovans arose from a mixing of Lake Dwelling and Terramare peoples with Urn Field peoples from the 10th century B.C. onward. The Villanovan cemeteries are named after the owners of the land where they were found. The early period is Benacci (comprising phases I and II), the first phase of the late period is named Arnoaldi, the final phase being Certosa. Benacci I and II practised cremation burial almost exclusively; inhumation gradually became customary during Arnoaldi, spreading still more during Certosa. But cremation burials in urns and in large barrel-shaped vessels (*tombe a dolio*) continued. The Benacci I urns are still comparatively plain, being closely related to the pottery of the Urn Field culture. During Benacci II they are more delicately formed and copied in bronze, new forms appearing (situlae, cists and bowls). The cultural standard rises during Arnoaldi, and by Certosa the culture has become Etruscan. Thus figural decoration of bronze vessels spread north of the Apennines, from which comes the Certosa situla, a masterpiece of embossed work. It has a late successor in the Arnoaldi situla of the 5th century B.C., which already shows traces of Celtic craftsmanship. The Celtic invasions after 400 B.C. determine the end of the Villanovans.

Golaseccans or Comacines.—Named after Golasecca, on the left bank of the Ticino river, this culture covers the region of lakes in northern Italy and southern Switzerland, as well as the valley of Lombardy and Piedmont as far as Liguria. Its origin is similar to that of the Villanovan, with the Urn Field element more modified by the native Ligurian tradition. The geographical position of the Comacines permits a less detailed chronology. Phases I and II correspond to the period from Benacci I to Certosa. Phase III belongs to the late Iron Age. The pottery of phases I and II is closely linked with the Urn Field culture pottery and serves as cremation urns. Ornamented bronze vessels from the Villanovans or Atestines occasionally appear in phase II and were imitated (*e.g.*, situla of Sesto Calende).

Atestines.—This culture is centred on Este (ancient Ateste) and extends over Venetia into the Balkans. It is rooted in the Urn Field culture, and its possessors are usually identified with the Veneti. Four phases are distinguished; Este I is ill-defined, Este II has an individual character, Este III is the climax corresponding to Certosa, and Este IV shows Celtic influences. The culture was terminated by the Roman occupation of the territory in 183 B.C. The Atestines developed the decoration of situlae (*e.g.*, situlae Benvenuti, Rebato, Prà d'Este, Boldu-Dolfin), an art which they learned from the Etruscans. Their products were traded as far as the Hallstatt Illyrians (*e.g.*, situla lid from Hallstatt) and the Balkan Illyrians (situlae of Vace, Magdalenska Gora, etc.).

Picenes.—This culture spread on the Adriatic coast of central Italy around Novilara near Pesaro. The pre-Urn Field traditions, especially of inhumation, remained strong, and there were cultural links with the opposite mainland. Two phases can be distinguished, the Molaroni and the Servici. Grave goods are similar to those of central and northern Italy, but pendant ornaments are preferred. The pottery, however, is characteristic. From the 6th century comes the stone statue from Capestrano inscribed "Magubregaeque hoc monumentum Raginevique S. . . . i." The two names are Picenian.

Hallstatt Illyrians.—The Hallstatt culture, named from more than 2,000 tombs found at Hallstatt, spread far over central Europe, from eastern France to Austria. It is divided into western, northern and eastern, with further local subdivisions. These regional distinctions reflect variations in the Urn Field culture and proximity to northern Italy. It derived from the late Urn Field culture and was at its prime from the 7th to the 5th centuries B.C. In the sub-Alpine region it was ended by the Celtic migrations about 400 B.C., but it continued to the early years A.D. in the central Alpine range.

The Hallstatt necropolis furnishes a cultural sequence for the western group. Iron is increasingly used for weapons, ornaments and tools, but bronze continues in use for ornaments (especially belt fittings). Bronze vessels are still made, but imports from the Atestines are also found (*e.g.*, Hallstatt situla lid). Pottery tends toward ostentation, and the graves show distinctions of class. The Celts originated within the western group during the 5th century B.C.

Lusatian Illyrians.—The early Iron Age culture of central Germany and Silesia, centre of diffusion of the Urn Field culture, shows a direct descent from that culture and has very few iron implements. Its area includes western Poland. Vessels are painted in imitation of those of the Hallstatt Illyrians but are inferior. The Lusatian Illyrian culture was comparatively simple.

Balkan Illyrians.—The region occupied by the Balkan Illyrians corresponds to the Roman province of Illyricum. It is the hinterland of Classical Greece and bordered by the Hallstatt Illyrians and Thracians and influenced by the Atestines. This causes a threefold division of the Balkan Illyrian culture—the Vace group in Carniola, the Nesazio group in Istria and the Glasinac group in Serbia, continuing into Macedonia. Vace and Glasinac pottery is similar to Hallstatt, while Nesazio pottery shows Atestine influences. Bronze embossing is carried on by the Nesazio group. The Vace and Glasinac groups prefer pendant ornaments. There is very little Celtic influence throughout the area, so the culture continues at least to the Roman occupation (2nd century B.C.).

Thraco-Cimmerians.—Southern Hungary and Rumania are influenced from the 6th century onward by the Scythians advancing from south Russia. From this area came the famous gold treasure of Michalkow (Galicia) and finds of Fokoru (Hungary) and Vlci Trn (Bulgaria). The knotted bow of the Michalkow fibulae places the find in the culminating phase of the early Iron Age, during which a specific culture is found in the region, parallel to the Hallstatt and Balkan Illyrian. Literary evidence permits the naming of this group as the Thraco-Cimmerians, from among whom the Dacian power arose and threatened the Celts toward the end of the late Iron Age.

Late Bronze Age in Northern Germany and Southern Scandinavia.—The contemporary culture of northern Europe was ignorant of iron and continued its late Bronze Age culture (Montelius IV–VI), rich in bronze implements often of complicated manufacture (*e.g.*, large trumpets or luren). During Montelius phase IV it shows strong influence from the central European Urn Field culture, but in phase V the culture and its bearers spread east and southeast, establishing contact during phase VI with the Hallstatt Illyrians. In view of these movements we may consider the Scandinavian migrants of the late Bronze Age as well as of the early Iron Age to be Germanic.

The idea of evolution was slowly accepted, accompanied by many rancorous disputes. The chief accomplishment of the period between 1859 and 1900 lay in the recognition of a considerable time depth for man. The system of arranging the primates remained unilinear, but it was extended far back into the geological past. Both fossil races of man and contemporary races were arranged according to their assumed degree of morphological primitiveness. The findings of extinct forms of animals by paleontologists, the excavation of older cultures by archaeologists and the discovery of Neanderthal skulls all contributed to questioning the scriptural authorities who credited the world with being only approximately 6,000 years old. Combined researches of geologists, paleontologists, archaeologists and physical anthropologists finally established the antiquity of man as well as of other forms of organic life and thus the evolutionary sequence became of foremost interest. The first recognized discovery of the extinct race of Neanderthal man was made in 1856 in northwestern Germany and was disputed by many persons, including the great German pathologist and physical anthropologist Rudolf Virchow. An earlier discovery of a Neanderthal skull in Gibraltar in 1848 had been largely ignored. The continuing search for more primitive specimens of fossil man was richly rewarded when in 1891–92 Eugène Dubois discovered the Java ape man, now classified as *Pithecanthropus erectus*, considered one of the earliest known races of man.

4. New Approach.—By the end of the 19th century several useful classifications of all the races of the world had been completed. Many of the differences between the races were quite well known. Similarly, differences between man and the anthropoid apes had been inventoried and also between modern man and fossil man. A great deal of attention was paid to the number of differences and it was assumed that the degree of relatedness was adequately indicated by the degree of morphological similarity.

The year 1900 may be taken as a turning point in the development of a new conceptual approach, although no single date can fully comprehend a shift in such an exceedingly complex continuum. Two major events took place which were to have far-reaching consequences: (1) the rediscovery of G. J. Mendel's two genetic principles by several investigators and (2) K. Landsteiner's discovery of the ABO blood groups. Mendel had formulated the basic principles of heredity in 1865 but these had passed unnoticed. The inheritance of the blood groups was not at first appreciated, but within ten years became a focus of research and thus a building stone in modern racial studies. Many new concepts came into use with the increasing influence of genetic theory, such as the breeding population, genetic equilibrium, genetic drift and the gene frequency method of differentiating populations or races. Attention was immediately directed to the processes of change, those ways in which gene frequencies are modified. At the same time increasing attention was paid to the significance of traits and to the ways in which they were interrelated. Experimental studies were devised to demonstrate the functional significance of differences in morphology. The concept of straight-line evolution (orthogenesis) was qualified and examples of reversals or major shifts in the direction of evolution were objectively examined. The concept of the missing link went into discard.

The realization that a change in way of life which introduced a species to a new "adaptive plateau" and brought about many radical changes in its structure obviated the need for a belief in so-called missing links. The techniques of anthropometry were reinforced by many other techniques, such as blood typing, so that the physical anthropologists had a much more versatile set of research tools.

5. Statistical Methods.—Spanning both the pre-evolutionary and the evolutionary periods of physical anthropology was the development of statistics and their application to the measurement of man, included under biometry. As early as 1835, L. A. J. Quételet (1796–1874) had applied the statistical concept of the normal probability curve to human beings. He demonstrated that most of the statures in a population will cluster about a mean and that the frequency of both taller and shorter statures will diminish in frequency at opposite ends of the curve. Sir Francis Galton (1822–1911) succeeded in constructing new measures of variability, correlation and regression. Galton also investigated certain aspects of human heredity. Karl Pearson (1857–1936) classified the types of distribution, perfected the coefficient of correlation, developed chi-square and was a founder of the journal *Biometrika*. Not the least of his many contributions consisted in separating the sample from the population it represented and indicating the necessary restrictions for interpreting a population in the light of information drawn from the sample. R. A. Fisher, continuing the development of modern statistical theory initiated by Pearson, made extensive contributions in the design of experiments and to the field of genetics. One of the trends in the anthropological use of statistics is toward those kinds that preserve the description of the organism as a whole. Analysis of variance, multiple regressions, discriminate functions, generalized distance and factor analysis all share the criterion of treating different variates as a single coherent vector. Unfortunately, the finest statistical treatment will not compensate for poorly selected units of observation or measurement.

C. Problems of Trait Definition and Evaluation

1. Introduction.—A major problem in physical anthropology is that of the trait or unit of observation to be employed. Different inferences are based on the same traits as a result of a different evaluation of them. Also, different traits are cited for the same specimens evaluated by different researchers. The essential difference between the anthropoid ape theory of human origin and the catarrhine monkey theory rests in the different evaluation of traits. The old method of simply enumerating differences did not contribute to the meaning of the differences or indicate the way in which they came into being. The realization that not all traits are of equal taxonomic value made necessary the development of systems, compatible with genetic theory, that would provide an objective basis for the evaluation of traits. Traits commonly used may be categorized into relatively few classes: (1) items which are present or absent, such as an eighth bone in the wrist, a muscle or a particular blood group; (2) proportions such as the relatively greater length of forearm and lower leg in the Negroes as contrasted with Mongoloids; (3) sequence in growth, such as the order of tooth emergency or suture closure; (4) growth rates, such as differences in the attainment of maturity; (5) conformations such as the jutting cheekbones of the Mongoloids; (6) size, such as the differences in stature between Pygmies and Bantu Negroes or differences between sexes and races in cranial capacity. A functional complex constitutes a trait in the sense that the complex as a whole is the object of selection. The above kinds of traits are often compared by frequency. Thus the gibbons have ischial callosities whereas only 36% of chimpanzees show the same denuded areas of thickened skin on the posterior.

2. Measurements.—The problem of what to measure or, perhaps more commonly, what a series of measurements means after it has been assiduously collected, is omnipresent. In many cases it has been found that what was formerly treated as a single unit is actually composed of discrete, isolable elements. The practical meaning is that an over-all observation or a single measurement may conceal important differences and, conversely, that several observations or measurements may actually be different aspects of the same phenomenon. An example of the former is provided in various measurements of the head. The same proportion of head length to head breadth (cephalic index) may result from different measurements. Thus, roundheaded persons may be so because of a relatively short head length or of a great head breadth and great head length. (Pygmies of New Guinea have a cephalic index of 83.4 and the Aleuts have a similar ratio of length to breadth, yet the actual dimensions are considerably less in the Pygmies.) Again, cranial length will often be the same but the different bones of the vault will contribute different amounts to the total length. It has been shown that an over-all measurement of iliac height does not portray the difference between male and female as sensitively as the separate measurements of lower and upper iliac height. The upper iliac height is greater in males whereas the lower iliac height is greater in females.

Examination of research into methods of distinguishing sex in

the pelvis provides examples of the fact that many traditional observations have been treated as independent observations when in fact they were simply different aspects of the same things. It had been common practice to distinguish male from female pelves by observing approximately 17 characters. S. L. Washburn demonstrated the interdependence of many of these characters and analyzed the sex differences into three separate and relatively independent systems. Several characters are dependent on the growth of one of the three elements of the pelvis, the pubic bone. This bone is responsive to female hormone and consequently grows longer in females than in males. The lengthening of this element alters three other characters, the subpubic angle, height of the pubic symphysis and shape of the obturator foramen. An index based on the length of the pubic bone and one other element of the pelvis, the ischium, will determine the sex of more than 90% of skeletons. To this ischium-pubic index may be added the sciatic notch, a character of independent development and evolutionary history. It is broader in females than in males. This difference represents an adjustment to erect posture that was necessarily different in females for obstetrical reasons. A third kind of character is the size of the socket which receives the head of the thigh bone. It is larger in males than in females. The absolute size difference between male and female may also be observed in the ischial element of the pelvis. The use of these three fundamentally different kinds of characters will determine the sex of pelves accurately and economically. The use of the 17 or more traditional characteristics includes many unnecessary observations which are simply aspects of these three basic characters.

3. Experimental Methods.—Attention to the definition of traits and their significance for both evolutionary and racial studies has led to a more general use of experimental techniques and this constitutes one of the trends in the newer physical anthropology. These experimental methods include use of the split-line technique, a way of showing the mechanical arrangement of the bone, the stress-coat technique, alizarin vital stain, removal of bone or teeth, excision of muscles, inactivation of muscles, etc. Other methods of factoring the complexes of interdependent traits are: (1) comparison of contemporary forms and of fossil forms; (2) individual development including embryology; (3) observation of the variations normally occurring in populations, and the variations which occur in disease.

4. Evaluation.—Traits have been evaluated in many different ways. They have been assessed as generalized or primitive as opposed to specialized. An example is the hand, which has remained similar to the earliest known primate hands, whereas the foot has become specialized for walking and has lost its former mobility. Traits have also been divided into those that are adaptive as opposed to nonadaptive. This division is recognized as being difficult to demonstrate. Further, nonadaptive traits would be of limited theoretical value if evolution were dependent on the selection of forms which were adapted to a particular ecological zone. One of the useful approaches to this problem rests on the explicit premise that the "major force in evolution is selection of functional complexes." (S. L. Washburn, "The New Physical Anthropology," *Transactions* of the New York Academy of Sciences, series ii, vol. 13, no. 7, p. 300 [1951].) Adaptation of a group of animals to a particular way of life, an adaptive zone, has been achieved by alterations in a complex of skeletal and muscular traits.

Primary characters are the most important characters; *i.e.*, those which have made an evolutionary radiation possible. The primary character or adaptation responsible for the origin of man appears to have been a new kind of pelvis. Bipedal locomotion depends on a pelvis which provides the necessary points of origin for muscles in positions which enable them to operate efficiently in standing position and in walking rather than the inefficient shuffling seen in the apes. Secondary characters are a consequence of the new selection and are based on the primary characters. These are composed of such changes as the enlargement of the anterior muscles of the thigh, stabilization of the knee and ankle joints and a broadening of the heel bone. A third category of incidental characters is the relatively minor associated differences which have few or no functional implications; *e.g.*, the number of articular facets on the heel bone. The significance of the short broad ilium (upper portion of the hipbone) of man, compared with the high narrow ilium of the apes, lies in the fact that the muscles have been rearranged so that man can extend his leg with considerable power and finish his step with drive. The ape must walk with a bent-knee gait and cannot push forward or complete extension of the leg with real power. The principal muscle involved is the *gluteus maximus*. In the apes this is a small muscle and in a position where it cannot exercise the same leverage as in man. Thus, the differences between man and the apes may be viewed in terms of primary adaptation to different adaptive plateaus. Once man entered a new adaptive zone, characterized by bipedalism or erect posture, selection for this new manner of locomotion brought about many ancillary or secondary changes. The differences, then, take on an interpretable significance when they are related to a complex, and such a complex has evolutionary meaning. On the basis of erect posture and bipedal walking man has become a distinctive genus. Thus we have the evolution of a new genera in a relatively short period of approximately 1,000,000 years.

Each of the other major primate groups may be distinguished on the bases of the distinctive complexes which contributed to its branching off as an adaptive radiation. Thus, the anthropoid apes are adapted for brachiation, a complex which is still retained in large part. The monkeys and the lemurs do not, however, share this functional complex. The development of stereoscopic vision and the enlargement of the corresponding areas of the brain characterizes a complex which was the basis for the development of the monkeys. This is shared with the apes and man but not with the lemurs. The lemurs in turn have a complex characterized by a prehensile hand which is also possessed by the monkey, apes and man. Knowing the fossil record of primates and the major functional complexes which characterize the living primates, it can be seen that man's body has been dissected by evolution and that these four areas have evolved at different times and are shared only with those primates that underwent the same radiations.

The Four Adaptive Radiations Leading to the Contemporary Primates

Major functional complex	Lemur	Monkey	Ape	Man
Hand	x	x	x	x
Stereoscopic vision	–	x	x	x
Brachiation	–	–	x	x
Bipedalism	–	–	–	x

The concept of parallelism has been of great theoretical value in understanding several similarities. Thus, the South American spider monkey is the one monkey in the world capable of brachiation. It has acquired this ability quite independently of the apes of Asia and Africa. Parallelism is not simply a way of discounting resemblances; it also provides examples of the way in which similar selection on related animals produces similar results.

D. Fossil Record of Man's Evolution

1. South African Australopithecinae.—Interpreting the fossil record of man's evolution has been considerably facilitated by the increasing discovery of many new skeletal remains and by especially significant forms. A substantial background has been provided by the incredibly rich finds of the Australopithecinae of south Africa. Often referred to as man apes they may well constitute the first representative of man. Possessing a cranium with mixed ape and human characters, their skeletons provided important answers to questions concerning the human form. Fossil men were recovered in clusters numbering from 3 to 13 or more and, consequently, it is no longer necessary to place as much reliance upon the necessarily enigmatic single skull remains such as that of Rhodesian man or the Heidelberg mandible. It is possible to secure a reasonable synopsis of the major outlines of cranial transformation without resorting to evidence of past races represented by only one skull or skeleton. The importance of this rests in the fact that no single individual, living or skeletal, can represent a population. The authenticity of single skulls has usually become a major question, often obscuring the possible significance present

Western Europe.—There is no cultural uniformity to the west of the Hallstatt Illyrians, though there are two main zones. Central and southern France and northwestern Spain form the first zone, with a culture developed from the west European Bronze Age influenced by Urn Field and Hallstatt elements. The persistence of cremation permits the name Cremation Burial culture. Outstanding material comes from the tombs around Narbonne, from the Ger plateau and from Ávila, Guadalajara, Saragossa and Soria. In the 4th century B.C. La Tène elements appear, though the Celtic migration did not cause any break in this culture except in southern France. At the southern foot of the Pyrenees it may have lasted until the end of the late Iron Age, while in northern Spain it was probably absorbed into the Iberian culture during the 3rd century B.C.

In the second zone, consisting of western France, the rest of the Iberian peninsula and the British Isles, the Atlantic Bronze Age culture continues, with elaborate implements often found in hoards. The older pottery types persist—food vessel, cinerary urn, incense cup. Noticeable change occurs only during the 5th century B.C., when the Celtic migrations began.

Late Iron Age and Its Cultures.—Outside Greece and Italy the European late Iron Age begins during the 5th century B.C., when the Celtic La Tène culture begins to migrate, uniting what had previously been individual culture areas since Neolithic times. Only the Iberian peninsula was unaffected for a millennium. The history of the late Iron Age consists thus in the relations of a small number of widespread cultures with each other and with the rising power of Rome.

Celtic La Tène Culture.—In Britain the period corresponding to the continental late Iron Age is called early Iron Age A, B, C. During the 5th century B.C. southeastern Britain was occupied by Celts from the continent. This Iron Age A phase continues into the 4th century B.C., overlapping the Iron Age B of the southwest, which produced the Glastonbury pottery. The Iron Age C culture begins with the invasion of the Belgae into Kent in 75 B.C. The Celticization of Ireland may have begun during the 2nd century B.C., bringing the Goidelic strain to the island. (*See* also LA TÈNE.)

Germanic Culture of the Northern Early Iron Age.—During Montelius phase VI the northern late Bronze Age culture spread as far as the middle Rhine, Main and Sudeten mountains, where in the 4th century B.C. it was isolated by the Celts from its northern connections. Little iron was used, and local differences are clearer than chronological ones. Hanover, Schleswig-Holstein and Denmark form the richest zone, being close to the La Tène area. Norway and Sweden are comparatively poor. The Germans were passive toward the Celts in the 4th and 3rd centuries B.C., but during the 2nd they themselves began to move. The Cimbri and Teutons during the later 2nd century B.C. advanced southward from Jutland (113 B.C., battle of Noreia), followed by the Vandals, then the Burgundians and in the late 1st century B.C. the Goths. The Germanic tribes advanced during the 3rd to 1st centuries B.C. in central Germany and Bohemia, in southwestern Germany (Vangiones, Triboci-Nemetes) and western Germany (Chauci, Frisii, Langobardi, Angrivarii, Cherusci, Chatti, Main-Suebi), where they became strongly Celticized. The resulting wars, described by Caesar, made the Germans neighbours of the Roman empire. During these wars in the last century B.C. much Celtic loot fell into Germanic hands; *e.g.*, the silver cauldron from Gundestrup, Denmark, and the chariot from Dejbjerg.

Rhaeto-Illyrian Culture of Alpine Tradition.—In the central Alps the culture of the Urn Field Age continued, enriched by influences from the various early Iron Age cultures. There are local subgroups of the culture: Bellinzona (Ticino), the Melaun-Fritzens (Grisons, Lichtenstein, Vorarlberg and the Tirol) and the east Noric group (Styria, Carinthia). The first group shows affinities with the Certosa period and the second with the Hallstatt Illyrians, while the third is a direct continuation of the native Hallstatt culture. We know from written sources that the Illyrians contributed racially to forming the Rhaetians. The Alpine traditionalism remained influential in Grisons.

The Iberian Culture.—Celtic movements of the 4th century B.C. penetrated Spain from France as far as the Sierra Morena; beyond, the population established there from Neolithic times remained undisturbed. Avienus, writing in the 4th century A.D., first writes of the Iberians and gives their tribal names. The culture begins in the 6th century B.C. and ends with the Roman penetration of the 2nd century B.C. There had early been trade with Greece and Carthage, stimulating imitation; *e.g.*, in pottery, with its stylized figural decoration, with many local variations. Figural sculpture also was influenced by Greek art; *e.g.*, the Lady of Elche. The main cultural centres are on the coast; the interior may have retained the older culture into the Roman period. (RD. P.)

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IX. INDIAN SUBCONTINENT

After the Paleolithic assemblages of stone tools there is little evidence of human cultures in the Indian subcontinent until the establishment of agricultural communities in Baluchistan and northwest India, probably in the 4th millennium B.C. though perhaps earlier. Thereafter the rise of the Indus civilization shows the existence of a bronze-using urban economy of a type familiar throughout the ancient orient from the early 3rd millennium B.C.

The Indus Civilization.—By about the middle of the 3rd millennium B.C. there had been established in northwestern India a Bronze Age civilization, urban and literate, over a tract of country 1,000 mi. long and comprising mainly the valleys of the Indus, Sutlej and Ravi rivers. In some sense this Indus civilization must be related to the village cultures of Baluchistan and Sind, but there is a sudden transition from simple, self-sufficient hamlets and townships to a complex system of unified government expressed in stereotyped pottery forms, the use of kiln-fired bricks, a consistent series of weights and measures and a formal script throughout the area. Sixty or more sites are known, ranging from villages to towns and including two major cities, Harappa in the Punjab and Mohenjo-Daro, 350 mi. S. down the Indus, in Sind.

While this civilization shares in its basic technology features in common with the other contemporary urban cultures of the ancient orient, it has a strongly marked individuality and seems on the whole to have had little contact by trade or diplomacy with its nearest neighbours in Elam and Mesopotamia. Dating is therefore not easy, but in the mature form in which we know it the Indus civilization was certainly flourishing in the time of Sargon of Akkad, and lasted virtually unchanged for another millennium, when it appears to have been brought to a violent end by the Aryan invasions. The static quality of its material culture is very marked, showing as it does no essential changes from beginning to end of the available stratigraphic series.

The bulk of our information comes from three sites, Harappa, Mohenjo-Daro and Chanhu-Daro, of which the second has the best-preserved layout. At Harappa traces of an earlier settlement, with pottery of Zhob valley type, were found below the citadel defenses; at Mohenjo-Daro and Chanhu-Daro the earliest levels are inaccessible beneath the present water table. The village sites of Amri and Lohri in Sind showed an Indus civilization settlement in each case overlying one using the painted buff ware of Amri type. At Chanhu-Daro, two phases of secondary occupation were identified over the Indus culture ruins; of these, the so-called Jhukar culture may have some western affiliations in its bronze types (shaft-hole ax and pins), and is referred to again below. At Harappa, the last phase, again later than the Indus civilization, is represented by a cemetery (Cemetery H) and some occupation scatter, with distinctive, painted black-on-red pottery of uncertain origin. The not altogether typical site of Rupar in the Himalayan foothills has a settlement with painted gray ware, also referred to below, overlying the Indus phase.

The two major cities, Harappa and Mohenjo-Daro, may, in the absence of any other sites of comparable size yet discovered, be taken as twin capitals. Their material culture is identical, and although the site of Harappa has been much robbed, enough remains to imply that the city had a plan closely similar to that of the better-preserved Mohenjo-Daro. The layout appears to have consisted of a gridiron of building blocks separated by wide streets; there is some evidence for 12 such blocks forming a square city one mile across, oriented to the points of the compass, and with the central block on the west side occupied by a defended citadel set on a massive platform of mud brick faced with baked brickwork. At Harappa the defenses of the similar citadel have been partially excavated, showing the presence of angle towers, monumental gateways and terraced approach roads. The defenses themselves comprised a clay rampart and mud-brick wall bonded into a similarly constructed platform, and the outer face was revetted with a baked brick skin.

The lower town, explored in large areas at Mohenjo-Daro, consisted of courtyard houses set within the main blocks and separated by small irregular lanes. Bathrooms were common, and there were elaborate drainage systems communicating with main sewers in the streets. At both the cities blocks of what appear to be workmen's quarters of identical two-roomed units have been recognized, at Harappa associated with a series of circular corn-pounding platforms and a great granary; at Mohenjo-Daro the comparable granary was on the citadel itself. The brickwork was probably largely plastered, and the use of wood for upper stories is likely. The Mohenjo-Daro granary appears to have been mainly a timber construction above its massive podium.

The buildings on the Mohenjo-Daro citadel include a large bath with surrounding verandah, assembly halls and what look like collegiate or communal buildings as well as the granary. There is no recognizable palace or temple, and a priesthood with affinities to Hindu tradition has sometimes been inferred as the likely seat of authority.

The material culture of the Indus civilization includes a competent wheel-made pottery tradition, with some black-on-red painted pottery. Tools and weapons (spears) are of copper or bronze and are archaic in type, neither the shaft hole for axes nor the mid-rib for spears and knives being known. There are, however, good beaten bronze vessels and elaborate jewelry in gold and semiprecious stones. Faïence was made and there was a very high standard of seal engraving. Models in clay and bronze show that more than one type of wheeled cart was in use, drawn by oxen, as there is no evidence for the use of the ass or horse.

While there is no monumental art in the Indus civilization, a number of important pieces of sculpture in stone and castings in bronze show the existence of a vigorous and individual art style. Some stone sculpture seems to have had metal embellishments attached and to have been painted. There are a large number of figurines of women and animals in baked clay. The steatite stamp seals, usually square, are among the most characteristic works of art in the Indus civilization, engraved in an assured style of glyptic with animal or mythological figures.

These seals also afford the main source for the Indus civilization script. Nearly 400 signs exist, in a stiff hieroglyphic style, not however recognizably pictorial, and they presumably represent a syllabary. The language they denote is unknown, and the longest inscription contains only 17 signs; most of them have not more than half a dozen.

A carefully controlled system of weights and measures prevailed throughout the Indus civilization. The cubical stone weights fall into a system binary in the lower values (probably based on the traditional Indian ratio 16) and decimal in the higher, with fractional weights in third. Fragments of what appear to be scales indicate the existence of a decimally divided "foot" of 13.2 in. and of a "cubit" of about 20.7 in. Corroboration of the use of both these units comes from a large series of check measurements on buildings of the culture.

The basic agriculture on which the civilization relied is hinted at by finds of wheat, barley, peas and melon seeds in the cities, and a very important find of fragments of cotton cloth at Mohenjo-Daro indicates the antiquity of this fibre in India. Domestic animals include humped cattle, dogs, cats and buffalo, while the animals depicted on the seals imply a jungle and marsh fauna existing in conditions very different from those obtaining in the region today.

The main evidence for outside contacts is afforded by the seals of Indus type found in Mesopotamian sites. About 30 are known, and dated contexts range from *c.* 2500 to 1500 B.C., the majority being Sargonid. Other pieces of evidence include stone "house urns" (probably from the Makran) found in early Dynastic contexts in Sumer and at a low level in Mohenjo-Daro, and representations of humped bulls (presumably Indian) on early Dynastic objects at Tell Agrab.

Animal-headed and spiral-headed pins on Indus sites, and a shaft-tube ax-adz from Mohenjo-Daro, suggest imports or invasion from the west in the second half of the 2nd millennium B.C., and with this would go the metal types in the Jhukar levels at Chanhu-Daro already mentioned. It is difficult to associate these, however, with the Aryan invasions of the *Rigveda*, though they may represent some tentative precursors of this movement. The "H" cemetery at Harappa has sometimes been attributed to invaders from the west, but the red-on-black painted pottery, although distinctive in its ornamental repertory, is nearer to local traditions than to anything likely to have been brought from the northwest at this time. The massacred bodies in the houses and streets at Mohenjo-Daro, and much other evidence, indicate that this must have been the case, even if the civilization was somewhat on the wane by this time.

Post-Harappan India.—The end of the Indus civilization came

suddenly and apparently as the result of attack from the west. Precise dates cannot be given, but the centuries between 1500 and 1300 B.C. would represent a likely chronological setting for these events that brought the Indus civilization to an end. Direct archaeological evidence has not been obtained for the Sanskrit-speaking newcomers, but their material culture is reflected in the *Rigveda,* composed in the second half of the 2nd millennium B.C. and consisting of a group of hymns and religious poems. From this evidence it can be seen immediately that the archaeology of the Aryans in India must have been in accordance with other branches of Indo-European language speakers at that time: a semipastoral existence based on flocks and herds and above all the horse; the use of the war chariot; and a technology which did not include the use of iron. The effect of this barbarian economy upon the highly developed urban culture of the Indus civilization can only be guessed at, but such evidence as there is suggests that the city culture was largely submerged except in certain important contributions to religious thought and speculation.

The problems of the phases immediately following the Indus civilization in northern India engaged field workers and excavators there in the years immediately following World War II. It was shown that on at least one site of the Indus civilization (or, archaeologically speaking, the Harappa culture), that at Rupar, 60 mi. N. of Umballa, a settlement of people using a characteristic black-on-gray painted pottery follows upon that of the Harappa culture. This black-on-gray ware has furthermore been found on more than 20 sites between the rivers Sutlej and Ganges, including a dozen places mentioned in the ancient Indian epic the *Mahabharata,* usually supposed to have been composed late in the 2nd millennium B.C. and largely descriptive of events in the Doab, in which the majority of these sites lie.

At one of the most famous of these, Hastinapur near Meerut, excavation has shown that the earliest settlement on the site, overlaid by one using black-on-gray ware, was characterized by an ill-fired, thick, ochre-washed pottery, known also from two other sites in the same region, Rajpur Parsu and Bisauli. Both these sites have also produced hoards of copper tools including flat ax blades and barbed spearheads or harpoons (though not in conclusive association with the pottery); such hoards and single finds of analogous copper implements are found elsewhere in the Doab and extend into Bengal north of the rivers Narbada and Mahanadi.

It seems likely then that these copper hoards date from an immediately post-Harappa phase, probably overlapping with the stage in which the painted black-on-gray ware was in use, and that a date late in the 2nd millennium B.C. or early in the 1st would be appropriate. Whether any of these elements of material culture can be referred to the Aryans must of course remain a matter of conjecture.

Outside the restricted area of northwest India discussed above, evidence for post-Paleolithic man is very slender until the dawn of the historical period. Some of the flint industries of microlithic type and the pointed-butt stone axes may go back to the 2nd millennium B.C., but there is no direct evidence of their upper date, and their lower date, as will be seen, comes to a century or two before the Christian era. Such stone types occur on the whole in India south and east of the Vindhya hills and the Ganges.

The lower limit of the painted-gray-ware culture in northwest India is unknown, but the next archaeological phase that can be distinguished has the advantage of being linked with more than one historical event. At Taxila in the extreme northwest the earlier settlements in the Bhir mound must lie in the 4th century B.C. as they antedate the Greek imports on the site associated with the campaigns of Alexander, if not in an even earlier phase. House plans of about this time in the Bhir mound show buildings set round a courtyard and including a hall with a line of three central pillars. On the same site a very characteristic pottery type can be assigned to the pre-Alexandrian levels; it has a burnished, almost metallic black surface and has been named northern black polished ware. It can be shown that this type of pottery continued in use into the historical Mauryan period, to about 200 B.C., and it has been shown to have a distribution in India practically coextensive with the empire of Asoka, *c.* 274–232 B.C. The not very conclusive evidence from the Ahichhattra (Ramnager) excavations suggest that there at least northern black polished ware is later than the painted black-on-gray ware described above, but there is no evidence as to whether there was direct succession.

Mauryan archaeology is represented by the well-known sandstone pillars with the Asokan edicts (with carvings of the same period, these share a particularly highly polished surface); the well-known series of stupas, which at such sites as Sanchi show clearly the derivation of the type from a burial mound with surrounding timber fence; small circular temples such as that at Bairat in Rajasthan; and rock-cut caves reproducing architectural forms. The great fortified site of Old Rajgir, which has been attributed to the 5th or 6th century B.C., has been shown by excavation to begin its existence at a time when northern black polished ware was in use at least, though this need not mean a pre-Mauryan date.

The best-known archaeological evidence of the Mauryans is the inadequately excavated and recorded site of the capital city of Pataliputra (Patna). Extensive remains of the timberwork defenses recorded by the Greek envoy Megasthenes were found, however, as well as the timber substructures of what was interpreted as a ceremonial hall of Achaemenian type with polished stone columns. Later excavations suggested that this interpretation of the remains should be treated with reserve, but the stone polishing together with the type of the pillar capitals show that in the 3rd century B.C. there must have been powerful Iranian influences on Mauryan art and architecture.

Outside northwest India and the boundaries of the Mauryan empire under Asoka little is known of the archaeology of the late 1st millennium B.C. Work at Brahmagiri in Mysore State, however, has given a partial sequence in that region, running back from the historical Andhra dynasty of the mid-1st century B.C. to an approximate date early in the 1st millennium B.C. The sequence can be divided into two pre-Andhra phases, of which the first is a basically stone-using culture, but one importing or making a few objects of copper and still more rarely of bronze. The stone industry includes pointed-butt stone axes and microliths of types mentioned above, and is accompanied by a coarse, hand-made pottery. There is slight evidence of rectilinear timber-framed houses, and burial was by inhumation.

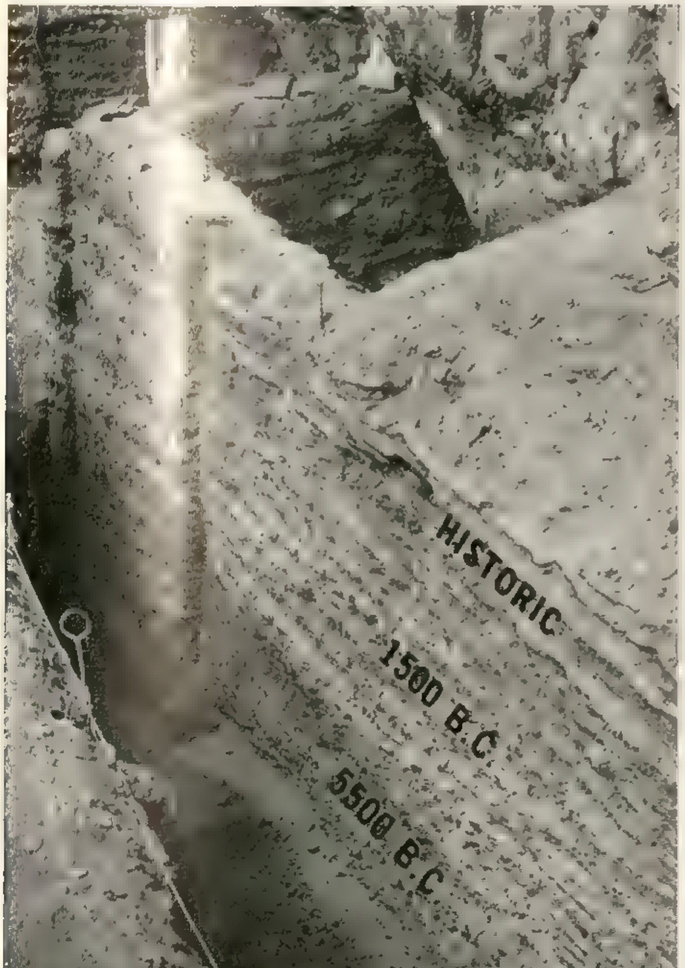
This phase was succeeded by an intrusive, iron-using culture having no affinities to that which preceded it. The iron equipment of these people includes sickles, swords, spears, knives, arrowheads and wedges, and they have a distinctive "black-topped" red pottery. Timber buildings seem to have been used.

The most striking feature of this phase is the great series of elaborate megalithic burials, some within stone cists of types widely distributed in peninsular India between 10° and 18° N. lat. The relationship of such tombs to the chambered collective tombs of Europe is quite uncertain, and they may well be the result of an independent evolution from a simple pit grave with slab lining. The Brahmagiri tombs were of two types, both set within circular walled structures; in one type there was a central pit in which the body appears to have been laid on a bier with its grave goods and left to decay, selected bones later being transferred elsewhere; in the other the burials were made in stone cists, on occasion with a porthole entrance through one side. The burials were fractional, with up to six skulls present in one tomb, and grave goods included iron tools and weapons and pots ranging in number from 6 to 62 in the ten excavated tombs of this type.

In the town site at Brahmagiri adjacent to the cist graves just described, the culture corresponding to that represented by the grave goods in the tombs could be stratigraphically placed earlier than a settlement of the Andhra culture, itself dated by Roman coins to the middle 1st century B.C. The iron-using megalithic culture, intrusive to the area, would then fall into the two centuries before that date, and historical probabilities would suggest that it was a reflection of folk movements in the disturbed years following the death of Asoka about 232 B.C.

In the northwestern part of the peninsula archaeological material such as that at Taxila in the Sirkap site can be dated in reference to Indo-Greek historical connections through the Saka dynasties of the 1st century B.C. into Indo-Parthian and Kushan

Step-trench excavation of Tell Judeidah, an ancient city of Syria. The tell (mound) of debris grew from the sixth millennium B.C. to the early Christian era. Buildings, largely of mud brick, slowly crumbled, collecting within and around the bases of the walls. The debris preserved the bases of the walls and added to the height of the ground level. On top of this layer, other buildings were built and the process was repeated. Some layers do not extend all the way across the mound



TWO KINDS OF STRATIGRAPHY

Both sites were inhabited during several millennia, and debris has been deposited in layers. Layer interfaces do not necessarily correspond to boundaries between cultural phases

Trench excavated in the floor of Veratic cave near Birch Creek, Idaho. A rock shelter, not a true cave, it was occupied by Indian food collectors who camped briefly, leaving artifacts. Detritus eroded from nearby cliffs to cover these remains. Other groups camped on top of the layer, and the process was repeated. The layers in the walls of the trench suggest climatic conditions under which they were deposited, and permit inferences about man's environment. Three major climatic phases and several cultural phases, spanning nearly 10,000 years, are represented

BY COURTESY OF (TOP) THE ORIENTAL INSTITUTE, THE UNIVERSITY OF CHICAGO, (BOTTOM LEFT) LLOYD FURNISS AND IDAHO STATE UNIVERSITY MUSEUM

Partly occupied Indian pueblo at Old Oraibi, Ariz.; buildings to the right are abandoned. If this village now were abandoned entirely, a tell-like layer of noncontemporaneous remains would result. On excavation, the buildings could not all be expected to belong to the same period of occupation

CHRONOLOGICAL INFERENCES FROM MAN-MADE REMAINS

South end of the temple of the goddess Innanna (Ishtar) at Nippur, Iraq, showing remains of two shrines. The walls are from the ninth (now labeled VII) of 24 levels, indicating their relative date. Architectural style and objects found inside were compared with similar objects from other sites with known dates, and the cultural phases are identified as Early Dynastic II/III

Great plaza and pyramidal mound supporting Temple I at Tikal, one of the largest Mayan centres in Guatemala. Unlike Egyptian pyramids, this mound was built for the temple, as well as for burials. An earlier pyramid was later encased inside a larger one, forming inner and outer layers. Chronology is inferred from layering, architectural style, inscriptions and the contents of Late Classic and Post-Classic burials

BY COURTESY OF (BOTTOM LEFT) THE ORIENTAL INSTITUTE, UNIVERSITY OF CHICAGO, (BOTTOM RIGHT) UNIVERSITY OF PENNSYLVANIA MUSEUM; PHOTOGRAPH, (TOP) SPENCE AIR PHOTOS

Hut in the Paleolithic settlement at Doení Věstonice, Czech., with an oven containing remains of more than 2,300 clay parts of animal figurines. The presence of these earliest-known ceramics in only one hut indicates that special loci of production already existed

Grave Circle A and shaft graves at Mycenae, Greece, that yielded elaborately decorated treasure testifying to craft specialization and wealth of occupants. The stonework suggests experience with monumental architecture; and the exclusiveness imposed by the circuit wall indicates the burial ground of an elite. These imply a stratified society with occupational specialization, and large-scale architecture which is usually associated with urbanism

CULTURAL INFERENCES FROM MAN-MADE REMAINS

Mississippian ceremonial mound group at Etowah, near Cartersville, Ga., dated before European contact. Traces of a moat are visible behind the mounds; in the foreground is a plaza containing burials. The mortuary-temple mound in the left background now is completely excavated. Differences in content and orientation of the burials imply social differentiation. Accounts by early explorers from Europe suggest that the two mounds in the foreground may have supported houses of ceremonial leaders. The complexity of this centre and the absence of others in its vicinity suggest that it served more than the immediate area

Possible kill site at Isimila in Tanganyika. Negative evidence, absence of bones from the extremities and skull, suggests that the *Hippopotamus amphibius* may have been slaughtered or scavenged by men; other predators rarely are as selective. Absence of other human traces may indicate that the location was functionally specific, that only one subsistence activity was carried out here. Tools from elsewhere in same horizon identify the feature as Lower Paleolithic, late Acheulian

Grave of a bear from a dwelling site at Sorviken near Storuman, Sweden. The axecleft skull and the bones, cracked as if for marrow, imply that men ate the animal. Religious practices are implied by the ritual arrangement of the bones with the head to the north, and the covering of branches and birch bark. Other artifacts and their present-day counterparts link the site to Lapp culture

Paleolithic open air site at Ambrona, Spain, with bones of extinct straight-tusked elephants. Positive evidence, stone tools and traces of fire may indicate human activity beyond that of a functionally specific site

CULTURAL INFERENCES FROM ANIMAL REMAINS

PHOTOGRAPHS (TOP LEFT, BOTTOM) F. CLARK HOWELL, UNIVERSITY OF CHICAGO, (TOP RIGHT) S. JANSEN "FRAN NORRLANDSÄLVAROCH FJALLSJÖAR"

times. In the southeast, however, fixed points for dating the native cultures were lacking until the identification and excavation of a Roman trading station at Arikamedu on the Coromandel Coast. The site, which may be the Podouke of the *Periplus maris erythraei*, yielded imported Arretine and other Mediterranean pottery of the 1st centuries B.C.–A.D., together with gems and glass, and had a considerable area of brick-built structures, some of which may well have been warehouses. A characteristic type of native pottery on the site has rouletted patterns derived from the imported Arretine wares, and this constitutes a secondary dating point which has been used on other sites such as Brahmagiri; it occurs also at the town site adjacent to the well-known Amaravati stupas and elsewhere in eastern India.

At one such site, Sisupalgarh, near Bhuvaneswar in Orissa, it was possible to utilize the Arikamedu and Brahmagiri dating evidence to good effect on a city site which continued in occupation until the middle of the 4th century A.D. The material culture represented on the site appears to have been uniform throughout its history, with imported pottery of the Brahmagiri megalithic culture appearing in the early (but not the earliest) phase and rouletted Arikamedu ware at a later stage. The culture appears to have been iron-using throughout, with timber and brick buildings and later stone constructions of laterite blocks. Early in the middle period (beginning of the 2nd century B.C.) the city was enclosed in defenses which form a square with a side ¾ mi. long; the rampart was originally of clay but was faced with burnt brick revetments in the early 1st century A.D.

The great series of excavations at Taxila take one into the world of Greek and Parthian contacts; the Sirkap site was occupied from the middle of the 2nd century B.C. and was defended by bastioned stone walls almost from the first. In its second period, ending about A.D. 150, Roman imports of glass and bronzes were reaching northwest India.

Elsewhere the application of archaeological method to the later phases of Indian history has hardly begun. Studies of sculpture on art-historical lines have been carried out, but no secure series of types dated from excavations has been produced. A beginning has been made at Ahichhattra, near Bareilly, where a stratified sequence of pottery and figurine types has been obtained and correlated, stretching over nine main phases between before 300 B.C. and A.D. 1100. This city site was continuously occupied and constantly rebuilt during this period; houses were built of burnt bricks, and there were two remarkable terraced temples, square in plan, one of which was dated as early Gupta (4th century A.D.).

Apart from some architectural studies, archaeology has been used in Islamic contexts only in the small-scale excavations at Adilabad, a fort of the Tughlakabad complex at Delhi, occupied and constructed around A.D. 1325.

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X. CHINA, SOUTHEAST ASIA AND JAPAN

Gobi Cultures.—At the beginning of the Holocene, when the waters of retreating glaciers gave the finishing touches to the loess-covered landscape, north China appears to have been uninviting as a habitat for man. No traces of human activities bridge the gap between the late Paleolithic industry of the Upper cave at Chou-k'ou-tien and the Yangshao villages of the late Neolithic. In other words, in place of a Mesolithic or early Neolithic there is a hiatus. In Mongolia, however, finds pertaining to those phases were made in abundance. Deposits of microlithic industries around ancient lake beds tell of a flourishing life of hunters and, later, primitive husbandmen in lands that have since turned into deserts in the slow process of desiccation which made the Gobi grow and the Chinese swamplands shrink. The best-explored station of the Gobi culture is Shabarakh-Usu (44° N., 104° E.). Their lithic inventory links these cultures with the expanded front of post-Paleolithic microlith-using cultures in the west, such as the Capsian of north Africa and the Natufian of Palestine, though possibly with a time lag. Even so, Pierre Teilhard de Chardin considers a date as early as 8000 to 10,000 B.C. for the beginning of Shabarakh. Comparable strains appear in Jehol (Ulan Hata; Lin-hsi) and north Manchuria (Hailar and Ch'i-ch'i-ha-erh [Tsitsihar] regions), where Siberian influences are predominant. It is noteworthy that these industries of small chipped blades and scrapers and polygonal nuclei (micronuclei) are not found to the south of the line where later was erected the gigantic structure of the Great Wall, which thus marks a cultural border line of surprising stability.

Painted Pottery Cultures of North China.—The Neolithic hiatus came to an end when, unheralded by archaic forerunners, a splendid late Neolithic culture with painted pottery spread rapidly across north China. First discovered by J. G. Andersson at Yang-shao-ts'un (west Honan) in 1921, this still insufficiently explored complex is often termed "Yangshao culture." Its upholders were settled farmers who were living in fairly large villages on the fertile and sparsely forested loess soil along the rivers of Kansu and the adjacent provinces to the east as far as Honan. Sometimes they chose steep terraces that were easily defensible and well above the flood plains. Their staple crop was millet, but rice too was cultivated, at least in Honan. Pits dug in the loess served as dwellings and storage holes; in Kansu, walls with a plaster finish have been observed. The existence of timber huts can be surmised. The implements were made of polished stone; no chipped tools occur. Heavy axes with a rounded rectangular cross section, flat axes, adzes and knives of trapezium and semilunar shapes with two perforations are the commonest types. Beautiful minerals such as turquoise, jade, amazonite and marble were worked into pendants and beads, and jade, imported from east Turkistan or Siberia, was cut into slabs and perforated with hollow drills. Jade disks similar to those used by the Chou princes in ceremonial and worship were recovered from burials in the Pan-shan hills in Kansu.

The hitherto known phases of the Painted Pottery culture are named after type sites in Kansu, the only region where such phases have been recognized. The following styles appear as a clear sequence: Pan-shan, Ma-ch'ang, Hsin-tien and Sha-ching. There is no stratigraphic evidence of this sequence from any one site, but in a locality at Hsin-tien a layer of Hsin-tien remains was found to overlie a Yangshao stratum. No metal was observed in the Pan-shan and Ma-ch'ang sites, whereas both Hsin-tien and Sha-ching have yielded small bronze objects. This circumstance indicates a chronological relationship which is suggested also by the ceramic styles. Ma-ch'ang can be shown to have evolved from the Pan-shan style, the leading motif of which is the spiral or rotary S curve. Characteristic of the Ma-ch'ang style are angular ornaments such as meanders and T hooks. Transitional designs are numerous. Hsin-tien retains the meander in its narrow repertory of ornaments, but the shapes of the vases have undergone changes that point to some break in traditions. Sha-ching offers the aspect of an impoverished Hsin-tien style.

However, developments in Kansu localities not mentioned so far appear to have taken a somewhat different course. Patterns in black, executed with sweep and temperament, peculiarly conventionalized systems of curves derived from the spiral motif, are typical of the wares found in several dwelling sites such as Ma-chia-yao, Lo-han-t'ang and Chu-chia-chai. Comparable ornaments recur in tripods of the Ssu-wa-shan group, a cruder and most often unpainted ware which appears to have come from eastern China presumably some time after Ma-ch'ang. Some of these conventionalized patterns occur also in south Kansu, side by side with impressive flowerlike designs which are nearly identically found in specimens from Ching-ts'un and Hsi-yin-ts'un (southwest Shansi). These "flower" patterns are safe links between Kansu and the Shansi-Honan nexus and provide a dependable basis for chronological equations.

Hsi-yin-ts'un is a large dwelling site where small-scale excavations were carried out by P. L. Yüan and Li Chi in 1926. In contrast with Kansu, the painted wares there are associated with a burnished black ware which in the upper strata increases at the expense of the painted ware. The same mixture of painted and

black potteries—which are outnumbered by coarser types in grayish and brownish hues—obtains also at Yang-shao-ts'un (west Honan). Several west Honan sites, however, have the lustrous black or gray wares but no painted pottery at all. Excavations conducted by teams of the Academia Sinica in north Honan in the 1930s repeatedly resulted in the observation of red-black-gray sequences in this stratigraphic order, with gray usually referring to the Shang dynasty horizon. Finally, in the easternmost provinces (Shantung, Anhwei, Kiangsu, Chekiang) black alone is encountered. This distribution is highly significant. It clearly points to Kansu as the radiating hearth of the painted pottery in China. The ultimate sources of the art of vase painting will, however, be found in the near east and secondary centres in southeast Europe (Ukraine, Balkans), which latter offer the closest parallels to China.

Northern Frontier Sites.—Along the border line of the (chipped) microliths and (polished) neoliths referred to above, a number of sites between Lake Koko-nor and Jehol have been observed which testify to northern advances of the Painted Pottery culture. The most important of these sites in Ulan Hata (Chinese: Ch'ih-feng) in Jehol, where the painted ceramics enter an environment which theretofore was essentially similar to the Linhsi facies of the Gobi cultures. Farthest east, the strange ossuary of the Sha-kuo-t'un cave (between Mukden and Shan-hai-kuan) marks the easternmost extension of painted pottery, which there again is associated with elements of northern derivation.

Black Pottery Culture.—The typical pottery of this complex, which is also termed Lungshan culture (from an eponymic site in west Shantung), is black, lustrous, often surprisingly thin; wheel-thrown, the vases are distinguished by sharp, angular silhouettes; their surfaces occasionally show some incised geometric ornament and are never painted. Nor have painted ceramics of Yangshao type been encountered in any of the numerous sites located from Shantung down to Hangchow bay. Gray, brown, yellowish and whitish pots occur with the black wares. Implements are made of polished stone, shell, bone and antler and are largely similar to those from Yangshao. Metal objects are extremely scarce; a few arrowheads of bronze were unearthed in southwest Shantung. Excavations at Ch'eng-tzu-yai (Lungshan) revealed a lower stratum without metal, separated by a sterile sandy layer from an upper stratum which corresponds to a settlement abandoned apparently some time in the Western Chou period (1027–771 B.C.). While the early Yangshao farmers had domesticated chiefly the pig and the dog, and later had also cattle and sheep, those of Lungshan I had acquired the horse. To consider this complex as developed from the Painted Pottery culture entails serious difficulties; rather it may be assumed that new contacts with western Asia, particularly northern Persia (Tepe Hissar) and the east Caspian steppe (Shah Tepe), two areas offering conspicuous analogies, contributed to its formation. China would thus be linked with that widely spread ceramic fashion of black and gray burnished wares which in the old world supervened almost universally after the painted pottery and which appears as basically one and the same manifestation under varying names such as Aunjetitz (central Europe), Minyan (Aegean), Jhangar (Sind). In any case, the western analogies make it unlikely that the Lungshan culture in eastern China goes back beyond the beginnings of the 2nd millennium B.C., whereas its end may have been precipitated by the rise of the Shang dynasty around the middle of the 2nd millennium.

The southernmost Black Pottery culture station known is Liang-chu (Chekiang). At that site were found stone tools of apparently southern character (ridged adz; stepped adz) as well as pottery types strikingly reminiscent of west Asian ones (footed bowls), which in China have their parallels not only in Lungshan (Shantung) but also in the province of Szechwan, a circumstance which makes it all the more puzzling that this type of bowl with its characteristic long, hollow stem has not been reported from Kansu.

Whereas no trace of a script has come to light in Lungshan sites, there are several features to connect this culture with the Shang dynasty: shapes of Shang gray pottery and Shang bronzes of archaic type; tamped earth structures; and the use of animal bones, specifically shoulder blades, for the purpose of divination.

Bronze Age in Northern China.—Compared to western Asia, bronze appeared rather late in China. The oldest Bronze Age site known is that of the last capital of the Shang dynasty (*c.* 1523–1028 B.C.), located in an area of several villages west of Anyang (north Honan) and dating most probably from 1300–1028. The finds made there during 15 campaigns directed by Li Chi between 1928 and 1937 revealed a stage of metallurgy so highly advanced that the assumption of a more archaic phase became almost imperative. That phase would, naturally, correspond to the period of early Shang rule between *c.* 1523–1301, which is archaeologically still obscure. None of the earlier Shang residences, however, are identified, nor do we know of stray finds of truly primitive types of bronze tools or vessels. It seems, therefore, that the splendorous Shang civilization had emerged suddenly against the background of the Black Pottery culture, whose remains were found immediately underneath the Shang (or Yin) stratum in various localities of the Anyang area (Hsiao-t'un, Hou-kang, Kao-ching-t'ai-tzu, T'ung-lo-chai). This stratigraphic relationship, on which the calculations of the absolute age of China's prehistoric cultures depend, suggests the first half of the 2nd millennium B.C. for Lungshan and the late 3rd millennium for early Yangshao, dates which are in agreement with those based on comparisons with west Asian or European analogies.

Numberless objects of exquisite workmanship in bronze, clay, marble, jade, turquoise, shell, bone and antler have come from lavishly equipped tombs of the Shang kings and noblemen at Hsiao-t'un and Hou-chia-chuang, reflecting some facets of their mentality and luxurious mode of life, the bellicose aspect of which is more fully revealed through burials of war chariots, harnessed horses, skeletons of immolated prisoners and a great variety of weapons (without the sword). Historically important are the finds of scores of oracle bones and tortoise shells with incised texts relating to warfare and hunt, sacrifices to the royal ancestors, crops and herds, the weather and everyday events. They are written in a script which differs only paleographically from the Chinese ideograms still in use; it is a fully developed script, the origins of which are unknown. The same might be said of Shang art another unmistakable manifestation of Chinese genius: neither its sources nor its evolution are fully understood In contrast with the Neolithic past, which appears only as part and parcel of developments spreading all across Eurasia, something *sui generis* and specifically Chinese came to life in Shang art which profoundly affected the future course of Chinese art.

Southern China.—Scanty evidence of a Paleolithic in the Yangtze valley is followed by an archaeological void. Intense searching in no fewer than 367 caves along the Yangtze gorges (N. C. Nelson, 1926) yielded not one object of an archaic Neolithic character. In the deep south, the "Mesolithic of the Kwangsi caves" appeared some time during the obscure period of millenniums preceding the Neolithic. A crude pebble industry without flakes, blades, polished tools or pottery, the Kwangsi Mesolithic closely resembles the Hoabinhian of Tongking and probably was an offshoot of the latter rather than a locally rooted culture. The remains were collected from hardened layers overlying Pleistocene yellow clays. Without traces of subsequent developments, this culture disappeared again in time to permit stalagmitic covers to form on top of the archaeological deposits.

In the area between Swatow and Hong Kong, late Neolithic remains were observed by J. Shellshear, D. J. Finn and R. Maglioni. On the basis of those finds, Maglioni proposed the following provisional sequence: Hoifung I (Sov) has the polished rounded ax (*Walzenbeil*) as its characteristic tool; its potteries consist of a cord-impressed ware similar to Indochinese types, a smooth-finished ware with incised, dotted or stamped geometric ornaments around the neck, and footed dishes showing traces of paint in red and white. Hoifung II (Sak) stone tools are partly polished axes, leaf-shaped arrowheads and stone bracelets. In addition to a coarse corded ware there is a finer one with foot rims and stamped décor. Some unassimilated ethnic groups living in south China may be descendants of the "Sak people." Hoifung III (Pat) denotes a Chalcolithic culture with the stepped adz (*Stufenbeil*) as its most typical tool. Locally quarried hardstones were used for

bracelets, beads, arrowheads, beautifully finished flat axes and lanceheads, as well as halberd blades which undoubtedly are related to the bronze *ko* of Shang and Chou times. Corded ware continued to be made. A better, thinner but not wheel-made ware distinguished by a net pattern in low relief is a feature paralleled in the Black Pottery complex of Shantung. This culture, with affinities to the north and across the sea (Philippines), was probably that of a seafaring folk that may have to be identified with the Yüeh people; modified by a gradual acquaintance with metallurgy, it persisted until the conquest of the south by Han Wu Ti's armies in 111 B.C.

Indochina.—In contrast with a rich fossil fauna, no trace of Pleistocene man or his artifacts has been found in this area. The earliest cultures known are those of the caverns and *abris* in limestone formations of Tongking and north Annam. Paleo-Mesolithic in character, according to M. Colani, they are comprised under the designations of Hoabinhian and Bacsonian. In the deposits of the numerous sites (Bacson massif, north Tongking, 45 sites; Hoabinh, south Tongking, 33; north Annam, 18; central Annam, 3) three stages have been recognized, which partly overlap. Large, crudely chipped implements, among which the Hoabinhian "short ax" stands out, are typical of Hoabinhian I. Hoabinhian II shows a tendency toward smaller sizes of stone tools. Grinding of the edges of otherwise raw or crudely worked pieces is an innovation which H. Mansuy regarded as a foreign contribution. The so-called Sumatra type of oval adz chipped on one side only was current in Hoabinhian II and in Bacsonian I. The tendency toward smallness is also displayed by the Hoabinhian III tools. Edge grinding remains a characteristic trait of the Bacsonian II phase, and it was practised apparently all along the coastal stretch down to Perak. In Bacsonian III the old types of chipped scrapers and oval adzes give way to more perfectly polished tools, and for the first time there appears pottery, some of which shows cord impression.

The only station in the open and close to the modern sea level is Da-but (Thanh-hoa, Annam), where a sequence of ten strata yielded lithic types primitive enough to be described as eoliths, yet associated with pottery. The typical Bacsonio-Hoabinhian stations are never encountered in the alluvial lands occupied by the rice-growing Annamites.

Craniological remains of the early phases revealed two distinct elements, viz., a Melanesid one (Pho-binh-gia type) of Papuan-Melanesian affinities, in stations closer to the coast, and a Veddid one (Dong-thuoc type), of Indonesian-Malayan affinities, encountered farther inland. A third component points to paleo-Mongolid advances from China toward the late Bacsonian. Negrito traits were recognized by E. Patte in a child's skull from the late Neolithic site of Minh-cam (Quang-binh, Annam).

Late Neolithic assemblages are best known from settlements in the alluvial regions along the lower Mekong (Somrong-Sen; Mlu-prei) in Cambodia and at the upper Mekong (Luang-Prabang) in Upper Laos. From among a great variety of perfectly shaped and polished stone tools, the shouldered adzes—still absent in the archaic Neolithic of Da-but—stand out as most typical. Occurring in many transitional forms, their distribution coincides, as shown by R. von Heine-Geldern, with that of the Austroasiatic peoples in India (Munda) and farther India (Mon-Khmer), whereas they are sparsely represented in China and Japan and are absent in Indonesia. Some ceramics of this period have incised spiral designs which recall the painted spirals of Kansu (northwest China). Bronze objects appear before the end of these settlements, especially socketed celts derived from Yünnan types, the ultimate prototypes of which are Siberian and European.

The bronze culture of Dong-son (Thanh-hoa, Annam) is dependent on China and may have to be connected with movements of the Yüeh (southern Chinese: Viet) into Tongking and Annam before the middle of the 1st millennium B.C. A puzzling aspect of the Dong-son bronzes is their closeness to Hallstatt.

Philippine Islands.—Having been linked to south China and Formosa in the north, to Malaysia, the Sunda shelf and Borneo in the southwest and to Celebes in the south by land bridges in Pleistocene times, the Philippines reflect the early cultural stages of the continent and at the same time functioned as one of the major gateways to the Pacific islands.

The oldest-known artifacts, found on Luzon and Mindanao in strata resembling the Trinil beds of Java, are considered to be of Middle Pleistocene age. Cleavers and hand axes of possibly Upper Pleistocene age have also been collected in Luzon. This island moreover is very rich in Mesolithic sites that have yielded chert and obsidian chipped tools of semimicrolithic cast in stratified deposits. Similar industries recur in the Sunda Islands. No human skeletal remains have been recovered from any station of these phases.

Heavy and crude implements of Hoabinhian type associated with osteological material identifiable as Melanesid in character point to connections with Indochina. So do roughly worked axes ground at the edge only, which H. O. Beyer equated with Bacsonian types from about 6000–4000 B.C.

The first Neolithic wave, supposedly entering by way of Formosa, brought the round ax to the Philippines, whence this type traveled on into the Pacific as far as New Zealand. The ridged and tanged adzes appear to have come the same way but were developed on special lines in Luzon, where there probably originated the Polynesian tool known as the Hawaiian tanged adz. Continental inventions such as the Hoifung III stepped adz, but another variant of these peculiarly articulated adz types, contributed also to the formation of the Philippine form of the stepped adz in the 1st millennium B.C. The shouldered celt, sparsely met with on Luzon and Celebes, agrees with the archaic Indochinese types and thus may have arrived before 2000 B.C. The final Neolithic phase is marked by the advent, perhaps over several routes, of rectangular and trapezoidal adzes made of beautifully polished hard rocks. Refined lithic techniques such as the sawing and drilling of hard minerals were known to the islanders in the last millennium B.C. Their basically Neolithic culture was not greatly altered by the possession of some bronze socketed celts and weapons which reflect continental developments before 1000 B.C.

Japan.—Archaeological research in Japan has resulted in a detailed knowledge of the distribution and types of prehistoric remains without having led, at least by the 1950s, to a clear overall picture. To some degree this is due to the fact that the critical areas and phases on the Asiatic mainland are insufficiently explored. A question of prime interest, that of a Japanese Paleolithic, has not been solved. In late Pleistocene and earlier Holocene times the country was connected with the continent by land bridges that would have enabled man to migrate. Yet undisputed Paleolithic relics are wanting; conceivably they did exist but vanished under the ocean when in geologically recent times the country sank to its present level. The isles thus formed—perhaps only after 5000 B.C. in G. J. Groot's estimate—come closest to the continent in the extreme northeast (Sakhalin) and in southwest Honshu and north Kyushu opposite the southern tip of Korea. These areas no doubt were the two gates through which the main streams of Neolithic immigrations must have passed, while a third one, Kyushu, stood open to seafaring peoples from the south.

Japanese Neolithic.—The position of the isles favoured early intrusions of Siberian elements. The importance and southward diffusion of the latter, whom we may broadly equate with the Europid Ainu component of Neolithic Japan, can still be gleaned from linguistic survivals. No language older than Ainu has left its traces in Japan, according to John Batchelor, who showed that Japanese geographical names of non-Japanese etymology are without exception Ainu in origin and that geographical names in Siberia can be explained by Ainu words. Siberian connections can also be proved archaeologically. Trim chipped tools of fine homogeneous rocks such as flint, obsidian, agate, chalcedony and the like, which by their technique and their shapes—polyhedral cores or nuclei, lamellar flakes, fine blades—are related to lithic traditions of the subarctic zone of north Asia, are excellently represented in the northeast (*e.g.*, in the Sumiyoshi site, Hakodate city, Hokkaido) but are scarce in southwest Japan. Their prototypes will be found among the shapely materials from the Angara and Baikal areas rather than in Manchuria and the Gobi, as suggested by H. Watanabe. The same holds true for much of the primitive

pottery. Vessels with pointed bottoms, wavy rims, decoration by shell impression and shell streaking, spatula grooving and lunular impressions have their counterparts in Siberia as early as the 3rd millennium B.C. (Ulan Khada, Angara). An important early site in Honshu, Tado (Yokosuka city), which in addition to shell-impressed pottery offered samples of fibre and cord impression, is closely related to Sumiyoshi. The term "Tado-Sumiyoshi" defines that archaic Neolithic culture which had spread over the whole of northeastern Japan.

The Mongolid (Tungid and north Sinid) strain of the prehistoric Japanese must, to a large extent, be attributed to arrivals from Korea by way of the Tsushima straits, attested to by finds of clay vessels with pointed bottoms and with roller-stamped décor such as were made at Sobata (north Kyushu). Derived from a Korean *Kamm-Keramik* complex, this ware, along with an associated lithic industry, is again related to the Gobi cultures and the northeast Asiatic sphere at large. Distinctly Chinese types such as tripods with hollow or solid feet, as well as derivatives of the painted and black potteries, are absent.

Japan's Neolithic stone implements are so varied as to cover nearly the whole range of types current on the continent, inclusive of southeast Asia. An assemblage of crudely chipped pebble tools found with pointed-bottom pots in the Kozanji shell mound (Hyogo prefecture, Inland sea) has its closest parallels in the Hoabinhian of Indochina.

The time of the first arrivals from the continent is far from being exactly determined. Dates prior to the subsidence of the land are precluded by the very location of the Neolithic sites, shell mounds, close to the present shore line. E. von Eickstedt holds that the isles were still unpopulated as late as the 4th or 3rd millenniums, an assumption which is not contradicted by the crude estimates permissible on archaeological grounds, namely, the Siberian and Gobi parallels, with time lags commensurate to the eastward transmissions.

Jomon Period.—A coherent story in Japan's prehistory begins with the Jomon culture, named after its major archaeological legacy, the Jomon (cord pattern) pottery. Apparently this culture arose in the Kwanto plain (central Honshu) from the contact and amalgamation of the ethnic forces which had moved in from the northeast and the southwest and were absorbed, according to T. Esaka, by an already present older *Homo japonicus*. It has to be admitted, however, that the intimated process of absorption is not proved archaeologically any more than anthropologically, whereas there seems to be little reason for doubting that Jomon man, whose physical characteristics are well known from many excavated (contracted) burials, entered into the ancestry of the Japanese and, more pronouncedly, of the Ainu. Jomon man's unique ceramic art, distinguished by vases of bold and sometimes fantastic shapes with cord-impression effects, curvilinear designs, as well as plastic ornaments of an exuberant and imposing aspect, has been studied intensely, with a stress on the Honshu finds.

The early Jomon period adds fibre-tempered pots with flat bottoms to the pointed-bottom types, and there appear polished axes (Sekiyama; Kurohama). A widespread pottery style, Moroiso, distinguished by relief decoration, overlaps with the following stage. Middle Jomon produced ceramic types with heavy relief décor and spiral designs (Otamadai; Katsuzaka). Grotesque clay figurines of females and stone batons of a probably phallic significance appear in this period, as do polished cylindrical axes and, in the northeast, also quadrangular ones. In the later Jomon period, finer, thin-walled vessels predominate, and contrasts of smooth and corded surfaces as well as incised patterns are typical modes of decoration (Ubayama; Horinouchi; Omori). It should be noted that the Horinouchi type is found all over Japan, as is the graceful Kamegaoka style of the subsequent final Jomon period. Stemmed arrowheads are considered a novelty of the later Jomon culture, which on the whole retained the pre-Neolithic aspect of the bygone phases but advanced toward community life on a village level, as indicated by the very large sites. In the final Jomon period (Kamegaoka; Shonohata; Angyo) remarkable innovations are seen in the economic sphere. Agriculture was now practised, and cattle had finally become known after many ages during which the dog had been the only domesticated animal. Urn burials are a significant new trait, as are such luxuries as lacquered cups and combs and tooth-shaped jade beads. In the ceramics of this period, openwork effects and the pedestaled bowl were introduced. Lasting on in northeast Japan, the Jomon culture came to an abrupt end when a superior culture that possessed the horse, metal and rice penetrated southwest Japan about the 1st century B.C.

Yayoi Period.—Ceramics of fine texture, reddish-brown colour and neat, wheel-thrown shapes, first discovered in a Tokyo street, Yayoi, are one of the archaeological records of the changes brought about by their makers, who came as conquerors and became the founders of Japan. They cremated their dead, but the few skeletons recovered show them to be of Tungid (Tungusic) affiliation. They had come from Korea and brought a short-lived Bronze Age into western Japan, where their bronze weapons and mirrors of Chinese type have been found. Some imported Han mirrors give a safe clue, for the first time, to absolute chronology. Advancing toward the Kwanto plain but not farther east, that bronze culture was soon superseded by an Iron Age, presumably under renewed influxes from Korea and possibly also from China. A hard, grayish ware, the Iwaibe pottery, is associated with iron objects in the dolmen burials of Yamato, centre of the consolidated power of the rising empire. Attractive figurines of warriors, women, animals, houses and ships—strikingly different from the uncouth Jomon idols—form part of the funerary gifts, as do iron weapons, armour, helmets and the familiar claw-shaped jewels (*magatama*). Jomon man, as far as he did not fuse with the Yamato people who from A.D. 400 onward maintained official relations with successive Chinese courts, was slowly pushed back to the northeast. By the end of the 1st millennium A.D., the region of Aomori and north Mutsu was all that he still held on Honshu.

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XI. ISLAMIC ARCHAEOLOGY

The first branch of Islamic archaeology to arouse interest was numismatics. The earliest publications—monographs by G. J. Kehr—date from 1724 and 1725, and a number of catalogues of coin collections in Rome, Padua, Göttingen and Stockholm were brought out during the course of the 18th century. The early 19th century witnessed the valuable work of C. M. Frähn, and in the second half of the century catalogues of the great numismatic collections in London, St. Petersburg, Paris, Istanbul and Berlin were brought out, which still belong to the main tools in this field.

Romantic interest in Spain led in the first half of the 19th century to the publication of large volumes with elaborate plates on the Muslim architecture of that country (the earliest writer being James Cavanah Murphy in 1813). The first investigation of the Muslim architecture and crafts of Egypt was attributable to Napoleon's campaign. French scholars were commissioned to bring out a systematic survey of Egypt, including its art, which was published in the 19 volumes of the *Description de l'Egyp-*

(1809–28). Later in that century other investigations of the Muslim architecture of Egypt were undertaken by Pascal Coste (1839), J. Bourgoin (1873–92) and A. C. T. E. Prisse d'Avennes (1877); the main value of these publications lies in their plates. Iranian architecture was studied somewhat later by P. Coste and E. Flandin (1851–67) and Hommaire de Hell (1859). The first half of the 19th century also saw the first thorough investigations of Islamic art objects (J. T. Reinaud, 1828, and M. Lanci, 1840 and 1845–46).

Muslim archaeology in the narrower sense (that is, the exploration of the past through excavations) did not commence before the very end of the 19th century. In 1898 excavations at the Qal'at Bani Hammad, the 11th- and 12th-century capital of the Hammadites in Algeria, were started by P. Blanchet and, in 1908, continued by L. de Beylié. Although this was only a site of limited, provincial interest, the published results threw considerable light on north African architecture, especially of the secular type, and on pottery and wall decoration. Another palace site of western Islam, Madinat az-Zahra, the residence of the Omayyad caliphs of Córdova in the 10th century, was first explored by R. Velásquez Bosco, about 1910, and these excavations were still intermittently continuing in the 1960s. Many structures were cleared and the elaborate stucco decorations applied again to the inside wall surfaces, while a small museum on the spot gave further insight into the material culture revealed by the excavation.

Perhaps the most important and most systematic excavation was conducted by the German scholars F. Sarre and E. Herzfeld at Samarra on the Tigris (1911–13). The campaigns cleared only a small portion of this immense 9th-century capital of the Abbasid caliphs, but they nevertheless provided a large amount of information about the arts and the life in a centre of the Muslim world in one of the artistically most active periods (*i.e.*, only a few decades after Harun al-Rashid). In view of the short existence of Samarra the excavated objects could also be used as a convenient clue for the dating of related but undated material from other sites. Several publications on the pottery, glass, wall decorations and paintings, as well as on the history of the site, were published, but the deaths of the excavators prevented the final publication of the volumes on the architecture, which would have been specially significant.

The great archaeological past of Muslim Iran was probed more extensively only at two sites. At Susa, J. de Morgan had started excavations at the end of the 19th century, but he and his immediate successor were mainly interested in the prehistoric and Achaemenid levels; a systematic unraveling of the various layers from the 13th century down to the pre-Islamic town was later undertaken by R. Ghirshman. More important as a cultural centre than Susa was Nishapur in northeast Iran, where J. Upton, W. Hauser and C. K. Wilkinson, on behalf of the Metropolitan Museum of Art in New York city, dug up the 9th-, 10th- and 11th-century levels, which yielded large amounts of stucco decorations, pottery, glass, stone carvings, metal objects and even some wall paintings, now to be found in the New York and Tehran museums. The great importance of this work (which was stopped all too soon) has been generally recognized. Other phases of the archaeological past of the east Muslim world, in the urban centre of Termez (Tirmidh) and the feudal castles of Khwarizm (Khorezm, Khiva), have been successfully explored by Soviet scholars, especially by S. P. Tolstov, who brought out three volumes on his Khwarizmian excavations (1948 and 1952). Even before this Russian scholars had published books on the Muslim architecture of central Asia and the Caucasus and articles on the finds at Sarai Berke, the 14th-century capital of the Golden Horde on the Volga.

The period between World Wars I and II saw a great deal of archaeological activity in Syria and Palestine, especially with regard to the earliest Muslim period, that of the Omayyad caliphs and their surviving monuments dating from the first half of the 8th century. Perhaps the most successful of these campaigns was that of the desert castle of Qasr al-Heir al-Gharbi near Palmyra, where the French archaeologist Daniel Schlumberger discovered an astonishing amount of figural and ornamental stucco decorations and paintings (exhibited in the Damascus museum, where the façade of the castle was also reconstructed). After World War II, the same excavator, as head of the French archaeological mission in Afghanistan, discovered at Lashkar-i Bazar on the Helmund river the vast palaces of the Ghaznevid winter capital. These excavations were particularly illuminating for knowledge of 11th- and 12th-century secular architecture, wall decorations and paintings. Other important archaeological work was done at Wasit, south of Baghdad, on behalf of the directorate general of antiquities of Iraq, by the British Institute of Archaeology (under Seton Lloyd and D. S. Rice) at the castle and Great Mosque of Harran in southeast Anatolia, and finally by Marguerite van Berchem at the medieval town of Sedrata in southern Algeria, the refuge of the heretic Ibadites.

Minor excavations took place at Fostat, the early Muslim capital of Egypt; the early Islamic centre of Istakhr near Persepolis; at Rayy, one of the most important medieval centres of Iran; at Balis in Syria; at Old Delhi and at several other towns and sites. In other cases excavators had really aimed at earlier civilizations, but before getting there the Islamic levels had to be cleared and these Muslim finds have often been accounted for in the main reports (Miletus, Baalbek, Hamah, Antioch, Alisar Huyuk, etc.).

Since a great deal of archaeological work depends on epigraphical studies, the importance of this specialized field has been fully recognized, once it was put on a sound basis by the Swiss Max van Berchem (1863–1921). This scholar organized a series of systematic investigations of epigraphic-historical nature, entitled *Matériaux pour un Corpus inscriptionum arabicarum*, to which he himself contributed several volumes while an international group of scholars wrote others. Publication of this series began in 1909 and the work was still in progress in the 1950s. Starting in 1931 the Frenchman Gaston Wiet, in collaboration with E. Combe and J. Sauvaget and assisted by a large group of other scholars, brought out a chronological *Répertoire* of Arabic inscriptions which by the mid-1950s had progressed to the 13th volume and the year 1305. Similar systematic collections for Persian and Turkish inscriptions had not been made, however.

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XII. MEDIEVAL ARCHAEOLOGY

Medieval archaeology may be defined as the study of the arts of Europe, especially western Europe, from the 6th to the 15th centuries. In the earliest phase, it is concerned with the reconstruction of culture from objects and monuments alike; on the European continent, this phase embraces the 6th, 7th and early 8th centuries (Merovingian in France, Visigothic in Spain), but in northern Europe it begins slightly later and extends into the 11th century (Saxon in England, Viking in Scandinavia, early Christian in Ireland). In the later phases (Carolingian, 8th–10th centuries; Romanesque, *c.* A.D. 1000–12th century; Gothic, 12th–15th centuries), unlike the archaeology of other periods and areas, it is primarily concerned with the study of monuments; this may be said to reflect the emphasis placed upon architecture by the middle ages. Medieval archaeology must be distinguished from the history of art in this respect. The historian of art seeks to determine the centres of artistic development and the relationships between them; he accounts for artistic conceptions and procedures and evaluates the aesthetic importance of the works of art. The archaeologist stops at complete documentation; he is concerned with the detailed examination of extant as well as destroyed monuments, with the authenticity of their parts and the dates of these parts and with the reconstitution of the original forms; he is also responsible for the formulation of a proper nomenclature for the various periods and styles of medieval art.

The history of medieval archaeology, as a scientific discipline, did not begin before the 19th century. Prior to this time, the study of medieval art was only one aspect of general antiquarian research; the works of B. Willis in England, A. Ponz and Eugenio Llaguno y Amírola in Spain, Ole Worm in Denmark and Bernard

de Montfaucon, A. L. Millin and Alexandre Lenoir in France treated the medieval period only as part of the total artistic heritage of each nation. In England, specific interest in the medieval period was evinced by Horatio Walpole, Thomas Gray and their circle around the middle of the 18th century, but it did not ripen into a field of study for nearly 30 years. J. Britton, J. Milner, G. D. Whittington, J. Bentham and others, from about 1800 on, studied medieval antiquities in detail, in both England and France. Attempts were made at this time to determine the origins of Gothic architecture and to isolate and name the successive periods of English Gothic in particular. J. Milner (1798) proposed the general term Pointed to distinguish English Gothic style from the Norman or Romanesque of the 11th and 12th centuries in Britain, and subdivided it into three main periods, those of the acute arch (*c.* 1150–*c.* 1300), the equilateral arch (*c.* 1300–after *c.* 1450) and the obtuse arch (*c.* 1450–*c.* 1550). In 1812 T. Rickman reordered and renamed the categories as Norman (1066–1189), Early English (to 1307), Decorated (to 1377) and Perpendicular (to the 16th century). Rickman's styles were accepted as standard until 1851, when E. Sharpe proposed the more flexible system of Norman (1066–1145), Transitional (to 1190), Lancet (to 1245), Geometrical (to 1315), Curvilinear (to 1360) and Rectilinear (to *c.* 1550). All three descriptive nomenclatures are drawn from the forms of English Gothic windows and tracery. The last codification was still current in England in the 1950s, although the dates of the phases were disputable. On the continent, the first important studies of medieval archaeology were immediately posterior to the Napoleonic domination. G. Moller (1815) and S. Boisserée (1823), in Germany, A. de Caumont (1824) in France and C. Amati (1825) and G. Cordero di San Quintino (1829) in Italy were academicians as well as antiquarians; their work paralleled the romantic movement in literature and the Gothic revival in architecture. As a result of this renewed interest in the middle ages, a large number of archaeological societies and national commissions for the conservation of artistic patrimonies were founded in the next two decades.

As in England a few years earlier, the 1820s and 1830s on the European continent produced the first important syntheses of medieval archaeology, with the description of the major styles and the first formulation of a nomenclature for the successive periods. J. B. L. G. Seroux d'Agincourt (1730–1814) had called the art of the 9th to 16th centuries Gothic. De Caumont (1824) distinguished between Romanesque and Gothic and subdivided each into three periods: Romanesque comprised Primitive (5th–10th centuries), Secondary (*c.* 1000–*c.* 1100) and Tertiary or Transitional to Gothic (12th century); Gothic comprised Primitive (1200–1300), Secondary (1300–1400) and Tertiary (15th century). For J. Quicherat (1851) and F. Kugler (1858), A.D. 1000 was the critical date for the start of the Romanesque style proper, although specific names for the earliest period were not formulated until the end of the century, when various styles such as Late Roman (to the 6th century), Merovingian in France (6th–8th centuries) and Visigothic in Spain (to 711) and Carolingian (8th–10th centuries) were isolated. In the 1840s the discipline of medieval archaeology was given a firmer scientific basis by Robert Willis (1800–75) in England and by E. E. Viollet-le-Duc (1814–79) in France. Willis was interested in the exact analysis of individual monuments. His report on the state of Hereford cathedral in 1841 is a model study of an edifice preparatory to its restoration; his *Architectural History of Canterbury Cathedral*, a work which remained the foundation for all studies of this edifice, appeared in 1845. Viollet-le-Duc was active primarily as a restorer; his *Dictionnaire raisonné de l'architecture française du XI^e^ au XVI^e^ siècle* (1854–68) is a compilation of evidence collected from monuments undergoing restoration and fitted into the historic framework of medieval architecture as it was then understood. The primary contribution of this work to archaeology was the formulation of the controversial precept that the forms of Gothic architecture were determined by their function. The position of Viollet-le-Duc with regard to the construction of this architecture, namely that the rib was an indispensable armature for the vault, was challenged only by G. Dehio and E. Gall in Germany; it was accepted in France until 1934, when P. Abraham vigorously asserted that the rib was structurally without function but important in the visual effects of the style. The *Dictionnaire* remains, nevertheless, a summation of the French contribution to medieval archaeology during the first half of the 19th century.

The last two decades of the century and the years preceding World War I produced the syntheses of archaeology upon which modern knowledge is largely based. C. Boito published a study of Italian medieval monuments (1880) and Dehio and G. von Bezold a corpus of medieval architecture in all of western Europe (1887–1901); at the same time, R. de Lasteyrie du Saillant gave a comprehensive course on medieval French archaeology in Paris. In France, Germany, Austria, England and Switzerland, and later in Sweden and Denmark, repertories and descriptions of monuments by province or canton were begun by state commissions and archaeological societies; some of these series were not yet complete in the mid-1950s. In the 1880s the Merovingian and Carolingian periods, named from the corresponding periods in French history, were assigned a permanent place in the field, and an endeavour was made to define their styles. Dehio and Bezold established different categories for Germany, where the Carolingian style was the direct source for the styles of the succeeding Ottonian, Salic and Hohenstaufic periods; they expanded the term Romanesque, which designates a single style in France and Spain in the 11th and 12th centuries, to include the architecture of the Carolingian period. Because of this, Romanesque still has two different meanings as it is applied to the Rhine valley and to the Atlantic states. In France, the Romanesque style, from De Caumont on, has been divided into regional groups or schools. By 1900, De Caumont's three phases of Gothic had been amplified and given descriptive names: Transitional (12th century), Classic or High Gothic (1195–*c.* 1240), Rayonnant (to *c.* 1370) and Flamboyant (to 16th century). Transition later proved to be an unsafe term methodologically: it is considered that the principles of Gothic structure (ribbed vault, point support and point abutment) were not developed from Romanesque (continuous support) but were opposed to the latter; hence there was no transition, properly speaking, from one to the other. In 1884 E. Lefèvre-Pontalis claimed that Gothic architecture began with the ribbed vaults of the small abbey of Morienval near Soissons (dated by him *c.* 1122). An international dispute ensued, in which A. St. Paul, Dehio and J. Bilson participated; in 1898 Bilson showed that the ribbed vaults of Durham cathedral, a Romanesque edifice, were nearly 30 years older and suggested that Gothic did not originate in a single monument but was the creation of the Île-de-France region and was based on a series of earlier experiments in the technique of structure and in visual effects. Bilson brought to the field the same precision and care as had R. Willis. Finally Camille Enlart published his *Manuel d'archéologie française* in 1902–16, and A. K. Porter his *Mediaeval Architecture* in 1909; each is a summation of medieval archaeology, the first of detailed evidence, the second of filiations and developments.

The period following World War I saw a double movement in the field. On the one hand, scholars began a more extensive examination of the evidence. J. Puig y Cadafalch (1928) isolated an entirely new category of monuments from the 10th and 11th centuries, which he termed the "first Romanesque art" because they seem preliminary to the main development of this style (*c.* 1050). Henri Focillon (1931) re-evaluated the origins of Romanesque sculpture in the early 11th century; a similar project of Focillon, who died in 1943, and a group of his students for the architecture of the year 1000 was nearing completion in the mid-1950s. R. A. S. Macalister (1928), A. K. Porter (1931) and F. Henry (1933) re-examined Irish culture and art in the early Christian and medieval periods; J. Roosval in Sweden, M. Mackeprang in Denmark and A. W. Clapham in England synthesized the results of medieval archaeology in their respective countries. On the other hand, excavation, which was incidental in the 19th century and regrettably unscientific in most cases even up to 1914, began to occupy archaeologists' attention. Sites such as Cluny, Lorsch, St. Denis and Agaune were systematically explored. The destruction caused by World War II facilitated and accelerated

this activity; both France and Germany later yielded important information for the medieval period, most of which was still unpublished in the mid-1950s and could not yet be brought to the stage of synthesis. The stratigraphic technique of excavation was adapted to medieval sites such as St. Martin at Angers, France (1929), and Corfe, Eng. (1950); these experiments were as yet so isolated in the 1950s that no important conclusions could be drawn from them. Similarly, excavations in the interiors of monuments are now kept open for future study, wherever possible, by the simple expedient of placing strips of reinforced concrete across them, to support the pavement (St. Denis, Lausanne, Trier, Bourges).

The second contribution of the 1820s to medieval archaeology was the conservation of monuments. Organized control virtually did not exist in the 18th century; even Bartolommeo Cardinal Pacca's decree of 1820, for the preservation of the artistic patrimony of the papal states, was limited in its effectiveness, since it was aimed mainly at preventing the destruction or exportation of works of art. The dilapidated state of certain monuments served as an excuse for French archaeologists, under the leadership of De Caumont, to unite in requesting governmental intervention (1825–30). A state agency was created in France in 1830, which became the model for similar agencies in other European nations (Belgium, 1835; Prussia, 1844; Austria, 1853; England, 1882; Italy, 1909; Spain, 1928). The function of these commissions was the repair and maintenance of historic monuments; it was subsequently expanded to include historic sites. In the 1930s European legislation on historic monuments was brought up to date in nearly every nation, with provisions defining the spheres of activity of the commissions and the legal aspects of expropriation sometimes necessary to conservation. Conservation in most cases entails restoration. The first edifice to be restored by a modern state commission was the Church of the Madeleine at Vézelay (1840), under the care of Viollet-le-Duc, who can be said to have dominated the 19th-century theory of restoration; his original aim was to restore in the style of the original, but his later work shows that he often added entirely new parts in such style. This approach has been severely criticized, since it renders the original form of the edifice obscure amid restored parts and additions. The most satisfactory theory of restoration, that replaced parts or added consolidations be made obvious and apparent, was accepted by a United Nations Educational, Scientific and Cultural organization board of experts in 1950.

Medieval archaeology includes the study of objects in collections and those recovered by excavation, such as coins, textiles and metal objects; but excavations specifically to recover objects have been made only for the early phases and in such sites as the tombs of the medieval kings at Santa Maria la Real de las Huelgas in Burgos, Spain (1944–45) and at Westminster abbey (1949). Discoveries important for the history of medieval pottery were being made in the 1950s in the Royal Commission on Historic Monuments excavations in England. The scientific analysis of objects was facilitated by the use of modern laboratory techniques, which, in the case of Merovingian metalwork and early Flemish paintings, sometimes provided firm documentation as to their nature and authenticity.

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XIII. POST-PALEOLITHIC AFRICA

Africa is vast, with little known about its archaeology; a general pattern was beginning to emerge by the middle of the 20th century, although many more careful scientific excavations completed by definitive publication were required.

In Africa the investigator meets with particular difficulties: cultural influences may have come from afar; climatic change has resulted in the inaccessibility of areas which were important a score of centuries ago; and severe soil erosion has caused stratification to be practically nonexistent on occupation sites. There is one compensation, however: in certain out-of-the-way corners of Africa men are still living under conditions that have changed little since the end of the Paleolithic; and the answers to some riddles that occupation sites propound to the excavator may be found there.

The Paleolithic was everywhere followed by the Mesolithic, a period when man continued to use stone tools, mostly microlithic, and, while still in the hunting and gathering stage, depended less for his food supply on large mammals than on fish and mollusks. In Africa the evidence for the Mesolithic is still scanty, but man, although scarce, must have existed. In the lower Nile valley, sites have been examined only at Helwan and Kom Ombo. At the latitude of Khartoum, for a considerable distance to each side of the Nile, have been found sites of a Mesolithic culture in which large, well-fired, unburnished pots decorated with designs impressed with a fish spine to make them resemble baskets were made, and barbed bone harpoons were used for fishing. Arrows were mostly armed with stone lunates, and in general the microlithic industry shows relations with the Capsian (of northwest Africa) and the Wilton (of east central Africa). The fauna indicates a climate much wetter than the present. The upper Kenya Capsian with traces of similar pottery found at Gamble's cave probably represents the Mesolithic of Kenya. Its pottery also copies basketwork. And while it is impossible to say where pottery was invented, the discovery of a prepottery Neolithic in Asia, with the existence of modern mud-lined baskets among the Nilotes, the accidental burning of which could have led to the invention of pottery, suggests that pottery was possibly an African discovery.

Neolithic.—The Neolithic is a field in which archaeologists are likely to make important discoveries. The inventions which led to the rise of man above the savagery of the Old Stone Age were made gradually in different places, and probably over a long period. Some, such as the domestication of animals, took place more than once. In a famine, a wild animal will sell itself into slavery to man for the food that will preserve its life. Thus cattle and goats, while certainly domesticated in Asia, may have been independently domesticated in Africa too. African jackals may have provided one breed of domestic dog, while the donkey and the cat are African. The polishing of stone implements was probably a by-

product of the grinding of red ochre, in wide demand for its magic properties since the Paleolithic and extensively used in Africa in the Mesolithic and later. One result of the grinding of ochre was to polish the grindstone, and another, when the upper grindstone was used at an angle, was to develop a sharp edge which, produced accidentally, may have led to the idea of grinding the cutting edge of celts or other tools. Repeated pecking of the flat surfaces of the grindstones which became too smooth to grind ochre efficiently led to perforation of the stone and thus to the development of the disk macehead of the Nile valley. Archaeology must establish where and when celts were first ground; but the partly polished celts of the Fayum and Khartoum are probably the earliest forms of that tool known. The cultivation of wheat, barley and flax probably were Asiatic developments which first entered Africa through the Nile delta; but more investigation is required. N. I. Vavilov and others indicate Abyssinia as the centre of the *Triticum dicoccoides* group of wheat grass and think that the cultivation of one form of wheat may have originated there.

In Egypt civilization first reached its full development *c.* 3000 B.C., but though it passed through Copper and Bronze Ages and introduced copper tools to the Sudan, there is no evidence of either of these ages in the rest of Africa, where a transition from the Stone Age, generally still Mesolithic in type, directly to the Iron Age took place gradually during the last two millenniums, and in a few places had not yet taken place in the middle of the 20th century. In some localities, an intermediate state, when Neolithic forms were used, occurred (*e.g.*, the former Belgian Congo and Gold Coast), but elsewhere (*e.g.*, Kenya) polished stone celts seem so rare that they may have been comparatively late imports from the north.

It is only with reference to Egypt and the Sudan that archaeologists in Africa can date finds that precede the Arab and European opening up of Africa; and more investigation is required to ascertain the extent of the influence of ancient Egypt on the rest of Africa. When Egypt was virile and prosperous, its traders traveled far beyond its boundaries to procure objects in demand by Egyptians, and with them must have gone small trade goods such as beads; but continuous raiding for slaves probably left a no man's land on Egypt's southern frontier and so prevented its having a greater influence. Mining for gold and copper may have taken the Egyptians far into Africa, but several gold mines in the northern Sudan attributed to the pharaohs appear to date only from the middle ages. The Neolithic cultures of Kenya probably owe their stone bowls only indirectly to Egypt.

Some cultural influence of ancient Crete may yet be traced in north Africa.

Iron Age.—The Iron Age in Africa began in the 6th century B.C. at Meroë, where an Egyptian form of civilization slowly degenerated for almost 1,000 years, from 550 B.C. to A.D. 350; but for several centuries the process of iron smelting was kept secret, and it was not before the 2nd century A.D. that it began to spread in Africa. Lake Chad probably was a secondary centre of dispersion, from which the knowledge of ironworking spread west, southwest and southeast. Possibly with it went—at any rate to west Africa—the custom of making sculptured stone and terra-cotta likenesses of deceased persons or their heads. For it is to be noted that the earliest figurines from Nigeria (Nok) are associated with ironworking. Excavations near Lake Chad show a people with pottery of early type with a full Iron Age technology, with Indian carnelian beads and figurines suggesting Punic influence. In classical times civilizing influences probably reached west Africa mostly north of the Sahara through the Fezzan, the home of the Garamantes. The date of the famous bronze heads of Ife is problematical, but they may have been inspired by an imported Roman bronze of the 1st century A.D. Cultural influences also traveled as far as the horn of Africa down the Red sea; of which a Greek captain in the 1st century A.D. gives an account in the *Periplus maris erythraei*. Traveling overland in the uncharted interior, divided among xenophobic tribes, long closed the interior of Africa south of the Sahara to external influence. Along the east coast, Greek influence was succeeded by that of southern Arabia, and Axum (Aksum) took over control of African trade from Meroë in the 4th century A.D. The prosperity of Axum largely depended on trade between India and Rome; it is therefore natural that Axum should have been the gateway through which Indian influences entered Africa, among them the construction of rain-water reservoirs. Its well-known obelisks may also show Indian influence. It is possible that some of the African gold that reached Rome through Axum may have come from as far as Senegal by the trans-African route between the desert and the forest that linked west Africa with the Red sea. Certain sites, along the east coast with stone masonry and many-roomed houses probably show Axumite influence. Small trading stations stretching between Aidhab on the Egyptian frontier and Zanzibar, usually with small mosques built in coral rag, celadon and sgraffito ware, glass and rare coins, date from the 11th and 12th centuries A.D. In the 13th and 16th centuries there were a number of merchant towns, in the ruins of which shards of celadon and glass are characteristic. As far south as Somaliland, connections were with Egypt. Farther south, similar merchant cities were connected with Islamic India. Later east coast settlements down to the 19th century are to be dated by Chinese porcelain and other imports.

From the 15th century also begins at certain coastal sites evidence of the European opening up of Africa.

On many sites readily datable imports are nonexistent, and archaeologists therefore try to reconstruct the past from the study of rock pictures, domestic animals, tribal brands and property marks, styles of building and burial, irrigation, tools, weapons and beads.

Rock pictures are difficult to date. They are rarely associated with sites of a single culture. Subject matter may help by giving a *terminus a quo*; *e.g.*, extinct animals, horses, chariots, camels, firearms, etc. Superposition is difficult to establish, and typology based on style can be misleading; investigators are also sometimes deceived by ignorance of the native artist's culture or by his inaccuracy. Rock pictures, too, may not survive where exposed to the weather. Too much, therefore, must not be deduced from their absence when it is due only to natural causes. Lifelike representations of wild animals are usually early, especially when engraved. North of the Sahara the earliest human representations seem to be of Bushmanoid archers. After a lengthy period during which man's main concern was cattle, in parts of northwest Africa came representations of chariots, which began in classical times and went on into the following period when horsemen with round shields gave place to camelmen with round shields. Most representations of camelmen do not antedate the Arabs.

Tribal brands and property marks may reveal connections with the Berber script or even with Meroë or Egypt. The typology of tools and weapons is a field in which further study will help the archaeologist. Beads, too, repay study. Modern and mediaeval beads from Venice, Hebron or Gablonz (Jablonec nad Nisou) can be identified, and agate and carnelian beads from Cambay in India; or even ancient Egyptian beads, if found.

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(A. J. AL.)

XIV. POST-PALEOLITHIC ASIA IN THE TERRITORIES OF THE U.S.S.R.

Post-Paleolithic archaeology of central and northern Asia is based chiefly on excavation work of the 20th century. At the beginning of the century it was almost unknown, except for stray finds and several sporadic excavations. At the end of the 19th

century interest was stimulated by linguists who sought the origins of Finno-Ugrian and Turk languages. Collections of bronze and art objects from western Siberia and the Yenisei valley caught the attention of western and Russian archaeologists; classification of Bronze and Iron Age material started. In 1913 B. E. Petri excavated an important Neolithic stratified site at Ulan Khada, Lake Baikal region. In the 1920s and 1930s excavation was carried on by Soviet archaeologists in Altai, in the regions of the upper Yenisei, Angara, Selenga, upper Lena and Amur rivers. Princely burials of extraordinary richness were uncovered in Altai. Systematic excavations steadily continued after World War II, embracing almost all areas of Siberia and Russian Turkistan. Culturally and racially these territories are divisible into two blocks: (1) the southwestern, covering the area from the Caspian sea to the upper Yenisei, extending over the zones of semidesert, steppe and forest steppe, and (2) the eastern and northern, covering mountainous regions from Lake Baikal to the Pacific ocean and the taiga (coniferous forest) and tundra belts of northern Siberia. The first is represented by Europoid people, the second by Mongoloid. These two blocks were in conflict until the Mongoloid overflowed the Europoid in several waves.

Europoid Block in Northern Russian Turkistan, Altai and Upper Yenisei (Minusinsk) Region.—The earliest Neolithic culture is represented by the hunting and fishing culture in the steppes and in the oases, to which pointed or round-bottomed pottery was known. The small flint industry continued from the earlier Mesolithic times. In the period from the end of the 3rd millennium B.C. to *c.* 1700 B.C., food-producing economy (cattle breeding), copper, painted ware and other elements from the south entered the area. Sheep, cattle and horses were the chief domesticated animals. Copper knives and stone sledges for mining appeared. Pottery was mostly round-bottomed, decorated with geometric stamped or scratched patterns in rows. Typical burial of the dead was in a contracted position under an earth mound. Excavations in Khwarizm (Khorezm, Khiva) revealed large communal houses of oval form. In the region of the Aral sea (Khwarizm) this culture was given the name Kelteminar, in Altai and the region of Minusinsk Afanasievo, although related cultural features are found between southern Russia and the upper Yenisei. Continuous culture development is seen in the beginning of the Bronze Age in the middle of the 2nd millennium B.C. This culture, named Andronovo, is relatively uniform in this wide area in spite of some local variations. Agriculture now played an important role. People lived in earth huts, reared cattle, sheep and horses. Bowl- and flowerpot-shaped vessels were flat-bottomed, well smoothed, decorated with geometric patterns, triangles, rhombs and meanders, pointing to relationship with the painted pottery of the southern regions. Burial in contracted position persisted. The typical elements of a religion of food producers, the fire and sun cult, as well as bread offering, are evidenced. Wooden constructions in rich graves may have designated social differentiation.

Toward the end of the 2nd millennium B.C. in the region of Minusinsk a Sinid group broke in which brought with it a bronze inventory of Ordos (north China) type. Cemeteries of single graves covering the dead in extended position in stone cists, equipped with round-bottomed pots, appeared. New people mixed with the local Andronovo population. Through this immigration the so-called Karasuk culture originated and spread its influences farther to western Siberia and Russian Turkistan. Trade relations extended to central Russia. Exchange with the centres of the far eastern metallurgy introduced a new character of material culture (daggers and knives terminating in animal sculptures, series of ornaments) and stimulated the flourishing of metal industry in a wide area. The regions west of Minusinsk—Altai, Kazakhstan and Kirghizia—show variations of Karasuk culture with strong local elements with which the persistence of the ancient racial type corresponds. Chronology of this period is based on comparisons with north Chinese bronzes.

The Karasuk period persisted down to *c.* 700 B.C. From *c.* 700 to *c.* 200 B.C. culture developed along similar lines. Vital trade contact is traced from north China and the Baikal region to the Black sea and the Urals, influencing the uniformity of the culture.

TABLE I.—*Chronological Table of Southern Siberian Cultures*

Approximate dates	Aral sea (Khwarizm)	Western Kazakhstan	Altai	Upper Yenisei (region of Minusinsk)	Lake Baikal region
c. A.D. 400					
	Kushan	Sarmatian III		Tashtyk	Noin Ula
c. 100 B.C.			Shibe		Figure
	Kangli	Sarmatian II	Pazyryk	Tagar III	Graves
		Sarmatian I		Tagar II	Stone Tombs II
c. 700 B.C.	Massagetian	Sauromatian	Maiemiric	Tagar I	Stone Tombs I
c. 1200 B.C.	Amirabad Suiargan (southern elements appear)	Late Andronovo	Karasuk influenced	Karasuk	Shivera (Karasuk-like)
c. 1500 B.C.	A	N D	R O N	O V O	Glazkovo
	(local variation)				
	A	F A N	A S I E	V O	Kitoi
c. 2000 B.C.	(Late Kelteminar)				
	P	R E - A F	A N A S I	E V O	Serovo
	(Early Kelt	eminar)			
c. 3000 B.C.					Isakovo

A mounted warrior element occurred, although the agricultural and cattle breeding elements persisted. In the high Altai, Tien-shan and Pamirs appeared graves of nomadic warriors with coburial of horses. Regarding the local facies or separate political confederations, cultures of this period are called Tagar in the region of Minusinsk, Maiemiric in Altai, Sauromatian in western Kazakhstan, Sakian in Tien-shan and Pamirs, Massagetian in Khwarizm.

The art of the steppe zone from southern and eastern Russia to China developed into specific animal style. The decorative talent is illustrated in the great ingenuity which the artist displayed in filling up with animal figures a shape determined by practical ends. The elk, ram, bird, cat-animal portrayals of the middle of the 1st millennium B.C. exhibit a conjunction of the highest verisimilitude with rigorous stylization; later the organic form of the animal was ruled by extreme stylization. The elements of naturalism link this style with the naturalistic animal style of the north Eurasian forest belt. New motifs in the steppe and forest steppe belt—portrayal of groups of animals, antithetic and interwined groups of bodies, curled up animals, beasts and birds of prey—originated in a borrowing of ideas from the near east and China.

Pre-Christian culture, although influenced by the Persian empire, progressed gradually until the new flow from the east started. The territory between the lower Volga and Altai represents a unit with a common destiny. Chinese and western sources report that the Sarmatian-Sakian time was followed by the supremacy of the Huns, who dominated the western steppes as far as the Urals and the Volga. Archaeological investigations show that the east-west movement started at a time when the Hun confederation had not yet been consolidated. In east Kazakhstan appeared an eastern group of Stone Tombs people not later than the 5th century B.C. The main east-west stream ran presumably from Manchuria-upper Lena, along the northern border of the Gobi, into the Lake Balkash territory and from there on, avoiding powerful cities in Khwarizm, into the steppes north of the Caspian. For centuries up to the consolidation of the Turkish khanate in the 6th century A.D., Mongoloid components were mingling with the local Europoid, which have never been wiped out. The known pre-Turkic tribes—Massagetians, Sakians, Usuns, Khakas—all show more or less Europoid traits.

The cultural pattern from Altai to Transbaikalia in the last centuries B.C. and first centuries A.D. is largely traced to China of the Han period. Social differentiation is evidenced by princely burials, extraordinarily well preserved in five large burial mounds of Pazyryk and Shibe in the high Altai. Complete burial places were frozen and even perishable substances were preserved, including human bodies and horses with harness and saddles, textiles, felt and leather objects, clothing, fur coats, false beards, besides jewelry, mirrors, hair plaits, etc. All materials were finished with virtuosity. The art combined animal, plant, geometric and realistic human designs. Polychromy played an important part. Mummification, tattooing, scalping and the use of amulets is evidenced.

Meanwhile, in the region of the Aral sea the apogee of the

Khwarizm civilization was reached in the epoch of the empire of the Kushans. During the 1st and 2nd centuries A.D. the irrigation system attained its greatest development. Numerous cities were built along the banks of the canals.

Mongoloid Block of Northern and Eastern Siberia.—The arctic and subarctic zones exhibit a continuous culture belt in a sub-Neolithic stage from boreal times through several millenniums. Making of pottery and polishing of stones, but neither farming nor domestication of animals, except the dog, were known. People lived in small, seminomadic communities, in round, semi-subterranean houses. The arctic sea shores demonstrate sea-hunter cultures. In the north this stage of life lasted down to the present time. The region of the Amur river in east Siberia shows a long-lasting Neolithic, of which the oldest forms resemble certain finds of northern Japan (proto-Ainu) and China. Cultural continuity is traced from the Neolithic through the stages in which copper smelting and iron were known. In the farthest northeast, archaeological and other data suggest that the Kamchadal, Koryak and Chukchi entered the area from the west less than 2,000 years ago and found the coastal region occupied by a population related to the Eskimo. The Ural region was linked with the east and north Russian and west Siberian culture. During the middle and end of the 2nd millennium B.C. the culture of the middle Ural region is famous for its elk and water-bird sculptures portrayed in wood. Cultural relationship between the northern Baltic and northwestern Siberia, forming a continuum up to the early historic period, furnish this area with the characteristics of the home lands of the Finno-Ugrians.

The best-explored regions are the shores of Lake Baikal, the Angara valley, the upper Lena and the lower Selenga. The earliest Neolithic culture shows Siberian Upper Paleolithic traits; the flint tradition of small implements persisted alongside a woodworking and quartzite industry which developed as a result of adaptation to a taiga environment. Chronological phases are based chiefly on the Angara grave materials by means of stratigraphy and comparisons. The following successive cultures are discerned (terminology as used by the Soviet archaeologist A. P. Okladnikov): (1) Isakovo, showing the earliest appearance of pottery, alongside flint and bone tools (arrowheads, knives, points, half-ground adzes); the period may reach back to *c.* 3000 B.C. (2) Serovo, characterized by thinner pottery, decorated by dentate stamping, boss, pit and net impressions and by stone inventory of more regular forms; reinforced bows with bone backing and fish effigies of stone appear; the period belongs to the 3rd millennium B.C., probably to its second half. (3) Kitoi, placed before the middle of the 2nd millennium B.C., shows a variety of more developed forms of equipment; the great number of fishhooks found in the graves indicates that subsistence was now based primarily on fishing instead of hunting; sculptures of human faces in stone and stone rings appear; close parallels in stone and bone industry as well as in art style are found from northern Scandinavia and northern Russia to China. (4) Glazkovo, extending through the middle of the 2nd millennium B.C. to *c.* 1300 B.C., continues a similar mode of life; novelties include the appearance of burial mounds and burials in stone cists, copper knives and arm rings, nephrite rings and disks.

The first bronze inventory in the region of Lake Baikal is related to the bronzes of the Shang period in northern China and the earliest Ordos bronzes. Life was then of semisettled character, and cattle breeding was known. Continuity of culture in the Bronze Age stage is traced up to *c.* 300 B.C. The period between *c.* 700 and 300 B.C. in Transbaikalia, called Stone Tombs I, exhibits a transition to nomadism and mounted-warrior conditions. Cultural elements held in common with the Scythian steppe zone appear as far in the northeast as the Lena river. South-north and north-south movements are attested in the last centuries B.C. The south-north movement is assumed as Yakut migration from the Baikal to the upper Lena region, the north-south movement from Cisbaikalia to Transbaikalia as migration of the taiga group, related to the Tungus of the present day.

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XV. OCEANIA

The archaeology of Oceania involves for the most part short time perspectives, because migrations within the open Pacific could have occurred only after the development of seagoing canoe navigation in Neolithic times. The exception is the New Guinea-Australia region, where the ancestors of the Australoid- and Negritoid-type peoples evidently arrived in Paleolithic times.

Records of early travelers described some of the more spectacular sites; *e.g.*, the giant statues of Easter Island and the royal tombs of Tonga. By the late 19th century a few scientific institutions and private scholars were carrying on sporadic archaeological work. Occasional finds were made in caves, as in Hawaii, or by rough excavation as when F. W. Christian in 1896 tells of tearing out the floors of tombs in the so-called Venice of Ponape (*see* below). Otherwise finds were almost all surface materials; *e.g.*, tools, stone constructions and petroglyphs. A number of local scientific institutions formed mainly in the early 20th century included archaeology among their activities, notably the B. P. Bishop museum in Hawaii. Yet even by the mid-20th century few professional archaeologists had undertaken prolonged work in the area. Fortunately "depth" excavation became a feature of studies, as by H. D. Skinner and R. Duff (New Zealand Maori), E. W. Gifford (Fiji, New Caledonia), K. P. Emory (Hawaii) and A. Spoehr (Marianas). Most territories adopted conservation laws. Successive Pacific Science congresses and Congresses of Prehistorians of the Far East materially advanced interchange of archaeological knowledge. In 1951 the Pacific Science board of the U.S. National Research council established a committee of specialists to foster archaeological work in the Pacific area.

The long-term history of the oceanic peoples, especially the Polynesians, has been the subject of many speculative theories. Professional scholars reject ideas involving a lost continent (*e.g.*, Lemuria, Mu) or direct relations with the near east (*e.g.*, the Lost Ten Tribes, migrations of "Children of the Sun" from Egypt), early India (*e.g.*, Indus valley-Easter Island connections) or Japan (*e.g.*, supposed language relations). They also insist that, while eastern-voyaging Polynesians could well have reached the American continent, and some may have found their way back into the islands, none of the various theories which claim that oceanic peoples had their homelands in North or South America are scientifically credible (*e.g.*, E. Rout's imaginative *Maori Symbolism*, T. Heyerdahl's thesis for the "Kon-Tiki" voyage). Similarly they reject theories explaining the pre-Columbian civilizations on the American continent in terms of influences by way of the tropical Pacific islands from Asia. The vast weight of archaeological as well as racial, linguistic and ethnological evidence continues to support the long-standing hypothesis of the settlement of Oceania by a succession of migrants from the southeast Asia region, with at most very minor contacts eastward to America.

The archaeological record begins when early *Homo sapiens* populations, comparable with the fossils of Wadjak in Java, Aitape in New Guinea and Keilor and others in Australia, were moving eastward. This apparently occurred during the fourth glacial epoch when sea levels were lower, land pathways perhaps generally more uplifted and interisland channels narrower than now. Early man could then migrate with lessened water obstructions from the Asiatic continental platform (Sunda shelf) through the intermediate Celebes-Molucca-Lesser Sunda zones on to the Australian

continental platform (Sahul or Papuan shelf). Some scholars suggest such movements even during the third glacial, but this seems very dubious. Core tools typologically Paleolithic and sometimes heavily patinated occur in both southeast Asia and Australia, and crude flake tools often of microlithic size are found in the intermediate zones (*e.g.*, Celebes, Timor) as well. Yet all these are surface finds or of dubious age when at subsurface levels. Doubtless most early groups moved in glacial times near shore lines now inundated, though valleys suitable for inland hunting or locally uplifted coasts might yield finds if properly searched. The vital western New Guinea region, much of which is swampy and lacking stone, has had little systematic study, and the materials reported are not typologically old.

The hypothetical picture has the isolated Australian and Tasmanian populations developing along regional and local lines characteristic of their later archaeological perspectives: generally Paleolithic, but with some Neolithic and also recent Malay trading contacts along the north coasts. The New Guinea region, however, was penetrated by canoe-migrating peoples carrying Neolithic elements which come to dominate the picture. The meagre evidence suggests that the first comers were "dry" gardeners living in semisedentary hamlets, with crude stone tools including adzes and axes of oval cross section; such shifting cultivators are found still from southeast Asia to the Solomons and New Hebrides. The Melanesian areas were also penetrated, apparently later and especially along the coasts, by village-living peoples with more sedentary cultivation, stone construction in various forms, finer tools including quadrilateral cross-section types, stone pestles and mortars, pottery and other later Neolithic elements. In New Guinea, for example, as shown by A. Riesenfeld, these influences appeared to arrive by way of the northeast coast from the outer fringe of islands, perhaps the Bismarcks, Admiralties and others. Unhappily archaeological work in all these Melanesian zones has been limited to sporadic surface collecting and recording, and to occasional tools turned up by garden workers or miners; time sequence definitions are out of the question except as they may be inferred from Neolithic chronology in southeast Asia. Information was extended somewhat through systematic excavation work in 1951 by Gifford in New Caledonia at the east end of the main Melanesian chain. This enriched knowledge of local stonework and other elements, but yielded only shorter-term chronological perspectives; his earliest radiocarbon date showing human occupation was approximately 846 B.C.

By contrast, archaeological work in Polynesia and some zones of Micronesia is considerably more advanced. For northwest Micronesia a vital clue is a radiocarbon dating of approximately 1527 B.C. from a stratified deposit excavated by A. Spoehr in the Marianas. Spoehr estimated from collateral evidence that occupation may go back to 2000 B.C. The Mariana *latte* sites (rows of capped stone pillars, probably posts of important houses), together with stone mortars, pottery and other artifacts, suggest migrations from the Philippines area in late Neolithic times. In 1954 D. Osborne began studies in the Palau area of southwest Micronesia, which may be even more important for oceanic prehistory because of proximity to Melanesia as well as Malaysia; his first reports revealed large earth platforms, widespread stonework, graves, pottery and other indications of rich archaeological deposits.

Farther east, the low coral islands of the Carolines, Marshalls and Gilberts yield limited artifacts of shell, bone and coral rock capable of some comparative study. The few high islands in this part of Micronesia, however, have extensive stone construction and other more diversified elements. Yap, for example, has stone ceremonial platforms, stepped tombs, "stone money," pottery, etc. Ponape's most spectacular site, the "Venice" called Metalanim, has several acres of stone-faced islands and canals, the principal structure being a rectangular enclosure with double walls up to 40 ft. high containing a central stepped tomb and also vault tombs. A much smaller Venice exists on Kusaie, most easterly of the Carolines. Scholars generally attribute such elaborations of the basic stonework elements, in Polynesia as well as Micronesia, to local creativity rather than undemonstrated outside influences.

Spoehr suggested that for archaeological purposes Micronesia and Polynesia may usefully be treated as a continuous zone. With them, too, may justifiably be placed the Fiji zone of eastern Melanesia, most easterly limit of the potter's craft. K. P. Emory, compiling known data on stonework in this whole area, distinguished two great types: one to the west (Micronesia, Fiji, Tonga, Samoa areas), characterized by ceremonial courts, perhaps with god houses, and platform tombs often of stepped types; the other to the east (Societies, Hawaii, New Zealand and islands eastward to Easter Island), characterized by temple structures, usually with altars, standing stones probably as back rests for gods and priests in the rituals, and cist burials within the structures. He notes the Tokelaus as having combinations of these elements, suggesting a transitional zone. From simpler shrines having a few standing stones (*e.g.*, inland Tahiti, New Zealand, small, outlying Hawaiian islands) the Polynesian temple became elaborated into various local forms including usually larger size and "megalithic" stonework. In Hawaii wooden posts or images generally replaced standing stones. In the Tuamotus huge coralline slabs were often used, and in the Marquesas the stones were sometimes carved in human (or god) form. Emory, A. Métraux and other specialists consider that such comparative study solves the "mystery" of the Easter Island statues. Rather than being relics of some lost continent or pre-Polynesian migration, they follow this last pattern of carved figures, standing on altar platforms (called by the standard Polynesian name *ahu*) in which there are cist burials. Apparently a local inventive urge toward large size, combined with the presence of easily worked volcanic tuff, produced this one of the many variants of the Polynesian place of worship.

Such local constructions, however, together with other more spectacular elements such as widely scattered petroglyphs and a dubiously old "script" on Easter Island, have less significance for historical reconstruction than detailed study of variability in minor artifacts. Skinner, Emory and R. Duff were particularly successful in demonstrating the importance of adz types for distributional studies. For example, a stepped adz type called by Emory the Polynesian adz could relate back to what H. O. Beyer called independently the Philippine adz. This is one of a number of archaeological and other parallels which suggest the Philippines area as the starting point for at least some of the migrations into the open Pacific. Chronology is still vague for the eastern zones, though Gifford had a radiocarbon date of approximately 46 B.C. from Fiji and Emory one of approximately A.D. 1005 from Hawaii. Theories of contacts with the American continent must be treated with caution so far as they lean on gross parallels such as stone images or art resemblances; the most concrete evidence by the 1950s was the presence of the sweet potato, apparently an American plant, in Oceania in prehistoric times.

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(F. M. Ko.)

XVI. THE NEW WORLD: EARLY MAN

The first scientifically controlled discovery of the remains of man in the new world, projectile points, associated with the bones of extinct animals, was made in 1926 by the Colorado Museum of Natural History under the direction of J. D. Figgins near the small town of Folsom, N.M., where the party was excavating a deposit of bones of the extinct Pleistocene animal *Bison taylori*. Over the next two years additional projectile points were found at the same site. Scientists were invited to examine them before they were removed by the workmen. In this way scientists not

associated with the excavations corroborated the authenticity of the discovery. Although numerous reports of projectile points associated with extinct animals had been made for nearly a century, practically none had been excavated under scientific controls and extreme scepticism marked the attitude of scientists toward any claim that the remains of man in the new world could be contemporaneous with the long-extinct animals of the Ice Ages. Therefore, the discovery near Folsom is of the greatest historical importance in proving that man lived at the same time as the extinct animals and derived his food, in part at least, by hunting them. Since 1926 numerous discoveries of tools and weapons have been found under rigidly controlled scientific conditions in North, Central and South America, so that a whole new area of study developed in American archaeology, that of Early Man.

The beginning of the period of Early Man must date from his earliest appearance on the continent, the exact time of which cannot be fixed. The close of the period probably varies in different parts of the continent. Generally, the practice is to fix an arbitrary point in the development of new world prehistory. In this article Early Man will be understood to be that population which was contemporary with the Pleistocene fauna, as shown by association in excavated sites or sites of the same age as determined by methods of dating other than the association with extinct animals.

There is no reason to believe that the extinction of the Pleistocene animals occurred throughout the continent at the same time. Following the last Ice Age there were three great climatic changes: increasing temperature and decreasing rainfall, high temperature and aridity, and cooler and moister to the climate of the present, in that order. These climatic conditions did not press equally on all parts of the hemisphere nor even on the North American continent. The climatic changes affected the vegetation, which in turn caused critical problems of adjustment for those animals which were adapted to the previously established environment. The climatic changes and the disturbance of the food supply in some areas and its destruction in others contributed directly and indirectly to the extinction of the Ice Age animals, as did the hunting activities of man. Some geographical areas probably offered more favourable conditions for survival than others. It is because of these variables that it is unwise to try to be precise in fixing a date which terminates the period of Early Man.

In the eastern United States, with few exceptions, the earliest evidence of human occupation dates from a period called the Archaic, following the extinction of the Pleistocene animals. The Archaic period will not be discussed here (*see* sec. XX, below), but attention will be called to the few evidences of Early Man in that area.

Early Man must be discussed in terms of his tools, weapons, hunting practices and a few other odds and ends of his life as indicated by objects from archaeological sites. It is uncertain what Early Man looked like, for there is insufficient skeletal material to use as a basis for an opinion.

The customary method of naming the tools of Early Man has been to assign them group names, such as the Folsom complex, after the name of the site or nearby locality where the discovery was first made. Particular types within complexes have also been so designated. Thus the Llano complex, a name suggested for a hunting culture found throughout a section of the American southwest and the southern plains, was first recognized in a region known as the Llano Estacado or Staked Plains. The characteristic points of the suggested Llano complex are known as Clovis Fluted, named for Clovis, N.M., near which they were found. Where there is a succession of developments in what is thought to be the same culture, the word stage has also been used to indicate the different periods through which the culture has passed, such as Sulphur Springs stage, Chiricahua stage, within the Cochise pattern.

Authenticated discoveries of Early Man have been made in Oregon, northeastern California, Nevada, Arizona, New Mexico, Colorado, Nebraska and Texas. Less well-authenticated instances are found in Kansas, Wyoming and North Dakota. (In the last two cases the age indicates probable Early Man sites but the animals are not identified as Pleistocene). Stray Folsom points have been found in other states, Saskatchewan and Alaska. On the basis of the equivalent fluorine content of human bones and animal bones from the same level, association should be accepted for previously questioned finds from California, Mississippi and Florida. In Mexico finds come from near Tepexpan, approximately 50 mi. N.E. of Mexico City in the Valley of Mexico. In South America two caves from near the extreme southern tip of Patagonia, a site at Punín in the highlands of Ecuador, and caves in the Lagoa Santa region of the highlands of east Brazil have shown Early Man's occupation of that continent. These sites from Alaska to Patagonia show that Early Man occupied practically the whole hemisphere.

In North America there are two great geographical regions from which most of authenticated finds come, the high plains east of the Rocky mountains and the basin-range area between the Rocky and the Cascade-Sierra mountains from the Columbia river on the north to Mexico on the south. These two areas represented different ecological regions; accordingly, in the high plains Early Man's economic activities were largely confined to hunting, while in the western area he was a gatherer of seeds as well as a hunter. A third area, crescent-shaped, with one horn in southeastern Arizona and the other probably in Nebraska, joins these two areas in a way not clearly understood and represented by the Llano complex. Information indicates both a hunting and gathering area and hunting only in the eastern part.

In view of the vast area involved and the relatively small number of sites excavated, final statements cannot be made about the relations of these three areas to one another, nor to Mexico nor South America. The brief discussion that follows is not based on relative antecedence of one area to another but on the regional manifestations.

Folsom Complex.—The Folsom complex of the high plains has as its most distinctive feature a skilfully made projectile point. This point varies in size, but most specimens do not run more than two inches in length. The greatest width is usually somewhat toward the point from the centre so that the sides converge slightly to a concave base. After the point had been completely shaped, a long flake was detached from each surface to produce a channel reaching nearly to the tip. Into these channels was fastened the end of the arrow shaft. Finally, the edges at the base were ground off to prevent their cutting the sinew thread used to fasten the point to the shaft. Knives made on the same general pattern but longer and heavier than the points are also found, more often with one but sometimes with two channel flakes removed. These two artifacts are the only distinctive traits of the tool assemblage of the Folsom hunters.

The Folsom remains are associated primarily with skeletal parts of the Pleistocene bison *Bison taylori*, although the remains of other animals are sometimes present. There is a complete absence of grinding tools in the Folsom sites, and the usual inference has been that the whole economy was based on hunting. Such high degree of food specialization is doubtful in view of the evidence that Paleolithic man in the old world was a gatherer as well as a hunter, at least in season. It may be that most Folsom sites represent hunting camps or actual kill sites rather than housekeeping sites. However that may be, evidence shows Folsom man to have been a hunter on the high plains whose life was closely adapted to the bison and its range.

In the early stages of research on Folsom man it was assumed that the artifacts associated with him represented the culture of the earliest migrants into the new world from Siberia by the way of Alaska. This theory found support in the distribution of Folsom points along the Yukon and the area north of the Brooks range in Alaska. Later it was called into question and another advanced which would have the origin of the Folsom complex in the southern high plains where specialization of hunting activities occurred and the bison came to displace the horse, the camel and the mammoth. Then as the bison gradually moved northward, following the shift of range with the changing climate, the hunters followed them. At present decisive evidence is lack-

ing in favour of either of the competing and contradictory theories.

Llano Complex.—The Llano complex is characterized by a projectile point which has much the same shape as the Folsom but tends to be a little larger; instead of two channel flakes there is generally a short one on each side. Some of the points show that a number of narrow parallel flakes were detached by pressure to produce the channel or fluting. These points are called the Clovis Fluted. The rest of the assemblage of artifacts, such as scrapers, are no more diagnostic of age or cultural position than those of the Folsom complex.

The economy of the Llano people is not clear, largely because there is no agreement on the place of the Sulphur Springs stage of the Cochise basic pattern in the over-all picture. The Sulphur Springs stage shows a heavy dependence on seed gathering as inferred from the great number of grinding stones. The Llano sites, on the other hand, are those of hunters of the mammoth, the horse (*Equus*) and the camel. Emil W. Haury believed the Llano hunters were somewhat earlier than the seed gatherers, but until dates are available which separate them sufficiently in time to prove this, it is also reasonable to think of them as representing different facets of the economy of the same people as related to the seasonal opportunities of the environment. The bison does not appear to have been a food animal of significance in this area. In addition to the animals already mentioned, the following are probably to be associated with the Llano complex: jaguar, tapir, sloth and dire wolf, all extinct varieties.

A bone projectile point (234 mm. long and 17 mm. in maximum diameter) comes from the same horizon as the Clovis Fluted points at the original site. It is pointed at one end and beveled for lashing to a shaft at the other. This point, used by the elephant hunter, has been found in Oregon, northeastern California and Florida.

Excavations at the Clovis locality by the Texas Memorial museum in 1949–50 showed that, there at least, the Clovis Fluted points are earlier than the Folsom and that the associated animal assemblages are those which have been described above for the two complexes. It is this stratigraphic relationship and the different animal assemblages which in part gave rise to the theory that the Folsom complex is derived from the Llano.

In the great basin both cave and open sites have shown Early Man to have been both a hunter and gatherer. Thus his economy was clearly more like that with which we are familiar for primitive peoples. There is no distinctive type of projectile point that characterizes this area. Points tend to be notched either at the corners or on the sides, although some strongly suggest the Clovis Fluted, and others have a slightly constricted base giving a triangular-shaped end. Dry caves in Utah, Nevada and Oregon have preserved much more evidence of the utensils of the early inhabitants than have the open sites of the other regions. Basketry, cordage, sandals, spear throwers and many other objects give a fuller picture of the economy and technique of adaptation of these hunters to their environment. In this area the extinct animals closely approximate those of the Llano complex. They include the sloth, a variety of elephant (probably mammoth), camel, horse and bison, though the species of the latter is indeterminable. The greater variety of seeds and nuts in this region than in the grasslands of the high plains provided an opportunity which the inhabitants seized upon to enrich their food supply. The use of grasses, tule (*Scirpus lacustris*), sagebrush bark (*Artemisia tridentata*) and bast fibres of various sorts for basketry, cordage, mats, sandals and probably other articles of clothing, and the employment of greasewood (*Sarcobatus vermiculatus*) for projectile foreshafts indicate a wide range in the exploitation of the environment.

The discovery of Tepexpan man in the Valley of Mexico in 1947 and the excavation in 1952 of the skeleton of a mammoth associated with projectile points and scrapers were noteworthy extensions to this area occupied by Early Man. The points are not similar to the Clovis Fluted but the period is probably the same as that represented by this type of point.

J. B. Bird's excavation of Palli Aike and Fell's caves in southern Patagonia revealed human remains associated with those of the sloth and horse (*Equus*) in the earliest stratum. Projectile points from this level are mostly stemmed. Scrapers, bone flaking tools and lava cylinders are reported. Cremation was practised. One reconstructed skull suggests the Lagoa Santa type from eastern Brazil, an area of Early Man occupation as shown by the excavations of Confins cave.

The hunting methods of Early Man were to a large extent governed by the kinds of available weapons. Probably a thrusting spear, the spear thrower, clubs and rocks were used to dispatch large animals. A long, knifelike stone blade may have been used as a spear point or a knife or both, depending on the owner's needs of the moment. Many sites of Early Man are in old bogs and adjacent to water holes. Animals were probably driven into the marshy ground and killed or were killed after having been found mired there. The "animal drive" method of hunting occurs in the Paleolithic of Europe, and its use in the new world by Early Man shows that the technique had apparently a worldwide distribution at a very early period.

Chronology.—The development of the radiocarbon (C^{14}) method of dating has given a series of dates for Early Man sites in the new world that has systematized to a greater extent than formerly knowledge of the early occupation of the hemisphere. At the same time it has helped formulate some of the most pressing problems in this field. Radiocarbon dates are derived from two kinds of sources: actual artifacts, and charcoal or burnt bones, which are used as indirect evidence of human occupation. The number of dates derived from artifacts is limited, partly because those made of cellulose material from this period are scarce and the finder hesitates to sacrifice them, especially if there is only one. Some artifacts have had to be treated with preservative to remove them for study and are thus rendered useless as a source for radiocarbon dating. The oldest artifact from the new world is a pair of sandals from Fort Rock cave in Oregon with a date of 9053 ± 350 (7103 B.C.). (All C^{14} dates are reckoned in years before the present, B.P.) Atlatl foreshafts (the atlatl was an instrument for throwing a spear) from Nevada are 7038 ± 350 (5088 B.C.) years old. Dates derived from sloth dung covering occupational material, from charcoal of fireplaces and from burnt bones show that Early Man was in the great basin more than 10,000 years ago, as was the case for the high plains. The age of the burnt horse and sloth bones from Palli Aike cave is $8{,}639 \pm 450$ (6689 B.C.) years, thus indicating that man had made the long trek from Alaska to the tip of South America close to 10,000 years ago. C^{14} dating showed for North America that the occupation of the two great regions, the high plains and the basin-range province, was contemporaneous. In view of this similarity in time, the differences in culture and exploitation of the environment in the two areas is a problem of considerable interest.

Some problems confronting the student of Early Man are: (1) When did Early Man first enter the new world and at what place or places? (2) What areas did he pass through in his occupation of the hemisphere? (3) Was more than one major north-to-south route followed at different times, as is suggested by the contemporaneity of the cultures of the high plains and the great basin and their mutual exclusiveness as far as distinctive weapons are concerned? (4) What is the relation of the Clovis Fluted point (Llano complex) to the Folsom point (Folsom complex)? (5) Was there a northward movement of the Folsom hunters as has been suggested? (6) What was or were the line or lines of migration followed into South America?

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(L. S. CM.)

XVII. SOUTH AMERICA

The archaeology of South America covers a span of human his-

tory going back approximately 10,000 years. The earliest inhabitants of the continent were migrant hunters who followed a way of life similar to that of the first occupants of North America. They were related to these early North Americans in that both belonged to an American Indian racial stock which had its origins among the Mongoloid peoples of northern Asia. About 15,000 to 20,000 years ago, if not earlier, these northern Asians entered the Americas by way of the Bering strait. By 7000 B.C. some of them had reached the southernmost tip of South America, where evidences of their camps have been found in caves along the Straits of Magellan. By the 2nd millennium preceding the Christian era the American Indian occupied most of the two continents, and he had developed a native agriculture based upon maize and manioc. A sedentary village life—comparable with the farming communities of the old world Neolithic stage—was founded upon this agricultural economy. The origins of this American "Neolithic" appear to lie somewhere in Mesoamerica (Middle America) and Andean South America. Perhaps both areas progressed more or less simultaneously with a gradual interchange of ideas between them. Certainly, by 1000 B.C. the Indian civilizations of both Mesoamerica and Peru had achieved large permanent villages, pottery making, weaving, stone carving, distinctive art styles and specialized architecture. The prehistory of South America is to a large extent the history of the spread and development of this sedentary agricultural way of life throughout the continent. In Peru, where such a "Neolithic" or Formative base was attained early, the story is one of successive elaborations —both technological and social—deriving from it. In the northern and southern Andes and throughout much of the tropical lowlands this "Neolithic" basis of civilization was established in prehistoric times, but subsequent achievements never measured up to those of Peru. Elsewhere, in areas such as the Gran Chaco, Patagonia or the hinterlands of eastern Brazil, the agricultural technology of the Formative was never adopted, and in these regions the Indians continued an existence similar to that of the first hunters, fishers and gatherers who occupied South America.

The principal objectives of South American archaeology in the 20th century have been those of culture distribution and sequence. In some areas, as in Peru, it has been possible to work back from the ethnohistoric documentary materials on the 16th-century Inca empire into the fully prehistoric periods. In other localities documentary sources are less adequate, and it has been impossible to set up ethnohistoric-archaeologic base lines. However, in some regions, such as remote sections of the tropical forests or Tierra del Fuego, Indian groups are still living in accordance with old aboriginal customs, and these tribesmen and their ways and handicrafts can be related directly to archaeological evidences found in the immediate territory.

Systematic archaeological research has advanced more rapidly in Peru than in any other area of South America. The German scholar Max Uhle was the first scientific pioneer in this field. By the first decade of the 20th century he had set up the major outlines of Peruvian archaeological chronology. A. L. Kroeber expanded and refined the Uhle scheme, and further research by Peruvian, North American and European students developed an impressive corpus of knowledge for the area. In this connection, radiocarbon dating became important in establishing absolute dates. In general, the prehistory of the north and south Andes is less well known than that of Peru, and lowland South America is even less systematized than the north and south Andes. An outstanding exception to this is the West Indies, where Irving Rouse worked out detailed sequences and distributions of cultures for the islands.

A. Natural and Cultural Areas

The natural environment of South America varies dramatically, and changes in land form, vegetation and climate are accompanied by marked differences in human cultural adjustments. The ten areas which are used here, and which have both natural environmental and cultural distinctiveness, are defined and characterized as follows:

1. Southern South America: Uruguay, the Argentine pampas and Patagonia, Tierra del Fuego and the Chilean archipelago. For the most part, this is low-lying country with sparse forest cover. Climate varies from subtropical to cold temperate. In pre-Columbian times agriculture was not successful in the heavy soils of these regions.

2. The Gran Chaco: the adjacent portions of Argentina, Paraguay, Bolivia and Brazil. Terrain is flat and low, climate varies from semiarid to tropical, and wet-dry seasons are marked. Vegetation is predominantly scrub. This was not an area favourable to primitive agriculture.

3. Eastern Brazil: the narrow coastal plain and interior uplands of Brazil south of the Amazon. This is semiopen, parklike and grass-covered country except for the dense forests along the major rivers. Climate varies from tropical to subtropical. Some native agriculture was practised along the rivers, but the area was largely nonagricultural.

4. The Amazonian lowlands: the vast lowland territories of the Amazon system except for the east Brazilian uplands. This is tropical country with alternating river forests and open grasslands. Native agriculture—especially manioc—was important.

5. Venezuela: the area of the modern republic and the adjoining Guianas. The coast varies from semiarid to swampy. There are tropical river valleys and open grasslands or llanos in the south and west. Native agriculture was of importance in some regions.

6. The West Indies: all the islands from Trinidad to Jamaica and north to and including the Bahamas. Agriculture was of importance on these tropical islands except for the western part of Cuba.

7. The Central Andes: the Peruvian coast and highlands and the adjoining highlands of Bolivia. An area of tropical latitudes in which climate varies greatly depending upon elevation. Agriculture was of great importance, with native irrigation and terracing highly developed in the oasis valleys of the desert coast and in intermontane highland basins.

8. The South Andes: the Chilean coast and highlands and the adjacent highlands of Argentina. This is an area of extreme to moderate aridity with a temperate climate. Agriculture was practised in pre-Columbian times but was of less importance than in the central Andes.

9. The North Andes: coastal and highland Ecuador and Colombia. Tropical to temperate country, depending upon the elevation, in which native agriculture was of importance.

10. Lower Central America: Panamá, Costa Rica, Nicaragua and eastern Honduras. Tropical country of varied terrain. The northern frontier is a cultural one, being the limits of Mayan and Mexican cultures of Mesoamerica. Native agriculture in this area was similar to that of the north Andes.

Southern South America.—Archaeological sequences along the Straits of Magellan reveal an ancient land-hunting economy going back as much as 9,000 years. The earlier periods of this sequence may relate to cave finds as far north as Buenos Aires province, and the middle periods clearly affiliate with the pampas and Patagonia as demonstrated by the common possession of certain projectile point forms and the bola stone. To the north, along the Paraná river, prehistoric sites show the refuse remains of hunting and fishing peoples who manufactured unpainted pottery decorated with incisions and punctations. Pottery of this tradition diffused southward to the pampean and Patagonian guanaco hunters. In very late prehistoric times Guaraní Indians who practised agriculture and made painted pottery, settled in small, isolated communities around the delta of the Río de la Plata; but the Tehuelche, Puelche, Querandí, Charrua, Chaná and other early historic tribes, whose cultures are derived from the old local hunting tradition, continued in control of most of the area.

The Gran Chaco.—Little archaeological information is available from the Chaco. Inhabited in historic and modern times by tribes who were essentially hunters and gatherers, there is reason to believe that the prehistoric populations of the area followed a similar pattern of life. Only small refuse sites and cemeteries have been reported. The prehistoric and protohistoric

pottery is plain or very simply decorated with finger and stick impressions. Some of the modern tribes manufacture a pottery decorated with cord impressions and unfired pigments, and occasional potsherds of this kind have been found in prehistoric sites. Ceramic evidences suggest that there have been contacts between the peoples of the Chaco and the Guaraní and Paraná river pottery-making traditions to the east. Some authorities have noted rather vague resemblances to the prehistoric ceramics of the Argentine Andes, Bolivia and Peru.

Eastern Brazil.—In the state of Minas Gerais remains of an early longheaded Indian population, the Lagoa Santa, have been found associated with a prepottery culture. This prepottery culture of the Minas Gerais caves is characterized by a crude chipped ax which is also a common artifact type in the earliest-known period of the Brazilian coast, the Archaic phase of the sambaquis or shell mounds. In Minas Gerais the prepottery culture is succeeded by one which possesses plain pottery and polished stone celts. On the coast the Archaic phase is followed by the Southern phase of the sambaquis. The Southern phase is noted for its fine work in ground and polished stone, including axes and celts, plummetlike stones and a variety of effigy dishes. Pottery occurs in the coastal shell mounds only in the latest levels and is attributed to the Tupí-Guaraní peoples. A reasonable hypothesis is that the Archaic and Southern phases of the sambaquis are the remains of hunting and gathering peoples such as the Botocudo or the Patashó and that these tribes were pushed back from the coast by the incursions of Tupian-speaking groups.

The Amazonian Lowlands.—Large native towns, long since vanished, once existed along the Amazon and its major tributaries. These ancient populations left little in the way of permanent architecture and are known largely from their ceramics and burials. On the island of Marajó, in the Amazon delta, a culture sequence reveals a long period of occupation by hunting and fishing tribes prior to the advent of the people responsible for the handsome red, black and white and modeled burial urns. The makers of this fine pottery, known as the Marajó style, were sedentary village agriculturists who appeared suddenly at the delta and disappeared just as rapidly. They were succeeded, once more, by simple fishers and hunters. The origins of Marajó civilization are obscure, but it is probable that its centres were westward somewhere in the middle or upper drainages of the Amazon.

Near the confluence of the Amazon and the Tapajoz is another important prehistoric phase, the Santarém. Santarém pottery is ornately modeled rather than painted. The style has no known close relatives in the Amazon drainage, but there are some similarities to pottery found along the middle Orinoco in Venezuela. Like Marajó, Santarém is a fully prehistoric complex with no contacts with the historic horizon.

A number of scattered pottery finds, mostly burial urns, have been made along the middle Amazon and on several of the upper tributaries. Some of these show suggestive parallels of form and decoration to the Marajó style. Apparently the vast water network of the Amazonian system made possible widespread cultural contacts, but, except for the region of Marajó Island and the delta, little is known of culture sequence and development.

Venezuela.—Venezuela is a meeting ground of two major streams of cultural influence, those of the tropical lowlands, which centre on the middle and lower Orinoco river and which may have some affinities with the Amazon, and those of the sub-Andean highlands to the west, which link closely with northeastern Colombia.

On the lower Orinoco a white-on-red pottery style is the earliest-known period. This style, the Saladero, is followed by the modeled and incised Barrancos style. This succession of ceramic types on the Orinoco has a direct bearing upon culture sequences in the West Indies, which seem to be closely related to those of Venezuela.

Andean Venezuelan cultures have traits which point westward. These include such ceramic features as ring-stand and tripod bases for vessels, black-on-white painting and figurines.

A preceramic phase, the Manicuare, also was discovered in Venezuela. It is not clear if the Manicuare culture relates to the preceramic period of the West Indies.

The West Indies.—The preceramic cultures of the West Indies are sometimes referred to as the "Ciboney," a name applied to a primitive, nonpottery group living in western Cuba at the time of the Spanish conquest. Some authorities have suggested that the Ciboney entered the West Indies by way of Florida, but this point is debatable.

Pottery-making agriculturists, presumably of the Arawakan linguistic family, appear to have swept out into the Antilles from Venezuela in two major waves. The earlier invasion is marked by the white-on-red pottery of Saladero derivations and the later invasion by the incised and modeled Barrancos-derived pottery. The climax of West Indian native civilization came in the later period and had its focus on the island of Puerto Rico. An outstanding feature of West Indian Arawakan culture was a ceremonial ball game played in a specially constructed stone-walled court.

The Arawaks were suffering from the inroads of the Caribs, another mainland South American tribe, when Columbus discovered America. Within 50 years the Spanish had established their first permanent bases in the Americas, and the native cultures and peoples of the West Indies were destroyed.

The Central Andes.—Along the north coast of Peru are deep refuse deposits of early fishing and agricultural communities which date back as early as 2500 B.C. Maize was unknown at this time, but a number of roots and beans were domesticated, as was cotton. Houses were subterranean pits lined with boulders or hand-made adobes. Plain pottery first appeared at 1200 B.C.

About 800 B.C. maize and decorated pottery of the Chavín style appeared in the middens. Aboveground houses became common at this time, and there was a shift away from the immediate shore line back into the coastal valleys, which suggests the increased importance of agriculture and, perhaps, the beginnings of irrigation. This Chavín period, with maize and a full agricultural economy, marks the inception of the Peruvian Formative, or "Neolithic," cultures.

Permanent temple structures of adobe and stone were erected in the Chavín period, but the greatest politico-religious structures date from the succeeding Classic stage (*c.* A.D. 300–1000). These were the mammoth adobe pyramids of the Mochica civilization of the north coast, the stone temples of the Recuay culture of the north highlands and the huge stone enclosures of Tiahuanaco of the Bolivian altiplano. The Classic stage also saw a climax in the arts as evidenced by the Mochica portrait pottery, Nazca ceramics and textiles and Tiahuanaco stone carving. Metallurgy was also developed during the Classic. Unlike Classic Mesoamerica, however, the Peruvians did not evolve a complex calendar or system of writing.

The close of the Classic stage of Peruvian civilization is signaled by a widespread decline in religious architecture and a general falling off of the arts. Technological advances are noted, however, in metals, with increased use of copper and bronze for tools and weapons. A new type of settlement—a planned compound-type community in a walled rectangle—is seen in many parts of the area. Concomitant with this change is the Peruvian-wide diffusion of an art style referred to as "Tiahuanacoid." This Tiahuanacolike art, named for its similarities to the sculptured designs of the old Classic centre of Tiahuanaco, may have been the symbol of an empire which served as a prototype for the later Inca state. These Tiahuanacolike influences disappeared around A.D. 1200, and a number of local kingdoms—each with its own distinctive art style—sprang up. The Chimu nation, on the north coast, is one of the best known of these. Early in the 15th century the warlike Inca, beginning at Cuzco in the south highlands, embarked on a program of conquest and expansion that was to carry them north to Ecuador and deep into Chile. Overrunning the local kingdoms, they were masters of the situation by 1530. They were, in turn, overthrown by Francisco Pizarro in 1532.

The South Andes.—The South Andes were marginal to Peru-

Bolivia in their cultural development. On the north coast of Chile, at Arica and Pichalo, preceramic, nonagricultural fishers continued in this mode of existence long after agriculture and pottery had become established in Peru. Maize and ceramics appear to have been diffused to north Chile as late as the end of the Peruvian Classic stage (*c.* A.D. 1000), although this important question is not settled. The Arica culture on the Chilean coast and the Atacameñan culture of the interior desert oases of north Chile persisted until the Inca conquest of this region. Atacameñan towns were small and compact, and subsistence was based as much upon llama and alpaca herding as upon agriculture. A similar civilization, that of the Quebrada de Humuhuaca, was developed contemporaneously in the far north of Argentina. Farther south, around Serena in Chile and in the adjacent portions of the Argentine Andes, was the Diaguita civilization. Its local prototypes are not fully known, but certain features of Diaguita pottery and metalwork suggest remote and indirect Tiahuanaco influences. Inca influences in these regions are seen in architectural and artistic changes, but for the most part these are rather superficial.

The North Andes.—Peruvian influences are not so clearly registered in the archaeology of Ecuador and Colombia as they are in the south Andes. This does not mean that they are nonexistent or unimportant, but the picture of prehistoric development is more complex in the north. One of the reasons for this is that strong currents of counterinfluences were moving into this area from Mesoamerica and, probably, from Venezuela. On the coast of Ecuador there is a culture sequence which probably goes back as far as the Peruvian Chavín period and ends with the Manteño civilization of the late prehistoric and protohistoric periods. On the coasts of Guayas and Manabí the Guangala and Cerro Jaboncillo cultures appear to mark a peak in artistic development that may be comparable with the Peruvian Classic stage. It should be emphasized, however, that these Ecuadorian coastal cultures are not Peruvian in any specific sense. Adobe pyramids are found on the Ecuadorian coast, but ceramic styles are distinctly local. Of special interest is a figurine art based upon a mold technique. This figurine tradition extends north along the coast to Esmeraldas and to Tumaco in Colombia. Slight correspondences to Mesoamerican figurines have been noted.

Colombian prehistoric cultures are sharply divided into a number of small regional centres. In the absence of reliable chronologies for most of the area it is impossible to arrange these developments in sequence, although some of them, such as the Chibcha centring upon Bogotá, were clearly protohistoric. The stone monuments of San Agustín, in southern Colombia, may be distantly related to Peruvian highland cultures such as Recuay and may be equally old. In northeastern Colombia, pottery sequences indicate a long occupation and one which is allied to western Venezuela, underlying the protohistoric civilization of the Taironas.

Lower Central America.—In Panamá, an early shell-mound culture, quite possibly preagricultural, has been discovered on the Azuero peninsula. This shell-mound culture, the Monagrillo, antedates the later agricultural, pottery-making civilizations; but Monagrillo ceramics bear no resemblance to those of these later cultures such as the Coclé or the Veraguas. It is of interest that Coclé and Veraguas metal ornaments are highly similar to those of Colombia, and there are also ceramic affinities between these late prehistoric cultures of Panamá and northern Colombia. In Costa Rica and Nicaragua the Nicoya polychrome style of pottery has similarities to certain Mexican styles, but there are also pottery strains in these regions which appear to derive from Panamá and even farther south. By the 1950s, nothing had yet been found in lower Central America—with the possible exception of Monagrillo—which could be demonstrated to be as early as the pre-Maya Formative cultures of the Ulúa valley in Honduras.

Whether all of Nicaragua, Costa Rica and Panamá was unsettled during the Formative stage in Mesoamerica (*c.* 1600 B.C. to A.D. 100), or whether the earlier periods had not yet been disclosed, remained to be seen in the 1950s.

B. Internal and External Relationships

The long culture sequence on the Peruvian coast, with the appearance of domesticated plants at 2500 B.C. and of maize and Chavín pottery at 800 B.C., is not duplicated elsewhere in South America. This fact, plus the high developments of native civilization in the central Andes, argues for Peru as an important centre of "Neolithic" beginnings. The south Andes appear to have received the stimuli for a "Neolithic" or Formative type culture from Peru, and the diffusions of these stimuli may have taken place as late as A.D. 1000. The relationships between Peru and the Amazonian lowlands were still a mystery at mid-20th century. There had been insufficient archaeological investigation on the upper Amazon to determine culture sequences or approximate ages of cultures. The evidence at Marajó Island, at the mouth of the Amazon, suggested that tropical forest civilizations developed on the upper drainages of that river and moved eastward; but this was still largely a matter of speculation. There was also the possibility that the tropical forest influenced Peru in the early periods. J. C. Tello of Peru advanced the theory that Andean agriculture and the Chavín culture had their beginnings on the eastern forested slopes of the Andes. At mid-century, however, there was no substantial evidence to support this hypothesis. One of the most promising areas in which to investigate Andean-lowland relationships is the north Andes, particularly Colombia. It is noteworthy that certain human effigy burial urns of the lower Magdalena valley in Colombia have widespread Amazonian parallels. The direction of movement of such traits is, unfortunately, still unknown.

The question of relationships between Peru and the north Andes leads into the problem of the wider interrelationships of South American civilization. What are the connections between Peru and Mesoamerica? For the most part the similarities that exist between these two major centres of the new world are those of basic inventions rather than specific customs or styles. Maize and a number of other domesticated plants are held in common. Similarly, pottery making, weaving, stone carving and the building of great pyramids as bases for religious buildings are common achievements. It seems most likely that such ideas and techniques were exchanged at an early time, probably at the beginnings of the Formative cultures in each area. Radiocarbon dates would appear to favour the priority of Mesoamerica in these exchanges, but the problem is by no means resolved. Besides these various basic traits which the two areas share, there are a number of secondary traits which clearly point to diffusion between such distant points as Peru and Mexico. Metallurgy is one of these. It has a long history in Peru and Ecuador and is widespread in Colombia and parts of lower Central America. As opposed to this it makes a late appearance in southwestern Mexico, so that there seems little doubt that it was a technological complex diffused from south to north at a relatively late prehistoric date.

There is, finally, the question of transpacific contacts between Oceania and southeastern Asia and the west coast of South America. Various theories have been put forward for prehistoric migrations in both directions. That such occasional voyages may have been made is not beyond the bounds of possibility. It is, however, unlikely that they had profound effects upon the course of native South American civilizations, which are, in their racial histories, languages and cultural patterns, distinctly autocthonous.

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XVIII. MESOAMERICA

Geographic Limits and Cultural Characteristics.—Central and southern Mexico, Guatemala, British Honduras, El Salvador and part of Honduras are recognized by archaeologists to have constituted a cultural unity in pre-Columbian times. The name Mesoamerica is now generally used to refer to this culture area. Its limits are defined by lines roughly drawn from the mouth of the Pánuco river to the mouth of the Grande de Santiago river on the north and from the mouth of the Ulúa river to the Gulf of Fonseca in the south. Within these geographic limits, peasant cultures of Neolithic type developed into civilizations—comparable with the early civilizations of the near east, the Indus valley, the Hwang-ho valley and Peru—during the 3,000 years prior to the Spanish conquest.

The beginnings of sedentary life based on cultivation of plants have not been found in Mesoamerica, and it is not possible to link the early hunting and gathering cultures (*see* sec. XVII, above) with the oldest-known farming cultures. With regard to the birth of the Mesoamerican civilizations, most of the elements which serve to define this stage of cultural development appear in the last centuries B.C. of the beginnings of the Christian era. These traits are: full-time specialization, extended trade, social stratification, theistic religion and priestly hierarchy, writing, mathematics, astronomy, calendar, monumental architecture and urban centres of considerable size. However, metallurgy—associated in the old world and in Peru with the first phases of civilization—did not become widespread in Mesoamerica until after A.D. 1000, and even then metal (gold, silver, copper) was mostly used for ornaments and for specialists' tools; only in western Mexico did metal digging tools become a part of the farmers' equipment.

The most significant archaeological data on the growth of Mesoamerican civilizations are presented in what follows in the form of regional sequences.

Central Mexico.—Leaving out the evidence for early hunters and food gatherers, in the continuous sequence from the earliest-known farming cultures to the Spanish conquest, five major epochs may be distinguished. These are: Archaic, Teotihuacán, Toltec, Chichimec and Aztec. The last three are defined on historical rather than archaeological grounds.

The early Archaic phase is represented by remains of a peasant culture found in the lower levels of deep middens at El Arbolillo and Zacatenco, in the foothills of the Guadalupe range, north of Mexico City. Maize was cultivated. Hunting and seemingly fishing too (for the sites were located on the shore of the then existing lake) played a secondary role in the economy. Vestiges of woven cotton surely indicate commercial relations with less elevated regions, probably Morelos and Guerrero, for the Valley of Mexico is too high for the cultivation of this plant. Shell ornaments made from Pacific coast species are another indication of external trade. Long permanent settlement is indicated by thick deposits of refuse. The houses had mud-daubed walls and probably thatched roofs. Quite elaborate ceramics point to a long tradition of pottery making whose origins are still to be found. Hand-made terra-cotta figurines, always representing women, may be interpreted as indication of the mother-earth religious concept.

To the middle Archaic phase belongs the large cemetery of Tlatilco, west of Mexico City. There, several hundred burials have been found. The contents of the graves indicate a much more developed culture. There are evidences of human sacrifice; indications of fashion such as artificial head deformation and tooth mutilation; clay masks; flat and cylindrical clay stamps; terra-cotta figurines representing warriors, shamans, dancers and acrobats; and luxuries such as jade and pyrite. Although the evidence for houses is scanty, there is no doubt that the site was a large settlement; numerous narrow-mouthed conical or bottle-shaped pits four to five feet in depth, found filled with rubbish, seemingly served originally for storage purposes. Common to Tlatilco and to a number of contemporary sites—such as Gualupita and Atlihuayan—in the Valley of Morelos, are traits of the so-called Olmec style. These traits are infantile features in the representations of the human figure, and jaguar motifs which surely indicate some religious symbolism. According to present evidence, this style seems older in central Mexico—and also in Oaxaca—than in the Olmec region of southern Veracruz and Tabasco.

The last Archaic phase witnessed the beginnings of monumental religious architecture, represented by the truncated conical platforms of Cuicuilco, south of Mexico City. The largest of these platforms is 130 yd. in diameter at the base and 74 ft. high. The earth nucleus was faced with retaining walls of undressed stones. There were altars on the summit. The lava flood produced by the eruption of the neighbouring Xitle volcano put an end to the occupation of this site. Elsewhere, there is evidence that the Archaic period lasted for a few centuries afterward.

Radiocarbon dates for the Archaic period range from 1400 B.C. for early Zacatenco to 500 B.C. for the eruption of the Xitle.

Teotihuacán, 25 mi. N.E. from Mexico City, is the type site for the second major epoch. The earliest remains of occupation found at this site are pottery (of late Archaic type) incorporated into the building material used for the oldest edifices. These were built some time after the eruption of the Xitle and probably no later than the time of Christ. From this beginning to the destruction of the city there was a single, continuous occupation. At about A.D. 300 the urbanized area covered a minimum of 600 ac. and by A.D. 700 more than 1,800 ac. It is on open ground and had no city walls. Large temples and palaces formed the nucleus of the city; the largest temple pyramid now stands 212 ft. high, without the temple itself, which has disappeared. In the residential sections buildings were densely clustered. Streets and plazas were paved with lime plaster, and there was a complete underground system of drainage. This metropolis was violently destroyed, some time between the 8th and the 10th centuries, and never rebuilt.

After the fall of Teotihuacán came the period of Tollan, the capital of the historic Toltecs. Its ruins are located in the outskirts of modern Tula, state of Hidalgo. Systematic excavations of the ceremonial centre at this site were begun in 1940. Notwithstanding the aureole of greatness surrounding the Toltec metropolis in the Aztec sagas, the remains are far less impressive than Teotihuacán. The Toltec period lasted from the 10th century to the end of the 12th or beginning of the 13th.

The period of the Chichimec (barbarian) invasions and the rise of the Aztecs of Tenochtitlán (founded in the 14th century) followed. Whereas there is copious historical information for these periods, comparatively little systematic excavations have been done to link archaeology and history.

Oaxaca.—The excavations at Monte Albán, one of the largest sites in all Mesoamerica, located on top of a hill which rises 1,200 ft. above the central valleys of Oaxaca, have revealed a long occupation of this place, first as a ceremonial and residential centre and later as a cemetery. The sequence has been divided into five periods or phases named Monte Albán I to V, the third subdivided into two subphases (a and b). Monumental stone building began in MA I and reached its peak in MA IIIa times, when the whole top of the hill and the northern slopes were covered with temples and residences. Burial chambers, some of them decorated with mural paintings, are found under their floors. At the end of MA IIIb the place was abandoned and the buildings fell into ruin. Subsequently Monte Albán was used only as a burial ground. The phases MA IV and V, perhaps partially contemporaneous, are defined on the basis of the material found in these burials. Tomb 7, a funerary chamber built and used in the MA III period, was reused in MA V times for the burial of

a lord and his retainers, with jewels of gold, silver, jade, turquoise, pearls and other materials.

It is noteworthy that since MA I, although possibly toward its end, there is evidence for a numerical system, hieroglyphic writing and calendar, perhaps the oldest in Mesoamerica. Also, a number of stone carvings belonging to the phase MA II have been interpreted as meaning "conquest" of different unidentified places by the people of Monte Albán. If this is true, these glyphs would be the oldest evidence of wars of conquest known to date in the same area. Although artificial fortifications protecting Monte Albán have not been recognized, its location in a strong defensible position is unusual, for most of the Mesoamerican settlements of comparative age were situated in open ground, with obvious disregard for defense. However, the selection of hilltops for settlement appears to have been frequent from the earliest periods in the mountainous Mixtec region, to the west of Monte Albán.

Outside Monte Albán, its earliest phase is represented at Monte Negro, near Tilantongo. MA IIIa has been found at Yucuñudahui, near Chachoapan, and MA V—associated with a hilt of a 16th-century Spanish sword—at the neighbouring Las Pilitas. Another MA V site is Inguiteria, near Coixtlahuaca, where evidence of Aztec occupation has been found. It is historically known that the Aztecs conquered Coixtlahuaca about 1460.

Radiocarbon dating for beams of a collapsed roof of Tilantongo (MA I) yielded 650 B.C.; for beams in a tomb of Yucuñudahui (MA IIIa), A.D. 300. Cross dating with other regions makes it possible to date the beginnings of MA IV about the 10th century, and there is ample evidence that MA V lasted to the Spanish conquest.

Guatemalan Highlands and Pacific Coast; El Salvador.—At Kaminaljuyú (a very large site situated in the outskirts of Guatemala City) and neighbouring places of the highlands, a continuous sequence has been established which covers the time from Archaic agricultural communities to the Spanish conquest. It has been divided into three main periods, subdivided into phases as follows: Pre-Classic period—Las Charcas, Arevalo, Majadas, Providencia, Miraflores, Arenal and Santa Clara; Classic period—Aurora, Esperanza, Amatle and Pamplona; Post-Classic period—Ayampuc and Chinautla. Kaminaljuyú itself was abandoned at the end of the Classic period.

The Las Charcas phase is represented by the findings made in rectangular or bottle-shaped pits with small top openings, dug deep into the subsoil for storage or other purposes (some of them contained burials), and in irregular excavations (possibly dug to obtain material for building) filled with trash. There is evidence for maize, polished greenstone celts, excellent pottery, textiles, terra-cotta figurines (human and monkey effigies) and flat and cylindrical clay stamps, as testimonies of a sedentary way of life of long-standing tradition. In the following Arevalo phase monumental building (earth mounds) began at Kaminaljuyú, and during the Miraflores phase one of the largest mounds of this site was built. It developed from a small platform, about 6½ ft. high, through six major reconstructions and several minor additions, to a stepped pyramid more than 65 ft. high, covered with mud plaster. Two burial chambers have been discovered near the top. Several bodies were found in each chamber, masters—who had been lying extended on a low wooden platform in the centre of the tomb—and their retinue. Funerary furniture includes hundreds of fine pottery vessels, shell, bone and jade ornaments, mushroom-shaped stones of unknown use, and a pyrite mosaic mirror.

A burial mound at Finca Arizona, near San José, on the Pacific coast, belongs to the Arenal phase. Unlike the mound of Kaminaljuyú just described, the tumulus of Finca Arizona lacks burial chambers. It grew through successive additions of earth platforms. Upon each one of the platforms there were several bodies and the offerings. The ruins at El Sitio, near Ayutla, on the Mexican border, also belong to this phase. There are many mounds formally arranged around plazas and plain monuments of columnar basalt. Urn burials are a feature of this site and at the neighbouring El Jobo.

During the Esperanza phase of the Classic period strong influences from central Mexico, emanating without doubt from Teotihuacán, were felt throughout the whole area. At Kaminaljuyú the identity with Teotihuacán is so great—in what refers to ideology and style—that a colonization at the aristocratic level has been postulated. At Kaminaljuyú itself this phase is represented mainly by the contents of a dozen tombs found beneath two mounds. The tombs were beam-roofed chambers. The earliest ones were covered by low platforms, the later ones by pyramidal or stepped pyramidal structures with stairways on one side and one-room temples on the summit. These funerary monuments were rebuilt each time a new tomb was made, so that a number of superimpositions resulted. Most, if not all, of the tombs were built for the interment of important adult males with slaves or concubines—generally adolescents 13–17 years old—sacrificed to accompany their masters. In three of the tombs the suite included a dog. In others, instead of complete skeletons of retainers, only the skulls with lower jaws were found, evidence of ceremonial beheading. In some cases, the main occupant was sitting on a wooden litter or box. The furniture includes always a milling stone and a variety of fine pottery vessels, jade and shell ornaments and pyrite mosaic mirrors, and there are traces of objects of perishable materials, such as cloth and feathers, but not of the products of metallurgy.

In late Classic times metallurgy appears for the first time, the metal objects (of gold-copper alloy) being quite certainly imports. Technique and style point to Panamá as the place of origin. The earliest were found in a burial at Tazumal, near Chalchuapa, western El Salvador, and are datable at about A.D. 750.

The Post-Classic period, represented by findings made in other highland sites, is characterized by late Mexican influences detectable in monumental architecture and burial customs (cremation instead of inhumation), attributable to invasions recorded by the native tradition. These were earlier, however, than the expansion of the Aztec empire, which only reached the present Mexico-Guatemala border at Ayutla about 1500 and did not push beyond. Also, there was a change in settlement pattern; whereas earlier sites were generally established on open ground and lacking artificial defenses, Post-Classic sites are for the most part situated on mesas surrounded by ravines and further protected by stone walls. Sites such as Utatlan, capital of the Quiché, or Iximché, capital of the Cakchiquel, are examples of such castle towns.

The beginnings of the Pre-Classic period may go back to before 1000 B.C., as does the Archaic period of central Mexico. Cross dating with the central Maya region makes it possible to date the Classic period from before A.D. 300 to A.D. 900. The Post-Classic period ended with the Spanish conquest.

Central Maya Area.—This area includes the foothills and the lowlands between the Chiapas-Guatemalan highlands and the parallel 18° 30′ N., from Comalcalco (Tabasco, Mex.) to Copán (Honduras). Occupation at Uaxactún (Petén, Guat.) by sedentary pottery makers began at an undetermined date, although certainly earlier than the beginning of the Christian era, and the site was abandoned in the 10th century A.D. The sequence of phases at Uaxactún is generally used as a standard for the whole area. For the last 600 years of this continuous sequence, it may be tied with the Long Count dates of the inscriptions. Unfortunately, the correspondence of dates expressed in this system of reckoning time and our calendar has not been securely established. For the Christian equivalent of the Maya Long Count dates given in this article the Thompson correlation, accepted by a majority of specialists, has been used.

The oldest remains at Uaxactún (termed Mamom phase) were found in the black earth under the earliest pavements, only in a restricted area of the site, indicating a small settlement. No milling stones have been found in this deposit. This absence perhaps indicates that maize was not cultivated yet. Instead starchy roots and tubers may have been the staple food plants cultivated at this time. Rare obsidian tools and jade indicate a little trade with the highlands, for these materials are not found in Petén. Alignments of rough stones may indicate garden plot boundaries or the remains of retaining walls for house

platforms. Burials were simple interments. The pottery and hand-modeled terra-cotta figurines belong to the generalized archaic Mesoamerican pattern.

A stepped platform (Temple E-VII-sub), decorated with grotesque stucco masks, is the oldest monumental building known to date at Uaxactún or at any other site in the central Maya region. It is dated in the following Chicanel phase, which ended in the second half of the 3d century A.D.

From about A.D. 300 to about A.D. 900 (phases Tzakol, to 600, and Tepeu, to the end) a refined civilization, superimposed on the elements of a peasant culture, flourished over all the area. Besides Uaxactún, sites worth mentioning are Palenque, Bonampak, Yaxchilán, Piedras Negras, Tikal, Holmul, Quiriguá and Copán. Tikal (in central Petén, near Uaxactún) was the largest and possibly the oldest of these centres. The civic and religious nucleus covers about 500 ac., and the suburbs extended a long distance. This civilization is characterized by monumental stone architecture for temples and palaces, with rooms roofed with corbeled vaults; elaborate tombs; artistic climax in sculpture, painting and the minor arts; hieroglyphic writing; highly developed arithmetic, astronomy and calendar. The tallest building is Temple IV at Tikal, 229 ft. high from the base of the stepped pyramid to the pinnacle of the roof. Burial customs for the upper class are exemplified by the crypt found in 1952 under the Temple of the Inscriptions, at Palenque. A hidden stairway leads to a vaulted chamber, where the corpse of some personage was buried in a sarcophagus. Six adolescents lay guarding the entrance to the chamber.

From A.D. 800 to 950, one after another of the centres of this civilization were abandoned and fell into ruin. Then the central Maya seem to have reverted to a pattern of peasant communities. There are only scanty archaeological data for the following period.

Northern Maya Area.—This region is formed by the peninsula of Yucatán, north of the parallel 18° 30′. Archaeological surveys in the 1940s showed that, contrary to a formerly widespread misconception, this area had a well-distributed and probably dense population of sedentary farmers as early as the central Maya region. There was also a cultural florescence comparable and contemporary with the Classic Maya civilization of Petén and adjacent regions. The chronological outline stands as follows: Formative period (subdivided into Early, Middle and Late), beginning at a still undetermined date and ending at about A.D. 300; Yucatán Regional and Florescent periods, corresponding to Tzakol and Tepeu of the central area (4th to 10th centuries); Toltec period (Chichén-Itzá, 987–1204); Post-Toltec period, subdivided into Mayapán phase (1204–1460) and a last phase, archaeologically ill-defined, from the fall of Mayapán to the Spanish conquest (1540). From 1204 onward, the strong alien influences which characterize the Chichén phase vanished, and the introduced ideas disappeared or were integrated into the traditional Maya cultural pattern.

The beginnings of monumental architecture may date from Middle Formative times at Santa Rosa Xtampak, and to the Late Formative phase belongs a large raised terrace with several buildings on it, at Yaxuná. A Long Count date, carved on a stone lintel at Oxkintok, corresponds to A.D. 475—the earliest inscription yet found in Yucatán by the 1950s. At the same time, good stone masonry, resembling closely the characteristics of the early Tzakol style of the central region, and the corbeled vault were already in use. Cobá, where a number of steles carved in pure Petén style record dates ranging from 623 to 732, was the centre of a net of radiating causeways, the longest one—to Yaxuná—62 mi. long. These causeways, running generally in a direct straight line, are raised above ground level, have rubble cores held by stone retaining walls, and the surface—which has slight camber—was packed hard with stone rollers. One of these road rollers is still to be seen near the Yaxuná causeway. Four distinct regional styles of monumental architecture are distinguishable for the Yucatán Florescent phase. They are characterized by differences in the baroque decoration of the façades. Some typical sites are Río Bec, Xpujil, Etzná-Tixmucuy, Uxmal, Labná and old Chichén. Chacchob also belongs to this phase; it is surrounded by a stone wall enclosing an oval area roughly 550 by 380 yds. This marks a change from open to fortified towns.

Chichén-Itzá, the political capital of northern Yucatán in the following period, shows strong Toltec influences in monumental architecture, sculpture and ideology. In the Cenote of Sacrifice (a large natural well) metal objects imported from Panamá have been found and also sheet gold disks—quite certainly imported as such—on which Itzá artists embossed scenes depicting the subjugation of the native population by these invaders Mayapán, which succeeded Chichén in the supremacy, was a walled city. The wall encompasses an area of more than 1,000 ac., and the suburbs extended for some distance beyond.

The Gulf Coast.—The earliest occupation of the Olmec area of southern Veracruz and western Tabasco is represented by pottery vessels and figurines found in the lower levels of the excavations at Tres Zapotes (southern Veracruz). They belong to an early lowland pottery pattern also found in Petén and in the Ulúa valley. The relationships with the Archaic periods of the highlands are fewer. The Middle Tres Zapotes phase is correlated in time with the horizon marked by the expansion of Teotihuacán influences and by the Tzakol phase of Uaxactún (A.D. 300–600). The occupation of La Venta, in the swamps of western Tabasco, is also assigned to this period. La Venta is regarded as the type site of the florescent Olmec culture. It was a site of ceremonial character, not a large centre of population; people settled in small hamlets scattered around this nucleus. These hamlets changed location frequently, as is characteristic in most tropical rain-forest areas of the world. La Venta, as well as the other centres of the Olmec culture, is famous for impressive stone sculptures of a refined style; noteworthy among them are colossal human heads. The continuous occupation of Tres Zapotes came to an end at about A.D. 1000. Later, the site was reoccupied for a short period and abandoned again before the arrival of the Spaniards. A carved stele at Tres Zapotes bears a date which, if expressed in the Maya Long Count system, would correspond to 31 B.C. However, it is doubtful that the starting point of the Olmec calendar was the same as that of the Maya Long Count.

In central Veracruz the ruins of Cempoala are well known. It was a southern Totonac capital where Hernán Córtez stayed at the beginning of the conquest of Mexico. To the north, the ruins of El Tajín, near Papantla, are outstanding from the viewpoint of architecture. It seems that the great period of construction at El Tajín falls between A.D. 600 and 900.

Western Mexico.—This archaeological province includes the present states of Michoacán, Jalisco, Colima, southern Nayarit and southern Guanajuato. More or less complete local sequences have been worked out for a number of zones in this area, but their mutual correlations and those with the other major Mesoamerican regions are insufficiently understood. It is not possible to draw a comprehensive picture of the archaeology of this area. However, two aspects of it are worth mentioning. One is the extraordinary ceramic statuary of Colima, Jalisco and southern Nayarit. The artists who modeled these small, baked clay sculptures portrayed, frequently with jovial irony, scenes of everyday life; the figures were deposited in tombs as if to continue in the mansion of the dead the routines of life on earth. The ethnographical data provided by these sculptures reflect a culture markedly divergent, in many aspects, from the rest of Mesoamerica. The other aspect deserving mention is metallurgy. The metal objects from this area in museum and private collections and the findings made in excavations at Tzintzuntzan (a historical Tarascan capital) Cojumatlán, Apatzingán and Tuxcacuesco (where metal items appear only in the upper levels, shortly before the Spanish conquest) show technical and stylistic differences from the metallurgical traditions of other Mesoamerican regions. It is probable that west Mexican metallurgy originated independently from the rest of Mesoamerica. From the viewpoint of techniques it exhibits similarities with the pre-Columbian metallurgy of Ecuador and the north coast of Peru. Also the abundance of implements such as blades for digging tools, axes, awls and fishhooks is exceptional in Mesoamerica. Findings in the southwestern United States, dated

from the 10th century A.D. onward, of copper bells quite certainly made in western Mexico set a minimum date for the beginnings of west Mexican metallurgy.

The Northern Frontier.—At Pánuco, in the Huasteca region of northern Veracruz, a long continuous sequence has been discovered. It has been correlated with the sequence for central Mexico, from early Archaic times to the Spanish conquest. In late periods (after the 10th century) Huasteca influence extended northward to the Río Grande delta. However, earlier Mesoamerican influences are discernible in the archaeology of the lower Mississippi basin; the nature of the contacts and the route of diffusion are not clear, however.

In the central section of this frontier, there is archaeological evidence that territories formerly occupied by sedentary farmers were abandoned at the time of the fall of Tollan and taken over by nomadic hunters. La Quemada, in the state of Zacatecas, was a castle town situated on a hill surrounded by cliffs and further protected by stone walls; a network of causeways linked the acropolis with a constellation of small villages scattered all over a fertile valley. La Quemada was burned down before the arrival of the Spaniards. This site is of special interest because it is located at the entrance of one of the corridors of communication between the civilizations of Mesoamerica and the aboriginal cultures of the southwestern United States, the one following the piedmont of the western Sierra Madre. There is a gap between the northernmost Mesoamerican settlement in this direction (Zape, in the state of Durango) and the southward extension of the southwestern cultures (Casas Grandes, Chihuahua). However, there is evidence for some trade along this corridor.

The other corridor linking Mesoamerica and the southwest was along the coastal plains of northern Nayarit, Sinaloa and southern Sonora. This was an area culturally marginal to Mesoamerica, although strong influences emanating from central Mexico were felt there during Toltec times. The excavations in this area have failed to reveal any evidences of occupation debatable before the 9th century A.D. However, earlier Mesoamerican influences reached the Hohokam area of southern Arizona, seemingly through this corridor.

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XIX. ANGLO-AMERICA

Although human history in the Americas is reckoned in thousands of years (*see* sec. XVI, above), Anglo-American archaeology is concerned here with the period between 4000 B.C. and A.D. 1800. Usually, Anglo-America includes only the area north of the international boundary, but the northern tier of Mexican states falls archaeologically within Anglo-America. The 6,000-year span of time covered here encompasses all the American Indian story, from climax to near extinction. During this period the population density of the continent increased a thousandfold.

The physical appearance of the very earliest Americans has not yet been learned, but the physical type in 4000 B.C. is known to have differed from the Indian types of Columbus' time. The population of all Anglo-America evidently was derived from Eurasia. Even though the physical affiliation of much of the prehistoric population is Mongoloid, E. A. Hooton and others, in the 1920s, demonstrated that other racial elements could be recognized. This polyhybrid nature of the American Indian was long interpreted as evidence of successive immigration of different physical stocks into North America, with subsequent hybridization occurring in the Americas. The extent to which identifying physical traits had been submerged by Mongoloid physical traits was regarded as a measure of the passage of time, the Mongoloids being regarded as the latest arrivals on the American continent. J. B. Birdsell in 1950 and George Neumann in 1952, in entirely different studies, demonstrated that in the first arrivals the Mongoloid physical traits are conspicuously lacking. The wide diversity of physical type seen among the American Indians comes many years later than 4000 B.C. (*see* INDIAN, NORTH AMERICAN).

Development of Techniques.—It is necessary to mention that Anglo-American archaeology has moved away from antiquarianism (with neither problems nor perspective) only after 1930. An exception is the restricted and specialized area of the American southwest, where there were 50 years of intensive but disorganized work by A. F. A. Bandelier, E. L. Hewett and Byron Cummings, before N. C. Nelson, A. V. Kidder and A. L. Kroeber in the early 1920s developed a systematic attack upon the problems. Refinement of the archaeology of the southwest had resulted by 1950 from the work of Earl H. Morris, Frank H. H. Roberts, Jr., Harold Gladwin, Emil Haury, J. O. Brew, Paul Martin and Erik Reed.

Study of the earthworks in the eastern half of the continent began much earlier, however. In fact, Thomas Jefferson excavated an earthen mound and reported his findings. The important figures in the early stages of earth mound exploration between 1840 and 1920 were such men as E. G. Squier and E. H. Davis, T. H. Lewis, Cyrus Thomas, J. W. Powell, Gerard Fowke, C. B. Moore and William H. Holmes. Even so, until 1930, all Anglo-American archaeological data were chaotic and discrete. Writing was descriptive; the technique of comparison with other sites, distant or adjacent, was not yet developed. Stratigraphy, upon which relative chronology is based, was not often observed; if observed, it was ignored in interpretation. Field techniques were far from adequate. The reports are concerned with the "vanished race of giants" or "lost arts" or "lost tribes," rather than with cultural connections or time-space relationships.

In the 1930s, however, a scheme of classification called the midwestern taxonomic system was devised. Will C. McKern is credited with the major work on the idea. This scheme operated much like the zoologists' classification, with the sole and expressed objective of establishing degrees of similarity between collections of archaeological remains. Time-space problems were explicitly ignored; but from the relationships discovered, time and space relationships developed. The system was espoused by all leaders in eastern and midwestern archaeological study, and amazingly fast progress in the organizing of all archaeological material resulted from its use. Scientific progress, however, was only partly in classification; the techniques of digging and recording were tremendously improved after 1930; Carl Guthe and Fay-Cooper Cole were entirely responsible for this improvement. Excavators became conscious of the importance of exact records. Notice of stratigraphy; the segregation of specimens by precise provenience; preparation of maps, sketches and photographs; and other precautions were made routine excavation techniques. Greater technical precision resulted in fuller information; more precision in analysis was therefore possible. By 1950 it was possible to say that archaeological technique was more advanced than archaeological interpretation.

Anglo-American archaeology thus moved through three distinct phases: first, it can be characterized as antiquarian or romantic with a "flat" prehistoric landscape, with data chaotic until the 1920s. Next, systematic and improved techniques began to interest scholars by 1930. Thereafter date classification of data and the development of regional chronologies progressed, alongside the increased recognition and improved description of prehistoric cultures. Finally, it became possible in the 1940s to undertake synthesis of the regional data. This concern with synthesis—the third phase—marks the beginnings of maturity for Anglo-American archaeology; synthesis raises the study to the level of science. The work of men such as Alex D. Krieger with problems of the correlation of regional data and of continental, hemispheric and world-wide relationships was significant. Archaeology, from 1950 onward, increasingly contributed specific data for use in general anthropology.

The chronological bases upon which this section rests are varied

Stratigraphy, the principle of superposition, is, of course, primary; where available, dates derived from radiocarbon, from tree rings and from native or European documents are utilized.

Regional Divisions.—Students recognize several broad regions or cultural provinces within Anglo-America. These are the arctic, northeast, southeast, northern Mississippi valley, plains, southwest and coast-basin areas. These seven broad geographical areas (*see* Table II) are particularly useful in working with the more recent cultures. For convenience the regional treatment will be used here.

It is emphasized that the quantity and quality of archaeological information varies tremendously from region to region. In the southwest data are abundant; in the west coast-basin province they are disappointingly scanty for the period of interest. A very uneven treatment here reflects, as nothing else could, the incomplete status of Anglo-American study. Analysis here begins with the oldest remains and comes forward to recent times. It is emphasized that the cultural designations—Archaic, Woodland, etc. (*see* Table II)—are quite imprecise; they carry, unfortunately, both chronological and cultural implications. The reader cannot escape the awkwardness of poor nomenclature which has developed; he can only be warned about it.

Archaic.—Over the entire continent (uncertain in the arctic) there existed a culture called the Archaic. In a variety of forms, and divided into early and late phases, the Archaic is reported from nearly every state, but it is best represented in the northeast and southeast areas.

A typical Archaic site is Indian Knoll on Green river in Kentucky. This site is a deep, extensive shell-heap midden 250 ft. by 500 ft., marking the site of a long-used camp. Abundant river mussels were the staple food, rich and easily collected. There C. B. Moore (1915) and William S. Webb (1946) recovered more than 1,100 skeletons and 20,000 objects of flint, bone and shell of aboriginal manufacture.

The Archaic level of living was low, a hunting and gathering pattern, completely parasitic and dependent upon the environment. Subsistence was geared to natural resources; there was no domestication of plants or animals (except the dog). Not even pottery was known. Although communities were small, they were reasonably stable. At least, favourable shellfish localities were obviously occupied for long-continued periods, abandoned and then reoccupied. The shell heaps, however, also yield tons of broken animal bones, including dozens of species not now eaten, along with the deer; the latter usually predominated in the forest animal diet. The many nuts, berries and tubers were harvested and used in season. The domestic dog was present; evidently dogs were even of religious or ceremonial importance because many dog skeletons, buried with great care, are found. Burials—both human and dog—were made in the village middens. Usually a deep round shaft or well was sunk into the debris, and there the dead were placed; the body was in a tightly flexed position, knees to chest. Infrequently tools and ornaments of bone, stone or shell were placed with the dead. No dwellings were found, although there is evidence hinting that flimsy circular or crescentic windbreaks, floored with hard-packed clay, were built. Presumably skins served for clothing. In technology the culture was simple. Tools, weapons and ornaments were simple but specialized; their fabrications took considerable skill and patience. The list of material possessions which survive for the archaeologist to recover includes the atlatl or spear thrower, netting, basketry, shallow stone mortars with pestles, awls, needles, scrapers, chisels, fishhooks and chipping tools, all made of bone and antler, nut-cracking stones (small slabs with many shallow cups on one or both faces), beads of marine and fresh-water shell, chipped stone knives, arrow or lance points and drills; scrapers and choppers were numerous, as were hammerstones. Flint objects were usually large. Chipping was usually bold, done by percussion.

In the late Archaic new items were added to the inventory of artifacts. Among these are polished stone celts (an ungrooved ax form) and grooved axes, atlatl weights (called boatstones or bannerstones), tubular pipes and stone bowls (steatite or sandstone). James B. Griffin states that the centre for the polished stone complex appears to be in the northern Mississippi valley. Barbed bone harpoons and polished slate knives, on the other hand, are a special characteristic of the Laurentian culture of New York. Copper objects—made of native free copper—were much used by Late Archaic peoples in the Lake Superior region. These latter objects were widely traded.

It must be realized the above descriptive material applies essentially to sites in the southeast. Local cultures—somewhat variant from this pattern but closely comparable or identical in orientation and level of achievement—have been discovered from coast to coast. Further, the time of local occurrence varied greatly. For example, Early Archaic in New York (Lamoka site) has a date of about 3500 B.C. Early Indian Knoll is also dated at about 3500 B.C. Dates for Archaic sites farther south tend to be younger. The Archaic culture is generally believed to have developed in the northeast and spread to the rest of the country; but in the coast-basin province the same levels of culture, comparable life ways and comparable artifacts are reported at a date much earlier than 2000 B.C.

TABLE II.—*Chronological Relationships of the Broad Cultural Divisions of Anglo-American Archaeology*

Period	Arctic	Northeast	Southeast	Northern Mississippi valley	Plains	Southwest	Coast basin
A.D. 1800						Fusion	
A.D. 1000	Eskimo	Late Woodland and Late Mississippi	Late Mississippi Middle Woodland Early Mississippi	Mississippi and Late Woodland	Mississippi Mississippi and Woodland blend	Florescent Formative Elementary	Persistent Desert culture base akin to Archaic
A.D. 1	Birnirk	Woodland (Middle)	Woodland (Early)	Woodland (Middle)	Woodland (Middle) Woodland (Early)		
1000 B.C.	Dorset	Woodland (Early)		Woodland (Early) Archaic (Late)			
2000 B.C.	Pre-Aleut	Archaic (Late)	Archaic (Late)			Desert	
3000 B.C.			Archaic (Early)	Archaic (Early)	Archaic		Desert
4000 B.C.		Archaic (Early)					

There are geological reasons for the concentration of the Archaic east of the Mississippi river. The entire west, as well as the plains, was subject to long, recurrent droughts, from 5000 B.C. to about the 1st century A.D., and to lesser ones since then. At the same time the woodlands of the east were relatively well watered. Drought conditions, and all that these imply, readily explain the less abundant Archaic remains outside the east.

What happened to the Archaic peoples? The culture itself merely changed, as do all life ways with the passing of centuries; the old way was simply lost. For example, Joffre L. Coe

believed that in North Carolina he could demonstrate archaeologically a continuous flow of culture from Late Archaic until historic times. Again, the marginal Algonkian-speaking tribes of the northeast possessed a culture which preserved many traits of the Late Archaic life way. The physical type of the population itself also persists; typical examples of the earliest American physical type can be found in living populations.

Early Woodland.—The Archaic period ends more by definition than at a specified time. Thus, when pottery is introduced or added to Archaic material culture, the Woodland culture is at hand. The traits of the early Woodland culture include most of those recorded for the Archaic, but by 1000 B.C. two important additions—mound burial and pottery—gave an altogether new complexion to the culture. The tubular smoking pipe was present by this time. Maize agriculture is believed by some to be this old in the northeast.

The Woodland pottery, as McKern pointed out in 1937, is an importation from Asia. It is coarse and rough, built by the coil process, usually of simple flowerpot form or possessing a conoidal base and slightly flared mouth. There were granules of crushed rock or coarse sand—called temper—mixed with the clay. The surfaces of the pottery were either plain or marked with the imprints of cord wrapped around paddles. In the southeast the first pottery was plain and had a fibre—grass or moss—temper.

The burial mounds are nothing but low heaps of earth. Bodies were placed under the mound and in pits later dug into the earth fill of the mound. Burials might also be laid on the surface of the first mound and covered over; thus mounds grew larger through accretions or additions. Burials were most often made in the flexed position.

Much local diversity exists in Early Woodland culture, and the range in time is very great. The northeastern material is older, by from 1,000 to 2,000 years, than material from southeastern sites of a comparable cultural level. In the plains Early Woodland exists, but had not, by the 1950s, been described with any certainty. Nothing comparable in form to Early Woodland exists in the southwest or coast-basin areas. The Adena culture of Kentucky and Ohio has been long regarded as being of Early Woodland age; in 1950 this placement became a subject of controversy. In effect, the Early Woodland stage constitutes a formative or transition stage into the richer Middle Woodland phases.

Middle Woodland.—Middle Woodland, best represented in the Ohio valley, probably developed there. For all practical purposes, the spectacular Hopewell culture, with its widely scattered variants, is the Middle Woodland. The age in Ohio of the climax phases falls from 200 B.C. to A.D. 1. In the southeast and eastern plains the age is markedly younger. In Middle Woodland, the cultural accretions to earlier forms include agriculture (maize, beans) and the enormous earthen burial mounds where prominent personages were buried with rich grave furnishings and much ceremony. The inventory of artifacts becomes rich and varied; an extensive trade over the northeast, southeast and plains testifies to a strong, wealthy and dominant culture which affected the eastern two-thirds of aboriginal Anglo-America for 1,000 years. In many fields the Hopewell people achieved technological artistry exceeding that later reached in the southeast and southwest.

The hallmark of this richly ceremonial culture is in the grave furniture, the extensive earthwork enclosures and the huge artificial mounds. These earthen mounds were erected, basket load after load, over large, criblike log tombs or subfloor pits; the tombs or pits contained important dead, usually laid down supine at full length. With the dead were artifacts of great beauty. Strings of river mussel pearls, fragile fanciful ornaments of sheet mica, enormous obsidian blades, scores of tools and ornaments of copper, beads and pins from both Gulf coast and Atlantic coast shells, beautiful pottery of varied form, grizzly bear teeth and claws, carved and polished stone including specialized effigy-type pipes and countless other items which are today *objets d'art*. The ceremonial pottery is easy to recognize; it appears wherever Hopewell influence reached and is used as an index marker for the culture. Although these people were numerous and had large villages, the elaborateness of the Hopewell ceremonials has blinded the eyes of investigators to the rest of the life way. Little of the "common" was known in the 1950s, but research was correcting this condition.

The Adena culture is related to the Hopewell; whether it is an ancestral form or a later, perhaps weakened or decadent one is controversial. Radiocarbon dates, however, place the Adena many centuries later than the major Hopewell sites. The effigy mounds of Iowa and Wisconsin are to be considered Middle Woodland, but appear to be as late as A.D. 800 or 900.

Late Woodland.—Middle Woodland marks the climax of the Woodland way; neither in geographic dominion nor artistry did the Late Woodland keep up the standard. In the entire southeast, the Late Woodland culture is even lacking or exists as scattered survivals; in rather subdued form it persisted in the northern Mississippi valley and northeast to be finally identified with the historic tribes of the eastern woodlands of the United States and Canada. In fact, the name Woodland was applied to the archaeological material because of its similarity to the material culture of these historic Woodland tribes. The Iroquois, Algonkin and indeed all the east coast tribes represent the end product of the Woodland way.

Mississippi Cultures.—Some time after A.D. 1 (the exact date is very controversial) Woodland dominance waned in the southeast. Probably between A.D. 500 and 800, coincident with or slightly earlier than the development of the high southwest cultures, the so-called Temple Mound or Mississippi culture arose, eventually to achieve a fabulous richness. For practical purposes the presence of truncated pyramidal earthen mounds of varying size mark the culture. These mounds were substructures for temples and priestly dwellings. The sites are found only in the rich river lands; maize farming was the subsistence base and permitted large populations with ample leisure for public works. The farmers were subservient to priest-rulers who dominated from sacred temple towns. The culture, containing Mexican elements from the beginning, apparently developed in the area just south of the confluence of the Ohio and Mississippi rivers; from there its influence spread up the Missouri river into the plains, over all the southeast and much of the northern Mississippi valley. Just how and by what route the continuing Mexican culture elements reached this part of Anglo-America is a controversial subject. In its early forms, the Mississippi culture was not especially spectacular; the climax is the later phase.

It is important to realize that the culture was flourishing or perhaps just passing its zenith when America was discovered in 1492. The De Soto chroniclers clearly, and often in detail, describe a living Mississippi culture type.

Scores upon scores of Mississippi sites have been dug. The remains are complex and rich. Large mounds, often in groups surrounding a plaza, formed the nuclei of large settlement areas; support was derived from adjacent farm villages. In general, art technology, religion, trade and government were all well developed. In pottery, from earliest times, great skill and artistry are seen. New vessel shapes—bowls, bottles, plates, effigies, etc.—replaced the simple Woodland forms, but seem to have been much influenced by Middle Woodland external decoration trends. Temper was often crushed shell. Painting of pottery was common. From stone, wood, shell and copper, tools and ornaments were made. Technology and art reached a climax in the southern cult—a rich, flamboyant assemblage of shell, copper, mica and stone specimens, strongly reminiscent of Valley of Mexico splendour. The Mississippi culture waned rapidly after the arrival of Europeans, but survived in weakened form until extinction or removal of the historic tribes of the southern states.

In the plains after A.D. 800 to 1000 a series of cultures, very similar to one another, in which Woodland and Mississippi elements blend, bespeak a large population with a wide area of dominance. The plains cultures are under intensive study. Generally they are characterized by village settlement, the earth lodge, practice of both horticulture and hunting, and distinctive ceramic tradition. Mounds were not built. The understanding of their intraregional and interregional relationships is crucial to full understanding of American prehistory.

Southwest.—The American southwest—locus of the Hohokam and Pueblo cultures—has been the scene of intensive archaeological work. The southwestern cultures are thought by some to have achieved the highest level of complexity found north of Mexico, although the Late Mississippi cultures vie for this honour. It must be pointed out that the glory of the Pueblo southwest was both recent and short-lived, falling between A.D. 700 and A.D. 1300. The greatest cultural virility and density of population appear to have fallen between the years A.D. 850 and A.D. 1050. Thereafter the population strength and geographic domination of the ultraconservative Pueblo way steadily declined until by the 1950s the entire Pueblo population numbered only a few hundred in northern Arizona and along the waters of the Rio Grande.

The Pueblo culture has two recognized regional centres—the Anasazi (four-corners area) and the Mogollon. Of the two the Anasazi is the more colourful and is here described. Hiroshi Daifuku in 1952 divided the history of the southwest into four meaningful periods, each with time and culture connotations: the Elementary stage (3000 B.C. to A.D. 1), the Formative (A.D. 1 to 700), the Florescence (700 to 1300) and the Fusion (1300 to 1700). The Elementary stage refers to an essentially Archaic pattern—the Desert culture which dates back to 9000 or 10,000 B.C.—which served as a base for the Pueblo. From the Desert culture—a nomadic, hunting-gathering life geared especially to a varyingly hostile, semidesert country—the southwestern high cultures developed. The Formative stage of development from the Desert base contains the seeds of all later specialization. It is early (A.D. 1 to 300) characterized by semisubterranean dwellings, subsistence on both wild foods and cultivated corn, domesticated dogs and great skill in textile work (plant fibres, hair and fur). Later (A.D. 300 to 700), stone was used in more elaborate pit-house construction, and agriculture—new varieties of corn and beans—pottery, turkey-feather textiles, bow and arrow, the village pattern and a strong sense of religion were added. Thus the Pueblo way was established. All subsequent additions to the culture complex were rooted in the Formative (also called Basket Maker). During the Florescence (also called Developmental and Great Pueblo periods) houses above ground, made of coursed masonry with stones set in mud mortar, culminated in the towers of Mesa Verde or the 800 rooms of Pueblo Bonito in Chaco canyon. Crude gray pottery developed into the flamboyant black on whites and polychromes of Mesa Verde and Kayenta. Agriculture became the chief source of food and allowed the leisure for arts and crafts to become varied and specialized. Cotton was added to the resources for textiles; the pit house evolved into the specialized kiva or ceremonial chamber, still used by the remnant Pueblo population. Religion, concerned with weather and food crops, became very complex and paramount in cultural importance. The social unit shifted from family to the clan and finally to the town. The turkey was domesticated; turquoise, alabaster and marine shells were used for personal ornament. In short, there was exuberant elaboration in technology, architecture and religion.

Then came the dismal years of 1273–99. A great drought and the presumed pressure of enemy (Navaho and Apache) peoples led to the abrupt dispersal and shrinking of the Anasazi. In turn came the migrations and population pressures of the period of Fusion. After 1300—the start of the period of Fusion—the evidences of interchange of ideas, migration and mixing of people and local variations of culture all over the southwest are legion. The Salado, the Patayan and the Sinagua are some of the local developments.

The Mogollon variant of Pueblo culture is somewhat earlier, and ancestral perhaps to the Anasazi. For example, Paul Martin reports plain undecorated pottery by A.D. 1. Although its developmental history generally parallels the Anasazi, it never became so fully dependent upon agriculture nor was it ever so flamboyant in technology, nor did the large urban centres grow up.

The Hohokam culture of southern Arizona can be divided into about the same cultural phases, but in general these phases are consistently 200 or 300 years older than comparable Pueblo manifestations. The Hohokam are noted particularly for their markedly different ceramic tradition, their consistent preference for cremation of the dead, jacal (stick and mud) houses, and for the extensive irrigation systems developed along the Salt and Gila rivers. Stone masonry, black-on-white pottery and a strongly formalized religion never interested these folk until after A.D. 1200, when Pueblo ideas reached them from the north.

Arctic.—The archaeology of the arctic was only in its beginning stages at mid-20th century. Aside from some enigmatic flint cores, scrapers and curious flake artifacts which appear to tie the cultures of the period before 1000 B.C. with central Asia, no Archaic remains, as such, have been discovered in the arctic. The Eskimo cultures appear to have come full-blown from Siberia. Pre-Eskimo remains cannot be readily ascribed to specific Asiatic sources, but appear to resemble Lake Baikal remains. The arctic cultures bear marked resemblances to one another for the 3,000 years they have existed. This is not surprising in view of the limited resources and rigid controls established by the environment, where the problems of subsistence and survival have not changed greatly. Generally the Eskimo and pre-Eskimo people subsisted upon large mammals; most were sea mammals. All the mammal hunters possessed permanent wooden houses, the kayak, umiak, snow goggles, wooden and clay utensils, hand sleds, many varied tools of bone, ivory, stone and driftwood, and many ornaments. Rubbed slate knives and points are a characteristic of the later cultures. Asiatic elements include the houses, skin boats, sleds and toboggans, toggle harpoon head, stone blades inserted on sides of wooden tools, spear thrower and bird darts, needle cases and a few other traits.

All the arctic artifacts are rich and varied in art styles. Art style and variations of artifact form permit differentiation among cultures, but the classes of artifacts and their uses are very uniform.

See also Index references under "Archaeology" in the Index volume.

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ARCHAEOLOGY, SOCIETIES OF. The first archaeological society met in London around 1585 or 1586. An outgrowth of the antiquarian interest of the 16th century, it was formed by a group interested in collecting and preserving British antiquities. It was soon abolished by James I on political grounds, but was revived in 1707 and formally established as the Society of Antiquaries of London in 1717. In 1751 it received its charter from George II. The activities of this society, whose membership is elective, have included the publication of *Vetusta Monumenta* (1747–1883), *Archaeologia* (1770–), *Proceedings* (1843–1920) and *Antiquaries Journal* (1921–), as well as the excavation and investigation of numerous sites in England.

During the late 18th and early 19th centuries increased interest in local archaeological remains led to the formation of other similar societies such as the Society of Antiquaries of Scotland (1780); the American Antiquarian Society (1812); the Société Royale des Antiquaires de France (1814), successor to l'Académie Celtique (1804); the Royal Society of Antiquaries of Ireland (1890), originally the Kilkenny Archaeological Society (1849) and later the Royal Historical and Archaeological Association (1869); the Royal Society of Nordic Antiquaries in Denmark (1825); the British Archaeological Association (1843) and the Royal Archaeological Institute of Great Britain and Ireland (1843); and even the Archaeological Society of Leningrad (1846). By the mid-19th century numerous county and provincial societies had been formed, particularly in the British Isles, the Scandinavian and Low Countries, France and Switzerland. Many of these engaged in field work. At the same time a strong interest in the prehistoric developed. This resulted in the late 19th and 20th centuries in the foundation of professional societies devoted more specifically to prehistoric and anthropological studies and

also of many state historical societies in the United States.

While this interest in national history and culture was growing, attention also was being directed to the classical antiquities of Greece and Rome. In 1734 the Society of Dilettanti was formed in England. At first it was devoted to discussion by travelers returning from the Mediterranean, but it soon acquired a serious interest in Greek and Roman archaeology. It supported several expeditions to Greece and Asia Minor before falling into obscurity around 1800. It was followed by a number of societies interested in classical and near eastern archaeology.

In 1829 the Istituto di Corrispondenza Archeologica was founded in Rome as an international undertaking under the auspices of Prince Friedrich Wilhelm of Prussia. By 1871 it had become a Prussian institution. In 1874 it changed its name to the Kaiserlich Deutsches Archäologisches Institut and established a branch in Athens. Following reorganization in 1885 it moved its headquarters to Berlin while maintaining the branches in Rome and Athens. Other branches have since been formed in Mainz, Ger.; Istanbul; and Madrid. It has published a number of technical journals, most notably the *Jahrbuch* (1887–) and *Mitteilungen der römischen und athenischen Abteilung*, and has carried out and published reports of extensive excavations in the Mediterranean area. Supported by the German government, it is a purely professional society.

In 1837 Greece formed another professional group, the Greek Archaeological Association. It also has excavated widely and published its reports in *Ephemeris Archaiologike*. In France the Académie des Inscriptions et Belles-Lettres, organized in 1663, although wider in interest, gave its support to the study of classical antiquities as did also the Association pour l'Encouragement des Études Grecques en France which published the *Revue des Études Grecques* (1888–). Archaeology has likewise received aid in Italy from the Accademia Nazionale dei Lincei, originally founded in 1603.

Increasing interest in archaeology was felt too in the United States, where the American Oriental Society was formed in 1842 and the Archaeological Institute of America in 1879 (incorporated in 1906). The latter, concerned primarily with classical archaeology at first, later widened its interests to include many fields of old and new world archaeology. Composed of member societies located in many cities, it is open to anyone interested. It has helped to found and is allied with American archaeological schools in Athens (1882); Rome (1894); Santa Fe, N.M. (1907); Jerusalem (1900); Baghdad (1923); and Egypt (1950); and the American School of Prehistoric Research (1921). It has also sponsored excavations, published a monograph series, the technical *American Journal of Archaeology* (1897–), the more popular *Art and Archaeology* (1916–34) and *Archaeology* (1948–) and a *Bulletin* (1910–) and provides lecturers for its member societies.

The Society for the Promotion of Hellenic Studies (1879) and the Society for the Promotion of Roman Studies (1910) in England are open to all interested and publish journals of a technical nature, but they are wider in scope, including literature and history as well as archaeology. Mention should also be made of the Austrian Archaeological Institute (1898) with a branch in Athens and the Deutsche Orient-Gesellschaft (Berlin, 1898).

See also ACADEMIES; ANTHROPOLOGY AND ETHNOLOGY, SOCIETIES OF.

See Glyn E. Daniel, *A Hundred Years of Archaeology* (1950); Joan Evans, *A History of the Society of Antiquaries* (1956). (M. C. R.)

ARCHAEOPTERYX is the group name applied to the most ancient known fossil birds whose remains come from the lithographic limestones of the Upper Jurassic beds near Solnhofen, Bavaria.

Remains of birds were first reported from these deposits by E. F. Baron von Schlotheim in 1820, but these initial discoveries were lost so that their identity is not certain. Only four fossil specimens of the primitive birds of the Upper Jurassic are known. One consists of an isolated feather, two skeletons are fairly complete and one is fragmentary.

In 1861 H. von Meyer described an excellently preserved impression of a feather from these beds under the name *Archaeopteryx* ("ancient wing") *lithographica*. The two halves of this imprint were placed in paleontological museums in Munich and Berlin. Later in the same year Ernst Häberlein secured a skeleton lacking most of the skull but with excellent impressions of the feathers of wing and tail at Langenaltheimer Haardt near Pappenheim in the same region. This was purchased by the British Museum of Natural History and described by Sir R. Owen in 1863 as *Archaeopteryx macroura*.

The second skeleton, found in 1877 in similar beds at Blumberg bei Eichstätt, came into the possession of another Ernst Häberlein, a son of the first one, and was secured for the Museum für Naturkunde in Berlin through Werner von Siemens. This example, preserved in two plates of stone, has the skull and is otherwise more complete than the one in London. A third skeleton, with the limbs, vertebrae and other bones, discovered in 1956, but not described in print until 1959, was found 820 ft. from the site of the London specimen.

On preliminary examination the two original skeletons were called the same species, but on study it was found that they differed somewhat, so that in 1897 the Berlin specimen was named *Archaeopteryx siemensi* by W. Dames. Later B. Petronievics separated the Berlin example as a distinct genus, which he called *Archaeornis* so that it became known as *Archaeornis siemensi*.

BY COURTESY OF (TOP) THE TRUSTEES OF THE BRITISH MUSEUM; (BOTTOM) THE AMERICAN MUSEUM OF NATURAL HISTORY

FIG. 1.—ARCHAEORNIS, ONE OF THE EARLIEST-KNOWN BIRDS

(Top) Drawing of the fossil remains of *Archaeornis*, after the original in the Berlin museum; (bottom) restoration of *Archaeornis* based upon the fossil specimen above

(*See* fig. 1.) However, it must be added that G. De Beer after study of the London specimen considered that the two represent a single species and attributes the differences to age or sex. The third skeleton is said to agree in size and characters with the one in London. The obviously primitive structure, with many reptilian characters, has led to much discussion as to whether they should be classified as birds or as reptiles.

The reptilian affinity is clearly indicated by the form of the skull, especially in the forward portion, where the absence of a bill, the presence of teeth and the relation of the bones to one another are unlike the condition presented by modern birds. Other skeletal elements, particularly the pelvis and the shoulder girdle, also show different degrees of resemblance to reptiles. Further, P. R. Lowe stated that in the London example the impressions of the wing feathers have both inner and outer webs equal in width, with the barbs apparently not firmly joined, instead of one web decidedly narrower and the whole a firm surface, his conclusion being that the animals should be considered more nearly related to dinosaurs.

If feathers are accepted as the main distinguishing character of the class Aves, however, it seems necessary to call both *Archaeopteryx* and *Archaeornis* birds. As such they stand as the most primitive known in this group, to be placed in a distinct subclass, the Archaeornithes (ancestral birds) and in the order Archaeopterygiformes.

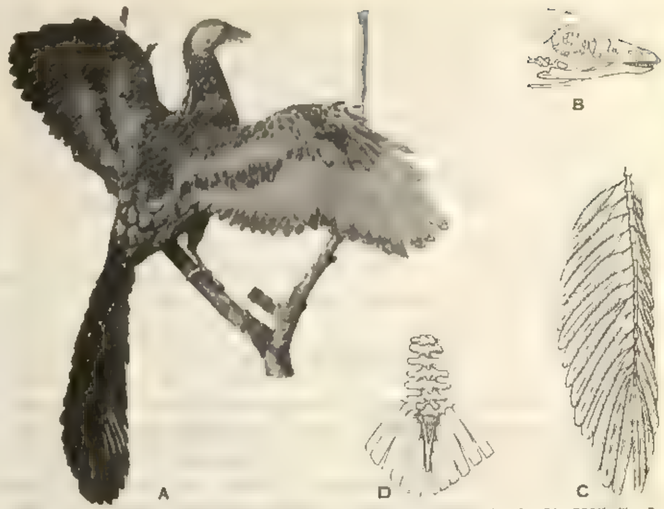
Archaeopteryx macroura, in life the size of a small crow, shows as an outstanding peculiarity a long tail of 20 vertebrae (resembling the reptilian type) with feather impressions along the sides and at the end. (*See* fig. 2.) The foot has fairly strong toes, adapted for perching and for walking or running, the tarsal portion being rather short in proportion, with the anterior elements fused with the tibia. The three metatarsals appear to be free, not fused as they are in adult modern birds. (*See* Bird: *Form and Function.*) The other leg bones are slender. Of the anterior limb bones the upper arm or humerus is slightly longer than the forearm. There are well-marked impressions of large wing feathers, the best preserved being about six inches long and one inch wide. There are indications of smaller body feathers.

The hand apparently had the metacarpal elements separated instead of fused into a carpometacarpus as in modern birds. There is indication of three separate fingers which terminate in claws; these are best preserved in the fossil specimen in Berlin. Concerning the bones of the pectoral girdle: the scapula meets the coracoid at a wide angle and fuses with it. The coracoid, a rectangular plate with a foramen and two notches on the inner margin, was given special study by Petronievics, who believed that he could distinguish a line marking off a precoracoid. The free angle of the joined clavicles, or furculum, is present, and near it a small part of the sternum. Its form is uncertain since its presence is known mainly from X-ray photographs.

The bones of the pelvis are separate, and the two pubes meet behind, symphysis apparently having been effected by a rounded mass of cartilage. There is indication of an obturator foramen. The sacrum is composed of six vertebrae. The skull is represented by a partial cast of the brain cavity; a fragment of the premaxilla, including pointed teeth that are elliptical in outline; and other scattered elements.

The later fossil skeleton, representing *Archaeornis siemensi*, has a skull in which the maxilla and premaxilla bear pointed teeth, and the hard bill of modern birds is absent. The skull in fact is distinctly reptilian, differing from that of modern birds and resembling reptiles in having the lower margin of the preorbital fenestra bounded by the maxilla instead of the jugal; in the small size of the brain; in the greater forward extension of the parietal and in other details of relation of the bones to one another.

Petronievics found 9 cervical vertebrae, part of them with ribs attached, 13 dorsal vertebrae and 20 caudal vertebrae, the latter number being the same as that in *Archaeopteryx macroura*. The scapular articulation with the coracoid is free (not fused, as in *Archaeopteryx*). The anterior tarsal elements are not fused with the tibia, and the three metatarsals likewise are free. There are



(A) BY PERMISSION OF THE BRITISH MUSEUM (NATURAL HISTORY); B, C, D) FROM W. P. PYCRAFT, "THE STORY OF BIRD-LIFE" (GEORGE NEWNES, LIMITED, LONDON, 1900)

FIG. 2.—ARCHAEOPTERYX

(A) Mounted reconstruction in the British museum; (B) detail of the reptilelike skull and (C) tail of *Archaeopteryx*, the latter in comparison with (D) the tail of a modern bird

excellent impressions of the feathers of wing and tail. *Archaeornis* is somewhat smaller, being about nine-tenths the size of *Archaeopteryx*.

While it is customary in restorations to show these birds perching in trees, it seems equally probable that they also ran about actively on the ground. However, they had progressed far in adaptation for aboreal life, as the first toe is turned back to form a foot fitted for grasping rounded branches.

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(A. Wt.)

ARCH AND VAULT. The arch is an architectural device primarily used for spanning intervals of space in one major vertical plane by means of inclined or curved masonry, as opposed to horizontal beams (trabeation). Structurally arches perform three functions: to cover, support, and buttress. But they have also been used in purely decorative ways and on occasion have been made to carry elaborate overtones of symbolism. When masonry forms based on the arch are used to cover extended spatial compartments, the result is a vault. (*See* Architecture.)

ARCH

Structure

Arch construction depends essentially on the mechanical properties of the wedge. If a series of wedge-shaped blocks—generally known by the French term *voussoir*—are set flank to flank in the manner shown in fig. 1, the result is an arch. During construction of the arch the voussoirs require support from below until the keystone has been set in place. This support usually takes the form of temporary wooden centring. Similar formwork is needed for all vaults, with the exception of domes, which are in principle self-supporting at every stage of construction by virtue of their concentricity. Theoretically the minimum number of voussoirs required to make an arch is two. In that case they simply lean against one another and the arch is triangular. There is no reason other than convenience why the voussoirs should be identical in shape or their joints radial (*i.e.*, converge on a common centre). If they are, then the arch is semicircular; but many variants are possible.

Within the limits of masonry construction, arches have two advantages over horizontal beams. (1) They can span much

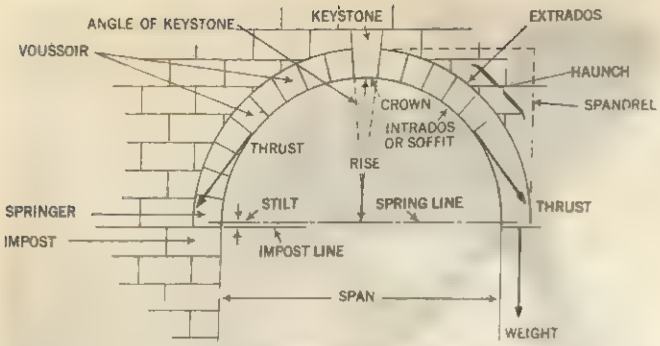


FIG. 1.—ELEMENTS OF THE ARCH

greater distances. The longest unsupported stone architraves in classical Greek architecture are seldom more than 20 ft.; any space much greater than this could be safely spanned only by timber. On the other hand, the Romans projected vaulting spans of up to 150 ft. (2) The arch can also carry a much greater load than a horizontal beam can. This carrying capacity follows from the fact that, subject to certain conditions, pressure downward on the extrados has the effect of forcing the voussoirs together instead of apart. (For terms *see* fig. 1.) One of the conditions is that the load on the crown of the arch should be less than that on the haunches, the crown being the weakest point. The critical factors here are the angle of the keystone and the depth of the bearing surfaces of the voussoirs. In a simple pointed arch, where two arcs of the same radius are struck from different centres, the weak crown of the semicircular arch is so to speak left out—an aspect well conveyed by the French term *arc brisé* (broken arch). In a pointed arch the angle of the keystone is also relatively wider. It follows that a pointed arch should be more efficient than a corresponding semicircular arch. Pointed arches are also more versatile than semicircular arches in that their height is no longer determined by their span. This geometrical factor was important during periods when arches had to be fitted into the proportions of predetermined space frames. In this respect the pointed arch resembles other nonsemicircular arch forms; *e.g.*, the segmental (an arc less than a semicircle), the horseshoe (an arc greater than a semicircle), and the stilted arch (an arch with one or more vertical courses between the springers and the impost blocks). To these may be added the mathematically more complicated arches based on elliptical, parabolic, or catenary curves.

The simplicity and aesthetic perfection of the semicircular arch, however, have secured for it recurrent favour for decorative purposes, and it has always been the form to which symbolic interpretations have most readily accrued. Even when the structural advantages of nonsemicircular arch forms were recognized, predilection for the visual properties of semicircular arches resulted in some curious hybrids; for example, in Apulia, Italy, especially in 12th-century buildings, a semicircular intrados is often found combined with an elliptical extrados, a form created by increasing the lengths of the bearing surfaces between the adjacent voussoirs toward the centre of the arch.

Voussoirs can also be combined to produce a horizontal as opposed to a curved profile. This application of the principle of the arch to the construction of what is in effect an architrave was used occasionally in both classical Roman and Romanesque architecture. When it was done, the voussoirs were often stepped or "joggled" for greater efficiency.

The false arch, as its name implies, is not really an arch at all but a combination of horizontal stones each cantilevered out beyond the one below to form an arch profile. Unlike any of the true arches, this kind is useless for carrying purposes and is therefore generally found only in vaults.

History

Ancient and Classical Times.—The earliest evidence for the use of arches is provided by vaults (*see* below). Large-scale false-arch forms occur extensively in imperial Hittite architecture. The best-preserved examples are the monumental gateways in the walls of the capital, Hattusas (Bogazkoy), built in the middle of the 2nd millennium B.C.; their shape suggests a catenary curve. The technique of the false arch passed from Asia Minor to Mycenaean Greece during the third quarter of the 2nd millennium B.C., and a modified version occurs in the Lion Gate of Mycenae itself.

Where the voussoir was invented is not certain. Bricks arranged like voussoirs and dating from the 9th century B.C. have been found in tombs at Tell Halaf (north Syria). If the reconstructions of the excavators of Tell Halaf are correct, one at least of the arches they once formed was pointed. The bronze bands from a door (now in the British Museum) from the Assyrian palace at Balawat (9th century B.C.) indicate that round arches for city gates were already a familiar feature in the Assyrian world. The reconstruction at Berlin of the Ishtar Gate of Babylon (early 6th century B.C.) gives some idea of what such gates must have looked like.

The Greeks made little use of the arch in their temple architecture, though there is evidence of arched gates in Greek cities, for example, at Elea (Velia) on the coast of Lucania, Italy (5th century B.C.). But the first exponents of arch construction in Europe seem to have been the Etruscans. It is conceivable that they brought this technique with them from their putative homelands in Asia Minor when they emigrated to central Italy, and the Greeks may have learned about arches from them. The question whether the Romans learned from the Etruscans or from the Greeks is still under discussion. Either way, however, it was in Roman Italy during the Late Republican period that the arch was first exploited on a grand scale both as a structural device and a symbolic form; *e.g.*, the aqueduct and the triumphal arch (*qq.v.*).

Development of the Pointed Arch and Its Religious Connotation.—During the first three centuries of the Roman Empire,

(LEFT) COURTAULD INSTITUTE OF ART, (RIGHT) EWING GALLOWAY

ROMAN ARCH AND VAULT

(Left) Ribbed barrel vault of cut stone, Temple of Diana, Nîmes, France; Roman, c. A.D. 130. (Right) Hadrian's Arch, Athens; Roman, 2nd century A.D.

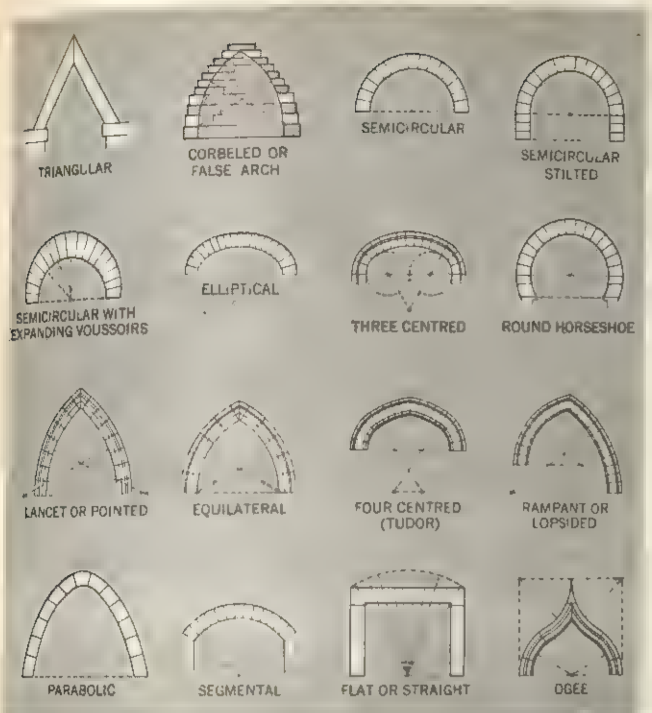


FIG. 2.—COMPARATIVE ARCHES

construction of arches went hand in hand with the construction of large-scale vaults (*see* below), and it was perhaps during this period that the advantages of nonsemicircular arch forms were first explored. Although there is some evidence for these forms among the surviving monuments of Rome, the most spectacular instances are to be found outside the empire in the palaces of the Sassanid Persians at Ctesiphon, near Baghdad, and Bishapur and at Constantinople in the great arches supporting the domes of Hagia Sofia and Hagia Irene (6th century A.D.). The spread of these variants is not easy to trace, but it seems that the pointed arch was already known in the 7th century when the Arabs occupied Syria and Persia. Whether or not it had a continuous history extending back to Tell Halaf is uncertain. As a purely decorative form on a miniature scale, the pointed arch appears in sculpture of the Gandhara period of ancient India (in what is now northwestern Pakistan), probably under Persian influence. The Arabs were certainly responsible for popularizing the pointed arch, and it was in mosques that this form first acquired a religious connotation. Christian architects in Western Europe who adopted the pointed arch in the late 11th century may have been trying to emulate their Muslim contemporaries. But they may equally have been trying to revive constructional techniques of the late Roman Empire, perhaps stimulated by renewed contacts with remote parts of the Eastern Christian world such as Armenia, where the pointed arch had long been in favour.

During the four and a half centuries from 1100 to 1550 arches were most widely used in European architecture, especially in churches and monastic buildings, whose ribbed vaults and flying buttresses reveal the arch as the first principle of Gothic structural engineering. Churches of that period became veritable systems of arches in which walls, windows, and roofs served only as screens against the weather. The ubiquitous use of the arch during the Gothic period can be plausibly explained in terms of structural advantages. But it is only necessary to compare churches with secular and military buildings of the same period to recognize the extent to which arches were used to make churches "different"—that is, the decorative and symbolic aspects of the arch were probably every bit as important as the structural. There is no unambiguous written testimony as to the nature of this symbolism, however, and the hypothesis must be left vague.

Gothic Principles of Construction.—A great variety of arch forms was used during the Gothic period. The earliest pointed arches seem to have been constructed according to certain rules governing the relation between the radius of the arcs and the span of the arch. The mid-13th-century additions to the notebook of Villard de Honnecourt (*q.v.*) contain cryptic allusions to *tiers-point* and *quint-point* arches, in connection with diagrams purporting to show how to make keystones. The angle of the keystone is determined by the position of the centres of the arcs in relation to the total span. *Tiers-point* probably meant that the radii were two-thirds or three-fourths of the span, *quint-point* that they were five-sixths or five-eighths. Another favoured formula was the equilateral arch in which the radii and the span were identical (also sometimes called *tiers-point*). In England, however, as early as the rebuilding of the choir of Canterbury Cathedral (after 1174) architects were prepared to put arcs of different size and radius together to produce lopsided arches; to depress arches by making the profile of the springers oblique; and even to introduce angles into the arcs. Phenomena of this kind betray a preoccupation with the visual as opposed to the mathematical conception of arch construction, and it is not surprising that the English took the lead during the following century in developing the possibilities of the ogee arch in which reversed curves appear. From this it was a short step to the nodding ogee, in which the reversed curve changes direction in two planes at once, and the arch inclines forward in a complex curve. Later still other forms of multicentred arches were popular in England. It was, however, reserved for the Germans and Bohemians in the 15th century to produce the most spectacular of all variations of the arch form: monumental nodding ogees, used for porches and vaults. These culminate in the work of Benedikt Reid in the Vladislav Hall (1493–1502) at Prague (*see* also below, *Vault*).

Renaissance to Modern Times.—With the Renaissance there was a strong reaction against the pointed arch in favour of the semicircular, the Roman arch form par excellence. Round arches also conformed well with Renaissance theories about mathematical perfection in architecture. On the other hand Baroque architects, who made great play with ovals in their designs, were often prepared to use elliptical or depressed arches.

Builders of churches continued to make use of arch and vault, but in secular buildings, which tended more and more to become

FEDERICO ARBORIO MELLA

SASANIAN BARREL VAULT

Ruins of the Taq-e Kisra, palace of the Sassanid Persians at Ctesiphon, Mesopotamia, with barrel-vaulted hall (right) in which a nonsemicircular arch form was used; 3rd or 6th century A.D.

suites of rooms on many floors, flat ceilings and rectangular doors and windows became more or less obligatory. It was not until the 19th century, with the construction of great public utilities such as bridges, viaducts, and halls to serve as railway stations or museums (not to mention neomedieval churches), that the arch became once more an important element of architectural construction. After Galileo, the mechanical properties of catenary arches could be explained theoretically. Moreover, new materials, in particular iron and steel, allowed structural engineers to construct arches of unprecedented magnitude; *e.g.*, the Bayonne (N.J.) Bridge across the Kill van Kull, which spans 1,652 ft. (504 m.; *see* BRIDGES).

VAULT

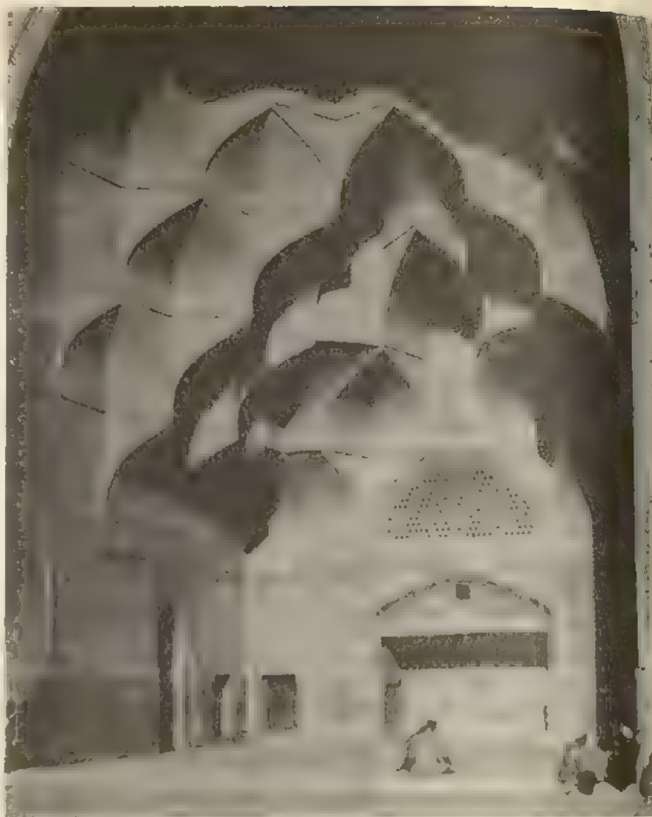
STRUCTURE AND BASIC TYPES

The simplest way to turn an arch into a vault is to broaden the soffit, creating what is called a barrel, tunnel, or wagon vault. If two barrel vaults are crossed at right angles over the same space, the result is a groined vault. If an arch is rotated through 180° the result is a dome (*q.v.*). These are the three basic forms of vault. Each is suited to a particular kind of plan: the barrel vault to a rectangle, the groined vault to a square, and the dome to a circle. Other types of vault have arisen from the desire to adapt one of the basic vault forms to a space to which it was not naturally suited. For instance, it is possible to combine four triangular pieces of barrel vault over a rectangular or square bay, to produce something approximating to a dome (the so-called cloister vault). Other variations arise from the use of nonsemicircular rather than semicircular arches; and a further alternative is represented by vaults constructed on the principle of the false arch.

HISTORY

Ancient and Classical Times.—The earliest vaults known—tombs at Ur in Mesopotamia and passageways inside the Egyptian pyramids (*c.* 2700 B.C.)—are vaulted on the principle of the false (or corbeled) arch; so also were the beehive tombs of Mycenaean Greece, the best-known of which still intact is the so-called Treasury of Atreus at Mycenae (*c.* 1300 B.C.). Later and less impressive examples occur in Etruscan cemeteries, as at Cerveteri and Vetulonia. The same principle is represented in primitive Irish architecture of the early Christian period; *e.g.* the Oratory of Gallarus at Dingle, County Kerry. The technique has persisted in Italy as a feature of the domestic architecture of central Apulia (as at Alberobello).

Apart from early miniature vaults over tombs, vaulting based



COURTAULD INSTITUTE OF ART

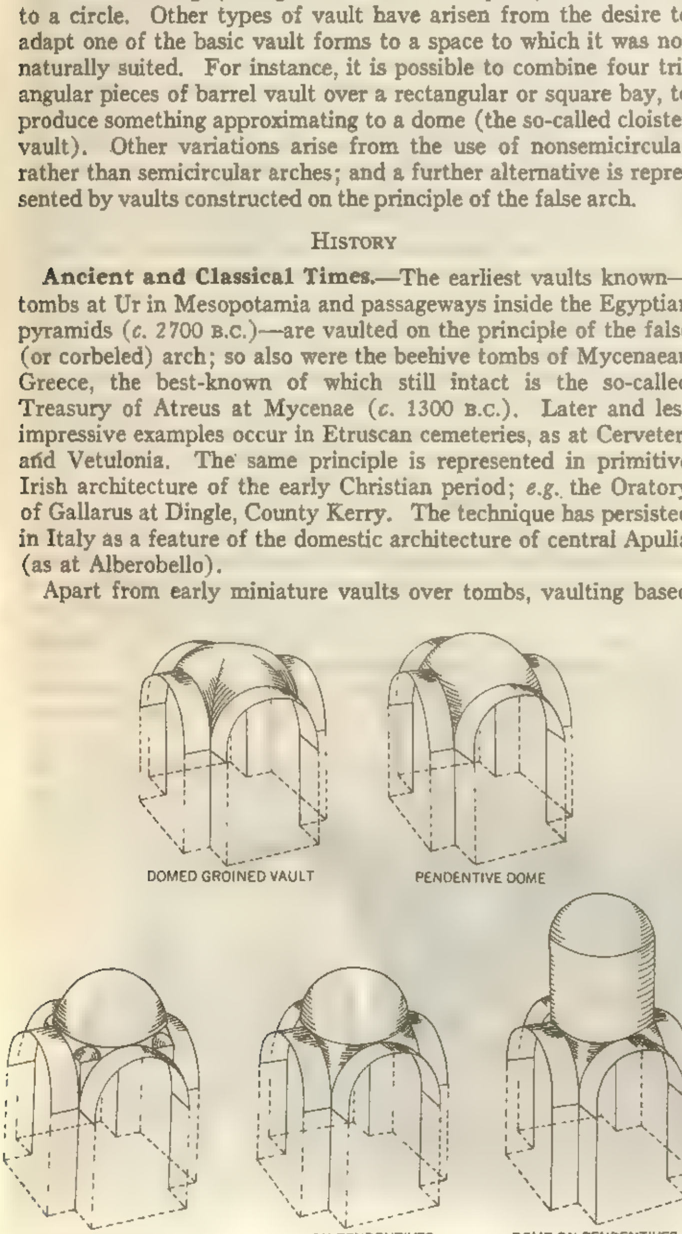
STALACTITE VAULT

Series of pointed arches forming a stalactite vault over a *mihrab* (prayer niche) in the Masjid-i-Jami (Friday mosque), Isfahan, Iran; Muslim, 11th century

on voussoir arches may have been a feature of Hellenistic palace architecture at Antioch and Alexandria. But the first real evidence is provided by Roman Republican monuments. Roman vaults were occasionally made of cut stone, but they are closely associated with the use of concrete. By the end of the Republican period most of the technical problems posed by the handling of concrete had been solved; yet the scale on which this material was used remained small. Surviving examples include the barrel-vaulted city bath at Pompeii and the underground basilica near the Porta Maggiore in Rome.

It was left to the great imperial patrons (from Nero onward) to exploit the possibilities of vaults over large spaces. From the Golden House of Nero (A.D. 64) to Hadrian's Villa at Tivoli (*c.* A.D. 130) a series of vaulted buildings was constructed in or near Rome which provided models to which reference was continuously made in subsequent centuries. These include the Aula Regia of Domitian's Palace on the Palatine Hill, built by Rabirius (*c.* A.D. 90), which was probably barrel-vaulted; the halls of Trajan's Market and Trajan's Baths, which were groin-vaulted; and the Pantheon, which was domed. A Greek mathematician, Hero of Alexandria, is known to have written a manual, the *Camarica,* on vaulting (now lost). Hero's dates are not certain, but if, as has been inferred from other evidence he lived during Nero's reign, his book may have provided the necessary basic instruction for Roman architects.

Byzantine Building: Hagia Sophia.—References to "the mechanicians of Hero's school" occur now and then in writings of the next five centuries. Isidore, the architect who was commissioned to replace the dome of Hagia Sophia at Constantinople after the original collapsed in 558, wrote a commentary on Hero's treatise, a fact that testifies to the relevance of this work. Both domes of Hagia Sophia were placed over a cubic space as opposed to a cylindrical, which sets the problem of how to effect a transition at the top of the space from a square to a circle. Basically, three solutions are possible. The simplest, usable for comparatively small spans, is to place horizontal beams across the



AFTER K. J. CONANT, "A BRIEF COMMENTARY ON EARLY MEDIAEVAL CHURCH ARCHITECTURE"

FIG. 3.—THE DOMED CROSS WITH VARIOUS VAULTING COMBINATIONS

corners, each projecting farther than the one below, until an octagon has been formed; and then to place the dome on the octagon. The second is to use arches (called squinches; *see* SQUINCH) instead of horizontal beams, a method that also results in an octagon but one of greater structural efficiency that can be safely enlarged. The third solution, and the one selected by the architects for both domes of Hagia Sophia, was to construct a dome whose diameter was the diagonal of the square. The result was four spherical triangles, called pendentives (*see* PENDENTIVE), emerging from the angles of the cube. If the pendentives are sprung at the right level, they combine to form a circular base.

Domes on pendentives seem to have been used on a small scale in a number of 5th-century buildings, but their first large-scale use was at Hagia Sophia. In the first design for that church the curve of the upper part of the dome may have been continuous with that of the pendentives. In its successor, however, the dome proper is struck to a smaller radius, and there is therefore a distinct break between the dome and the pendentives. The situation in Hagia Sophia is further complicated by the fact that the arches on which the dome is carried, and which therefore define the pendentives, are not simple semicircles; the pendentives themselves, therefore, are mathematically complex. It is not certain that these deviations from strict symmetry were made in the interests of greater structural efficiency; they more likely embody attempts to achieve preselected ratios between the various levels of the design.

The dome on pendentives, once established, proved so well suited to the aesthetics and iconography of Byzantine churches that it remained a central feature of nearly all subsequent Eastern Christian architecture.

Muslim Vaults.—The dome was quickly adopted by Muslim architects, who took it to India and Central Asia. They also developed forms of vault peculiar to themselves; *i.e.*, stalactite vaults, which are actually complicated squinches, for porches and *mihrabs* (the *mihrab* being a niche in the wall of the mosque indicating the direction of prayer); and intersecting parallel ribs, usually eight in all, for supporting domes. Isolated examples of both occur in medieval European buildings, among them stalactite vaults in the Capella Palatina at Palermo, Sicily, and intersecting parallel ribs in Spain.

Medieval Vaults.—In Western Europe large-scale vaulting was associated throughout the Middle Ages with church buildings. It began with barrel vaulting over the chancel, partly to protect the altar and partly to give the chancel a more imposing setting; an early example may be seen at Agliate near Milan. Subsequently in the 11th century the barrels were extended to cover the whole church. This form, which was much favoured in southern France, Italy, and northern Spain, required both continuous support and continuous buttressing, which made it difficult to combine with large clerestory windows. In the church at Tournus, France (late 11th century), instead of one continuous barrel, a series of short transverse barrels is carried on arches across the nave. A more satisfactory solution to this problem, however, was provided by the groined vault, which made an early appearance in hall crypts and porches but was not widely used for major spans until the end of the 11th century. Northern Italy may have been its place of origin, but it was soon established in Germany and Normandy.

COURTAULD INSTITUTE OF ART

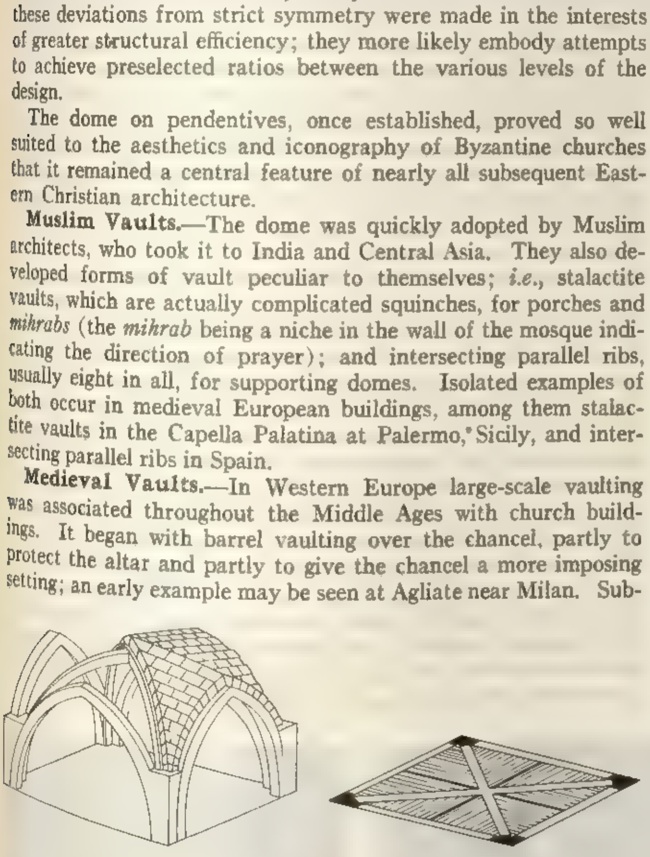
RIBBED VAULTING

Intersecting segmental arches forming pointed ribbed vaults in Durham Cathedral, England; Romanesque (Norman), about 1100

Groined Vaults.—A true groined vault is the result of intersecting two barrel vaults over a square bay. If the barrels are identical, the lines of intersection (the groins) form elliptical curves. Mathematically these are complicated, a by-product of the simple curves of the surface of the vault. If the bay is rectangular instead of square, one of the barrels has to be stilted, and in consequence the groins undulate. But even in such early Roman buildings as the Baths of Diocletian (late 2nd century A.D.) may be seen groined vaults, over rectangular compartments, in which the undulations have been straightened. In spite of the shape of the compartment, the groins are in effect elliptical arches. It follows that the several surfaces of the vault have ceased to have a strict mathematical connection with one another.

In the 11th and 12th centuries medieval architects slowly realized the possibilities of these simplifications. The earliest surviving example of straight groins over rectangular bays is to be seen in the nave of the abbey church at Vézelay, France (12th century), but by *c.* 1100 at Norwich, Eng., straight groins had been applied to the task of vaulting a turning ambulatory—mathematically perhaps the most difficult of all vaulting problems to solve. At Norwich the groins are no longer regarded as complete arches but are four arcs converging on a predetermined centre where they achieve equilibrium. This technique anticipates by some 40 years the more or less identical solution worked out in terms of ribbed vaults for the ambulatories of Saint-Denis, near Paris.

Ribbed Vaults.—In vaults of this kind the groins take logical priority over surfaces: they are the starting point rather than a by-product. The first step was to emphasize the groins visually by applying solid moldings to them. In the Baths of Diocletian, the groins were strengthened by embedding arches of flat tiles in the concrete. Originally these were not meant to be seen, but in decay the tiles must have begun to project and they may have provided a structural prototype for the most widespread of medieval vaulting forms, the ribbed vault. The rib, like the barrel and groin, may have originated in northern Italy at the end of the 11th century. But the great development of ribbed vaulting was all in the north, where the earliest, in the cathedral at Durham, Eng. (*c.* 1100), was virtually contemporary with that seen in north Italy. The earliest surviving vaults at Durham, in the choir aisles, are really no more than intersecting segmental arches, not clearly related to the wall and pier articulation and therefore perhaps conceived as a strengthening framework under the vault rather than as an integral part of the design. It is the sense of



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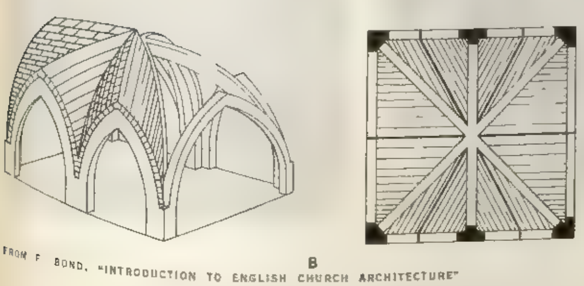
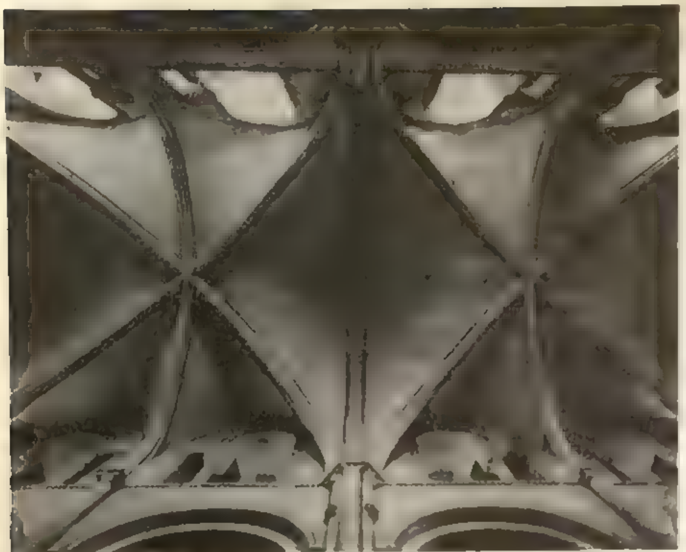


B

FROM F. BOND, "INTRODUCTION TO ENGLISH CHURCH ARCHITECTURE"

FIG. 4.—GOTHIC RIBBED VAULT TYPES

(A) Four-part vault, with filling of French type; (B) six-part vault, French type



CLARENCE WARD

SEXPARTITE VAULT

Intermediate transverse ribs cut the diagonal ribs at their intersections in the nave of L' Abbaye-aux-Hommes (St. Étienne), Caen, France; Norman Romanesque, about 1130

being totally integrated into an all-embracing system of arches that distinguishes subsequent Gothic ribbed vaults.

No doubt symbolism played a part in making ribbed vaults popular, but the nature of this symbolism is no easier to establish for vaults than it is for arches. Intersecting diagonal ribs (*croisée d'ogives*) certainly resembled the ciborium over the altar of Old St. Peter's, Rome, and a ribbed-vaulted bay could thus be regarded as a kind of ciborium writ large. Symbolic interpretations presumably followed rather than preceded structural innovations, although in the series of French Gothic buildings that link Abbot Suger's Saint-Denis (*c.* 1140) with Louis IX's Sainte-Chapelle (1240) structure and meaning seem constantly to have interacted with one another.

The use of pointed arches in the construction of Gothic ribbed vaults appears to have evolved very slowly. Contrary to a widely held belief, the fact that pointed arches could be adjusted so that the crowns of arches over different spans could reach the same height played little or no part in the process. On the contrary, it is already evident in the vaults over the nave of Durham Cathedral (1128–33) that the diagonal ribs were meant to be semicircular, and the transverse ribs, which cover a shorter span, are pointed precisely because they are struck to the same radius. The same idea may be observed in France in the sexpartite vaults of the cathedrals of Sens (*c.* 1140), Laon (*c.* 1170), and Bourges (*c.* 1200). A good deal of simple mathematical ingenuity was devoted to the design of these vaults. For instance, at Laon the dimensions of the double bays allowed the spans of the ribs to be calculated in terms of a Pythagorean triangle (actually 6: 8: 10). Thus the diagonal ribs have a radius of 5 and a span of 10, while the transverse arches have a radius of 5 and a span of 8. The transverse arches thus were *quint-point*. Not until the very end of the 12th century, in the cathedral of Chartres, was the decisive step taken of making all the vaulting arches pointed.

Elaboration of the Ribbed Vault: England.—The later history of medieval vaulting is to be traced largely outside France. A fundamentally different approach to the design of ribbed vaults is to be seen at Lincoln Cathedral in England, where, over St. Hugh's choir (*c.* 1200), a ridge rib is combined with two keystones and the first asymmetrical ribbed pattern. In the course of the 13th century in England the tendency was to increase the number of keystones still further and to crowd as many ribs as possible into the space available (tiercerons), even if this meant having ribs which did not reach the centre of the vault. These designs are based on the notion of ribs diverging from a common springer as opposed to the French idea of making them converge on a common apex. The logical outcome of the English practice was the cone of ribs in a centrally planned building such as a chapter house. Here again the crucial prototype occurs at Lincoln, where the ten-sided chapter house with 20 ribs was built *c.* 1230. Others followed at Lichfield, Salisbury, Westminster, Elgin, and Wells. The one at Wells (*c.* 1300) with 32 ribs is the most spectacular.

During the last years of the 13th century two other important features, both used decoratively, appeared in English vault design: one was the flying or skeleton rib (a rib with no filling), the other was the lierne (a rib which starts on one rib and ends on another). Liernes were at first concentrated in the higher central parts of vaults, where their function was roughly analogous to that of tracery (*q.v.*) in windows. The design of both vaults and windows required more careful planning than other types of masonry work did, and surviving Gothic architectural drawings are largely concerned with the geometry of vault and window patterns. In England the formal affinity between tracery and vaults reached the stage of virtual identity in the fan vault. The earliest fan vaults still surviving are in Gloucester cloister, dating from 1351 onward. Here they are no longer ribs in the ordinary sense of the word at all, but developing cells of tracery cut into the surface of the vault, the patterns being slightly modified projections of 13th-century rose window designs.

Fan vaults were suited to the smaller spans of aisles and cloisters, but it was not until the end of the 15th century that they were applied to the major spans of high vaults. The earliest of these apparently were at Sherborne Abbey, and the success of this experiment led to their use in two major works of the early 16th century, King's College Chapel at Cambridge and Henry VII's Chapel at Westminster Abbey. In both these buildings fan vaults are used in conjunction with powerful transverse ribs. At Westminster fans are ingeniously "threaded" on the transverse ribs so that the ribs disappear behind the fans in the greater part of the span. The fans terminate in pendants which must have been derived from the corresponding features of timber hammerbeam roofs (*see* HAMMERBEAM ROOF). Fan vaulting seems to have been an English specialty, and there is nothing comparable to it elsewhere in Europe, although the use of pendants in conjunction with elaborate ribbed patterns was widespread. Examples are found from Portugal to Austria.

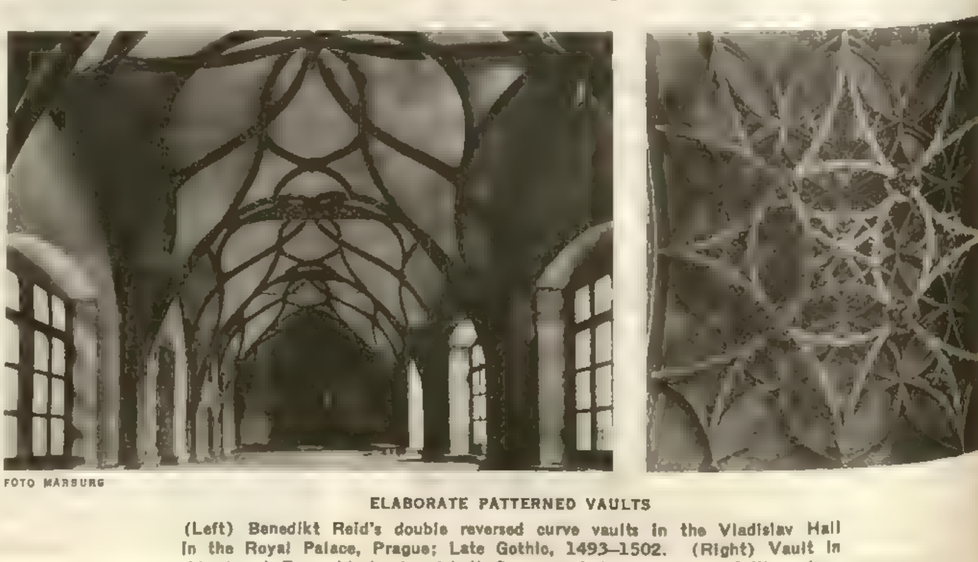
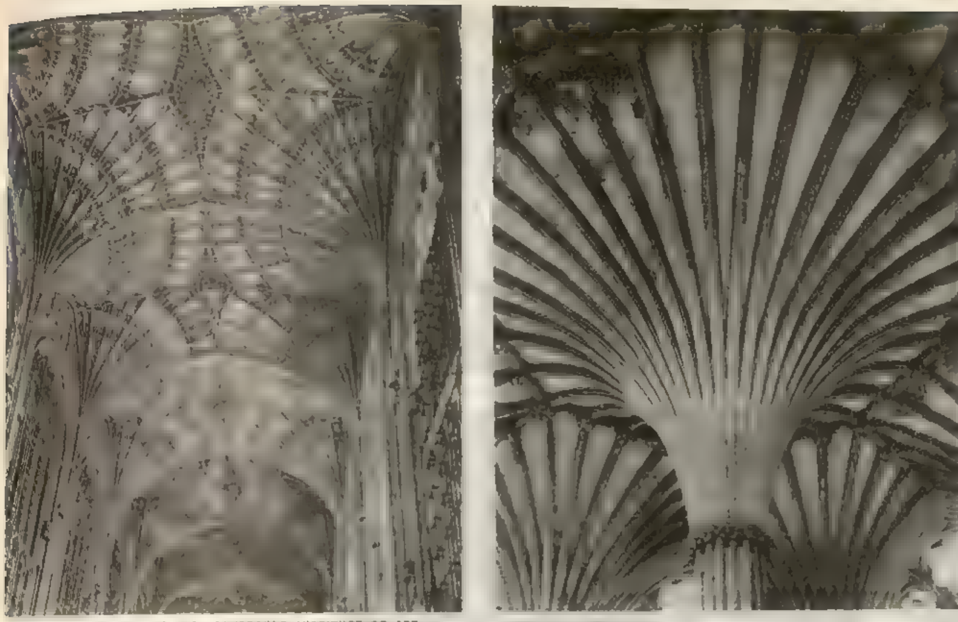


FOTO MARBURG

ELABORATE PATTERNED VAULTS

(Left) Benedikt Reid's double reversed curve vaults in the Vladislav Hall in the Royal Palace, Prague; Late Gothic, 1493–1502. (Right) Vault in side chapel, Frauenkirche, Ingolstadt, Germany; Late Gothic, early 16th century



(LEFT) A. F. KERSTING, (RIGHT) COURTAULD INSTITUTE OF ART

RIBBED AND FAN VAULTING

(Left) Fan vaulting in King's College Chapel, Cambridge, England; Late Gothic (Perpendicular), 1512–15. (Right) 32-ribbed cone in the chapter house, Wells Cathedral, England; Gothic (Decorated), *c.* 1300

Elaboration of the Ribbed Vault: Germany and Central Europe.—It is likely that English experiments with the visual aspects of vault design lie behind the development of Late Gothic vaulting in Germany, Austria, and Bohemia. The earliest of the elaborate German patterned vaults occur *c.* 1300 in the Baltic coastlands dominated by the Teutonic Knights. By the middle of the 14th century these ideas had percolated south through Silesia to Bohemia where they received fresh emphasis from the work of Peter Parler at the cathedral of Prague. Parler's "net vault," the essential principle of which was parallel as opposed to diverging ribs, was to prove particularly popular with German architects throughout the 15th century.

The last phase of German medieval vaulting was dominated by three major ideas. (1) The first of these was the double reversed curve, which the Germans—in contrast to the English, who were content to use this in the miniature form of the "nodding" ogee—used on a colossal scale to produce the most extravagant of all medieval patterned vaults. The architect whose name is most closely associated with this kind of vaulting is Benedikt Reid, whose masterpiece was undoubtedly the Vladislav Hall (*c.* 1500) in the Royal Palace at Prague. The ribs writhe and twist themselves into monster flower shapes that spread over some 60 ft. (2) A second characteristic of Late German Gothic was the construction of a pattern of flying ribs under the main one which carried the filling. Some of these became so complicated as to resemble expressionistic works of sculpture rather than architectural forms; in the cathedral at Ingolstadt we are obviously invited to think of the Crown of Thorns. (3) Some architects, working for the most part in Austria and Bohemia, developed the net vault into a system of cells by raising hollow pyramids on the framework of ribs. The visual effect of these is often strikingly modern, and indeed similar vaults have found favour with mid-20th-century architects such as Pier Luigi Nervi.

Postmedieval Vaults.—Insofar as Renaissance architecture revived antique forms, it tended to repudiate the extravagances of Late Gothic ribbed vaults (which in any case had never appealed to Italian taste) and reverted to straightforward barrel and groined vaults, with the dome assuming particular importance. The first of the great Renaissance domes is generally reckoned to be that of Florence Cathedral by Brunelleschi, though the problem of how to vault the dome which Brunelleschi solved (1420–34) had been bequeathed to posterity by the 14th-century architect of the cathedral, Francesco Talenti. The dome's span of about 140 ft. (43 m.) invites comparison with the dome of the Pantheon, and it is almost twice that of the next largest Gothic vault, that over the nave of the cathedral at Gerona, Spain. Michelangelo's dome for St. Peter's at Rome (1547–90) is almost as big as that of Florence Cathedral. For the most part, however, Renaissance vaults were less ambitious and concentrated more on exploiting the perfection of simple geometrical shapes. Baroque architecture, with its interest in compound and reversed curves, provided opportunities for mathematically complicated vaults, but these seldom involved a revival of medieval forms. A striking exception occurs in the work of Guarini (1624–83), who for the domes and lanterns of his two churches in Turin was clearly inspired by the crisscross rib patterns of Muslim and medieval Spain.

Contemporary Vaults.—The third great period in the history of vault construction (that is, after classical Rome and medieval Europe) is undoubtedly the present. Since the middle of the 19th century there has been a demand in industrial countries for covered halls of unprecedented size. Construction of these has led to the exploitation of new materials and new methods, and not least to a new understanding of the mechanical theory of vaulting. Such buildings are characterized by structural efficiency, and for reasons of economy the bare elements of the structure have not been disguised with superficial decoration. They have therefore little in common with traditional architecture. On occasion, however, when trouble has been taken with the design, they have considerable aesthetic appeal and have been hailed as initiating an architectural revolution.

The new materials fall into two categories. On the one hand,

ALINARI

BAROQUE VAULT

Crisscross rib pattern of the dome of S. Lorenzo, Turin, Italy, by Guarino Guarini; Baroque, 1668–87

(TOP) WIDE WORLD, (BOTTOM LEFT) CEMENT AND CONCRETE ASSOCIATION, (BOTTOM RIGHT) MAX DUPAIN, SYDNEY

MODERN VAULTING

(Top) Pier Luigi Nervi's Sports Palace at Rome, Italy; 1960. The dome has a span of 328 ft. (100 m.). (Bottom left) Shell vaults for a restaurant at Xochimilco, Mexico, by Félix Candela; 1958. (Bottom right) Joern Utzon's design for the opera house at Sydney, Australia; 1957

steel and reinforced concrete, which combine great strength under pressure with relative ease of handling, have more or less replaced stone and brick for the construction of very large carrying arches. On the other hand, glass, sheet metal, and thin concrete slabs have made possible very much lighter infilling than was possible with ordinary masonry. These advantages have been enhanced by the development of prefabrication of components in factories. This has now extended to the prestressing of parts, so that, when the building is assembled, warping under pressure or distortion by settlement, which bedeviled medieval if not Roman vault construction, have been virtually eliminated. The importance of prestressing can hardly be overemphasized, for in the very large vaults that were being built by the second half of the 20th century the traditional margins of tolerance would be prohibitive. Much more exact knowledge of the mechanical conditions affecting the behaviour of buildings makes it possible to calculate the minimum effective thickness of a vault, as well as its weight, the stresses to which it will be subjected, and the precise direction of thrusts, together with the necessary allowances for wind and weather. Occasionally calculations can go awry, as in the case of the Tacoma Narrows Bridge (Wash.), which collapsed in 1940. But by and large the total performance of a modern vault can be predicted with great accuracy, and it is in this that modern methods differ most fundamentally from those of the Middle Ages and antiquity, when everything was determined by traditional rules of thumb. This is one reason why 20th-century experiments in vaulting have followed one another with almost hectic assurance.

The characteristic outcome of the new technical knowledge has been the shell vault. Usually made of prestressed, reinforced concrete, shells can be made as thin as 1:500 of their span; further reinforced by ribs, they can be even thinner. They began with comparatively simple forms—for example, Eugene Freyssinet's aircraft hangar at Orly, near Paris (1927), which was a parabolic cylinder; and the Zeiss-Dywidag Planetarium dome at Jena, Ger. (1925). Since then an impressive series of hangars and market and exhibition halls has been built, in both America and Europe; among these Amman and Whitney's Trans World Airlines hangars at Midway Airport, Chicago, achieve a span of 270 ft. (82.3 m.), and Nervi's dome for the Sports Palace at Rome (1960) covers 328 ft. (100 m.).

The latest history of shell vaulting has been concerned with more complicated forms of solid geometry. An alternative to the continuous paraboloid cylinder is a succession of conoid sections joined together by windows. These may be either straight-sided or curved, and the curves may be either simple or conic, concave or convex, parabolic or hyperbolic. Perhaps the most sophisticated of all these compound forms is the hyperbolic paraboloid. The purpose of all these double-curved vaults is to play off one set of stresses against another. This can be done in another way by undulating the vault (making it like corrugated paper or metal) to increase its rigidity without increasing its thickness. Again, the undulations may be arranged in a straight sequence or in a circle or indeed in any number of irregular ways. While considerations of function and economy play a determining part in the design of such vaults, their geometrical versatility lends itself to architectural composition. Joern Utzon's 1957 design for the opera house at Sydney, Austr., and the numerous grouped vaults that appear in the work of the Mexican engineer Félix Candela, certainly aspire to produce aesthetic effects as well as solutions to technical problems.

The more successful of these designs are often oddly reminiscent of vaults from the past. The Spanish exponent of shell vaulting, Eduardo Torroja, observed that an intuitive grasp of the principles of shell construction can be detected in certain very light Byzantine vaults. The modern geodesic method of dispersing stresses evenly through vaulted surfaces is distantly anticipated in the net vaults of 14th- and 15th-century Germany. Austrian and Bohemian Gothic cell vaults call to mind Nervi's shallow span for the Exhibition Hall (1948–50) at Turin. And the groups of ribs cantilevered out of supporting piers like the arms of an umbrella, used by Nervi and Candela in conjunction with their great spans, were foreshadowed by the cones of ribs of English cathedral chapter houses and German hall churches. There is, of course, no question of direct influence or imitation. It is merely that vaults, more than most of the technical features of architecture, can be designed only in a limited number of forms, which accordingly tend to repeat themselves.

See also GOTHIC ARCHITECTURE; MODERN ARCHITECTURE; ARCHITECTURAL ENGINEERING; and references under "Arch and Vault" in the Index.

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ARCHANGEL (Arkhangelsk), an *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., covers 226,795 sq.mi., lying along the northern coast of European Russia from the Gulf of Onega (Onezhskaya Guba) to the eastern side of the Yugorski peninsula. The narrow eastern "panhandle" is occupied by the Nenets National *okrug* (64,749 sq.mi.). Administratively the *oblast* also includes the Solovets Islands in the White sea and the arctic islands of Kolguyev, Novaya Zemlya, Franz Josef Land (*qq.v.*), Vaigach and Matveyev. These islands constitute about one-fifth of the *oblast's* total area. Most of the mainland area displays low relief of morainic hills and mounds with broad valleys of rivers flowing northwest and north to the sea—the Onega, Northern Dvina, Mezen and Pechora. North of approximately 67° N. the area is bleak, open tundra with vegetation of mosses, lichens and dwarf shrubs. Southward tundra gives way to thin, stunted forest and then to dense taiga, coniferous forest of spruce, pine and fir with birch, covering almost the entire area. The climate is severe, with long cold winters and cool summers. Average temperatures for the city of Archangel are 8° F. in January and 59° F. in July. Rainfall averages about 16 in. annually.

The area was opened up as early as the 10th century by fur trappers and traders from Novgorod. Its subsequent importance to the Muscovite state lay in the port of Archangel, through which passed trade with England and, later, Holland. Overhunting gradually reduced the value of the fur trade but in the 19th century timber began to be exported in large quantities.

The *oblast*, which was formed in 1937, is thinly populated, with less than three persons per square mile (counting rural population alone) living mostly along the rivers. The population in 1959 was 1,275,839, of which 674,939 was urban. The main town is the administrative centre of Archangel. The Nenets National *okrug*, with its centre at Naryan-Mar, has about 45,534 persons. The Nentsy are a Finno-Ugrian group, known earlier as Samoyeds (*q.v.*).

The economy of the *oblast* is almost wholly based on forestry. Logs are rafted down the rivers to sawmilling centres at Archangel, Onega, Mezen and Naryan-Mar, or transported by light railway to sawmills along the Archangel-Vologda railway. Other main timber working centres, aside from Archangel, are Kotlas and Konosha. Agriculture is carried on in small clearings near the railways or rivers, and reindeer herding is important in the economy of the Nentsy. Fishing is significant along the coasts and rivers.

(R. A. F.)

ARCHANGEL (Arkhangelsk), a town and the centre of Archangel *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., is situated on the right bank of the Northern Dvina, 31 mi. from the sea, at the point where the river divides into several distributaries. Pop. (1959) 256,309. The town was founded as a fortified monastery, Archangel Michael, in 1583 and took over the functions of the older Kholmogory, farther upstream. Until the founding of St. Petersburg in 1703, Archangel was the largest port of the Russian north. It is now one of the supply ports for the North sea route. The port was of great importance during World War II for Allied convoys to the U.S.S.R. With Solombala and Ekonomiya, it extends for 10 mi. along the right bank of the river. The navigation season is lengthened by use of icebreakers. Its economy is almost wholly linked with timber (about 10,000,000 to 13,000,000 cu.yd. annually), which is either rafted down the Dvina or carried on the railway that runs south from Archangel to Vologda and central Russia. There is large-scale sawmilling, paper and pulp making, wood chemical extraction and manufacture of prefabricated houses. The main power station operates on timber waste. Timber forms the major export of the port, which is also the base of the Dvina river fleet and a fishing fleet. Shipbuilding and repair are important. There is a railway from Murmansk, skirting the southern shore of the White sea, which joins the Archangel-Vologda line at Obozërski. The station at Archangel is on the opposite side of the river from the town; there is no bridge. Another line connects the town with the outport of Severodvinsk on the Dvina gulf.

There are institutes of epidemiology, microbiology and hygiene, timber industry and also a teachers' college. (R. A. F.)

ARCHBISHOP, in the Christian church, the title of a bishop who, besides wielding ordinary episcopal authority in his own diocese, usually has jurisdiction (but no superiority of order) over the other bishops of a province. The functions of the archbishop developed out of those of the metropolitan (*q.v.*), though the title of archbishop, when it first appeared, implied no metropolitan jurisdiction. The title seems to have been introduced in the East, in the 4th century, as an honorary title of certain bishops. In the Western church the title was hardly known before the 7th century, and did not become common until the Carolingian emperors revived the right of the metropolitans to summon provincial synods. The metropolitans then commonly assumed the title of archbishop to mark their preeminence over the other bishops; at the same time the obligation imposed upon them, mainly at the insistence of St. Boniface, to receive the pallium from Rome, marked the defeat of their claim to exercise metropolitan jurisdiction independently of the pope. Its first recorded use is by Athanasius, bishop of Alexandria, who applied it to his predecessor Alexander as a mark of respect.

The title "archbishop" is still used in the Roman Catholic Church as an honorary title for certain simple bishops who are not metropolitans. After the Council of Trent the powers of the archbishop were considerably less extensive than they had been in the Middle Ages. The disciplinary powers once exercised by the archbishop can scarcely be said to survive. The right to hold visitation of a suffragan's diocese or to issue censures against him was made by the Council of Trent dependent upon the consent of the provincial synod after cause shown, and the only two powers left to the archbishop in this respect are to watch over the diocesan seminaries and to compel the residence of the bishop in his diocese. The confirmation and consecration of bishops is reserved to the Holy See. In the Orthodox and other churches of the East the title of archbishop is of far more common occurrence than in the West, and is less consistently associated with metropolitan functions. In the Orthodox Church there are autocephalous archbishops ranking between bishops and metropolitans.

In the Protestant churches of continental Europe the title of archbishop has fallen into almost complete disuse, though it was retained by the Lutheran bishop of Uppsala, who is metropolitan of Sweden, and by the Lutheran bishop of Turku in Finland.

The ecclesiastical government of the Anglican Church is divided between two archbishops: the archbishop of Canterbury, who is the "primate of all England" and the metropolitan of the province of Canterbury, and the archbishop of York, who is "primate of England" and metropolitan of York. The jurisdiction of the archbishop of Canterbury as archbishop of all England extends in certain matters into the province of York.

See also Episcopacy; Ministry, Christian.

ARCHCHANCELLOR: *see* Chancellor.

ARCHDEACON, originally the chief deacon at the bishop's church; during the middle ages, in the west, a chief official of the diocese, second in importance only to the bishop.

Though the name archdeacon does not appear either in east or west until the 4th century, earlier practice knew of a leader among the college of deacons attached to the bishop's service; *e.g.*, the martyr-deacon Lawrence (d. 258). The archdeacon was appointed by the bishop, and, as the name implies, his duties were, besides preaching, to supervise the deacons and their work (*i.e.*, the care of the sick and the arrangement of the externals of divine worship); one of the chief duties of the archdeacon was to supervise the distribution of alms. Thus, with his close relation to the bishop and his employment in matters of episcopal administration, and with the rapid expansion of the church and its revenues in the 4th century, his role grew correspondingly in importance. He became the first assistant to the bishop in the administrative and disciplinary work of the diocese, and represented him at councils. Upon a bishop's death the archdeacon governed the diocese until the election of a successor. In the 5th century the archdeacon was entrusted with the education of the younger clergy; this meant, in practice, decisive control over the admission of candidates to orders. During the 8th and 9th centuries the office tended to become more and more exclusively purely administrative, the archdeacon

relieving the bishop of the minutiae of government and keeping him informed in detail of the condition of his diocese. The archdeacon had thus become, on the one hand, the eyes of the bishop, but on the other hand, armed as he was with the powers of imposing penance and, in cases of extreme disobedience, of excommunication, he assumed his share in the jurisdiction of the bishop. First in France and then also elsewhere, he became officially the "vicar of the bishop in all things," including the right of visitation even of priests.

Beginning with the 10th century, the archdeacon (now generally an ordained priest) achieved a defined territorial jurisdiction, and soon dioceses were divided into several archdeaconries. The office was no longer subject to the bishop, but was conferred irrevocably by the cathedral chapter. This meant, in fact, that archdeacons became rivals of the bishop, functioning to an ever greater degree independently of him and seeking to lessen his spiritual and temporal authority in their respective archdeaconries. Details varied according to country, and the general law of the church did not sanction many of the practices; but an archdeacon of the 13th century exercised in his territory all the traditional rights of a bishop. The only thing lacking to him was the ordination to the episcopate and the power of ordaining.

From the 13th century onward a reaction set in. The power of the archdeacons rested upon custom and prescription, not upon the canon law; and though the bishops could not break the power of archdeacons, they could circumvent their influence by appointing new officials: auxiliary bishops, diocesan court functionaries, vicars forane for the country districts and, most important, the vicar general. Since the clergy could now appeal to these new bearers of authority, the power of the archdeacons rapidly declined during the 14th and 15th centuries. The Council of Trent (1564) completed the process when it withdrew matrimonial and criminal causes from the competence of the archdeacons, forbade them to pronounce excommunications, and allowed them only to hold visitations in connection with those of the bishop and with his consent. In the Roman Catholic Church at present the office of archdeacon is nothing more than an honorary title, and is not even mentioned in the Code of Canon Law.

In the Byzantine Church, the role of archdeacon, similar in its origins to that of its early counterpart in the west, was gradually absorbed after the 7th century by the chartophylax (literally, keeper of the archives), whose office in the course of time resembled somewhat that of the medieval archdeacon. It is now largely honorary. Only in the Anglican Church has the title of archdeacon retained more than nominal significance. Administrative authority is delegated to him by the bishop over the whole or a part of the diocese. In England, he must be an ordained priest. His duties, according to the Anglican ordinal, include the examining and presenting of candidates for holy orders. Other duties vary widely; in general, they concern some degree of supervision over clerical discipline and over ecclesiastical property.

See also DEACON; MINISTRY, CHRISTIAN.

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ARCHDUKE (Lat. *archidux*, Ger. *Erzherzog*), a title proper, in modern times, to members of the house of Habsburg (*q.v.*). The title of archduke palatine (*Pfalz-Erzherzog*) was first assumed by Rudolf IV, duke of Austria (d. 1365), on the strength of a forged privilege, in the hope of gaining for the dukes of Austria equal status with the electors (*q.v.*) of the Holy Roman empire—a status that had been denied to the dukes by the Golden Bull of 1356. The title, however, was not recognized by the emperor Charles IV and was not juridically held by the Habsburgs until 1453, when the emperor Frederick III, himself a Habsburg, confirmed Rudolf's privilege and granted the title of archduke of Austria to his son Maximilian and his heirs. All males of the house of Habsburg bear this title; their daughters and wives are archduchesses. The title archduke of Austria also occurs in the royal style of the Bourbon kings of Spain, though they were not descended in the male line from their Habsburg predecessors.

ARCHELAUS (ARCHELAUS SISINES) (d. A.D. 17), king of Cappadocia, 36 B.C.–*c.* A.D. 14. His family, the hereditary priest-kings of Comana (*q.v.*) in Pontus, had long played an important part in the political life of Pontus and Cappadocia; in particular, they had schemed for possession of the Cappadocian throne. This ambition was finally realized in 36 B.C. when Mark Antony granted Archelaus the kingdom. After the battle of Actium (31 B.C.) Archelaus made his peace with Octavian and so retained his crown; and in 20 B.C. Cilicia Trachea, eastern Lycaonia and Armenia Minor were added to his kingdom. A marriage with Pythodoris, the widow of King Polemo of Pontus, brought him indirect control of most of Pontus.

During the reign of Augustus the subjects of Archelaus are said to have accused him at Rome on some charge against which Tiberius defended him. Archelaus showed Tiberius no gratitude for this service, ignoring him during the years of Tiberius' sojourn at Rhodes. When Tiberius succeeded Augustus (A.D. 14) Archelaus was lured to Rome and charged before the senatorial court with revolutionary conduct. The outcome is not known, but Archelaus, now very old, soon died (A.D. 17). On his death Cappadocia (though not Cilicia Trachea and eastern Lycaonia, where Archelaus' son Archelaus became ruler) was annexed as a Roman province. A decision on the part of Tiberius to incorporate Cappadocia in the Roman empire may have been the real cause of Archelaus' disgrace.

Archelaus is said to have spent much time at Elaeussa, a pleasant residence on the coast of Cilicia. He was an erudite man, if one may judge from the titles of the geographical works written by him and now lost. (R. H. St.)

ARCHELAUS (d. 399 B.C.), king of Macedonia from 413 to 399 B.C., was the son of Perdiccas II by a slave mother. He obtained the throne by murdering his uncle, his cousin, and his half-brother, the legitimate heir. Archelaus proved, however, to be a capable and beneficent ruler; Thucydides praises his work. He fortified cities, constructed roads, and organized the army; he endeavoured to spread among his people the refinements of Greek civilization, and he invited to his new capital at Pella many celebrated men, among them Euripides, Timotheus, Agathon, Choerilus, and Zeuxis; he celebrated games at Dium. He adopted a Persian coin standard and developed Macedonian trade. He seized Pydna in 410 and *c.* 400 put the pro-Macedonian oligarchic party into power at Larissa. He was assassinated by one of his favourites while hunting (399).

See F. Geyer, *Makedonien bis zur Thronbesteigung Philipps II* (1930). (F. W. WA.)

ARCHELAUS (5th century B.C.), Greek philosopher, was probably born at Athens (if so, he was the first Athenian to become a philosopher), though Diogenes Laërtius (ii, 16) gives the alternative of Miletus. He was a pupil of Anaxagoras (*q.v.*) and is said to have been the teacher of Socrates. Some argue that this is probably an attempt to connect Socrates with the Ionian school; others uphold the story. In general he followed Anaxagoras, but in his cosmology he went back to the earlier Ionians. He appears to have given a pre-eminent position to "air" and did not distinguish it from "mind," thus avoiding Anaxagoras' dualism. Out of this "air," by a process of thickening and thinning, arose cold and warmth, or water and fire, one passive, the other active. The earth and heavenly bodies are formed from mud, the product of fire and water, from which spring the lower animals and man. Man differs from animals in possessing a moral and artistic faculty.

No fragments of Archelaus remain; for the testimonies of the ancient authorities *see* H. Diels and W. Kranz, *Die Fragmente der Vorsokratiker* vol. 2, 6th ed. (1951–52).

ARCHER, THOMAS (1668/69–1743), English architect, whose style is closer to Roman baroque of the 17th century than was that of any of his English contemporaries, was the son of a Warwickshire squire. He was educated at Trinity College, Oxford, and, although often described as a pupil of Sir John Vanbrugh, he was so only in the loosest sense of the term. After leaving Oxford, Archer spent four years abroad. In 1705, under Queen Anne, he was appointed to the office of groom porter, a sinecure

which made him licenser of gambling places throughout the kingdom; in 1715 he obtained an even more lucrative sinecure, comptroller of customs at Newcastle upon Tyne. Most of his architectural designs belong to the period 1705–15. They include the north front of Chatsworth House, Derbyshire (1705), Heythrop Hall, Oxfordshire (*c.* 1705), a garden pavilion at Wrest Park, Bedfordshire (1711), Roehampton House, Surrey (1712), and the churches of St. Philip, Birmingham (1710), St. Paul, Deptford (1712), and St. John, Westminster (1714); the last two were the outcome of his appointment, under the act of 1711, as a commissioner for building 50 new churches. In 1715 he bought the manor of Hale, Hampshire, where he rebuilt the house and the church. He died in London on May 23, 1743.

Essentially dynamic, and incorporating direct borrowings from Bernini and Borromini, Archer's style shows neither the occasional medievalizing of Sir John Vanbrugh's work nor the dawning neoclassicism of Nicholas Hawksmoor's. Though less original than they, he held his own as an architect in the Europe of his time.

See Marcus Whiffen, *Thomas Archer* (1950); H. M. Colvin, *Biographical Dictionary of English Architects* (1954). (Ms. W.)

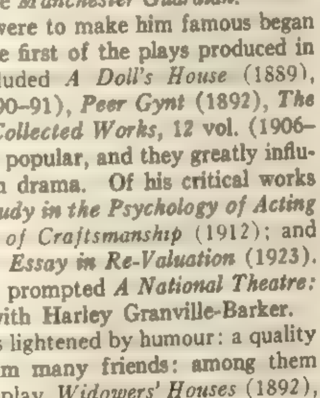
ARCHER, WILLIAM (1856–1924), Scottish drama critic, who influenced the revival of serious drama in England in the late 19th and early 20th centuries, was born in Perth on Sept. 23, 1856. While studying law at Edinburgh he began his journalistic career on the *Edinburgh Evening News*. After a world tour (1876–77), in 1878 he moved to London, and in 1879 became drama critic on the *London Figaro*. In 1884 he joined the *World;* his reviews for it and other periodicals were collected in *The Theatrical 'World,'* 5 vol. (1893–97). He was later drama critic on the *Nation*, the *Tribune*, and the *Manchester Guardian*.

The translations of Ibsen that were to make him famous began with *Pillars of Society* (1880), the first of the plays produced in England. Later translations included *A Doll's House* (1889), *Ibsen's Prose Dramas*, 5 vol. (1890–91), *Peer Gynt* (1892), *The Master Builder* (1893), and the *Collected Works*, 12 vol. (1906–12). Despite faults, these remain popular, and they greatly influenced the development of English drama. Of his critical works the best are *Masks or Faces? A Study in the Psychology of Acting* (1888); *Play-Making: a Manual of Craftsmanship* (1912); and *The Old Drama and the New: an Essay in Re-Valuation* (1923). His support for a national theatre prompted *A National Theatre: Scheme and Estimates* (1907), with Harley Granville-Barker.

The severity of his criticism was lightened by humour: a quality that, with his integrity, made him many friends: among them George Bernard Shaw, whose first play, *Widowers' Houses* (1892), he helped to recast on "Ibsenite" lines. Of his own plays, four were posthumously published; *The Green Goddess* (New York, 1921; London, 1923) was extremely successful and often revived.

"An energetic rationalist" (as J. M. Robertson called him), Archer wrote polemical essays for the Rationalist press (collected by Robertson in *William Archer as Rationalist*, 1925). Travels to the U.S., Spain, and India also resulted in books. He died in London on Dec. 27, 1924. (P. M. Y.; X.)

ARCHERFISH, the name given to several small fish because of their habit of projecting water from their mouths, thus wetting insects and knocking them into the water. The best-known species, *Toxotes jaculator*, inhabits the fresh waters of Java and other islands of the Malay archipelago.



BY COURTESY OF NEW YORK ZOOLOGICAL SOCIETY

ARCHERFISH (TOXOTES JACULATOR) SHOOTING DOWN A SPIDER

The archerfish, sometimes raised in home aquariums, reaches a length of 6 to 7 in. and can throw a jet of water 5 or 6 ft. with amazing accuracy. One of the Chaetodontidae (*Chelmon rostratus*) also inhabits Java and is, no doubt erroneously, credited with the same habit.

See also Aquarium: *Aquariums in the Home*.

ARCHERMUS, a Chian sculptor of the middle of the 6th century B.C. His father, Micciades, and his sons, Bupalus and Athenis, were all sculptors of marble, using, doubtless, the fine marble of their native land. The school excelled in draped female figures. Archermus is said to have been the first to represent Victory and Love with wings. This gives interest to a discovery made at Delos of a basis signed by Micciades and Archermus which was connected with a winged female figure in rapid motion (*see* Greek Art), a figure first regarded as the Victory of Archermus. Further investigation has discredited the idea that the statue belongs to the basis, which seems rather to have supported a sphinx.

ARCHERY, the shooting of arrows with a bow, is undoubtedly one of the oldest sports still being practised. The bow has been the most generally used and most widely dispersed of all weapons from its earliest days until the 16th century. Its importance in man's scheme of living is attested by the many family names—Archer, Arrowsmith, Bowman, Bownocker, Bowyer, Butts, Fletcher, Stringer, Yeoman—that have their origin in archery. After its replacement by firearms as a weapon of war, the bow became a favourite implement of sport.

For several decades the number of its followers has been steadily and rapidly increasing, both in the United States and the British dominions. Estimates have placed the number of archers in the United States and Canada in the second half of the 20th century at about 5,000,000, of whom 1,500,000 practice target archery and shooting for distance, and 3,500,000 field archery. The latter are reviving and developing the art of hunting with the bow and the crossbow (*q.v.*), their quarry being principally deer, wild pig and lesser animals; but moose, bear and mountain lion have fallen to the broadhead arrow.

Archery also is playing an important part in recreational work with both boys and girls in municipal playgrounds, in schools and colleges and among the boy and girl scout organizations and other youth groups. Archery also is highly valued in the process of physical therapy. In some schools for the blind both juniors and seniors are taught to shoot the bow accurately by sound. (J. W. An.)

HISTORY

The bow is probably man's first invention of a device in which energy can be accumulated slowly, stored temporarily and released suddenly under control and direction. The date of this invention—ranking in importance as a cultural advance with the development of speech and the discovery of the art of making fire—is at least 30 and more probably nearer 50 millenniums ago. The stout yew longbow, with its cloth-yard shaft, will ever hold its place of honour in English history for the victories it won at Crécy, Poitiers and Agincourt (*qq.v.*). For the American Indian, as for other aboriginals, the bow was the means of both subsistence and existence before and during the days of white colonization. South American Indians still use the bow for hunting and fishing. Pygmy tribes of Africa also depend on the bow for their livelihood, using poison on their arrows to render them lethal. (*See* also Bow and Arrow; Hunting and Fishing, Primitive.)

Many of the British monarchs of recorded history, up to and including Queen Victoria, practised archery. Of Henry VIII it was said by Raphael Holinshed in 1510 that "His Grace shotte as stronge and as greate a lengthe as anie of his garde." Roger Ascham (*q.v.*), archer, Cambridge scholar and tutor to Edward VI and Elizabeth I, was the author of *Toxophilus* (from the Greek *toxon*, "bow"), the first book on archery written in English (1545). In the dedication of his book to Henry VIII he said he had "written this English matter, in the English tongue, for Englishmen," so that the greatest possible number might read and learn.

Henry VIII in 1537 granted a patent to the Fraternity of St. George or Honourable Artillery company (H.A.C.; *q.v.*), and appointed Sir Christopher Morres and others as overseers of "the science of artyllary that ys to vyt, for long bowes, cross bowes, and handgunnes." Further patents were granted by James I in 1605 and Charles I in 1633, reinstating the company's practice

grounds, Finsbury fields, which had been partly fenced in by the owners. The fields extended roughly from Moorgate to Islington and in their heyday contained nearly 200 marks for shooting at rovers as well as numerous butts. By 1737, however, only 21 marks and 3 butts were left, one of the marks, a stone post named Scarlet, being still preserved at the armoury house of the H.A.C. When the H.A.C., about 1590, was discarding bows as war weapons, the Finsbury Archers, probably consisting of the remaining members of the H.A.C. archery section, started to flourish and held regular competitions until about 1761. The last of the Finsbury Archers joined the Toxophilite society when it was founded by Sir Ashton Lever in 1781.

The prince of Wales, afterward George IV, became patron of the "Tox" in 1787 and instituted the "prince's lengths," 100 yd., 80 yd. and 60 yd., of which distances the championship York Round still consists, and the revival of archery as a pastime then began. Nevertheless, although discarded as a weapon, the longbow, in skilled hands, was still superior to the inaccurate musket. During the American Revolution, Benjamin Franklin wrote to Gen. Henry ("Light Horse Harry") Lee, father of Gen. Robert E. Lee, wishing that bows could be added to the armament of the revolutionary army—"these were good weapons not wisely laid aside." While for centuries the longbow was the principal artillery weapon in England, in continental Europe the crossbow largely supplanted it, perhaps because the latter, though much slower in operation, needed less strenuous training in usage.

The Queen's bodyguard in Scotland is the Royal Company of Archers founded in 1676, whose headquarters are at Archers hall, Edinburgh.

In 1844 the first of the Grand National Archery (G.N.A.) meetings—the British championships—was held at York and the G.N.A. society became the governing body of the sport in the United Kingdom.

International competition in archery began with Anglo-French matches at Le Touquet prior to World War I, and in 1931, the Fédération Internationale du Tir à l'Arc (F.I.T.A.) was formed to conduct the annual world championship matches.

On Sept. 3, 1828, the oldest individual archery club in the United States, the United Bowmen of Philadelphia, was formed and had an uninterrupted existence for 60 years, until Oct. 1888. In 1932 the club was revived by Robert P. Elmer of Wayne, Pa. A physician and surgeon, his connection with archery began early in 1910; author of *Archery* (1933), his extensive research into this sport and his high degree of skill, which took him to national championships many times, made his influence on this sport so marked that thousands owed their enjoyment of archery to the inspiration he provided.

The National Archery association of the United States, the oldest organization of its kind in the U.S. that is national in scope and has had a continuous existence since its founding, was organized at Crawfordsville, Ind., in Jan. 1879. The official publication of the association is its monthly journal *"Tam," The Archers' Magazine*, counterpart of *The British Archer*. The National Field Archery association, founded 1939, is represented by *Archery Magazine*. The first U.S. national archery tournament was held in Chicago in Aug. 1879. With the exception of the war years (1917–18, 1942–45), a national tournament, to determine the champion archers for the year, has been held annually.

TOURNAMENTS

In target archery and field target shooting there are city, town, state, regional and national tournaments going on both indoors and outdoors all year round in the United States and Canada as well as in all other parts of the world where organized archery is in vogue. There are national and international mail matches as well as national and international competitions.

Target Shooting.—The regulation targets at all distances are 4 ft. in diameter (for the original prince's lengths the targets were 4 ft. at 100 yd., 3 ft. at 80 yd. and 2 ft. at 60 yd.) with four concentric rings, each 4.8 in. wide, and a central field or bulls-eye 9.6 in. in diameter. Colours and values (the "prince's reckoning") of the fields, going outward, are: gold, 9; red, 7; blue, 5; black, 3; white, 1. The target face is attached to a tightly compressed rolled mat, or bass, usually of straw, and it is supported on a stand with its centre 4 ft. above the ground. In tournament shooting, six arrows constitute an end, shot in two successive groups of three. The score for an end is expressed, for example, as "6–42," meaning that there were 6 hits, and that the scores for the individual hits totaled 42. U.S. men's championship shooting consists of two York rounds and two American rounds. In the York round, 144 arrows (in the United Kingdom the number of arrows is expressed in dozens) are shot; 12 ends at 100 yd.; 8 ends at 80 yd.; and 4 ends at 60 yd. The American round comprises 5 ends at 60, 50 and 40 yd. Highest total score for the four rounds determines the winner. In case of a tie, the score at the longest range wins. The U.S. women's championship is determined by the best total score in two National and two Columbia rounds. The former calls for eight ends at 60 and four at 50 yd.; the latter, four ends each at 50, 40 and 30 yd.

The British championships are based on the Double York round, for men, and the Double Hereford (24 ends at 80 yd., 16 at 60 and 8 at 50) for women. World championships for both men and women are based on two F.I.T.A. rounds, each consisting of (men) 36 arrows each at 90, 70, 50 and 30 m.; (women) 36 arrows each at 70, 60, 50 and 30 m. At 50 and 30 m. the target is 80 cm. in diameter, and at all distances the colours are divided into two zones each. Scoring is from one to ten. At the two shorter distances only three arrows are shot at an end. Target shooting was included in the Olympic games of 1900, 1904 and 1908 and bird shooting in the games of 1920 (*see* Olympic Games). Special rounds have been designed for club, high school and college tournaments.

Distance Events.—Flight shooting is an event scored on the basis of distance. No targets are used. Contestants are divided into classes by the pulling weight of their bows (see *Equipment and Use*, below). Clout shooting, as practised by the Royal Company of Archers and the Woodmen of Arden (1785) with traditional longbows, is at distances from 180 to 240 yd. (9 to 12 score). The 31-in. plain white target with a black centre is inclined at an angle of about 45° in the centre of five concentric circles drawn on the grass. The circle, 1½ ft. (called a foot) from the centre of the clout, scores 5 points; the 3-ft. circle (half bow) scores 4; 6 ft. (bow) 3; 9 ft. (bow and half) 2; 12 ft. (two bows) 1 point. An arrow which hits or touches the clout scores 6. Alternatively, scoring is by ends, the arrow nearest the centre of the clout winning the end. Two arrows only are shot at an end, the shooting being in two directions. Elsewhere, clout shooting is at a target 48 ft. in diameter, drawn on the ground in five zones, scoring as in standard target archery, with a small target or flag in the centre as an aiming mark.

The ancient sport of popinjay shooting, particularly popular in Belgium, consists of vertical shots at artificial birds of various sizes and values on perches at the top of a pole or church tower, usually 80 to 100 ft. up. In wand shooting, the target usually is a slat of soft wood two inches wide and projecting six feet from the ground.

Field Events.—A field round has been devised with 28 targets of various sizes, at different elevations and distances, and an established method of scoring.

HUNTING

Interest in archery in the United States increased after the publication, in 1878, of a book entitled *The Witchery of Archery* by Maurice Thompson, first president of the National Archery association. The book was a compilation of essays that had appeared in *The Atlantic Monthly*, *Field and Stream* and other journals, describing the idyllic hunting experiences, with bows and arrows, of the author and his brother, Will Thompson. During the years from 1911 to 1926 the regard for the sport in the U.S. and Canada was quickened further by the exploits and writings of Saxton Pope, San Francisco surgeon and professor at the University of California medical school, and his friend Arthur Young. Pope's interest was kindled by his associations with Ishi, last of the uncivilized Yana Indians, whose knowledge about the construction and use of bows

and arrows was transmitted to Pope, his mentor and guardian. Pope and Young undertook to make superior implements of the sport, designed for hunting, and to prove to their own satisfaction that the ancient weapon could successfully lay low the largest North American game animals. After killing grizzly bear and moose, and following Young's superb and courageous feat of killing a great Kodiak bear with a single arrow, Young and Pope went to Africa and added lions to their list. Pope's book *Hunting With the Bow and Arrow* (1923) helped to stimulate interest in the sport.

In the United States the National Field Archery association fosters sportsmanship in hunting, maintains and issues current information regarding state game laws as they apply to bow-and-arrow hunting, and confers the Art Young award upon those of its members who have taken big game with the bow. National archery associations in Great Britain and continental Europe have not concerned themselves with hunting with the bow and arrow.

As for the killing power and penetration of a hunting arrow there is practically no game existent which has not been killed with a bow and arrow. During the 1950s as a test of the killing power and penetration of an arrow a big game hunter, William Negley, with the help of a white hunter, Eric Rondgram, stalked and killed two African bull elephants in one day. Negley used a laminated wood and glass fibre bow of approximately 100 lb. pulling weight and steel-tipped broadheaded arrows approximately 29 in. in length. At a range of 10 to 15 yd., the arrows penetrated cleanly up to the feathers and the first elephant traveled less than 50 yd. before it fell. A second arrow at approximately the same range penetrated to the heart and killed the beast in a matter of seconds. Killing power and penetration such as this is comparable to the heaviest rifle bullet except that it does not render anywhere near the amount of shock that a bullet gives to the game. The arrow kills by penetration and hemorrhage while the rifle bullet kills mainly through shocking power.

With the ancient English longbows and their 700 to 800 gr. arrow the force of the arrow was sufficient to penetrate practically every means of defensive armour that was in existence at that time. As technical knowledge of the weapon increased it was found that lighter arrows with higher velocities gave considerably more penetration on live game than the heavier slower arrows of ancient times. This is the reason that the bows for target field and hunting are much lighter in drawing strength than in times past but in proportion so are the arrows; therefore the arrows get much greater velocities and penetrations are accordingly greater. The maximum effective range of the bow and arrow for hunting is 40 to 90 yd; the average kill of deer, however, is made at 30.5 yd.

Special bow fishing sets are in use on which a reel and line is attached to the handle of the bow and the end of the line is attached to a barbed arrow. The arrow is shot at fish on or near the surface of the water and the barbed point and the line permit both arrow and fish to be recovered.

EQUIPMENT AND USE

Bows.—In the process of shooting, the bow is held in an approximately vertical position. The ends of the bow are grooved to provide firm seats for the ends of the string. These grooves are called nocks. The same term is used for the slot or notch of the arrow which holds it in position on the string. The bow has a back, as well as a belly, which are, respectively, its convex and concave sides as it is drawn. The grip, or handle, is as a rule fitted to the hand similar to the so-called pistol grips of the modern rifle or shotgun. Immediately above the grip on one side is a narrow strip of leather which protects the bow from the rub of the arrow as it passes by. Part of the formation of the grip is a narrow shelf called the arrow rest which holds the arrow in place while it is being drawn back and over which the arrow slides when it is released. A loop or eyelet at each end of the string permits its being held securely in the two nocks one at each end of the bow. Bending the relaxed bow and sliding the loop toward the nock on each end until it drops into the nock is called bracing the bow. A bow is usually fitted with a string

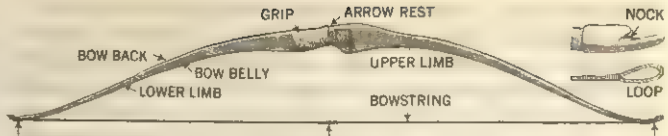


FIG. 1.—PARTS OF RECURVED BOW

of such length that its bracing height, that is, the distance from the string to the inner side of the grip, is an archer's fistmele (the width of the fist with fully extended thumb). This distance, depending on the archer's own dimensions, is somewhere between 6 and 8 in. When the bow is not in use it is unbraced, keeping it free from strain except when in actual use.

Bows used in target shooting weigh (force at full draw) from 20 to 60 lb., depending on the archer's strength. Length may be between 5 and 6 ft. Hunting bows range in weight between 50 and 100 lb., but some archers of Herculean brawn claim ability to manage up to 175 lb. Flight bows, for distance shooting only, weigh up to 90 lb. for regular style shooting, and up to 200 lb. in foot bows. Such a bow is strapped to the archer's feet. He shoots it while lying on his back, with his feet elevated to give the arrow the proper angle for maximum distance, and draws the string with both hands.

In the order of general preference, wooden bows are made of western yew (*Taxus brevifolia*), osage orange (*Maclura pomifera*), and dagame (*Calycophyllum candidissimum*). Other kinds of wood, including hickory, bamboo and red cedar, have been used as component materials in laminated bows. There also are bows of aluminum alloy made very similar in form to the orthodox wood bow, as well as bows of famous English and Swedish steels. Materials for covering the back of a bow, either as mechanical protection or to improve performance or durability, include parchment, rawhide, sinew fibre and silk fibre, the two latter in a matrix of glue. Many archers of the older order preferred to make their own wooden bows of the various popular woods as mentioned above. These they called self bows because they were as a rule made entirely of one piece with perhaps a backing and a facing of sinew or silk. However, as the sport progressed, so did the equipment. Skilled artisans began making bows of fibreglass and of laminated wood backed and faced with fibreglass. This is the modern composite bow, the efficiency of which is many times greater than the old time self bows and is the nearest approach to the traditionally famous oriental bow, the efficiency of which has not, as yet, been approached.

Arrows.—The parts of a target arrow are the nock, to which reference was made above; the shaft or stele, comprising the body of the arrow between the nock and tip; the shaftment, the portion of the stele to which the feathers are attached, extending to the crest; the crest, a distinctive, identifying arrangement of

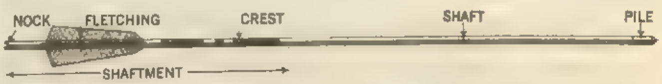


FIG. 2.—PARTS OF ARROW

coloured bands, encircling the stele a short distance forward from the fletching, or feathering; the footing, a section of hard dense wood comprising the foreshaft; and the pile, or metal cap, to give durability to the tip as it penetrates the target. A hunting arrow, or broadhead, differs from a target arrow in its greater weight, larger feathers and steel-bladed broadhead, sharpened to razor keenness.

The material preferred by many archers, when obtainable, and by experienced arrow makers is Scots pine (*Pinus sylvestris*; *see* PINE). This is the wood used almost exclusively by the arrow makers of England—Scots pine from Norway, preferably grown north of the Arctic circle. The "old deal" of story and tradition is usually Scots pine, a "deal" being a timber with a section at least 3 by 11 in., and "old" connoting that these timbers are frequently salvaged from old buildings being wrecked. Arrows of cedar and pine are usually footed with a tropical hardwood

called beefwood. Hunting arrows are usually made of birch.

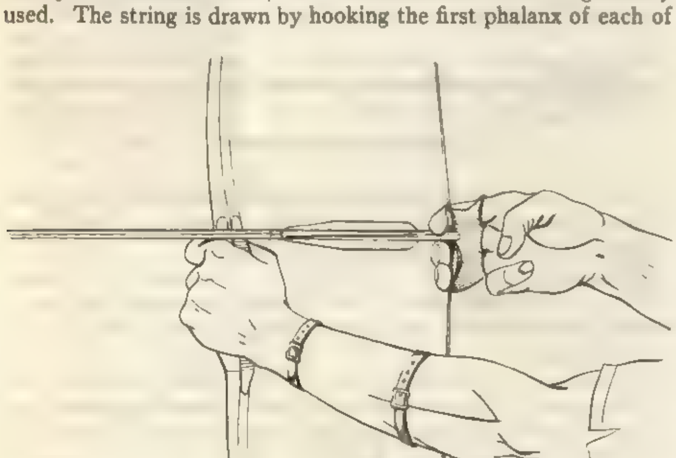
In the United States most arrows for both target, field and hunting are made from Port Orford cedar, almost the only suitable wood obtainable. Arrows are also made of fibreglass, compressed Port Orford cedar and aluminum alloy (in the United Kingdom tournament arrows are made almost exclusively of aluminum alloy). These materials are easily composed so that the spine and stiffness of the arrow as well as its thickness can be readily maintained and for this reason arrows of these materials have been largely responsible for the tremendous increase in efficiency of the weapon not only in target shooting but in field archery and bow hunting as well. Target, field and hunting arrows also have undergone another change in that three feathered shafts have been superseded to a great degree by shafts which contain four, six and eight feathers. This gives them remarkable stability and has increased their range and accuracy to a considerable degree. Another innovation has been the substitution of plastic vanes cut out to approximately the same form as the feathers but giving the arrow a greater potential for velocity and low trajectory.

Bow Strings.—Traditionally, strings for bows were made of linen, usually shoemaker's thread. Modern bow strings usually are made of any one of a number of the Celanese products such as Fortisan and Dacron. These strings are extremely light and of fantastic strength in comparison with the traditional linen.

Accessories.—Many accessories are available to the archer such as special quivers for carrying hunting shafts as well as target arrows. Hunting quivers are designed to carry a number of broad-headed shafts and to dispense them with easy access. Some are attached to the bow to enable very rapid shooting. Target quivers differ slightly from hunting quivers as do the various leather accessories required by the archer in the form of arm guards, finger tabs and shooting gloves.

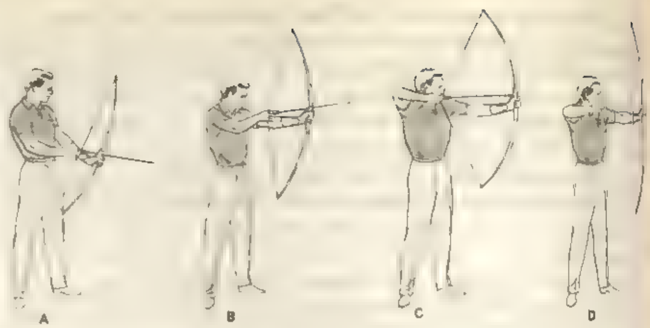
Drawing and Loosing.—Different peoples have developed a variety of methods of drawing and loosing the string. In 1885 E. S. Morse classified these as primary, secondary, tertiary, Mediterranean and Mongolian. The primary, according to Morse, is the simple pinch draw, in which the arrow is grasped at the nock between the thumb and first finger in a tight pinch, and drawn back. Obviously, only a weak bow can be thus drawn, since it depends upon the frictional force between the fingers and the arrow. Indian arrows have been found with the nock end enlarged to a knob, to permit a more secure grasp. The secondary draw is a modification of the primary, in which the second and third fingers rest upon and exert a direct pull on the string. In the tertiary draw, the first finger, in addition to grasping the arrow, crosses the string at an acute angle and pulls directly upon it, assisted by the second finger.

In the U.S., Canada and England, as in other countries in which the sport has taken hold, the Mediterranean loose is generally used. The string is drawn by hooking the first phalanx of each of



FROM A PHOTOGRAPH BY A. E. HODGKIN, "THE ARCHER'S CRAFT," FABER & FABER LTD., LONDON

FIG. 3.—DRAWING FOR MEDITERRANEAN LOOSE DEMONSTRATED BY ARCHER EQUIPPED WITH ARM GUARD ON LEFT FOREARM AND SHOOTING GLOVE ENCASING THE FIRST THREE FINGERS OF THE RIGHT HAND



FROM PHOTOGRAPHS BY A. E. HODGKIN, "THE ARCHER'S CRAFT," FABER & FABER LTD., LONDON

FIG. 4.—SHOOTING TECHNIQUE: (A) NOCKING ARROW; (B) SIGHTING TARGET; (C) DRAWING BOW; (D) LOOSING ARROW

the first three fingers upon it, with the arrow nocked between the first and second fingers. In most Asian countries the Mongolian draw is practised. This is distinctly sophisticated as compared with the other kinds classified by Morse. The archer, wearing a protecting ring of horn, bone, ivory or jade upon his thumb, to protect it against injury from the great pressure of the string, hooks the thumb about the latter and locks the thumb with his first finger. The string is loosed by disengaging the finger and thumb.

Technique.—In describing the technique of shooting as practised in the U.S., Canada and England, it will be assumed that the archer is right-handed, and that he employs the Mediterranean loose. Equipped with an arm guard or bracer on his left forearm, to protect against painful string slap, and with a shooting glove which encases the ends of the first three fingers of his right hand in stiff, smooth leather thimbles, he stands astride the shooting line, facing at right angles to the direction in which he intends to shoot, with the target at his left. The string is engaged with the protected fingers of the right, while the handle of the bow is grasped in the archer's left hand. The arrow, with its nock fitted to the string, and with its shaft at right angles to the latter, rests against the arrow plate on the left side of the bow. As the archer raises the bow with his left hand, he draws the string with his right, and brings the drawn bow into an approximately vertical position. Without moving the body while drawing, he turns his head toward the target, and aims with his right eye, by a method described below. His right elbow is well elevated and the forearm transmits the force exerted by the muscles of the shoulder and upper arm through the fingers to the string. The string comes to rest pressing against his chin. When he is ready to loose the arrow, he continues to pull back, with deliberation, and, almost without conscious intent, allows his fingers to slide off the string. It is of utmost importance that there be no forward creep of the arrow prior to the loose, to assure uniformity of distance in successive shots. The bow hand must be steady, and remain immovable until the arrow is well on its way. Accuracy in the shooting of successive arrows at a target requires that the individual arrows in the set have great uniformity of dimensions, weight, stiffness, balance and finish, and that the bow be unchanging in weight, so that the total energy for propelling each shaft may be the same.

Assuming perfect execution of the draw and loose, hitting a distant mark requires a certain angle of elevation of the drawn arrow. This angle is found by a few trial shots, after which it may be reproduced by sighting over the tip of the arrow at some selected point, called the point of aim, on the ground, on the target or in the landscape behind the target. To identify the point of aim an artificial marker may be used. Many archers prefer to use a bow sight which permits aiming directly on target. The sight is attached to the bow just above the handle and has a small bead or pin which can be moved up or down for elevation and can be moved to either side to make allowance for lateral adjustments required by either wind or a variation in the stiffness or spine, of the archer's arrow.

In field shooting and in hunting, where distances to targets or marks are unknown, and terrain may be rough, obviously no point

of aim marker can be used, nor is there much virtue in using a sight at unknown distances. Instinctive aiming then becomes necessary, unless it is done with the aid of markings on the bow after the distance has been estimated. Proficiency in marksmanship both at the target and in hunting is acquired only through patient, careful practice.

Arrows and Their Flight.—An arrow is said to be properly matched to a bow if, when it is well loosed, it passes the bow smoothly, without impact against the arrow plate, and takes off steadily on its flight. When the arrow is loosed, the lateral forces upon it cause it to bend, and to be set in oscillation about two nodal points, each approximately one-fifth to one-fourth the distance from the end of the shaft. The period of oscillation must be so related to the time of passage of the bow that the instantaneous displacement of the part of the shaft opposite the arrow plate is outward. When this condition obtains, the arrow remains clear of the bow in passing, and flies precisely in the vertical plane defined by the line of aim. An arrow that is too stiff or too limber oscillates either too rapidly or too slowly for proper synchronization with its time of passage, which results in its impinging on the arrow plate somewhere along the shaft, with consequent deflection.

That property of an arrow which an archer calls spine combines the elements of both mass and stiffness. These factors determine the period of oscillation, and mass determines the time it takes from the instant the arrow is loose, to clear the bow. The arrow must bend instantly when it is released to oscillate and curve itself around the bow. Since this time interval also depends on the performance of the bow the concept of spine involves not only the arrow but also the bow that shoots it. Thus an arrow with suitable spine for one bow may not have the correct spine for another.

In order to have some measurable scale for reconciling the relationship of the proper spine of an arrow to the bow that shoots it, spine testers have been developed in which an arrow shaft is placed upon two upright posts 26 in. apart and a two-pound weight is hung in the centre of the shaft. The refraction or measurable distance which the arrow bends is an indication of both its stiffness and its ability to return to normal straightness.

The location of the centre of mass, or balance point of an arrow, becomes especially important when there is a side wind or quartering wind. In addition to the drift in the direction of the wind, the arrow is caused to yaw; *i.e.*, its axis deviates from the direction of its flight. This gradual rotation about a vertical axis through its centre of mass, with the point moving into the wind, is caused by the unbalanced forces produced by the pressure of the wind behind and in front of the balance point, respectively. It is accentuated by large vanes, and by a centre of mass located forward. Conversely, yawing caused by wind is minimized by small feathers and a centre of mass located well back. In strong cross winds an arrow may strike the target at an angle so large with respect to its direction of flight that it is broken on impact.

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(P. E. K.; J. W. AN.)

ARCHES, COURT OF: *see* ECCLESIASTICAL LAW (ENGLISH).

ARCHIANNELIDA, a mixed group of aberrant segmented worms regarded as a subunit of the class Polychaeta. *See* ANNELIDA: *Polychaetes.*

ARCHIAS, the name of several Greek poets whose epigrams are in the *Greek Anthology*. It has been suggested that some of these poems were written by the poet Aulus Licinius Archias of Antioch, who when accused of illegally assuming Roman citizenship was successfully defended by Cicero in his speech entitled *Pro Archia*.

See T. Reinach, *De Archia poeta* (1890).

ARCHIDAMUS, the name of five Spartan kings of the Eurypontid house.

ARCHIDAMUS I, in Herodotus (viii, 131) grandson of Theopompus, therefore near the beginning of the 7th century B.C. Pausanias (iii, 7; not to be reconciled with Herodotus) mentions a somewhat later Archidamus, whose reign is said to have been peaceful.

ARCHIDAMUS II (5th century B.C.), son of Zeuxidamus who died young, succeeded his grandfather Leotychides, who was exiled soon after the Persian Wars, but Archidamus' reign seems to be counted from his death in 469. After the disastrous earthquake of 464, when the Messenians revolted, Archidamus organized the defense of Sparta, but for the next 30 years all known operations of the Spartan army were commanded by members of the other royal house. When Archidamus next appears, in 432, Thucydides presents him as a prudent statesman of great authority, who wished to postpone the war with Athens but was overborne. He led the Peloponnesian invasions of Attica in 431, 430 and 428, and the operation against Plataea in 429. He probably died in 427.

ARCHIDAMUS III (4th century B.C.), king of Sparta (360–338) in succession to his father Agesilaus II. He led the relief force sent to Boeotia after the Theban victory at Leuctra in 371, and commanded during the confused fighting in the Peloponnese which followed it. Isocrates' pamphlet *Archidamus* represents him as resolutely refusing to recognize the independence of Messenia. He defeated the Arcadians in 367 at the "tearless battle," so called because no Spartan was killed; suffered a reverse at Cromnus in 364; and showed great courage in the defense of Sparta against Epaminondas in 362. Succeeding to the throne in 360, he supported the Phocians against Thebes in the Sacred War of 355–346. Sent with a mercenary army to help Tarentum against its Italian neighbours, he fell with most of his force at Mandorium in 338, allegedly on the day of the battle of Chaeronea.

ARCHIDAMUS IV (3rd century B.C.), son of Eudamidas I. The precise dates of his reign are unknown. In 294 he was defeated by Demetrius Poliorcetes (*q.v.*) at Mantinea, and Sparta was saved only because Demetrius was called away by the activities of Lysimachus and Ptolemy.

ARCHIDAMUS V (3rd century B.C.), son of Eudamidas II, fled to Messenia after the murder of his brother Agis IV in 241 (*see* AGIS). In 227 he was recalled by Cleomenes III, but was murdered soon afterward. Plutarch blames the murderers of Agis, Polybius accuses Cleomenes himself. Both are heavily prejudiced, but it seems that Cleomenes took no steps against the murderers.

(A. As.)

ARCHILOCHUS (fl. 7th century B.C.), was the earliest writer of elegiac and personal lyric poetry in Greek of whose works any considerable portion has survived. The ancient Greeks regarded him as one of their greatest poets and the extant fragments strongly suggest that they were right. He was born on the island of Paros, perhaps *c.* 710 B.C., and was a bastard (his father was the founder of a Parian colony on the island of Thasos and his mother may have been a Thasian), but this would probably have made little difference to him had he not been spurned as a suitor by a certain Neobule. According to the story (based presumably on his own words), his fury at this insult expressed itself in verse of a savagery which drove her and her father Lycambes to suicide.

It was perhaps as a result of this rebuff that Archilochus went to live in Thasos, where he seems to have become a soldier of fortune, later serving in Thrace and other places and composing his poetry as he served. Pindar's main reference to him suggests that his life was never very prosperous. He may have lived to witness the solar eclipse in 648.

He was the first Greek poet whose work has survived to employ the elegiac couplet and the various iambic and trochaic metres (from the dimeter to the tetrameter), as well as sundry combinations of dactylic elements with iambic or trochaic (the so-called "asynartete" metres), some of which were taken over into Latin by Horace. He was also the first European writer to make his personal experiences and feeling the main subject of his poems, and he may fairly be called the originator of individualism in literature. An attempt has been made to reconstruct the main outlines of Archilochus' epodes, and there is no doubt that the stories

of the ferocity with which he attacked Neobule and her father (not to mention other eminent Thasians and Parians) are fully justified; but the popularity and influence of his poems in later times testify to the universality, as well as to the force and originality, of his genius. This is perhaps most evident in the admiration for his works expressed by Horace. The fragments, to which papyrological discoveries have made considerable additions, show that he was among the most skilful handlers of the Greek language and a metrical innovator of the highest ability and importance.

The fragments were edited by F. Lasserre and A. Bonnard, with a French translation, in the Budé series (1958).

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ARCHIMANDRITE, the honorary title of certain unmarried priests in the Eastern Orthodox Church, meant in the Byzantine period the superior of a monastery (now called hegumenos) and then of a federation of monasteries. Archimandrites rank next after bishops, and use certain episcopal insignia. *See* also ABBOT.

See J. Pargoire in F. Cabrol, *Dictionnaire d'archéologie chrétienne et de liturgie*, vol. i, col. 2739–2761 (1907). (H. M. W.)

ARCHIMEDES (*c.* 287–212 B.C.), Greek mathematician and inventor, was born at Syracuse, in Sicily. He was the son of Pheidias, an astronomer, and was closely associated with, if not related to, Hieron II, king of Syracuse, and Gelon his son. He studied at Alexandria and doubtless met there Conon of Samos, whom he admired as a mathematician and cherished as a friend. On his return to his native city he devoted himself to mathematical research.

Archimedes himself set no value on the ingenious mechanical contrivances which made him famous, regarding them as beneath the dignity of pure science and even declining to leave any written record of them except in the case of the *sphairopoiia* ("sphere making"; *see* below). As these machines impressed the popular imagination, however, they naturally figure largely in the traditions about him. Thus he devised for Hieron engines of war which almost terrified the Romans, and which protracted the siege of Syracuse for three years. There is a story that he constructed a burning mirror which set the Roman ships on fire when they were within a bowshot of the wall. It is probable that Archimedes had constructed some such burning instrument, though the connection of it with the destruction of the Roman fleet is more than doubtful. More important is the story of Hieron's reference to him of the question whether a crown made for him and purporting to be of gold did not actually contain a proportion of silver. According to one story, Archimedes was puzzled till one day, as he was stepping into a bath and observed the water running over, it occurred to him that the excess of bulk occasioned by the introduction of alloy could be measured by putting the crown and equal weights of gold and of silver separately into a vessel of water and noting the differences of overflow. He was so overjoyed when this happy thought struck him that he ran home without his clothes, shouting "*eureka, eureka*" ("I have found it, I have found it"). Similarly his pioneer work in mechanics is illustrated by the story of his having said "give me a place to stand and I will move the earth." Hieron asked him to give an illustration of his contention that a very great weight could be moved by a very small force. He is said to have fixed on a large and fully laden ship and to have used a mechanical device by which Hieron was enabled to move it by himself; but accounts differ as to the particular mechanical powers employed. The water screw which he invented (*see* ARCHIMEDES, SCREW OF) is used even now in Egypt for the purpose of irrigating fields.

Archimedes died at the capture of Syracuse by Marcellus, 212 B.C. In the general massacre which followed the fall of the city, Archimedes, while engaged in drawing a mathematical figure on the sand, was run through the body by a Roman soldier. No blame attaches to the Roman general, Marcellus, since he had given orders to his men to spare the house and person of the sage, and in the midst of his triumph he lamented the death of so illustrious a person, directed an honourable burial to be given him and befriended his surviving relatives. In accordance with the expressed desire of the philosopher his tomb was marked by a sphere inscribed in a cylinder, the discovery of the relation between the surface and volume of a sphere and its circumscribing cylinder being regarded by him as his most valuable achievement. When Cicero was quaestor in Sicily (75 B.C.) he found the tomb of Archimedes, near the Agrigentine gate, overgrown with thorns and briers.

Works.—The range and importance of the scientific labours of Archimedes will be best understood from a brief account of those writings which have survived; and it need only be added that his greatest work was in geometry, where he so extended the method of exhaustion as originated by Eudoxus and followed by Euclid that it became in his hands, though purely geometrical in form actually equivalent in several cases to integration, as expounded in the first chapters of modern textbooks on the integral calculus. This remark applies to the finding of the area of a parabolic segment (mechanical solution) and of a spiral, the surface and volume of a sphere and of a segment thereof and the volume of any segments of the solids of revolution of the second degree.

The extant treatises are as follows:

1. *On the Sphere and Cylinder* is a treatise in two books, dedicated to Dositheus, and deals with the dimensions of spheres, cones, "solid rhombi" and cylinders, all demonstrated in a strictly geometrical method.

2. *The Measurement of the Circle* is a short book of three propositions, the main result being obtained in proposition 2, which shows that the circumference of a circle is less than $3\frac{1}{7}$ and greater than $3\frac{10}{71}$ times its diameter.

3. *On Conoids and Spheroids* is a treatise in 32 propositions, on the solids generated by the revolution of the conic sections about their axes, the main results being the comparisons of the volume of any segment cut off by a plane with that of a cone having the same base and axis.

4. *On Spirals* is a book of 28 propositions. Propositions 1–11 are preliminary, 13–20 contain tangential properties of the curve now known as the spiral of Archimedes and 21–28 show how to express the area included between any portion of the curve and the radii vectores to its extremities.

5. *On Plane Equilibria or Centres of Gravity of Planes* consists of two books and may be called the foundation of theoretical mechanics, for the previous contributions of Aristotle were comparatively vague and unscientific. In the first book there are 15 propositions, with 7 postulates; and demonstrations are given, much the same as those still employed, of the centres of gravity (1) of any two weights; (2) of any parallelogram; (3) of any triangle; (4) of any trapezium. The second book in 10 propositions is devoted to the finding of the centres of gravity: (1) of a parabolic segment; (2) of the area included between any two parallel chords and the portions of the curve intercepted by them.

6. *The Quadrature of the Parabola* is a book in 24 propositions containing two demonstrations that the area of any segment of a parabola is $\frac{4}{3}$ of the triangle which has the same base as the segment and equal height.

7. *On Floating Bodies* is a treatise in two books, the first of which establishes the general principle of hydrostatics, and the second discusses with the greatest completeness the positions of rest and stability of a right segment of a paraboloid of revolution floating in a fluid.

8. *The Sand Reckoner* is a small treatise addressed to Gelo, the eldest son of Hiero, expounding, as applied to reckoning the number of grains of sand that could be contained in a sphere of the size of our "universe," a system of naming large numbers according to "orders" and "periods."

9. *The Method*, addressed to Eratosthenes, is a treatise of vital interest, since in it Archimedes explains how he first arrived at many of his important results by means of mechanical considerations, namely, by weighing an indefinite number of elements of one figure against similar elements of another. This treatise, formerly supposed to be lost, was discovered in 1906 by J. L. Heiberg in a palimpsest at Istanbul and now forms part of Heiberg's Greek

text of Archimedes.

10. *A Collection of Lemmas,* consisting of 15 propositions in plane geometry, has come down through a Latin version of an Arabic manuscript; it cannot, however, have been written by Archimedes in its present form, since his name is quoted in it more than once.

Lastly, Archimedes is credited with the famous "cattle problem" enunciated in the epigram edited by Gotthold Lessing in 1773, which purports to have been sent by Archimedes to the mathematicians at Alexandria in a letter to Eratosthenes. Of lost works by Archimedes there are references to seven: (1) investigations on polyhedra mentioned by Pappus; (2) *Principles,* a book addressed to Zeuxippus and dealing with the naming of numbers on the system explained in the *Sand Reckoner;* (3) *On Balances or Levers;* (4) *On Centres of Gravity;* (5) the *Catoptrica,* an optical work from which Theon of Alexandria quotes a remark about refraction; (6) *On the Calendar;* (7) *On Sphere Making,* in which Archimedes explained the construction of the sphere which he made to imitate the motions of the sun, the moon and the five planets in the heavens. Cicero actually saw this contrivance and described it.

The *editio princeps* of the works of Archimedes with the commentaries of Eutocius is that printed at Basel (1544) in Greek and Latin by Hervagius. A Latin version was published by Isaac Barrow in 1675. Torelli's edition (1792) remained the best Greek text until the definitive text edited, with Eutocius' commentaries, Latin translation, etc., by J. L. Heiberg (1800–81; 2nd ed., 1910–15) superseded it. T. L. Heath edited *The Works of Archimedes* in modern notation, with introduction, etc. (1897) and also, as a supplement, the newly discovered *Method* (1912). Modern translations are those of F. Peyrard, in French (1808); E. Nizze, with notes, in German (1824); P. ver Eecke, *Les Oeuvres Complètes* (1921); A. Czwalina-Allenstein, *Kugel und Zylinder* (1922), *Über Spiralen* (1922), *Die Quadratur der Parabel* (1923), *Über Paraboloide, Hyperboloide und Ellipsoide* (1923), *Über schwimmende Körper und die Sandzahl* (1925).

See Science, History of: *Greek Science; see* also references under "Archimedes" in the Index.

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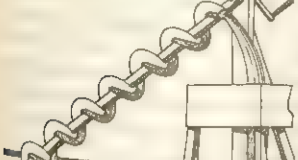
(T. L. H.; B. L. v. d. W.)

ARCHIMEDES, SCREW OF, a machine for raising water, said to have been invented by Archimedes for the purpose of removing water from the hold of a large ship that had been built by King Hieron II of Syracuse. It consists of a water-tight cylinder which encloses a helix, and has its lower open end placed a half turn in the water. The water is therefore lifted mechanically by the turning of the machine.



ARCHIMEDES' SCREW, INVENTED BY THE GREEK MATHEMATICIAN (c. 287–212 B.C.)

Other forms have the helix revolving free in a fixed cylinder, or consist simply of a tube wound helically about a cylindrical axis. The same principle is sometimes used in machines for handling wheat, etc.

ARCHIPENKO, ALEXANDER (1887–1964), Russian-American sculptor and painter, one of the pioneers of modern sculpture, was born in Kiev, May 30, 1887. After studying in Russia, he attended the École des Beaux-Arts in Paris (1908), where he came into contact with the Cubists. Representation of the human figure was subordinated in his works to the formal composition of voids and solids.

In "Walking Woman" (1912), holes were punched in face and torso, and concavities substituted for the convexities of the lower legs. "Boxing Match" (1913) attempted to convey the brutal energy of the sport in nonrepresentational, machinelike cubic and ovoid forms. As early as 1912, Archipenko executed the first of his famous "Medranos," circus figures in multicoloured glass, wood and metal, defying traditional use of materials. His later works were less revolutionary in form and conception. After a sojourn in Berlin, he settled in the United States in 1923, where he became a lecturer and teacher. He died on Feb. 25, 1964, in New York city.

(L. W. N.)

ARCHITECTURAL DRAWING: *see* Drawing, Engineering; Architectural Rendering.

ARCHITECTURAL EDUCATION. The functions of the architect are manifold and highly technical. He must be expert in the planning of buildings; *i.e.,* acquainted with the practical requirements of various kinds of structures, often complex, such as factories and commercial buildings, hotels, theatres, hospitals and schools. He must know how to arrange the several parts of these buildings in the most economical and convenient manner, for planning is the basis of architecture. He must understand both traditional and modern methods of building construction, and appreciate the importance of mechanization and of industrial techniques.

Though applied science is involved in architectural practice, it is always part of the means and never the end of architecture; the architect makes the technical sciences the servants of his art. Not only methods of construction, but surveying, sanitation, hygiene, heating, lighting, ventilation and acoustics come within this category, as do such ancillary subjects as the law and finance of building. The training of the architect also must include the study of perspective, skiagraphy, rendering (*see* Architectural Rendering) and the preparation of working drawings (*see* Drawing, Engineering). In addition, study of materials—their practical characteristics and the effects that can be obtained from them—is an essential element in the architect's education, since materials determine the durability and appearance of structures. Application of all this varied knowledge is implied in architectural design, with which the architect is primarily and ultimately concerned.

Architectural design involves thinking and visualizing simultaneously in three dimensions—plan, section and elevation—in such a way that the resultant composition is expressive and beautiful. For this is required efficient creative ability that no system of training can generate. Training, however, can make possible its fullest development, can direct it along the most profitable lines and can place at its disposal the accumulated experience of the past. These are the objects with which the systems of architectural education are chiefly concerned.

The study of architecture should be preceded by a liberal education, hence the modern tendency is for schools of architecture to require from candidates for admission evidence of a broad nontechnical education; in a number of cases liberal arts studies also are pursued during at least the earlier portion of the professional course. Architectural education in the United States is administered principally by universities, and in Europe and the British commonwealth either by universities or by institutions virtually of university rank, such as the École des Beaux-Arts in Paris, the High School of Architecture in Rome and the Viennese academy.

Teaching of architecture in some institutions is conducted in association with painting and sculpture; in others the curriculum has a strong mathematical bias; in still others emphasis is laid on preserving and developing traditional methods of design. In nearly all countries, however, architectural education is considered to be the responsibility of the practising profession. In France, where academic education was instituted in the 17th century, the most eminent architects have undertaken educational obligations. Elsewhere in the early days of architectural schools the attempt was made to divide the profession into two classes—theoretical nonpractising teachers and architects who practised and did not teach. But architecture rarely could be taught successfully by theorists, and modern architectural education has come to be placed largely in the hands of practising architects. Nevertheless, conditions of practice must inevitably differ from

those of theoretic training, and in order to effect a transition between the two, most systems of architectural education provide for some actual experience in practice.

Continental Europe.—*Italy.*—The emergence of Italy as a unified nation in the 19th century coincided with the end of the period in which training of architects was undertaken by independent academies founded during and after the Renaissance. Henceforth the state assumed the responsibility, establishing two types of institutions to discharge it: schools of civil engineering and institutes of fine arts. Architecture was taught in the first as a structural science and in the second as an art of design associated with painting and sculpture. But by divorcing the study of modern constructional methods from that of composition, two separate classes of experts were created, structural engineers and architectural decorators, the former well equipped in the scientific technique of building but unable to use their knowledge as artists, the latter insufficiently trained in the material and practical aspects of their subject but accomplished in superficial design. As was inevitable in an age that exalted applied science and mechanical skill, structural engineers soon acquired an authority superior to that of architects, with consequences unfortunate for both the latter and their work. To remedy this situation a number of proposals and tentative experiments were made in the latter half of the century resulting in the establishment in 1919 of the High School of Architecture in Rome, a school of university rank that requires from entrants a liberal education and previous artistic training. It is the central institution for architectural education in Italy. Its professional course extends over five years and the curriculum provides for a properly adjusted balance of scientific and aesthetic studies. There are also leading institutions in Milan, Florence and Venice, and an altogether happier relationship has developed between the engineer and the architect; the collaboration was reflected in some magnificent achievements in reconstruction after World War II.

France.—State control of French architectural education dates from the foundation under Jean Baptiste Colbert of the Royal Academy of Architecture in 1671. This control, temporarily interrupted by the Revolution, was resumed in 1795, when in the newly created Institut de France an academy of fine arts, embracing architecture, was included. The private school of architecture set up by J. D. Leroy during the Revolution was taken under the protection of the institute, incorporated with the other art schools administered by that body, and finally, in 1816, accommodated on the site it still occupies, under the name, famous throughout the world, of École des Beaux-Arts (*see* BEAUX-ARTS, ÉCOLE DES). Under Napoleon III a decree of 1863 drastically altered the organization of the school, restricted the authority of the Académie des Beaux-Arts over it and introduced the modern regime. The school became directly a state institution with a director at its head appointed by the minister of fine arts. Its professors were nominated by the educational council and its courses extended and increased in number. In addition to the professors who lectured, *patrons*, or heads of ateliers, were appointed to the staff. The problem of style, which the dissensions of the romanticists and classicists had made an acute issue, was solved by eliminating it. Periods were no longer prescribed or proscribed.

All designs were judged by logical standards, and matters of taste were permitted to remain matters of taste. Compositions might be submitted in any style or in no style at all; their value would be assessed upon grounds that had nothing to do with the question of architectural idiom.

The teaching of architecture in France is still centralized in the École des Beaux-Arts, and the 13 regional schools in Lille, Rouen, Rennes, Lyons, Marseilles, Strasbourg and other cities are still branches of the Paris *école,* working on the same programs and conducting simultaneously the same competitions among their students. Leading modern architects, and the students as well, are becoming increasingly critical of the system imposed by the École des Beaux-Arts, and radical changes are expected.

The course of studies leading to the government diploma in architecture is elaborate and difficult. Students are prepared for the *école* entrance examination either in certain ateliers that devote themselves exclusively to this task or in large ateliers concerned mainly with the subsequent design work of the course. The examination comprises tests in design, drawing and modeling, mathematics, descriptive geometry, science and the history of art. After admission to the *école* the work falls into three sections: second class; first class; and the great prize competitions, of which the most important is that for the Grand Prix de Rome. Before promotion from the second to the first class, further tests must be passed in science, mathematics, geometry, perspective, construction and design. Concluding the studies in the first class there are final examinations in physics, chemistry, building laws, regulations and design. On the results of these the diploma is awarded after a course that usually extends over at least four to five years.

In addition to the state system, the École Spéciale d'Architecture, founded as a private venture in 1865, also grants a diploma that has been officially recognized since 1934.

Other European Countries.—Architectural education in western Germany, the Netherlands, Switzerland and Scandinavia is given by a variety of institutions—technical institutes of university rank, colleges and schools of applied art. The duration of courses is generally four to five years. After World War I modern European architects turned the educational system toward more functional design and a closer contact with contemporary productive methods. In Germany the Staatliche Bauhaus at Weimar (later at Dessau) had started to combine artistic training in modern design with practical training in crafts and building. This method has since influenced various architectural curriculums in and outside Germany, most thoroughly perhaps those of the Chicago Institute of Design (in 1949 absorbed by the Illinois Institute of Technology) and the Hochschule für Gestaltung opened at Ulm in 1955 (*see* also BAUHAUS). After the end of the Nazi regime the Institutes of Technology at Munich and Stuttgart regained their former prestige, although the role of other German schools, especially those of the *Kunstgewerbe* ("applied art") category, should not be underestimated.

Belgium provides for the training of architects in municipal academies of fine arts and in the professional schools known as the St. Luc academies. The Copenhagen academy provides a complete training for architects in Denmark, where the trade and professional schools, as in many European countries, are also important. Norway has made architectural education a state responsibility and a diploma is awarded in the Technical university at Trondheim. The organized training of Swedish architects is largely in the hands of the Institutes of Technology at Göteborg and Stockholm and of the Stockholm academy. In the Netherlands, schools at Delft and Amsterdam, and in Switzerland the Eidgenössische Technische Hochschule at Zürich, bear the main responsibility for training architects. The technical colleges in Austria are of university rank, and some give instruction in architecture. The Viennese Academy of Plastic Arts carries the education of students to a higher stage. In Ireland, University college, at Dublin, provides a course of three years in the school, followed by two spent in gaining practical experience, leading to the degree of Bachelor of Architecture. In Spain architectural training is given at the High School of Architecture attached to Madrid university, and at the Barcelona school.

Great Britain and the Commonwealth.—So long as English architects followed, as they did throughout the 17th and most of the 18th centuries, a single architectural tradition, and were content simply to develop it, and so long as the technical requirements of building were relatively simple, the pupilage system was adequate for the education of the profession. But the foundations of this world of commonly shared artistic convictions and practice began to be undermined when architects ceased to be satisfied with giving to the style of the Italian Renaissance a national character, and sought their inspiration in the antique origins of that style.

The study of Roman forms was followed by the discovery and copying of Greek, with the result that by the end of the 18th century the architectural student had lost his certainty of outlook. The variety of the prospects opened to him was further extended by the romantic movement. This, finding its architectural

expression in the Gothic revival, completed the confusion that had been initiated by archaeological research. The orderly development of English architecture was lost in a "battle of the styles," and the offices of practising architects, which had formerly served as the instruments of a common professional education, were reduced to dissociated units, each the vehicle of a personal concept of architecture. Finally, by the latter half of the 19th century, the practical requirements of building and the methods of construction employed had greatly increased in range and complexity, so that the technical equipment required for their mastery alone had become more than could be supplied by the ordinary architect's office.

All these factors combined to render the pupilage system no longer a satisfactory method of education. Institutional training had to take its place, and during the 20th century considerable progress was made in establishing and developing schools of architecture devoted to giving systematic courses of instruction in the whole technique of building, and endeavouring to replace the lost traditions of design by teaching based on rational principles.

There are in Great Britain four types of institutions giving instruction in architecture: technical schools; schools of art; independent professional schools; and universities. With few exceptions the first two offer courses of not more than three years duration, and the classes are in many cases held at night. The main function of schools of this order, which are usually under municipal control, is to supplement the pupilage system in those parts of the country, still of considerable extent, in which it yet survives. But the real qualifying work is undertaken by schools with a full daytime course extending over five or more years. The five-year course was introduced at the Liverpool University school in 1920, when the Architectural Association school in London adopted one of similar character. Such courses, when taken at a university by matriculated students, lead to a degree; when taken at an institution of nonacademic rank, to a diploma similar to that granted by the universities to graduates who have not matriculated.

Among the principal schools of architecture in England are those of the Architectural association and of Liverpool university. In Scotland the Glasgow school has the greatest number of students; through its affiliation with the University of Glasgow, after 1925 it was able to offer a B.S. degree with honours in architecture. In other countries of the commonwealth have been founded university schools of architecture that conduct courses of study varying from three to five years in length. Particularly in Canada and Australia, English influence in architectural education is accompanied by American, with the result that the complete transition from pupilage to training under university auspices seems likely to be most rapid in those countries.

The normal curriculum of the larger qualifying schools in Great Britain provides for the study of design and construction throughout five years. In addition to the work done in the school studios, courses of lectures are given on the theory of design and construction, history of architecture, descriptive geometry, skiagraphy, perspective, sanitation, hygiene, surveying, specification, estimates, contracts, professional practice and other cognate subjects. Provision is sometimes made for specialization during the last two years, the course being then taken with honours in either design or construction to meet the demand for advanced qualifications in both spheres. In certain of the academic schools the first year program of study includes such liberal arts subjects as languages, social history and literature. A portion of the concluding part of the course is always spent by the students in gaining practical office experience. Town planning is a recognized subject in most schools of architecture.

From its foundation in 1834 the Royal Institute of British Architects (R.I.B.A.) has been the supreme controlling authority of the profession throughout the commonwealth and empire. Though the R.I.B.A. has never undertaken the teaching of architecture, it performed a notable service in raising the general level of professional knowledge by setting up, in the latter half of the 19th century, a centralized system of examinations. Through its board of architectural education it delegated to certain approved schools the task of qualifying candidates for admission to the institute, maintaining its own centralized examinations only for students not seeking entry through scholastic channels.

The following schools of architecture are recognized for exemption from the R.I.B.A. final examination (except in the subject of "Professional Practice"): Robert Gordon's Technical college, Aberdeen; Birmingham School of Architecture; College of Art and Crafts, Brighton; Royal West of England Academy School of Architecture, Bristol; Cambridge university; Canterbury College of Art; Welsh School of Architecture, Cardiff; University college, Dublin; School of Architecture, Dundee; Edinburgh university; Edinburgh College of Art; School of Architecture, Hull; Leeds School of Architecture; Leicester College of Art; Liverpool university; London university; Architectural association, London; Northern Polytechnic, London; the Polytechnic, Regent street, London; Hammersmith College of Art; Kingston-upon-Thames School of Arts; Manchester university; Durham university; Nottingham university; Oxford university; College of Art, Portsmouth; Sheffield university; Municipal college, Southend-on-Sea; Glasgow School of Architecture; University of Adelaide; University of Melbourne; Melbourne Technical college; University of Queensland; Perth Technical college; Gordon Institute of Technology; University of Sydney; New South Wales university; University of Manitoba; McGill university; University of Toronto; Auckland University college; University of Cape Town; University of Pretoria; University of the Witwatersrand; and Shri J. J. School of Art, Bombay. About a dozen other schools of architecture are recognized for purposes of exemption from the R.I.B.A. intermediate examination.

In both classes the maintenance of the requisite standard is assured by the periodic inspection of a visiting board, appointed by the R.I.B.A. board of architectural education, which reports to the institute on the work of the various schools granted or applying for exemption. The institute further requires to be satisfied as to the preliminary general education of students, and evidence must be submitted upon this point in each individual case. The R.I.B.A., with its provincial allied societies, has also instituted a scheme of maintenance scholarships which are competed for annually and are tenable at schools of architecture recognized by the institute. A number of valuable prizes and studentships are offered by the R.I.B.A. each year for competition among architectural students throughout the commonwealth. Open to students who are British subjects is the Rome scholarship in architecture, established in 1913 by the royal commissioners of the exhibition of 1851. (J. C. P.)

United States.—In the early days of the republic, the usual method of entering the architectural profession was, as in Europe, by a period of apprenticeship in an architect's office, supplemented whenever practicable by evening or part-time classes. As early as 1814, however, Thomas Jefferson included architecture in his program of higher education, and in the 1830s Robert Mills established a school of architecture in Washington, D.C. These projects, with several other ventures, did not immediately bear fruit and architecture commonly was a by-product of the technical colleges and schools of engineering. It was not until after passage of the Morrill Land-Grant act (1862), by which allotments of public land were made available in each state for the building of technical institutions, that the first successful professional schools of architecture emerged, the first three being those of the Massachusetts Institute of Technology (1868), Cornell university (1870) and the University of Illinois (1871). By 1898 nine schools were actively working, with a total enrollment of 362 regular students.

At that time too an increasing number of persons sought their professional education at the École des Beaux-Arts and, on returning to the United States, attempted to institute the French atelier system of tuition in their own country. So strong did this movement become that in 1894 a Society of Beaux-Arts Architects was formed in the United States to establish a central school of architecture on the French model. This was never achieved but, reconstituted in 1916 as the Beaux-Arts Institute of Design, the society continued to exercise considerable influence by its program of design competitions open to students throughout the country.

Teachers of architecture trained in the Paris *école* and advocating the same principles as their former French tutors soon were entrenched in the new schools. Thus young students in the United States, like the majority of young Europeans, were taught the arts of design in the classical, Gothic and Renaissance styles.

The revolt against eclecticism and the academies, that became so important a feature of the European scene at the turn of the century, and the example set by such architectural pioneers as Louis Sullivan and Frank Lloyd Wright, had little immediate influence upon U.S. education. But in 1932 an exhibition of modern architecture at the Museum of Modern Art, New York city, drew attention to the work and philosophy of such European progressives as Le Corbusier, Walter Gropius, Ludwig Mies van der Rohe, and, among others, Wright, Raymond Hood, William Lescaze and Richard Neutra. Political and economic instability in continental Europe caused many leaders of the new movement to move westward during the mid-1930s, first to England, then to take up teaching posts in the United States. In 1938 Gropius was invited to Harvard and was joined shortly afterward by his former colleague Marcel Breuer. Laszlo Moholy-Nagy, also of the Bauhaus, went to Chicago and in 1937 founded the "New Bauhaus," which in 1949, as the Institute of Design, merged with the Illinois Institute of Technology; and in 1938 Mies van der Rohe was appointed director of the school of architecture of the same institute.

Throughout this second phase of European influence, however, more varied influences were at work; and against the formal pattern of training can be set Frank Lloyd Wright's Taliesin fellowship and Eliel Saarinen's Cranbrook academy. The rationalist philosophies of the central Europeans were gradually enriched, diversified and largely assimilated by a new generation of architects; and the decade following World War II saw considerable reorientation in the schools. Architects trained in the 1930s began to assume leadership, and curriculums were scrutinized and revised in order to meet more adequately the needs of training for contemporary practice. The American Institute of Architects (A.I.A.), through its board of architectural education and research, played an even more important part in shaping educational policy, and practising architects throughout the country took an increasing interest in educational affairs.

A survey made by the A.I.A. in 1953 (*The Architect at Mid-Century*) showed that 64 schools were then established in the U.S., the majority of which offered a five-year curriculum leading to a degree or degrees (Bachelor of Architecture or Bachelor of Science in Architecture). Professional registration, whereby an architect is given licence to practise on his own account, is normally secured by examination following a period of at least three years in practice after graduation.

Latin America.—*Mexico.*—For many years architectural education in Mexico conformed in general to the pattern set by western Europe, the architect acquiring his training by apprenticeship. Although at the beginning of formal architectural schools Spanish and Italian influences were strong, the methods and principles of the École des Beaux-Arts soon dominated; one of the first courses in architecture introduced by the Mexican National Academy of Fine Arts was not only modeled upon that of the *école* but was largely directed by teachers with experience of the French system. Later, and more especially after World War II, Mexico made immense strides in architecture. The National School of Architecture is housed at the National Autonomous University of Mexico, in the construction of which 75 architects collaborated, providing remarkable evidence of the vitality of the modern movement in Mexico. The excellent five-year courses lead to a degree in architecture. Similar courses are offered at the industrially supported Monterrey Institute of Technology, the program of which is modeled on that of the Massachusetts Institute of Technology. A successful summer school is held each year at Monterrey jointly with the University of Texas (Austin). There are schools of architecture also at the University of Guadalajara and the Technological institute, Guadalajara. (T. Hh.)

South America.—The foundations of architecture and architectural education in South America were laid during the first colonial centuries, when the architecture of the Spanish Jesuit missions established a brilliant precedent especially in religious buildings. Early in the 20th century a new influence came from the great European immigrations; Italy especially contributed both masons and builders. Meanwhile, houses built by French architects or Latin Americans educated in Paris tended to follow the French style. Throughout South America architectural teaching and practice suffered by becoming overly academic. A revival began with the ministry of health and education building in Rio de Janeiro, the work of Le Corbusier, and with his lectures in Rio and the cities of the Río de la Plata (1929).

Argentina illustrates the development of architectural teaching in South America. Until 1810, instruction was offered only in drawing, but the Academy of Fine Arts, founded in that year, offered the rudiments of architecture. By 1878 an architect's degree could be obtained upon completion of the first four years engineering syllabus. In 1901 a group of Paris-trained architects founded the School of Architecture within the faculty of engineering in the University of Buenos Aires; the school became a faculty in 1946.

Except for Paraguay, all South American countries have architectural schools. These have much in common: syllabuses in which scientific and aesthetic courses are well balanced; five- or six-year courses in city planning and social problems; intensive study of reinforced concrete (the basic building material in the continent); and (except in Argentina) limited entry. Some, such as the faculty of architecture in the University of Chile, have building departments in which students gain practical experience by carrying out building programs for the university. The school of architecture at the Catholic University of Valparaiso deserves special mention for its apprenticeship system of education. (Ed. S.)

Japan.—Since 1873 Japanese architectural education has been under European influence. Before that knowledge of building was transmitted from master carpenter to apprentice through direct instruction. At the first national university, Tokyo Imperial, now Tokyo university, the first students of the department of architecture graduated in 1879, and architectural degrees were awarded at Waseda university in 1913 and Kyoto university in 1923. After World War II the education system was reformed. The course was prolonged one year, the four years being divided into two parts, with professional education assigned to the last two years. Within 15 years after the end of the war 20 national universities and 15 private universities had departments of architecture, graduating over 1,000 every year. Departments of architecture are not independent as in other countries, but belong to the schools of engineering. Only 20%–25% of graduates practise design after graduation. In some universities a two-year (master's degree) and a three-year (doctor's degree) course of graduate study is offered. (K. Ta.)

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ARCHITECTURAL ENGINEERING. Architecture has been defined as the art and technique of building; architectural engineering is that aspect of architecture most concerned with the technique of building (*see* also Architecture). At times the distinction between art and technique has tended almost to disappear (*e.g.*, the best Gothic architecture), and at other times has been marked to an alarming degree (*e.g.*, the worst 19th-century architecture). This article deals with structural engineering, both its history and principles of design, and environmental control. The article is divided into the following sections:

I. STRUCTURAL ENGINEERING

A. History

Structural engineering is that branch of engineering concerned with creating and, particularly, with designing structures. While originally relating primarily to civil engineering structures such as bridges, buildings, dams and the like, it now embraces all engineering design in which the chief requirement is the attainment of adequate strength by economical means, in keeping with the intended function of the structure. In this sense the structural design of aircraft, ships, pressure vessels (boilers, etc.), tanks, reservoirs and water towers, electrical transmission line towers and antenna masts, and a multitude of other products of technology, also falls within the compass of structural engineering.

As soon as man began to build, whether shelter, temple or bridge, he had to impart to his structure the strength needed to resist the forces of high winds, the weight of snow and other loads, such as that of the structure itself and of those using it. Aside from his personal skill he was helped only by the knowledge and tradition of previous experience. There was no body of scientific knowledge to aid in structural design until roughly the beginning of the 19th century.

1. Prescientific Development.—During the ages when masonry was the universal material for permanent construction, arches, vaults and domes were the only means of bridging sizable spans and of enclosing large spaces. These means illustrate the development which structural practice was able to achieve without the aid of structural science.

True voussoir arches (*see* ARCH AND VAULT) of wedge-shaped stones with radially arranged joints were used by the Egyptians and Ethiopians about 2000 B.C. Though the Greeks did not employ arches in their formal architecture, they must have known about them since Aristotle speaks of the keystones of arches supporting the structure by the "resistance which they oppose to all sides." This acute observation covers the extent of scientific understanding of arch action for about the next 2,000 years, as is evident from the following description of the nature of an arch by Leonardo da Vinci: "A strength developed by two weaknesses, for the arch is composed of two segments of a circle each of which, being weak in itself, tends to fall; but as each opposes this tendency in the other, the two weaknesses combine to form one strength." Such qualitative insight into the nature of arches, however, is of no quantitative use to one who has to decide what shape (circular, parabolic, elliptical, pointed) and what thickness of arch rib will be appropriate to carry the superimposed load of an arch of given span and of given material (brick, granite, marble). Yet during this very interval, roughly from 300 B.C. to A.D. 1500, the greatest development of arched, vaulted and domed construction took place.

The large-scale use of the masonry arch was begun by the Romans, starting from earlier Etruscan developments. The Aqua Appia aqueduct, begun in 312 B.C., was probably the first of the great Roman arched utility structures. During the next 500 years great numbers of arched bridges and aqueducts were built, dozens of which survive today. Spans of 80 ft. and more were not unusual; the bridge constructed in the time of Augustus Caesar at Narni, Italy, had a span given, variously, as between 111 ft. and 142 ft. As to height, the famous Pont du Gard at Nîmes, France, a three-tiered aqueduct and viaduct, rises to 155 ft., while the Puente Trajan across the Tagus river in Spain, with two main arch spans of more than 90 ft. each, reaches a height of more than 130 ft. All of these Roman arches are circular in shape, and most of them are complete half circles. They are made without mortar, the individual voussoirs having been cut with such accuracy as to result in perfect fit. Iron or bronze dowels were used between individual stones.

To enclose large spaces the Romans used not only barrel vaults, which are merely arches of great width, but also domes of circular plan (*see* DOME). The earliest known use of domes, on a small scale for roofs of huts, apparently was in Mesopotamia in the 8th century B.C. The long and discontinuous development found its climax in the Pantheon, completed in Rome under Hadrian in A.D. 125. It is a circular brick dome 142 ft. in diameter that rises to a height of 71 ft. from its springing. For sheer size of space enclosed without interior columns or other supports this structure was not equaled for more than 1,300 years, and not exceeded until the second half of the 19th century.

This revolutionary development, as well as the subsequent use of arches and vaults in the much less daring structures of Romanesque church architecture, was stereotyped in two respects. First, arches were almost invariably circular, which facilitated stonecutting but did not achieve optimum strength. Second, stability was achieved by sheer mass—the heavy piers and abutments of Roman bridges, and the excessively thick, small-windowed, buttressed walls of Romanesque churches and cathedrals. It remained for the Gothic builders to take the most daring step of all, to achieve stability by shape rather than by mass.

By pointing the arches and stretching them upward into a better structural shape, the Gothic builders not only lightened the arches themselves, but also, with tall, steep ribs, made the lateral thrust on the piers and abutments much less than that of the squat, heavy, circular arches. To resist the smaller side thrusts it was no longer necessary to provide large masses and heavy counterforts. Interior piers, through delicate balancing of the side thrusts of the several differently shaped arches supported by each one of them, became tall, taut columns of extreme slenderness. To provide lateral support for the arches rising inward from the exterior walls, massive counterforts could be replaced by light flying buttresses which, by virtue of their shape, were able to carry the arch thrust safely to the foundation without reliance on the stabilizing power of sheer bulk. Walls completely dissolved, and the entire structure became an upward pointed arrangement of interlaced arched ribs springing from columns and buttresses so slender that there was hardly any distinction between them and the arches. Inspired by the unique spiritual idea of the Gothic cathedral, these men went to the very limits of the structural possibilities of masonry (*see* GOTHIC ARCHITECTURE).

No previous experience provided guides for the dimensioning of this type of structure. Such experience was gained only in the construction of the cathedrals themselves and was paid for dearly in repeated collapses and failures. Not only are there actual records of the repeated failures, but legends tell how the devil kept tearing down each night what the workmen had constructed the previous day, and that final completion was due only to the intervention of heaven—testimony to the contemporary belief that such construction was really beyond the compass of human capabilities.

Arched, vaulted and domed construction reached its apex at the transition from the Gothic to the Renaissance in Brunelleschi's dome of the cathedral of Florence. The mean diameter of the octagonal area which it covers is almost exactly the same as that of the Pantheon in Rome, but rather than being circular in cross section, the dome is elongated upward and pointed like a Gothic arch, so that it rises to a height of 105 ft. from its springings. Structurally it is an intricate combination of a double-shelled dome (an innovation followed by all subsequent builders of masonry domes) and an 8-ribbed vault with 16 subsidiary ribs. Built freely into the air without scaffolding, and carrying a heavy masonry lantern over its open top, its shape was so perfectly selected that investigation by modern engineering analysis revealed hardly any structural feature which could have been improved upon with the technical means of masonry construction available at the time.

2. Roots of Scientific Development.—The transformation of structural engineering from a traditional art to a scientifically

based branch of engineering resulted from the following:

1. Systematic investigation began, by test and experiment, of the relevant properties of structural materials and of structural members made of them, particularly strength and resistance to forces of compression, tension, bending, shearing and the like.

2. Methods for calculating the forces caused within the material of a structure by the loads acting on it from without (structural analysis) were developed. Taken in conjunction with the relevant properties of the material used (1, above), these methods furnish the means of predicting quantitatively the reaction of the structure to such loads and forces, the manner in which it will deflect and deform, and the magnitude of stress and strain which will cause it to collapse and fail. (*See* MATERIALS, STRENGTH OF.)

3. The rapid technological, economic and social development that began with the Industrial Revolution in the latter part of the 18th century called for speedy solutions to structural problems which had no precedent and for which the slow trial and error process of the prescientific age was wholly inadequate. For example, in transportation alone, canals and their locks changed from small inland waterways to the vast installations of the Panama canal; railroad trains, rapidly increasing in both size and speed, had to be carried over bridges of ever-increasing span; highway motor transportation made similar demands on bridge engineering; ships became huge ocean liners and cargo boats which required larger harbour installations; and with dirigibles and airplanes came the need for hangars for them. All of these developments called for new types of structures made of new kinds of materials and designed scientifically; *i.e.*, with performance predictable not by precedent but by systematic use of general scientific knowledge.

4. Artificial structural materials were created with properties better adapted to their specific use and much more closely controllable in manufacture than those of the older materials (stone, timber, lime mortar, natural cement). The most important of these newer materials were (in approximate chronological order) cast iron, wrought iron, carbon and alloy steels, portland and special cements and concrete made with such cements, aluminum alloys and other lightweight metals; and there were new ways of using timber, such as plywood.

3. Founding of Structural Science.—The broad development of structural science began only toward the end of the 17th century and did not achieve the status of an effective engineering tool before the first half of the 19th century. It was preceded by two solitary figures, separated from each other by more than 100 years, and from subsequent progress by another half century: Leonardo da Vinci (1452–1519), painter, sculptor, architect, military and civil engineer, physicist, biologist and one of the most remarkably universal men that ever lived; and Galileo Galilei (1564–1642), astronomer, physicist, founder of classical mechanics and probably the first natural scientist in the modern sense.

The main distinction of Leonardo's contribution lies neither in his actual discoveries nor in their influence on subsequent development. In fact, this influence was rather slight, because his observations were haphazardly laid down in mirror-writing and sketches in the hundreds of pages of his notebooks, ranging over the entire area of his limitless interests. It is the method of approach of Leonardo's investigations which marks the turning point from traditional art to scientific structural engineering. His subjects included beams, columns, arches, trusses, wires. Toward all of them he had a dual approach: investigation by experiment, and application of the science of mechanics to structural problems in an attempt at quantitative calculation. In his detailed prescriptions on how to test the strength of beams, columns and wires, he indicated how the relevant variables (such as length, width and area of cross section) should be varied systematically in a series of several tests to obtain answers applicable not only, for instance, to a single tested beam, but to all beams whether actually tested or not. This method remained essentially the basis of systematic experimentation. Likewise, his attempts at determining reactions of (and internal forces in) structural framework by making use of the known simple propositions of statics, such as the law of the levers, represent the first instance of what was to develop into the discipline of structural analysis—application of the laws of physics, and particularly of mechanics, to the numerical calculation of the performance of engineering structures.

Galileo, who seems to have had some knowledge of Leonardo's work, used this same dual approach to arrive at the first quantitative results in structural science. He had a clear understanding of the resistance of structural elements to tension, showing that such resistance depends only on the area of the cross section and on the quality of the material used, of which he gave examples by relating actual test results of the tensile strength of copper. His investigations of the bending of beams, though mistaken in two assumptions relating to the distribution of internal forces, were so basic, precise and comprehensive as to influence all subsequent development. Indeed, so great was his authority that, in spite of the fact that the mistaken parts of his theory of bending had been improved and corrected by Edmé Mariotte in 1680 and by C. A. Coulomb in 1773, his two mistakes were repeated in some English and German textbooks well into the beginning of the 19th century.

4. Structural Analysis.—There developed from these beginnings a vast discipline whose scope can only barely be outlined here. In 1757 the Swiss mathematician Leonhard Euler published his analysis of the strength of columns, the basis of all subsequent development of the theory of buckling of structures. Coulomb in his famous memoir of 1773 (the first scientific structural treatise written by a practising engineer for the practising engineer) provided the correct basis for the analysis of beams, thus culminating the development started by Galileo. He also gave experimental results on the strength of sandstones, obtained on testing machines of his own design; developed a valid theory of earth pressure on retaining walls; formulated the first rational hypothesis of the conditions of the internal forces which cause brittle materials like stone to fracture; and dealt with the stability of arches. In another paper he dealt with the resistance of beams to twisting.

The theory of elasticity, one of the components of all structural analysis, was developed in France by Louis Navier (1785–1836) and his contemporaries Augustin Cauchy and Siméon Poisson. In 1826 Navier's published lectures represented the first systematic text on the strength of materials and on structural analysis based on the entire contemporary body of knowledge. Among many other original contributions, he developed the beginnings of the theory of suspension bridges, a number of which had been built in the preceding decades in England, their design having been based on careful experiments rather than on theory. Another early text of great influence in making scientific information available to designing engineers and architects was W. J. M. Rankine's *Manual of Applied Mechanics*, first published in 1858 and reissued with regular revisions for half a century.

The first practical method of analyzing trusses, a form of structure first developed by Andrea Palladio in the 16th century for supporting roofs and later also extensively used for timber bridges, was published in 1847 by Squire Whipple, U.S. engineer. J. C. Maxwell (Scottish), K. Culmann (Swiss), A. Castigliano (Italian) and H. Müller-Breslau (German), during the period from 1850 to 1910, laid the foundations and developed the basic methods for analyzing the modern types of framed structures for bridges and buildings. These same methods also found immediate application in ship construction (for which Thomas Young [1773–1829] was the first to have indicated a rational design approach) and later in the design of airplanes.

5. Structural Materials.—From the earliest beginnings of building to the time of the Industrial Revolution, timber, stone, brick and mortar made with lime or natural cement had remained the only structural materials. Metals in the form of small bronze or iron ties, clamps or dowels had found only occasional use for assuring more positive connections. The earliest investigators realized that even such rudiments of structural analysis as were available at the time were of no practical use unless supplemented by experimental information on the strength properties of these materials.

Mariotte was probably the first to make systematic tests of the strength in tension and bending of timber, metal and some other materials. He measured not only the forces necessary to fracture

the material, but also the deformations (deflection of beams, stretch of wires) prior to fracture, information which is essential in connection with all structural use. However, the systematic testing of structural materials was initiated by Pieter van Musschenbroek (1692–1761) of Holland, who developed special apparatus, similar in principle to some still in use, for the testing of beams and other structural elements in bending, tension, compression and other forms of stress. His data on various materials and their behaviour were extensively used by contemporary engineers. Late in the 18th and early in the 19th century, Coulomb and Pierre S. Girard in France, and Peter Barlow and Thomas Tredgold in England further advanced experimental techniques and accumulated useful information. In particular, T. Telford designed and built (1819–26) over the Menai strait in Wales a suspension bridge of 580 ft. span by means of wrought-iron chains. To determine the adequate strength of these chains, he established by full-size tests not only their strength, but the forces which would be acting in them once they were installed in the bridge.

Cast Iron.—The first of the new materials to be used structurally was cast iron; its employment for arch bridges was proposed by John Smeaton in 1755. The first such bridge was built in Coalbrookdale, Shropshire, Eng., in 1776 and was followed by many others. From that time, in England and then elsewhere, until well into the 19th century, factory buildings up to seven stories high were made with cast-iron columns and later also with flanged cast-iron beams for supporting the brick floors. Extensive tests by Tredgold, Eaton Hodgkinson and Sir William Fairbairn preceded the successful use of this material.

Wrought Iron.—Brittleness limited the structural usefulness of cast iron, but the tougher and more ductile wrought iron came into structural use after the introduction of the rolling mill by Henry Colt (1784). Rolled I-shaped beams (another example of strength achieved by shape) were first introduced in France by Ferdinand Zorès in 1845 in response to a unique situation compounded of a strike of masons, high prices for timber, fear of fire in combustible construction, and the increasing demand for longer span beams and ceilings.

Steel.—While wrought iron remained relatively expensive and somewhat unpredictable as to its properties, the processes developed by Henry Bessemer, William Kelly, Friedrich and Sir William Siemens and Pierre Martin between 1856 and 1862 provided an ample and cheap supply of steel. Its first large-scale structural use came in the girders of the upper stories of the Home Insurance building in Chicago, 1883. In 1894 the Carnegie-Phipps Co. in Pittsburgh issued the first handbook of rolled structural steel shapes (I beams, angles, channels, plates, etc.), which gave the designer information on available products and their structural properties. This publication became the forerunner of many similar ones in use all over the world.

Cement and Concrete.—Other structural materials include portland cement (patented by J. Aspdin in 1824) and concrete, an artificial stone made of sand, gravel, water and cement. The properties of concrete were somewhat unreliable until Duff Abrams in 1918 developed the principles of so proportioning the four ingredients as to obtain a concrete of predictable and controllable quality. Like any stonelike material, concrete is strong in resisting compression, but offers little resistance to tension and bending. Steel, on the other hand, is most favourably used when subjected to tension. Reinforced concrete, first used in buildings in the 1890s by François Hennebique in France and Frederick Ransome in the U.S., combines the advantageous properties of these two materials by embedding steel rods in the concrete mainly in those locations where tensile stresses would fracture the unreinforced concrete. Combining the durability, fire resistance, moldability and low price of concrete with the toughness and tensile strength of steel, reinforced concrete became one of the mainstays of modern construction.

Aluminum.—Industrial mass production of aluminum was developed by Charles M. Hall in 1886. By alloying it with other elements it can be made about as strong as steel; its chief advantages over steel are its lightness and its corrosion resistance. Its main structural applications have been in airplanes, but by the second half of the 20th century it was finding increasing use in other structures, including bridges and buildings.

6. Contemporary Types of Structures.—These differ from earlier construction chiefly in their clarification of structural function. The conventional heavy bearing walls and brick and timber floors were first replaced in the early English factories by cast-iron columns and floor beams whose only purpose was that of carrying load. In the Chicago school, chiefly the creation of William Le Baron Jenney, early use of iron developed around 1890 into the all iron and steel skeleton of the modern skyscraper, in which all loads are carried by the frame, and the walls are merely curtains serving for insulation and enclosure. Windows could be enlarged until they constituted a large fraction of the wall area. In the 1950s prefabricated light metal panels came to be used increasingly for exterior and interior walls in place of the conventional brick or masonry units. The use of steel framing permitted greater building heights and more flexibility in the use of the interior space.

A similar trend toward functional clarification is also evident from the comparison of modern bridges with those of earlier times (*see* BRIDGES). In addition to bridge building, the long-span roof freely enclosing a large space may serve as a gauge of structural evolution. This development took place chiefly in connection with markets, department stores, exhibition buildings, auditoriums, sports arenas and hangars. The Hungerford Fish market in London was an early (1835) example of free-spanning cast-iron construction of "modern" design. The Crystal palace, London (1851), represented the first all-iron framed building of large size. By way of the Palais de l'Industrie of the 1855 Paris exhibition, whose free span of 142 ft. about equaled that of the Pantheon, this development found its early culmination in the Galérie des Machines of the 1889 Paris exhibition. Its three-hinged, articulated and latticed steel arches had a free span of 377 ft. and represented a triumph of the recently emerged art of steel construction (*q.v.*).

While early long-span roof structures tended to be subdivided into individual, repetitive elements, somewhat as if a number of individual bridges had been put side by side to form the roof support, later types were designed as three-dimensional space structures obtaining their strength from being curved in all directions in the manner of an egg shell. Such reinforced concrete shells and the theory of their design were developed by Eugène Freyssinet in France and Franz Dischinger in Germany in the 1920s. The dome of a market hall in Algeciras, Spain, designed in 1934 by E. Torroja, covers an area larger than the Pantheon and has a thickness as small as 3½ in. at its thinnest. A similarly thin dome over an auditorium in Cambridge, Mass., rests on three points spaced 160 ft. from each other. Instead of a solid shell, such structures are also being made up of a network of light ribs. P. L. Nervi used this type of construction in precast reinforced concrete in imaginative ways in a number of hangars and exposition halls with spans up to 224 ft. The Dome of Discovery in London, built in the mid-1950s, covered an area of 365 ft. diameter (larger than any previous dome) by means of a dome-shaped network of light aluminum ribs.

Airplanes, likewise, represent such space structures in which spars, ribs, stiffeners and the outer metal skin jointly contribute in a delicately balanced manner toward attaining maximum strength with minimum weight ("stressed-skin structures"). The same principles of imparting strength to thin light structures by appropriate shaping are applied in such other structures as stressed-skin prefabricated houses of light timber framing bonded to strength-imparting skins of plywood or other wall sheeting, and lightweight steel structural shapes and floor and wall panels formed, for strength and rigidity, of sheet steel almost as thin as that of which automobile bodies are made.

Space structures of a different kind are the tall masts and antenna towers required for radio communication, particularly television. Consisting of relatively light, latticed masts braced against wind forces from any direction by systems of steel guy cables, they present entirely novel problems of structural theory as well as of erection techniques, and are among the highest structures. The height of several exceeds 1,000 ft.; a mast of 1,572 ft.

in Oklahoma City, Okla., was at the time of erection in 1954 the tallest man-made structure.

In all these examples structural efficiency is achieved by adaptation of shape to reduce and distribute favourably the internal forces acting within the structure to resist the external loads. It is these internal forces of compression, tension, shear and the like which, when permitted to exceed certain limits, cause structural breakdown. In the great majority of structures, material is treated as essentially passive; that is, as merely resisting these active forces. A novel method, that of prestressing, consists in introducing into a structure, in advance of loading, internal forces which are so directed by the designer that they will actively oppose the disruptive internal forces caused by the external loads. Since, as previously indicated, concrete is a material weak in tension, the essentially passive approach of conventional reinforced concrete construction has been to embed strengthening steel rods in those locations in the structure in which the external forces cause internal tension. The more active approach of prestressed concrete construction uses tightened steel cables in the concrete for creating, in advance, compression in those parts of the structure in which subsequent external loads will tend to cause tension. Thus, the structure has been strengthened by introduction of intentional internal forces directed and arranged to resist those caused by the loads. This results in saving of material and, therefore, frequently in a more economical design.

Another significant development in structural science is ultimate strength design. All structural materials are elastic at relatively low stress, but in various degrees all of them become plastic at higher loads and stresses. Formerly almost all structural design was based on preventing elastic failure; that is, on providing a margin of safety against even minute permanent deformations. In the late 1930s engineers began to realize that this rather formalistic criterion of elastic failure is often an inadequate and overconservative measure of the real, usable strength of many types of structures. A more realistic calculation of the actual strength can only be obtained by due consideration of the added resistance which many structures develop while undergoing limited amounts of plastic deformation. Thus the theory of plasticity, while still in its infancy at mid-20th century as compared to that of elasticity, had already provided important methods for the more efficient design of structures. (*See* also Architecture.) (G. Wr.)

B. Design Principles

Contemporary structural engineering is founded on the physical sciences. Through their application the engineer can predict the behaviour of a structure under various conditions. Through a process of analysis, the state of stress and strain in a structure is obtained and compared with values that have been empirically found safe for various materials. If the stress and strain values found by analysis are not greater than the safe values, the structure is satisfactory for the initially assumed loads.

Two important observations must be made regarding the process outlined above. First, engineering analysis is, at best, probable, because it deals with specific phenomena that will only approximate average behaviour. It is assumed that the material will behave according to the idealized average behaviour of that material. In reality, materials usually deviate from this average by amounts that depend on the care employed in their manufacture. Structural steel, used for buildings and bridges, is assumed to have an ultimate tensile strength of 72,000 lb. per square inch (p.s.i.). This means that a bar of this material with a cross section of one square inch should break under a load of 72,000 lb. In reality, a large number of tests would show that while most bars break at the predicted average load an appreciable number fail at larger or smaller loads.

Other probable assumptions used in an analysis are the magnitudes of the applied loads, from which the stress and strain of the structure are predicted. In analyzing the beams supporting the floor of a residential building, it is ordinarily assumed that the weight of the construction (dead load) and the weight of people and furniture associated with normal occupancy (live load) can be entered as an exact number in the analysis. It is clear, however, that this number may be subject to great fluctuations. The live load may be assumed to be 40 lb. per square foot (p.s.f.) distributed uniformly over the entire area of the floor; in reality, the weight of people and furniture varies appreciably from the assumed average.

In order to allow for these deviations from the assumed average, the structure is built to perform satisfactorily at loads higher than the anticipated maximum. This consideration is of vital importance and is usually provided for by law in building ordinances and codes.

The second important observation regarding the analytical process is that it can only be applied to a structure when all of its essential parts are known. The structural materials must have been selected, the type of the structure decided upon and all of the essential dimensions given. On the other hand, final decisions can be made only after the analysis is performed. Therefore, before the analysis proper can be executed, assumptions regarding materials, type of structure and dimensions must be made; later they will be refined by the analysis. That phase of the work in which all essential properties of the structure are conceived, before the analysis, is known as preliminary designing. The initial conception must at least approximate all requirements regarding function, load-carrying ability and economy; frequently preliminary solutions will entirely satisfy the requirements. The activity concerned with conceiving various solutions and selecting the most suitable one is usually called designing. While the analytical phase of structural engineering is based on physical sciences, designing remains essentially an art, for which knowledge of structural analysis, imagination, judgment and experience are prerequisites.

In a narrow sense, the purpose of design and analysis is to produce a structure that will safely support its own weight and all other anticipated superimposed loads; the structure must also be able to resist the effects of the elements (wind, earthquakes, temperature variations, snow and ice, foundation settlement, shrinkage or swelling of materials). Therefore the assumptions regarding loads, stresses, strains and deformations are the basis of the analysis.

Fixed loads (dead loads) consist of the weight of the structure itself, including all of its nonload-carrying parts. The weights of these can be computed, once the dimensions are known, from the specific gravity of the materials used. Movable loads (live loads) consist of humans, vehicles, furniture, etc.; they are estimated as average values in pounds per square foot. Typical live loads are shown in Table I.

Table I.—*Typical Live Loads*

Load	p.s.f.	Load	p.s.f.
Apartment houses		Office buildings	
Private apartments	40	Offices	80
Public stairways	100	Lobbies	100
Assembly halls		Schools	
Fixed seats	60	Classrooms	40
Movable seats	100	Corridors	100
Corridors (upper floors)	100	Stores	125
Snow (roof)		Wind	
(depending on location)	5–40	(depending on location)	5–30

It is customary to provide for the effects of a temperature variation of from about 50° F. to as much as 100° F. (depending on the location). The intensity of earthquakes is estimated on the basis of the past experiences of a location. Their effect is roughly estimated on the basis of the maximum acceleration to which the structure will be subjected during seismic motion. An average value of this acceleration is often assumed to be about one-tenth of the acceleration of gravity (0.1 G.).

Impinging forces (or loads) cause stresses and deformations within the structure. If their magnitude becomes great enough the structure may not be capable of performing its function, and a partial or complete collapse may result. Deformations and stresses must therefore be limited; the magnitude of these limits naturally depends on the material. The stronger material can operate with higher allowable stresses and support heavier loads. Strength characteristics are determined experimentally and average values are computed. Because anticipated maximum loads and

average strength characteristics are merely probable, the allowable stresses and deformations are set at a fraction of those that might impair the structure. The reciprocal of this fraction is termed the factor of safety; it varies, by material and type of load, from a minimum of about 1.5 (for steel) to over 5 (for masonry).

Typical values of allowable stress for structural steel are given in Table II.

Allowable stresses for other materials, such as reinforced concrete, aluminum, wood, masonry, etc., are also established. All of these values are subject to rather complex technical limitations and qualifications depending on the type of material used, the geometric properties of the individual member, minimum and maximum dimensions and other factors. Allowable deflections on beams that support floors are usually limited in terms of the span of the beam itself and are set from 1/360 to 1/180 of the span.

TABLE II.—*Typical Allowable Stresses for Structural Steel*

Stress	p.s.i.	Stress	p.s.i.
Tension	20,000	Shearing . . . . (rivets)	15,000
Compression . . . (columns)	17,000 (max.)	Bearing . . . . (rivets)	32,000–40,000

After the magnitudes of superimposed loads and of other effects have been established, the analysis must show that the structure will remain safe under all possible modes of failure and that the magnitude of stresses and deformations (which are a measure of strain) will be not more than the allowable values. The analysis can conveniently be subdivided according to the following four fundamental modes of failure of a structure:

1. Stability. The most elementary requirement is the stability of the structure. If the entire structure were a rigid body, it should not undergo any significant amount of sliding and rotation under the loads acting upon it. The stability of a structure is ordinarily ensured by its own weight or, if this is not sufficient, by means of guys or anchors. So-called gravity dams and retaining walls oppose the overturning forces of water or earth pressure by their sheer weight. High towers or masts are stabilized by means of guy wires.

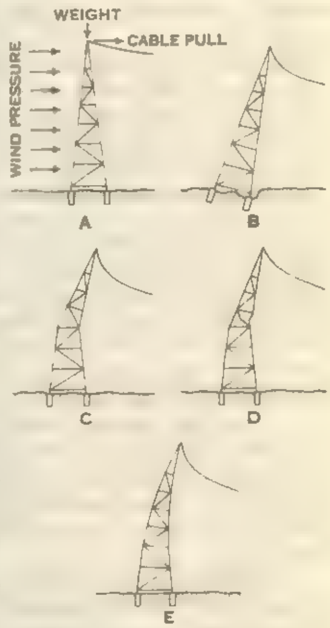
2. Strength. A structure which is stable may still be damaged if forces or loads tear, crush or shear off any part of it. The resistance of the structure against this type of damage is termed its strength. By analytical methods the magnitude of the internal forces and stresses can be determined and compared with allowable stresses. The analysis has to demonstrate that all stresses (tensile, compressive and shear) are not more than the allowable values.

3. Elastic Stability. Compression members, such as columns and struts, are subject to a failure independent of strength in the sense described above. This type of failure is called buckling. It is the tendency of slender members, subjected to compressive forces, to "get away from under the load." Narrow compression flanges of girders exhibit a tendency toward lateral buckling or twisting under transverse loads. All members of a structure must be analyzed for elastic-stability failures.

4. Rigidity. Structures subject to loads are deformed to varying degrees. A beam, for instance, will deflect under a transverse load, and tension members will elongate under axial forces. For satisfactory performance the deformation or distortion of structures must be limited, floors that lack sufficient rigidity will feel uncomfortably springy, or the ceiling plaster may crack.

The process and purpose of structural analysis and design can be further clarified with a greatly simplified example: It is desired to design a tower to support electrical transmission wires. The process of designing consists mainly of deciding on the materials to be used and the shape and dimensions the tower will take. Previous experiences and the comparison of various preliminary designs may lead to a form schematically shown in figure (A). The analysis begins with an estimate of the weight of the structure and the weight of the wires supported by it, together with the weight of snow or ice which may be carried by the wire. These forces act downward and are represented on the sketch by a vertical arrow. In addition, horizontal forces, symbolized by horizontal arrows, result from the pull of the cable and from wind forces, and must be resisted. The materials (which for this purpose would probably be steel) were decided upon during the initial phase of designing, and the allowable stresses are obtainable from building codes. The various fundamental modes of failure are illustrated in figures (B) to (E). Overturning (instability) may result from the action of wind and cable pull, resulting in rigid body rotation around the leeward foundation. Stability in this case will be secured by the combined weight of the tower and its foundation. Stability failure may also result from foundation settlement, which, however, could be classified as an excessive deformation of the subgrade.

One type of strength failure is illustrated in figure (C). As a result of the lateral forces, a windward member may be torn (tension failure). Failure may occur at the connections of the member by the shearing of the rivets. Figure (D) indicates an elastic-stability failure resulting from the buckling of a compression strut on the leeward side. Figure (E) illustrates the effect of insufficient rigidity, resulting in excessive deformations of the tower.



POSSIBLE MODES OF FAILURE RESULTING FROM THE FAULTY DESIGN OF A TOWER

(A) Forces acting upon a transmission tower; (B) failure due to static instability; (C) failure due to tension; (D) failure due to elastic instability (buckling); (E) failure due to excessive deformation

The purpose of the structural analysis is to prevent the failures illustrated from occurring except under loads that are in excess of the expected loads. (P. WR.)

II. ENVIRONMENTAL CONTROL

Man's physical environment consists of those factors which affect his ability to survive and his comfort. The conditions existing at or near the surface of the earth (land surface), chiefly in the tropic and temperate zones, are the most congenial, but other conditions can be created, accidentally or deliberately. Such artificial control over environment becomes especially important as man tends to extend the boundaries of his domain to include areas not on the earth's surface.

The important environmental factors subject to quantitative measurement and engineering control or manipulation are:

1. Atmosphere
   a. Density (pressure)*
   b. Composition*
   c. Temperature*
2. Radiation
   a. High-energy radiation, *e.g.*, cosmic rays, X-rays
   b. Ultraviolet, visible, infrared*
   c. Hertzian waves and longer wave lengths
3. Gravitational force
4. Air-borne vibrations (sound)*
5. Topography*

(The asterisks denote important variables for buildings and other well-controlled areas in general use.)

In the past, the influence of man on the total environment has been of a secondary nature, the most important effects being ecological and topographical. By cutting and/or burning, large wooded areas have been made into open fields. Vast tracts have been transformed into virtual deserts by indiscriminate cultivation by man and catastrophic erosion by natural forces, such as drought, wind and heavy rains. Still other areas, once considered deserts, have been irrigated to the point of supporting luxuriant vegetation.

Man's direct effect on other species has been quite drastic. The spread of agriculture, the tremendous increase in human population since the 18th century, and the growth of urban areas have completely eliminated some indigenous species and vastly reduced others. Birds and larger mammals have been the least successful in competition with man. Insects, on the other hand, have taken advantage of the reduction of natural predators, and at mid-20th century successfully competed with man for the available food supply.

Since the 19th century, engineering projects of increasing scope have changed the landscape to gain control over transportation routes, rivers, waterways and harbours. Other changes have been by-products of industrialization and the search for raw materials; *e.g.*, waste disposal, open-pit mining. And urban areas have spread explosively with shifting and increasing populations.

The influence of man on atmospheric temperature, motion, moisture content and precipitation patterns is highly uncertain. As of mid-20th century, no comprehensive theory of global weather existed which was capable of including all of the suspected influences on the weather pattern. Although there was no agreement on the influence of man's activities on the over-all weather pattern, it did not appear likely that they had had any fundamental effect up to that time. Consideration of the massiveness of the forces known to be the prime movers of weather, such as solar energy and the rotation of the earth, supported this view.

Control over environment requires separation of the space to be controlled from the general environment. The more complete the desired degree of control, the more substantial the separation must be.

1. Thermal Environment.—For engineering purposes, the human body may be considered to be a heat source having a constant temperature and giving off a variable amount of heat. The body transforms the chemical energy of food and oxygen into mechanical work and also into thermal energy (heat) which must be dissipated if the internal temperature of the body is to remain a constant 98.6° F. (37° C.). The amount of heat to be so dissipated varies widely according to size, age, sex and activity. An adult male at rest must dissipate approximately 400 B.Th.U. per hour of metabolic heat, while the same individual engaged in heavy work may generate 2000 B.Th.U. per hour which must also be dissipated. A 10° rise in body temperature almost invariably results in severe damage to the brain, or death.

The processes by which bodily heat is dissipated are:

1. Conduction: heat flow to a solid substance in contact with the body surface.
2. Convection: heat transferred to a fluid moving over the surface of the body, usually air.
3. Evaporation: latent heat added to surface moisture (perspiration) to cause evaporation.
4. Radiation: net loss of heat due to radiation interchange between body surfaces and surrounding surfaces.

To a large extent the body is capable of regulating its own heat loss. In response to the control of the sympathetic nervous system, the surface blood vessels can dilate or contract, thus increasing or decreasing the quantity of blood and, therefore, the heat near the surface. The heat can then be transferred to the surroundings. The other chief means of heat regulation is through the amount of moisture (perspiration) passing through the skin. As this moisture evaporates, heat in quantity equal to the latent heat of vaporization of the water is removed from the body. Of course, the surrounding conditions must allow the heat transfer to take place at the desired rate. Either the surrounding air temperature must be enough lower than body temperature; or the mean radiant temperature of the surroundings must be low enough to allow cooling to take place; or the relative humidity of the surrounding atmosphere must be low enough to permit evaporation at the required rate. Since all of these processes can and do occur simultaneously, the surrounding air and surface temperatures and the relative humidity are closely related to the ability of the body to lose heat.

The manner in which air temperature and relative humidity are related, with certain assumptions of velocity of air motion and neglecting the effect of radiation, is expressed in the so-called psychrometric chart (*see* AIR CONDITIONING). The limits of human tolerance while doing work for extended periods without serious raising of body temperature have been found by experience to be about 88° F. wet-bulb temperature (34° C.). This is equal to nearly 150° F. in completely moisture-free air. This figure can be modified upward or downward depending on the direction of heat transfer by radiation.

The concept of thermal comfort is related to the ease with which the body can adjust its rate of heat loss to its surroundings and degree of activity, and is subjective in nature because of the differing ability of individuals to adapt their bodily processes to the existing conditions.

There have been, however, standards of thermal comfort determined by large numbers of tests involving representative individual responses to varying thermal environments. As might be expected, these standards vary throughout parts of the world. For example, "ideal" winter indoor temperatures (domestic) vary approximately 7° F. between U.S. and British standards, the U.S. "ideal" temperature being about 72° F. and the British 65° F. Differences of this nature can be attributed to traditional differences in clothing, diet and acclimatization.

A considerable degree of control can be extended over the thermal environment in a building or other segregated area by manipulating structural elements and vegetation to make use of natural forces; *i.e.*, sunlight and wind particularly. The building may be oriented so that windows and extensive wall surfaces receive more or less solar radiation or intercept prevailing breezes. Trees and other forms of vegetation may be used to provide shade, either permanently or only during certain seasons, depending on the type of vegetation and the climate. Again, man-made shading devices may be attached to the building surfaces to control heat gain by radiation. Fixed louvers or shades depend upon the changing angle of the sun with the seasons to allow penetration of radiation in the cold months and exclusion of radiation during the hot months. Movable shading devices can provide flexible control in all seasons. Well-employed, these methods may eliminate the need for further controls in mild climates, and in severe climates can greatly reduce the energy consumed for heating and cooling.

All of these processes involve the consumption of energy. Fuels are burned, and the energy released by combustion is transferred either directly to the space (radiation from open fires) or to another medium (air, water, vapour) which is circulated through the space (air only) or through heat-transfer devices such as radiators or panels. Electrical energy is used either to power mechanical devices for raising and lowering temperatures (heat pumps, refrigerators), or directly in resistance or thermoelectric devices.

During the first half of the 20th century several methods were devised for absorbing and storing a large part of the solar energy which falls on buildings. This energy can be used to provide heat for living spaces and hot water, and will eventually be able to supply refrigeration. It was agreed that fossil fuels (coal, oil, gas), being used in ever-increasing quantities without significant replacement, would begin to become scarce and more expensive sometime before the end of the 20th century. Solar energy was expected to become of major importance at that time.

The composition of the atmosphere of inhabited spaces is modified by the inhabitants. During the process of breathing, the oxygen content of inhaled air is reduced by absorption in the lungs, the carbon dioxide content is increased, and considerable water vapour is given off by the moist respiratory tract. In addition the body secretes waste products through the skin which have volatile constituents. Contrary to popular belief (a belief held by most authorities in the 19th century and earlier), the body gives off no substances in concentrations which could be considered poisonous. Any physiological ill effects arising from crowded poorly ventilated spaces can be attributed entirely to increased temperature and humidity. The aesthetic objection to odours could, of course, affect certain physiological responses such as appetite. Thus the need for ventilation (except for spaces considered airtight, which must have the oxygen and carbon dioxide concentrations held within limits) resolves into a problem of temperature and humidity control, with odour control aesthetically

but not physiologically, necessary.

2. Luminous Environment.—Of the entire spectrum of electromagnetic radiation, ranging from cosmic rays (wave length 10^{-10} cm.) to power-transmission wave lengths (wave length 1.6×10^{10} cm. or about 100,000 mi.), the human eye responds only to a narrow band of wave lengths (between 0.38×10^{-4} cm. and 0.76×10^{-4} cm.) called the visible spectrum. Most of the radiant energy reaching the earth's surface from the sun falls into this region. Seeing, therefore, is one of our most important means of gaining information.

Visible radiation passes through the transparent parts of the eye, and the rays are focused by the lens so that they converge on the surface of the retina at the back of the eyeball which is covered with sensitized nerve endings. If sufficient energy is focused on this surface, the brain receives enough signals to construct a clear image. If, however, too much light or badly distributed light is received, then the result is to obscure the image. The eye has a built-in system for controlling the amount of light received. The transparent opening of the pupil can dilate to allow more light to enter under dim conditions or contract to exclude light under bright conditions. The response of the eye to quantities of radiation is actually logarithmic rather than linear; that is, in order to increase the apparent brightness of an object by a factor of 1, the amount of radiant energy coming from that object would have to be multiplied by a factor of 10. The maximum brightness that the eye can tolerate without discomfort would have about 1,000,000,000,000 times the energy of the minimum brightness which could be perceived.

The objective of controlled illumination is to provide the eyes with the optimum amount of radiant energy for the perceiving of images. The amount of radiant energy necessary to accomplish this objective varies greatly according to the task or type of visual information required. The viewing of fine detail or small objects requires more light than locating large objects. Also, the distribution of the light must not obscure or hinder the visual task at hand. Again, the problem of glare is more critical when fine visual tasks are attempted than with cruder objectives.

The most important source of illumination is, of course, the sun. Here the problem is one of limiting the amount of light to tolerable limits and of controlling the distribution of the light to eliminate glare. Because of the high intensity of direct sunshine as a source, the more diffuse reflected and scattered light that comes from the surrounding sky is preferred for most visual tasks. All other sources of illumination have their basis in the conversion of a portion of input energy of one form or another into visible radiation. Historically, man has used luminous flame sources (fire, candles, lamps of various sorts) since prehistoric times. More recently, light sources have used filaments heated by electricity or flame (incandescent lamps, mantles); gases, vapours or solids which give off visible radiation when excited by other non-visible, electrically produced radiation (mercury vapour, neon, fluorescent material); and also electric arcs. Other materials which give off visible radiation under the influence of electric current will probably also become important sources of illumination. In all of these instances the factors that indicate which method is to be used are those of economy (the cost of the energy necessary for the desired level of illumination), availability, convenience and suitability of the light produced for particular applications (wave length of colour distribution of the light produced). All of these factors have had an influence on determining standards of adequate illumination.

These standards have been continually revised upward, as efficiencies and quality have been raised and costs have been lowered. (*See* also LIGHTING; ORIENTATION.)

3. Acoustic Environment.—Vibrations with frequencies ranging between about 16 cycles per second and 20,000 cycles per second, when transmitted to the human ear by air or some other medium, are perceived as sound. The relative amounts of energy contained in these vibrations are interpreted as variations in loudness. An analogy can be made between the response of the ear to loudness and of the eye to brightness, although the physical mechanisms involved are completely different. The ratio of the energy level of received signals at the threshold of perception to that at the beginning of discomfort is about the same in each case; about 1 to 1,000,000,000,000. The speed of transmission of sound, of course, is much slower than for light. Sound travels approximately ⅕ mi. per second while light travels 186,000 mi. per second. Sound also differs from light in requiring a gaseous, fluid or solid medium for its transmission.

Control of the acoustic environment usually requires means of providing conditions in which a maximum amount of information can be transmitted from a source to a listener. Information may be contained in speech, music or any other sound conveying a message. Sounds which interfere with the message are termed noise. Acoustic control, then, means that noise must be reduced to a minimum, and the message-conveying sounds must reach listeners with sufficient energy to be clearly perceived and interpreted.

Noise which has its origin outside the listening space can be controlled by (1) removing the source to a distance; (2) enclosing the noise source in a massive enclosure; (3) isolating the listening space by a massive enclosure, which provides no air spaces or other mediums capable of transmitting vibrations between source and listener.

Noise may occur within the listening space because of excessive reverberation (reverberation time is the length of time it takes the energy level of an audible signal which is being reflected and re-reflected by surrounding surfaces to be reduced by absorption at the surfaces and in air to the point of inaudibility); echoes (*i.e.*, an audible signal which is reflected to a listener a sufficient length of time after his receiving the original signal and with sufficient strength so that it is distinctly recognizable); movement of listeners or equipment. Reverberation can usually be controlled by sufficient amounts of materials which absorb sound energy within the space. Echoes and focusing effects can be eliminated by proper shaping of reflecting surfaces and by proper distribution of absorptive materials. In some very large spaces the unaided signal from the source (voice, instrument, etc.) cannot effectively reach the listeners, so that mechanical or electronic amplification and/or distribution is necessary. (*See* also ACOUSTICS OF BUILDINGS.)

4. Sanitary Control.—An inevitable consequence of human occupancy and activity is the accumulation of waste materials, both organic and inorganic, which require removal and disposal. Systems of organic waste removal have gained wide usage since their development in the latter part of the 18th century. Most of the systems presently used in urban areas require large quantities of water both for transportation of wastes and in the treatment of these wastes.

During the 19th century the role of vermin and microorganisms in the cause and spread of disease began to be understood, and the control of filth and other conditions attractive to these forms of life became important for reasons other than aesthetic.

Hospitals, food-processing plants and many other types of spaces have adopted high standards of sanitation; they require construction methods and materials which allow thorough and frequent cleaning, often by mechanized means. This same requirement of efficient waste removal and ease of maintenance has become applicable to dwelling units as well as to the more specialized buildings and areas. (*See* also PLUMBING.)

5. Urban Environment.—Another aspect of human environment—and in some respects the most important factor of all—is the nature and character of the urban region: the visual, spatial, atmospheric and psychological environment created by the complex interaction of the sum of the economic, transportation and social patterns of all the inhabitants. Although created by man, this aspect of environment has only rarely and to a limited extent been controlled by him in a completely rational way.

Engineering control has been extended over certain specific problems arising out of this complex of forces, but by mid-20th century no comprehensive theory had been developed which could take into account all the factors involved and predict what effect changes in one area would have on all the others. As certain conditions have become so important as to be considered crucial, they have also become subject to one form of control or another. Air and water pollution, waste removal, provision of adequate light

and air between buildings, traffic circulation and transportation control, and location of types of activity within the urban framework are all examples of factors which have come under some form of control.

Recognition of a need for, as well as development of, a technique of control has had to precede its application.

It is to be expected that as knowledge in the various fields dealing with urban environmental problems is extended, the techniques of engineering control and the governmental techniques of their application will be developed. (*See* also CITY PLANNING.)

6. Summary and Conclusions.—Well-controlled environment became possible only after the development of the theory, equipment and available energy resources for controlling the various factors involved. At the end of the 19th century the cost of the equipment necessary to provide amenities in a typical large building for general occupancy was about 10% to 15% of the cost of the building. By mid-20th century the cost of this equipment in large urban structures had risen to more than 40% of the cost of the building. The co-ordination of the various services has become a major part of the design of contemporary buildings. The increasing cost of providing and operating these services has been due partly to changed aesthetic criteria (*e.g.*, the desire for large exterior glass areas); partly to new materials and building techniques, usually thinner and lighter than traditional materials; and partly to higher standards.

Considerable thought has been given to the construction of buildings that reflect the growing importance of controlled interior conditions. Architectural features that aid the mechanical devices (*e.g.*, shading devices on building façades exposed to the sun, efficient insulating methods for thermally controlled buildings) have become a legitimate form of aesthetic expression. With continuing advances in building technology, more frequent inclusion of services within the structural fabric of buildings, rather than as a later application, is to be expected. *See* CITY PLANNING; HOUSE DESIGN; INDUSTRIAL ARCHITECTURE; *see* also Index references under "Architectural Engineering" in the Index volume.

(R. J. P.)

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ARCHITECTURAL RENDERING is a branch of pictorial art and of architectural design whose special aim is to show, before buildings have been built, how they will look after they have been built. Modern renderings fall into two main categories: the quick perspective "design-study," by which an architect records or develops his initial concept of a proposed building; and the carefully made "presentation rendering," which presents a final design and is made for exhibition and publication.

The Perspective Design-Study.—When an architectural concept first forms in the designer's mind it is, necessarily, of a nebulous character. With the effort of putting it down on paper it emerges and crystallizes. This quick rendition of an idea may be no more than a thumbnail sketch, but if ably drawn the chief features of a design can be rendered clear. The inception of many a famous building can be seen in an apparently insignificant sketch, perhaps drawn during a conference on the back of an envelope.

Not all architects who design well can draw well. Of two eminent designers, Inigo Jones (1573–1652) and Sir Christopher Wren (1632–1723), the former was an outstanding draftsman, the latter was not. There have also been architects who drew beautifully yet designed badly; and when buildings are mechanistic, repetitive or standardized in character, their planners may not draw at all since no artistic problem is involved. But that there is a close relationship, in architecture, between drawing and designing has long been recognized. The link is a talent for visualization, and most architects make many sketches as an aid in developing their designs. When an architect is so engaged, it is as though he were revolving a building in his mind and seeing it from every possible angle.

Such sketches, having no pretensions as pictorial art, are seldom exhibited and are largely unknown to the public; however, their value to the art of architecture is well known within the profession. They are of particular value when a number of architects are associated on a board of design. When the United Nations headquarters in New York city was in the preliminary design stage, there was a board of design consultants made up of architects from many nations, speaking many languages. One language they spoke in common: the quick perspective study. In some of the discussions, the only sound was from pencils scratching on paper. In this project, as in many others, the gradual emergence of the final design can be traced in the progressive studies drawn by the architects involved. The term *parti* is sometimes used for a sketch of the basic scheme or main concept of an architectural design, particularly in plan.

The Presentation Rendering.—When an architect has been retained, it is desirable for him to show his client, as soon as possible, how the proposed building will look. This is something that the blueprints—the plans and elevations—do not readily reveal. Blueprints are geometrical diagrams serving as instructions to contractors; they do not pretend to show how structural forms appear to the human eye. Nor can the appearance of a proposed building be fully described in words. Therefore the architect usually prepares a picture, based on the final plans, which is a preview of the building.

If it is a modest affair and but one client is involved, the needs can usually be met by a pencil or water-colour sketch made simply and even quickly. However, it must be made accurately. A facile renderer can invest a dull design with a seductive charm, and exaggerations when stated in perspective drawings are not readily detected.

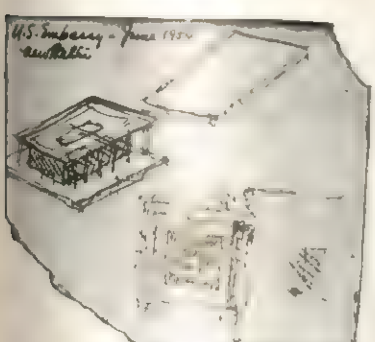
These considerations become even more pressing when the project is of considerable magnitude, such as a large shopping, technical or cultural centre, or a city redevelopment. The client may be a government agency, a board of directors or a large group of investors. Extensive financing may be necessary before actual construction can begin; public relations are often a major consideration. In such cases, the project is usually illustrated from many angles and in considerable detail. The presentation renderings become features in the promotion, and are assumed to have documentary value. They are so prepared as to stand the scrutiny not only of artists and architects but of engineers, realtors, officials, investors and such other interests as may be involved. The purpose of such renderings is not so much to help get buildings designed as to help get the designs understood by all concerned, and thereby to help get buildings built.

Whether the project is simple or complex, the essence of a good rendering is its reliability. This points up the problem (to practitioners, the attraction) of this art. For to portray a proposed building is to portray something that does not exist: rendering is an exercise in imagination. But if the picture is to be other than an architectural fantasy or better than an architectural fake the imagination must be fully controlled by a realization of the structural facts involved. It is a matter of equating artistic reach to architectural grasp.

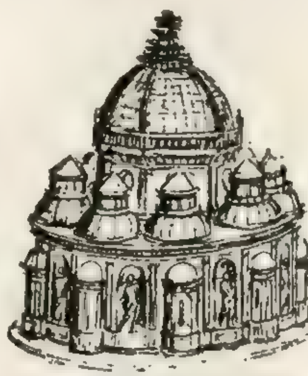
Design for a chapel by Bramante (1444–1514), Italian

Clock tower by Villard de Honnecourt (active about 1230), French

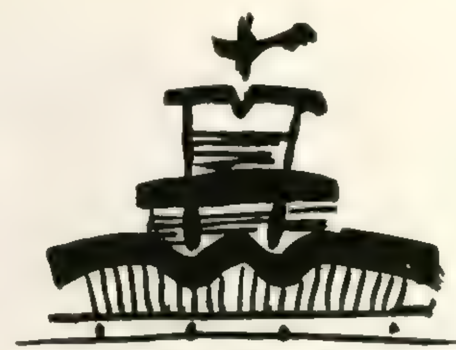
Study for the Masieri memorial, Venice, Italy, by Frank Lloyd Wright (1869–1959), U.S.



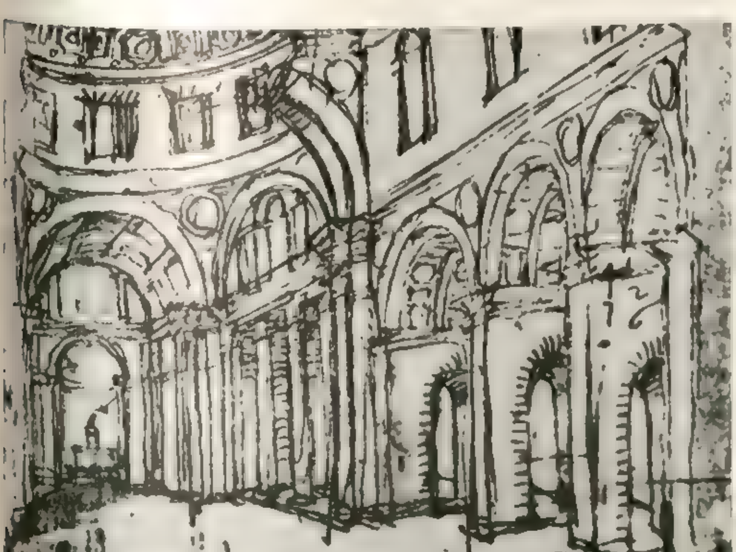
Initial sketch for the U.S. embassy, New Delhi, India, by Edward D. Stone (1902–), U.S.



Design-study by Leonardo da Vinci (1452–1519), Italian



Early study, Opera house, for Lincoln Center, New York city, by Wallace K. Harrison (1895–), U.S.



Study for St. Peter's, Rome, by Baldassare T. Peruzzi (1481–1536), Italian

Early study for Shell headquarters building, London, by Sir Howard Robertson (1888–1963), English

PERSPECTIVE DESIGN-STUDIES

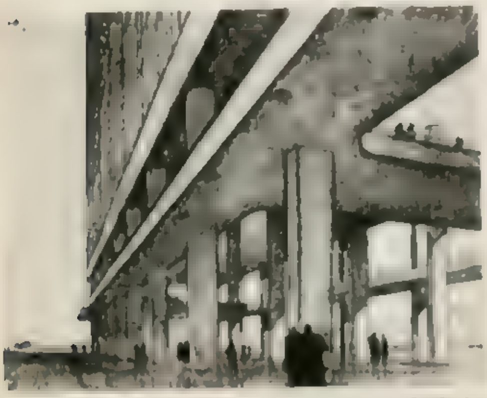
BY COURTESY OF (CENTRE) AVERY LIBRARY, COLUMBIA UNIVERSITY

ARCHITECTURAL RENDERING

Engraving by Daniel Marot (1661–1752), French

Rendering of design for *Chicago Tribune* competition by Eliel Saarinen (1873–1950), Finnish-U.S.

Chapel tower and chaplain's quarters, U.S. military academy, West Point, N.Y.; rendering by Bertram Grosvenor Goodhue (1869–1924), U.S.



Proposed United Nations centre, San Francisco bay, Calif.; by Ernest Born (1898–   ), U.S.

Design for a residence by Otto R. Eggers (1882–1964), U.S.

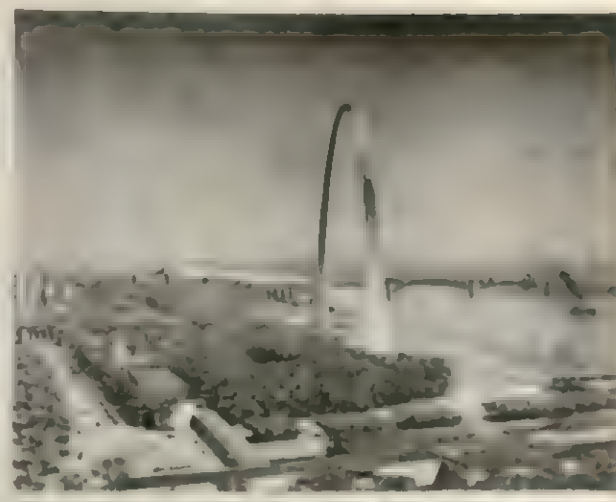
Custom house, New York city, by Alexander Jackson Davis (1803–92), U.S.

Por[illegible] of the Cathedral Church of St. Michael, Coventry, Eng.; by [illegible] (1907–   ), English

ARCHITECTS' RENDERINGS OF THEIR OWN DESIGNS

BY COURTESY OF (TOP LEFT) THE [illegible] MUSEUM, N.Y.; (TOP CENTRE) EERO SAARINEN; (TOP RIGHT) HENRY H. SAYLOR; (BOTTOM LEFT) THE NEW YORK HISTORICAL SOCIETY, [illegible] CITY

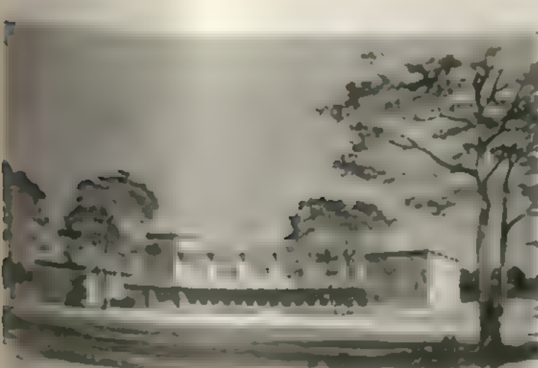
[illegible] by George Cooper Rudolph (Chase-Manhattan National bank, New York city; Skidmore, Owings & Merrill, arch.)



[illegible] by [illegible] (winning design, Jefferson memorial competition, St. Louis Mo. [illegible] Saarinen and Associates arch.)

Carbon pencil and charcoal by Chester B. Price (proposed opera house, New York city; Benjamin Wistar Morris, arch.)

Water [illegible] by Edward [illegible] (U.S. military cemetery [illegible]; Ralph Walker, arch.)



Tempera by Robert Schwartz (Lillian Welsh hall, Goucher college. Moore [illegible])

Tempera by [illegible] (office building of the English Electric Co. Ltd. Adams, Holden & Pearson, arch.)

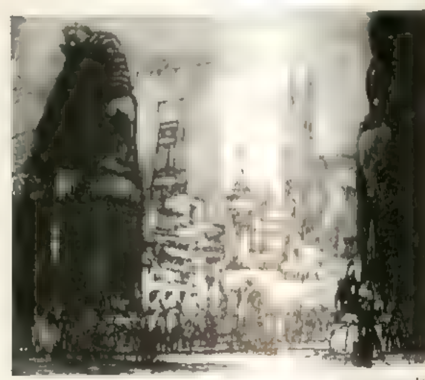
PRESENTATION RENDERINGS IN VARIOUS MEDIUMS

[illegible]

ARCHITECTURAL RENDERING

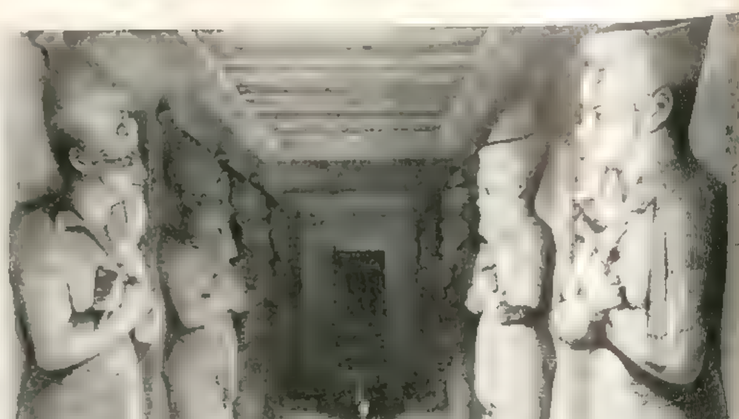
Imaginary scene; engraving by Giambattista Piranesi (1720–78), Italian

Imaginary building; lithographic pencil by Hugh Ferriss (1889–), U.S.



Imaginative reconstruction of a palace at Thebes; etching by William Walcot (1874–), English

Interpretation of existing buildings: "Scene in Venice"; oil by Canaletto (1697–1768), Italian



Interpretation of historical subject: interior of Abu Simbel; lithograph by David Roberts (1796–1864), English

VARIOUS TYPES OF RENDERING

To show how a proposed structure will really look involves a close study of how existing structures really look. People see buildings in different ways depending upon personal interests and limitations: a manufacturer of terra cotta may see, in a building, mainly the terra cotta; a realtor may count every window in a skyscraper. But there are elementary aspects of buildings which almost everyone sees, and these become the more serious concerns of rendering. For example, no one has ever seen an existing building in plan, section or elevation; the eye is so constituted that all objects are seen in perspective. Thus, the renderer's familiarity with the science of perspective draftsmanship is taken for granted (*See* PERSPECTIVE). However, to be lifelike a rendering must be more than a line drawing correctly laid out according to the rules of that science; to stop there achieves only the drafting-room realism that so often fails as art and conveys no lively sense of reality.

In reality, a building does not appear to be an assemblage of lines; it is made up of definite structural forms possessing distinct edges. But an edge is not a drawn line, and the forms are not abstract. The impression of solidity, gained from existing buildings, is essential to any convincing portrayal of proposed buildings, even though a building contains far more space than mass, and some modern buildings are phenomenal in their effect of airy spaciousness. The task, in short, is to portray the solid structural members surrounded by abundant space.

In looking at an existing building one senses it to be standing firmly on its foundation. This is true not only of a massive structure visibly resting on a massive foundation (*e.g.*, the Colosseum at Rome), but also of cantilevered buildings (*e.g.*, Frank Lloyd Wright's "Falling Water," a residence at Bear Run, Pa.) and of light, thin-shell constructions resting on only three point-supports (*e.g.*, Eero Saarinen's auditorium at Massachusetts Institute of Technology). One never sees a building apart from its surroundings, whether these be the natural surroundings of a country site or, in cities, the adjoining buildings and all the activity of street traffic. Buildings are always seen to have colour and textures, and these under the play of light, shade and shadow. And no one has ever seen a building in a vacuum; buildings stand in the atmosphere.

All these aspects of existing buildings have been explored over the centuries by artists as varied as Dürer of the 16th century, Rembrandt of the 17th, Canaletto of the 18th, Thomas Girtin of the 19th and Edward Hopper of the 20th. Such artists have been engaged in interpreting, rather than merely copying, natural appearances. Their interpretations have been highly personal. Their achievements, prompted by aspects of existing buildings, have a bearing on architectural rendering, for the same aspects are to be explored and interpreted in portraying buildings that do not yet exist. A long line of architects and artists has conceived architectural rendering to be a creative art.

History.—*Greece and Rome.*—A classic reference to rendering was supplied by Vitruvius, Roman architect-engineer of the 1st century B.C., who in listing an architect's qualifications wrote, two millenniums ago, "He must have a knowledge of drawing so that he can readily make sketches to show the appearance of the work which he proposes." (*Vitruvius: The Ten Books of Architecture*, trans. by M. H. Morgan, book i, ch. 1, p. 6, Harvard University Press, Cambridge, Mass., 1914.) Vitruvius referred to even earlier writings by Democritus and Anaxagoras, dealing with the same subject. Both gave brief but workable descriptions of perspective.

Actual examples of the ancient use of perspective were preserved in the murals of Pompeii. It appears unlikely that buildings so carefully designed as the baths of Caracalla or the Parthenon could have been constructed without some graphic directives drawn in advance. However, since any such drawings have disappeared it remains only a likely speculation that the Greek architect Ictinus could draw as well as build.

Medieval Europe.—From the middle ages some architectural sketches in perspective do remain; *e.g.*, the famous sketchbook of Villard de Honnecourt, master mason of the 13th century. But architectural rendering as we know it today began in the Renaissance. Collected in many museums and reproduced in many books, there is a wealth of material, both design-studies and presentation renderings by such artist-architects as Brunelleschi, Alberti, Peruzzi, Bramante, the Sangallos, Leonardo and Michelangelo.

Fine Italian renderings were later made by Domenico Fontana, Mauro Tesi and the Bibienas. The etchings of Piranesi (1720–78), while unconcerned with specific building projects, were renditions of a vast architectural imagination.

France.—In France, Jean Lepautre (1618–82) and Daniel Marot (1661–1752) were outstanding as both architects and renderers. The École des Beaux-Arts for many generations led in the perfecting of a type of rendering which involved the addition to carefully drawn plans and elevations of washes in monotone or colour, so applied as to elucidate and enhance the presentation.

England.—In England, the great draftsman Inigo Jones influenced the pictorial work of many architects of the 17th and 18th centuries. Sir John Soane was outstanding in the later 18th century, Charles Robert Cockerell and David Roberts in the early 19th. Thomas Girtin influenced British rendering by his appreciative handling of the environment of buildings including atmospheric conditions. Alfred Waterhouse, architect, was also an able artist of the 19th century. Sir Edwin Lutyens (1869–1944) left an impressive record of the development of an architect's designs from thumbnail sketch through presentation renderings to finished working drawings.

The library of the Royal Institute of British Architects, London, contains about 30,000 original water colours and drawings which amply illustrate the development of rendering in England over four centuries.

The United States.—In the United States, sketches by Thomas Jefferson, as well as early drawings by B. H. Latrobe and William Thornton dealing with designs of the Capitol at Washington, were preserved. A. J. Davis (1803–92) was perhaps the first American architect to gain fame as a renderer, or "architectural composer," as he called himself. Among other architects who could draw or paint as well as design were James Renwick and Richard M. Upjohn of the 19th century; also (their careers extending into the 20th century) Stanford White, Cass Gilbert and his head designer Thomas R. Johnson, H. Van Buren Magonigle, Bertram Grosvenor Goodhue, Charles Z. Klauder, Charles D. Maginnis, Paul Cret, Eric Mendelsohn and Eliel Saarinen. Artists having a love for architecture included Burch Burdette Long, John Taylor Arms and Jules Guerin.

Collections of original renderings by these and other American architects and artists are in many architectural libraries, *e.g.*, Avery (Columbia university), Burnham (Art Institute of Chicago) and the libraries of Massachusetts Institute of Technology, Yale and Harvard.

BIBLIOGRAPHY.—For contemporary techniques and renderers, *see* Sherley W. Morgan, *Architectural Drawing* (1950), which supplies a comprehensive bibliography; also W. W. Atkin, R. Corbelletti and V. R. Fiore, *Pencil Techniques in Modern Design* (1953). Sir Reginald Blomfield, *Architectural Drawing and Draughtsmen* (1912) remains the authoritative treatise on the history of rendering. (H. Fe.)

ARCHITECTURE (ARTICLES ON). The article ARCHITECTURE reviews the major fields of specialization, the techniques associated with the use of various materials and methods, and the various ways of manipulating space to house social institutions in attractive, durable and serviceable ways.

The major historical periods of architecture, the social forces in which they were rooted and the types of design that characterized them are discussed in a series of articles that includes (in approximately chronological order): EGYPTIAN ARCHITECTURE; PRE-HELLENIC ARCHITECTURE; GREEK ARCHITECTURE; ROMAN ARCHITECTURE; BYZANTINE ARCHITECTURE; EARLY CHRISTIAN ARCHITECTURE; ROMANESQUE ARCHITECTURE; GOTHIC ARCHITECTURE; RENAISSANCE ARCHITECTURE; BAROQUE AND POST-BAROQUE ARCHITECTURE; and MODERN ARCHITECTURE. Subdivisions of these periods in which locally distinctive versions were developed are represented by individual articles. For example, GOTHIC ARCHITECTURE is supplemented by three articles describ-

ing historic phases of its development in England: EARLY ENGLISH PERIOD, DECORATED PERIOD and PERPENDICULAR PERIOD; and phases of the Gothic style in France are presented in RAYONNANT STYLE and FLAMBOYANT STYLE. Similarly, RENAISSANCE ARCHITECTURE is supplemented by three articles describing its variations in England: TUDOR PERIOD, ELIZABETHAN STYLE and JACOBEAN STYLE.

Separate articles are devoted also to the historical development of distinctive national architectures, such as CHINESE ARCHITECTURE; INDIAN ARCHITECTURE; JAPANESE ARCHITECTURE; and RUSSIAN ARCHITECTURE. Additional articles on architectural styles include IBERO-AMERICAN ARCHITECTURE and ISLAMIC ARCHITECTURE.

The practical problems involved in the building of a residence today are treated in HOUSE DESIGN; the planning of a building with reference to sun, prevailing winds and similar factors is discussed in ORIENTATION.

Domestic architecture in various regions and eras, and the influences that have created modern trends are discussed in RESIDENTIAL ARCHITECTURE. Articles on other specialized phases include EDUCATIONAL ARCHITECTURE; GOVERNMENTAL ARCHITECTURE; INDUSTRIAL ARCHITECTURE; LIBRARY; MONUMENTS AND MEMORIALS; MUSEUM ARCHITECTURE; PARK AND PLAYGROUND; and RELIGIOUS ARCHITECTURE.

Articles dealing in detail with specific types of building include APARTMENT HOUSE; BASILICA; BATH; CASTLE; CATHEDRAL: *Architecture;* CHÂTEAU; CHURCH: *The Building;* FARM BUILDINGS; HALL; MANOR HOUSE; MINARET; PYRAMID; TEMPLE ARCHITECTURE; THEATRES (STRUCTURES); TOMB; and TOWER.

ARCHITECTURAL EDUCATION describes the general principles involved in directing the energies of talented students into productive channels, and discusses some of the leading architectural schools of the contemporary world.

One of the methods of interpreting architecture to the layman is the visualization of a building in drawings or paintings in which the primary emphasis is placed on their architectural design. These presentations, which are sometimes used by architects for their own guidance during experimental stages, are discussed and illustrated in ARCHITECTURAL RENDERING.

Insights into the visual interpretation of architecture are given in PERSPECTIVE.

The relationship of architecture to other arts and crafts in various cultures and eras, and the influence of shifting standards of taste are discussed in ART and FINE ARTS.

Articles dealing with the economic background of architecture include BUILDING INDUSTRY, which discusses the architect's relationship to the client, the contractor and community agencies; CITY PLANNING; and ZONING.

ARCHITECTURAL ENGINEERING discusses the principles of structural engineering and design, and the problems of environmental control.

The major orders of classical architecture, in each of which a distinctive style of column or pilaster represents a theme with characteristic variations, are described in ORDER, which will be found a helpful supplement to GREEK ARCHITECTURE and ROMAN ARCHITECTURE and to articles on specific buildings of classical Greece and Rome. Other articles related to this subject include BASE; CAPITAL; COLUMN; ENTASIS; and MOLDING.

Many articles are devoted to architectural forms, materials and processes, such as: ARCH AND VAULT; BRICKWORK; DOME; FOUNTAIN; ORNAMENT, ARCHITECTURAL; ROOF; SHOP FRONT DESIGN; SPIRE; STAIR; TRACERY; WINDOW; etc.

For significant insights into the relationship between architecture and the society it exemplifies, the reader should consult the biographical articles on leading architects of various countries and eras.

In many cases, the articles dealing with periods of architecture and regional styles have parallel articles in the field of art—for example, INDIAN ARCHITECTURE is supplemented by INDIAN ART; etc.

Individual buildings of historic or artistic importance are discussed in the general articles listed above, in architectural subdivisions of articles on nations and cities and in such special articles as ALHAMBRA, THE; ERECHTHEUM; PARTHENON; TAJ MAHAL; etc. Reference to the Index will guide the reader to this information and to illustrative plates.

ARCHITECTURE. Architecture is the art and the technique of building, employed to fulfill the practical and expressive requirements of civilized people. Almost every settled society that possesses the techniques for building produces architecture. It is necessary in all but the simplest cultures; without it, man is confined to a primitive struggle with the elements; with it he has not only a defense against the natural environment but also the benefits of a human environment, a prerequisite for and a symbol of the development of civilized institutions.

The characteristics that distinguish a work of architecture from other man-made structures are: (1) Its suitability to use by human beings in general and its adaptability to particular human activities. (2) The stability and permanence of its construction. (3) Its communication of experience and ideas through form.

All these conditions must be met in architecture. The second is a constant, while the first and third vary in relative importance according to the social function of buildings. If the function is chiefly utilitarian, as in a factory, communication is of less importance; if it is chiefly expressive, as in a monumental tomb, utility is a minor concern. In buildings such as churches and city halls, utility and communication may be of equal importance.

In three sections, entitled *Use, Techniques* and *Expression,* this article discusses the means by which these three conditions are fulfilled. They appear under the following headings:

I. USE

The types of architecture are established not by architects but by society, according to the needs of its different institutions. Society sets the goals and assigns to the architect the job of finding the means of achieving them. This section is concerned with types, the role of society in determining the kinds of architecture, and with planning, the role of the architect in adapting designs to particular uses and to the general physical needs of human beings.

A. TYPES

Architecture is created only to fulfill the specifications of an

individual or group. Economic law prevents architects from emulating their fellow artists in producing works for which the demand is nonexistent or only potential. So the types of architecture depend upon social formations and may be classified according to the role of the patron in the community. The types that will be discussed here—domestic, religious, governmental, recreational, welfare and educational, commercial and industrial —represent the simplest possible classification; a scientific typology of architecture would require a more detailed analysis.

1. Domestic Architecture.—Domestic architecture is produced for the social unit: the individual, family or clan and their dependents, human and animal. It provides shelter and security for the basic physical functions of life and at times also for commercial, industrial or agricultural activities that involve the family unit rather than the community. The basic requirements of domestic architecture are simple: a place to sleep, prepare food, eat and perhaps to work; a place that has some light and is protected from the weather and other natural inconveniences. A single room with sturdy walls and roof, a door, a window and a hearth are the necessities; all else is luxury.

The "Vernacular."—In much of the world today, even where institutions have been in a continuous process of change, dwelling types of ancient or prehistoric origin are in use, and in the industrialized United States barns are being built according to a design employed in Europe in the first millennium B.C. The forces that produce a dynamic evolution of architectural style in communal building are usually inactive in the home and farm. The life of the average person may be unaltered by the most fundamental changes in his institutions. He can be successively a slave, the subject of a monarchy and a voting citizen, without having the means or the desire to change his customs, techniques or surroundings. Economic pressure is the major source of his conservatism; lacking the resources of the group, the average individual is forced to restrict his demands to a level far below that which the technology of his time is capable of maintaining. Frequently he builds new structures with old techniques because experiment and innovation are more costly than repetition. But in wealthy cultures economy permits and customs encourage architecture to provide conveniences such as sanitation, lighting and heating, as well as separate areas for distinct functions, and these may come to be regarded as necessities. The same causes tend to replace the conservatism of the home with the aspirations of institutional architecture and to emphasize the expressive as well as the utilitarian function.

"Power" Architecture.—As wealth and expressive functions increase, a special type of domestic building can be distinguished that may be called power architecture. In almost every civilization the pattern of society gives to a few of its members the power to utilize the resources of the community in the construction of their homes, palaces, villas, gardens and places of recreation. These few, whose advantages usually arise from economic, religious or class distinctions, are able to enjoy an infinite variety of domestic activities connected with the mores of their position. These can include even communal functions: the palace of the Flavian emperors in Rome incorporated the activities of the state and the judicial system; the palace of Versailles, a whole city in itself, provided the necessities and luxuries of life for several thousand persons of all classes and was the centre of government for an empire. Power architecture may have a complex expressive function, too, since the symbolizing of power by elegance or display is a responsibility or a necessity (and often a fault) of the powerful. Since this function usually is sought not so much to delight the patron as to demonstrate his social position to others, power architecture becomes communal as well as domestic. In democracies such as ancient Greece and in the western world today, the show of power in private architecture may be reserved, but it is still distinguishable. (*See* also HOUSING.)

Group Housing.—A third type of domestic architecture accommodates the group rather than the unit and is therefore public as well as private. It is familiar to us through the widespread development of mass housing in the modern world, in which individuals or families find living space either in multiple dwellings or in single units produced in quantity. Group housing is produced by many kinds of cultures: by communal states to equalize living standards, by tyrants to assure a docile labour force and by feudal or caste systems to bring together members of a class. The apartment house was developed independently by the imperial Romans to suit urban conditions and by the American Indians to suit agricultural conditions. Group architecture may be power architecture as well, particularly when land values are too high to permit even the wealthy to build privately, as in the 17th-century Place des Vosges in Paris, where aristocratic mansions were designed uniformly around a square, or in the 18th-century flats in English towns and spas. Although most domestic architecture of today employs the style and techniques of the past, the exceptions are more numerous and more important for the development of architecture than ever before. This is because the distribution of wealth and power is widespread in parts of the world where architecture is vital, and because the modern state has assumed responsibility for a large amount of high-quality housing at low cost.

2. Religious Architecture.—The history of architecture is concerned more with religious buildings than with any other type because in most past cultures the universal and exalted appeal of religion made the church or temple the most expressive, the most permanent and the most influential building in any community. (*See* also RELIGIOUS ARCHITECTURE.)

The typology of religious architecture is complex, because no basic requirements such as those that characterize domestic architecture are common to all religions, and because the functions of any one religion involve many different kinds of activity, all of which change with the evolution of cultural patterns.

The temple or church serves as a place of worship and a shelter for the images, relics and holy areas of the cult. In the older religions the temple was not always designed for communal use. In Egypt and ancient Hinduism it was considered the residence of the deity, and entrance into the sanctum was prohibited or reserved for priests; in Greece it contained an accessible cult image, but services were held outside the main façade; and in the ancient near east and in Mayan and Aztec architecture, where the temple was erected at the summit of pyramidal mounds, only privileged members of the community were allowed to approach. Few existing religions are so exclusive. Beliefs as dissimilar as Christianity, Buddhism, Judaism and Islam are based on communal participation in rites held inside the temple or church. The buildings have even evolved into similar plans, because of a common requirement that the maximum number of worshippers be able to face the focal point of the service (the mosque's "point" is the Mecca wall). Consequently, the Moslems were able to adopt the Byzantine church tradition, modern synagogues are often scarcely distinguishable from churches, and early Protestantism absorbed Catholic architecture with only minor revisions (elimination of subsidiary chapels and altars, repositories of relics and some symbolic decoration).

Shelter is not always required for worship. Primitive rites are often practised outdoors with some monument as a focus, while the altar of Pergamum and the Ara Pacis Augustae in Rome are evidences of the open-air observances of the classical world. The atrium (forecourt) of early Christian architecture and the cloister were isolated areas for meditation and prayer.

The complex programs of later religions made the place of worship the focus for varied activities demanding architectural solutions; for example, the baptistery, bell towers and chapter houses of Christian architecture, the minarets around the mosque, and the holy gates of Buddhism. Most modern sects demand space for religious education adjoining the community church or temple. Catholicism and the religions of Asia have produced monasteries, convents and abbeys—connected to places of worship—which accommodate the organized practice of religion, adding domestic and often industrial, agricultural and scholarly functions to the religious.

Shrines and memoria consecrate a holy place for its miraculous character or for its association with the life of the founder, gods or saints of a cult. Since the importance of such structures is usually proportionate to the antiquity of their tradition and asso-

ciations with cult origins, they have had little importance in later architectural history. The major commemorative buildings of Christianity are those connected with the life of Christ (Church of the Nativity in Bethlehem) and the apostles or early church fathers (St. Peter's in Rome) or with the medieval cult of relics (Santiago de Compostela in Spain). No single formal design characterizes this type, but the theme of the domed or central-plan structure (round, square, polygon, Greek cross, etc.) connects the memoria of Asia (the Indian stupa, Chinese pagoda), pagan antiquity (the Pantheon in Rome) and Christianity (the Holy Sepulchre in Jerusalem). The significance of the form is discussed below under *Content*. (*See* also MONUMENTS AND MEMORIALS.)

Funerary art, which expresses man's relationship to the afterlife, is not always architectural, since it may be purely symbolic and therefore suitable to sculptural treatment, as in the classic Greek, medieval and modern tomb. Funerary architecture is produced by societies whose belief in the afterlife is materialistic and by individuals who want to perpetuate and symbolize their temporal power. Monumental tombs have been produced in ancient Egypt (pyramids), Hellenistic Greece (tomb of Mausolus, Halicarnassus, source of the word mausoleum), Rome (tomb of Hadrian), Renaissance Europe (Michelangelo's Medici chapel, Florence) and in the near and far east (Taj Mahal). Modern tomb design has lost vitality, though it remains as elaborate (monument to Victor Emmanuel, Rome) or as meaningful in terms of power (Lenin tomb, Moscow) as before. The exceptional examples are partly sculptural in character (Louis Sullivan's Wainwright tomb, St. Louis, Mo.; Walter Gropius' war memorial, Weimar, Ger.; and the memorial by L. B. di Belgiojoso, E. Rogers and E. Peressutti in a Milan, Italy, cemetery).

Since the 18th century much of religious architecture has lost individuality and importance through the weakening of liturgical traditions. But today, as in the past, outstanding architects have met new demands of use and expression with superior solutions. (*See* TOMB.)

3. Governmental Architecture.—The basic functions of government, to an even greater extent than those of religion, are similar in all societies: administration, legislation and the dispensing of justice. But the architectural needs differ according to the nature of the relationship between the governing and the governed. Where governmental functions are centralized in the hands of a single individual, they are simple and may be exercised in the ruler's residence; where the functions are shared by many, and established as specialized activities, they become complex and demand distinct structures. There are, however, no basic formal solutions for governmental architecture, since the practical needs of government may be met in any sheltered area that has convenient space for deliberation and administration. A distinct type is created rather by expressive functions arising from the ideology of the different systems of political organization (monarchy, theocracy, democracy, etc.) and from the traditions of the various offices of government (law courts, assembly houses, city halls, etc.). Governments that exercise power by force rather than by consent tend to employ the expressive functions of architecture to emphasize their power; they tend to produce buildings of a monumentality disproportionate to their service to the community. Those in which the ruler is given divine attributes bring religious symbolism into architecture. Democratic governments have the responsibility of expressing in their architecture the aims of the community itself, a difficult task in the modern world, when the community may be neither small enough to express itself easily nor homogeneous enough to agree on how to do so.

The simple democratic processes of the Greek city-states and the medieval free towns produced governmental architecture on a domestic scale, while the Roman empire and later monarchies seldom made important distinctions between the place and the seat of state functions. The widespread growth of representative government and the increase in the size and functions of the state in the 19th century created a great variety of buildings, some for entirely new uses. First, capitols, courthouses, parliament buildings, printing offices and mints; and later, post offices, embassies, archives, secretariats and even laboratories, when the work, the increased personnel and the complexity of mechanical aids demanded specialized architectural solutions. Bureaucracy, for better or for worse, has made governmental architecture more important than at any time in history.

In the first rapid expansion from about 1780 to 1840, neoclassic architects found impressive solutions to the new problems, but afterward governmental architecture lapsed into a century of conservatism, following at a safe distance behind private building. After World War II, governmental architecture showed new vitality. Outstanding are Le Corbusier's work at Chandigarh, India, the United Nations Educational, Scientific and Cultural organization headquarters in Paris, and the world-wide program of the U.S. department of state. (*See* GOVERNMENTAL ARCHITECTURE.)

Military building is closer to this type than to others, but its expressive function is so much subordinated to the practical that it is usually regarded as a class of engineering.

4. Recreational Architecture.—Few recreations require architecture until they become institutionalized and must provide for both active and passive participation (athletic events, dramatic and musical performances) or for communal participation in essentially private luxuries (baths, museums and libraries). Throughout history recreational architecture has been the most consistent in form of any type. Diversions may change, but, as in domestic architecture, the physical make-up of the human being provides consistency. If his participation is passive he must be able to hear and to see in comfort; if active, he must be given spaces suited to the chosen activity. In most cultures, recreational institutions have their origins in religious rites, but they easily gain independence, and religious expression is reduced or eliminated in their architecture.

Theatres originated in Greece with the rites of the god Dionysus, first as temporary installations and later as outdoor architecture using the natural slopes and curves of hillsides to bring the spectator close to the stage and to avoid the need for substructures. The Greek theatre was monumentalized and modified by the Romans, whose arches and vaults allowed construction of sloping seats from level foundations. In the middle ages churches and temporary structures were used for dramatic purposes, and in the Renaissance Roman theatres were occasionally revived (Palladio's Teatro Olimpico in Vicenza). The 17th-century development of opera, drama and ballet in Europe brought about a revival of theatre building, but in a new form conceived to satisfy class and economic distinctions (Farnese theatre in Parma; Residenztheater, Munich). A flat or inclined pit accommodated standing patrons, tiers of boxes rose vertically above in a horseshoe plan, and permanent covering (for both acoustics and comfort) made artificial lighting an important feature in theatrical performances. The modern theatre, while greatly improved in efficiency by new acoustical methods and materials, has kept much of the baroque form, though it provides seating throughout and usually substitutes sloping galleries (into which the unprivileged have been moved) for boxes. The motion picture has had little effect on theatre design.

The auditorium is distinguished by the absence of stage machinery and by its greater size. The development of large symphony orchestras and choirs, and of the institution of lectures and mass meetings, combined with growing urban populations to produce this modification of the theatre. (*See* THEATRES [STRUCTURES].)

Sports arenas, race tracks and public swimming pools of the present day owe their origin to the ancient Romans (though certain precedents can be found in Crete and Greece). Although the classical tradition of sports was broken from the early middle ages to the 19th century, even the design of arenas and tracks has been scarcely altered from the Colosseum and Circus Maximus, though the construction of large grandstands has inspired magnificent designs in reinforced concrete (stadiums at Florence, Helsinki and the University of Mexico). Sports that have no precedents in antiquity, such as baseball, have required modifications in design but have not been important for architecture. (*See* AMPHITHEATRE; STADIUM.)

Museum and library architecture was also an innovation of classical antiquity (library architecture appears independently in an-

cient China and Japan). Early examples are found on the Acropolis of Hellenistic Pergamum and in Roman Ephesus. Museums were not cultivated in the middle ages, and libraries were incorporated into monasteries. In the Renaissance and baroque periods library construction was rare, but important civic buildings were designed within religious institutions (Michelangelo's Biblioteca Mediceo-Laurenziana in Florence) and universities (Sir Christopher Wren's Trinity college library, Cambridge; James Gibb's Radcliffe Camera, Oxford). This type of architecture became truly communal for the first time in the 19th century, when the size of library collections and the number of visitors inspired some of the finest architecture of the modern period (G. Bindesboll's Thorwaldsen museum, Copenhagen; Sir Robert Smirke's British Museum in London; Henri Labrouste's Bibliothèque Ste. Geneviève in Paris; Alvar Aalto's library in Viipuri, Finland).

5. Architecture of Welfare and Education.—The principal institutions of public welfare are those that provide facilities for education health, public security and utilities. Some of these functions are performed by the church and the state, but, since their character is not essentially religious or political, they may require independent architectural solutions, particularly in urban environments. A consistent typology of this architecture, however, cannot be established throughout history, because the acceptance of responsibility for the welfare of the community differs in degree in every social system.

Buildings for the specific purposes of public welfare were seldom considered necessary in antiquity, in most of eastern architecture or in the early middle ages. But in Greece health facilities were included in precincts of the god Aesculapius, and in the east within Buddhist precincts. The Romans produced a highly developed system of water supply and sewerage of which their monumental aqueducts are an impressive survival.

In the later middle ages consistent forms began to emerge. With the separation of the university from a purely religious context, a concept of planning developed (particularly at Oxford, Cambridge and Paris) that still influences educational architecture. Hospitals designed as large halls were established as adjuncts to churches, monasteries and convents and gained architectural independence in the Renaissance (Ospedale degli Innocenti, Florence). Ancient and medieval prisons and guardhouses were occasionally isolated from military architecture (Tower of London; Bargello in Florence), but the prison did not become an important architectural type until fairly recent times (George Dance's Newgate prison, London, 1770; Henry Hobson Richardson's Allegheny county jail, Pittsburgh, Pa., 1884).

The expansion of education and health facilities beginning in the 19th century created a widespread and consistently growing need for specialized architectural solutions. Schools, from the nursery to the university, now demand not only particular solutions at all levels but structures for a variety of purposes within each level: advanced education demands buildings for scientific research, training for trades and professions, recreation, health, housing, religious institutions and other purposes. Most of the countries of the western world have produced educational architecture of the highest quality; the type is more important architecturally than in any past age.

6. Commercial and Industrial Architecture.—Buildings for exchange, transportation, communication, manufacturing and power production meet the principal needs of commerce and industry. In the past these needs were mostly unspecialized. They were met either within domestic architecture or in buildings distinguished from domestic types chiefly by their size. Stores, banks, hostelries, guild halls and factories required only space for more persons and things than houses could accommodate. Bridges, warehouses and other structures not used for sheltering people were of course specialized from the beginning and survived the Industrial Revolution without basic changes. This so-called revolution profoundly affected the typology as well as the techniques of architecture. Through the introduction of the machine and mass production, economic life moved out of the domestic environment into an area dominated by devices and processes rather than by individuals, creating the need for buildings more specialized and more numerous than the total accumulation of types throughout history. All the types cannot be discussed here, but a categorical listing into which they can be fitted will illustrate their importance for architecture:

Exchange.—Office buildings, stores, markets, banks, exchanges, warehouses, exhibition halls.

Transportation.—Roads, bridges, tunnels; stations for rail, sea and air transport and the dispensing of fuel; garages, hangars and other storage facilities; hotels.

Communication.—Structures for the transmission and reception of telephone, telegraph, radio, television and radar communication; for the printing and distribution of newspapers, magazines, books and other reading matter; for motion-picture production; and for advertising functions.

Production.—Mines, factories, laboratories, food processing plants.

Power.—Dams, generating plants; fuel storage, processing and distribution installations.

Each of these functions demands its own architectural solution, but in general they may be divided into two classes according to whether the plan must give greater attention to the size and movement of machinery or of persons. Wherever human activity is the chief concern, there has been less departure from traditional expression; banks in the form of Roman temples are an obvious example. The demands of machines have no tradition and have encouraged a search for greater, simpler and more flexible spaces; but frequently the practical function has entirely eliminated the expressive, so that, with some distinguished exceptions (Frank Lloyd Wright's S. C. Johnson & Son building, Racine, Wis.; Eero Saarinen's General Motors Technical centre, Warren, Mich.) most modern factories are not architecture. Where both men and machines must be given equal attention, as in railroad stations, architecture of the 19th and 20th centuries has vacillated between creating new forms and grasping for irrelevant traditions. (*See* INDUSTRIAL ARCHITECTURE.)

B. PLANNING

The architect usually begins to work when the site and the type and cost of a building have been determined.

The site involves the varying behaviour of the natural environment that must be adjusted to the unvarying physical needs of human beings; the type is the generalized form established by society that must be adjusted to the special use for which the building is required; the cost implies the economics of land, labour and materials that must be adjusted to suit a particular sum.

Thus planning is the process of particularizing and, ultimately, of harmonizing the demands of environment, use and economy. This process has a cultural as well as a utilitarian value, for in creating a plan for any social activity the architect inevitably influences the way in which that activity is performed.

1. Planning the Environment.—The natural environment is at once a hindrance and a help, and the architect seeks both to invite its aid and to repel its attacks. To make buildings habitable and comfortable, he must control the effects of heat, cold, light, air, moisture and dryness, and foresee destructive potentialities such as fire, earthquake, flood and disease.

The methods of controlling the environment considered here are only the practical aspects of planning. They are treated by the architect within the context of the expressive aspects. The placement and form of buildings in relation to their sites, the distribution of spaces within buildings, and other planning devices discussed below are fundamental elements in the aesthetics of architecture.

Orientation.—The arrangement of the axes of buildings and their parts is a device for controlling the effects of sun, wind and rainfall. The sun is regular in its course; it favours the southern and neglects the northern exposures of buildings in the northern hemisphere, so that it may be captured for heat or evaded for coolness by turning the axis of a plan toward or away from it. Within buildings, the axis and placement of each space determines the amount of sun it receives. Orientation may control air for circulation and reduce the disadvantages of wind, rain and snow, since in most

climates the prevailing currents can be foreseen. The characteristics of the immediate environment also influence orientation: trees, land formations and other buildings create shade and reduce or intensify wind, while bodies of water produce moisture and reflect the sun.

Design.—Planning may control the environment by the design of architectural forms that may modify the effects of natural forces. For example, overhanging eaves, moldings, projections, courts and porches give shade and protection from rain. Roofs are designed to shed snow and to drain or preserve water. Protective walls around buildings limit wind, light and heat.

Fenestration.—Windows are the principal means of controlling natural light; its amount, distribution, intensity, direction and quality are conditioned by their number, size, shape and placement and by the characteristics of translucent materials (thickness, transparency, texture, colour). But the planning of fenestration is influenced by other factors, such as ventilation and heating. Since most translucent materials conduct heat more readily than the average wall, windows are used sparingly in extreme climates. Finally, since transparent windows are the medium of visual contact between the interior and exterior, their design is conditioned by aesthetic and practical demands. (*See* WINDOW.)

Walls.—Walls control the amount of heat lost to the exterior or retained in the interior by their thickness and by the structural and insulating materials used in making them. Walls, when properly sealed and protected, are the chief defense against wind and moisture.

Colour.—Colour has a practical planning function as well as an expressive quality because of the range of its reflection and its absorption of solar rays. Since light colours reflect heat and dark colours absorb it, the choice of materials and pigments is an effective tool of environmental control.

Materials and Techniques.—The choice of materials is conditioned by their own ability to withstand the environment as well as by properties that make them useful to human beings. One of the architect's jobs is to find a successful solution to both conditions: to balance the physical and economic advantages of wood against the possibility of fire, termites and mold, the weather resistance of glass and light metals against their high thermal conductivity, and many similar conflicts. The more violent natural manifestations such as heavy snow loads, earthquakes, high winds and tornadoes are controlled by specific technical devices in regions where they are prevalent.

Any number of these controls may be out of reach of the planner for various reasons. The urban environment, for example, restricts freedom of orientation, design, fenestration, etc., and creates new control problems of its own: smoke, dirt, noise and odours.

Interior Control.—The control of the environment through the design of the plan and the outer shell of a building cannot be complete, since extremes of heat and cold, light and sounds penetrate into the interior, where they can be further modified by the planning of spaces and by special conditioning devices.

Temperature, light and sound are all subject to control by the size and shape of interior spaces, the way in which the spaces are connected and the materials employed for floors, walls, ceilings and furnishings. Hot air may be retained or released by the adjustment of ceiling heights and sources of ventilation. Light reflects in relation to the colour and texture of surfaces and may be reduced by dark, rough walls and increased by light, smooth ones. Sounds are transmitted by some materials and absorbed by others and may be controlled by the form of interiors and by the use of structural or applied materials that by their density, thickness and texture amplify or restrict sound waves.

Conditioning devices played a small part in architecture before the introduction of mechanical and electrical systems in the 19th century. The fireplace was almost the only method of temperature control (though the Romans anticipated the modern water system for radiant heating); fuel lamps and candles had to be movable and were rather in the sphere of furnishings than of architecture; the same is true of the tapestries and hangings used for acoustical purposes.

Today, heating, insulation, air conditioning, lighting and acoustical methods have become basic parts of the architectural program. These defenses and comforts of industrialization control the environment so efficiently that the contemporary architect is free to use or to discard most of the traditional approaches to site and interior planning.

2. Planning for Use.—While environmental planning produces comfort for the senses (sight, feeling, hearing) and reflexes (respiration), planning for use is concerned with convenience of movement and rest. All activities that demand architectural attention require unique planning solutions to facilitate them. These solutions are found by differentiating spaces for distinct functions, by providing circulation among these spaces and by designing them to facilitate the actions of the human body.

Differentiation.—The number of functions requiring distinct kinds of space within a building depends not only upon the type of building but also upon the requirements of the culture and the habits and activities of the individual patrons. A primitive house has a single room with a hearth area, and a modern one has separate areas for cooking, eating, sleeping, washing, storage and recreation. A meeting house with a single hall is sufficient for Quaker religious services, while a cathedral may require a nave, aisles, choir, apse, chapels, crypt, sacristy and ambulatory.

The planning of differentiated spaces involves as a guide to their design (placement, size, shape, environmental conditions, sequence, etc.) the analysis of use (number of uses and character, duration, time of day, frequency, variability, etc., of each), users (number, behaviour, age, sex, physical condition, etc.) and furniture or equipment required.

Circulation.—Communication among differentiated spaces and between the exterior and the interior may be achieved by openings alone in the simplest plans, but most buildings require distinct spaces allotted to horizontal and vertical circulation (corridors, lobbies, stairs, ramps, elevators). These are designed by the procedure of analysis employed for differentiating uses. Since their function is usually limited to simplifying the movement of persons and things toward a particular goal, their efficiency depends on making the goal evident and the movement direct and easy to execute.

Facilitation.—The convenience of movement, like the comfort of environment, can be increased both by planning and by devices. Planning methods are based on analysis of the body measurements, movements and muscular power of human beings of different ages and sexes, which results in the establishment of standards for the measurements of ceilings, doorways, windows, storage shelves, working surfaces, steps and the like, and for the weight of architectural elements which must be moved, such as doors, gates and windows. These standards also include allowances for the movement of whatever furnishings, equipment or machinery are required for the use of any building. Devices for facilitating movement within buildings replace or simplify the labours of daily life: the traditional pumps, plumbing and sewerage systems and the innumerable modern machines for circulation, food preparation and preservation, industrial processing and other purposes.

3. Economic Planning.—Major expenses in building are for land, materials and labour. In each case they are high when the commodity is scarce and low when it is abundant, and they influence planning more directly when they become restrictive.

The effect of high land values is to limit the amount of space occupied by any building as well as the amount of expenditure that can be reserved for construction. When land coverage is limited, it is usually necessary to design in height the space that otherwise would be planned in breadth and depth, as in the ancient Roman insula (apartment house) or the modern skyscraper. When the choice of materials is influenced by cost, all phases of architectural design are affected, since the planning procedure, the technique and the form of buildings are dependent on materials. High labour costs influence the choice of techniques and, consequently, of materials. They encourage simplification in construction and the replacement of craftsmanship by standardization. The development of light wood frame construction and methods of prefabrication were largely the result of the rising cost of labour.

Planning involves not only the control of cost in each area but

Wing of the palace of Versailles, France; late 17th and 18th centuries

Street in Pom[illegible] buried under volcanic lapilli and ash in A.D. 79

DOMESTIC ARCHITECTURE

Domestic architecture is produced to provide shelter and security for the social unit. The houses that lined Pompeian streets (left), built two millennia ago, are characteristic of "vernacular architecture," single-unit dwellings which tend to remain virtually unchanged for centuries; the Pompeian houses are little different from those built in small towns around the Mediterranean today. "Power architecture," symbolizing the might of the ruler, is represented here by the palace of Versailles (above), which once housed thousands of servants, soldiers, and courtiers, as well as the royal family of France. Group housing (below) provides homes for many families and is at once public and private

Simon Baruch Public Housing Development, New York City; 1950s

PHOTOGRAPHS, (TOP) DANESE—RAPHO GUILLUMETTE, (CENTRE LEFT) EWING GALLOWAY, (BOTTOM) PETER ROLL—PHOTO RESEARCHERS, INC.

ARCHITECTURE


Interior of the Vienna State Opera; 1861–69 (heavily damaged in World War II, rebuilt to the same design)


Roman theatre at Ephesus, in Turkey; complet[illegible] e reign of the emperor Trajan


Interior of the Farnese Theatre at Parma, Italy; 1618

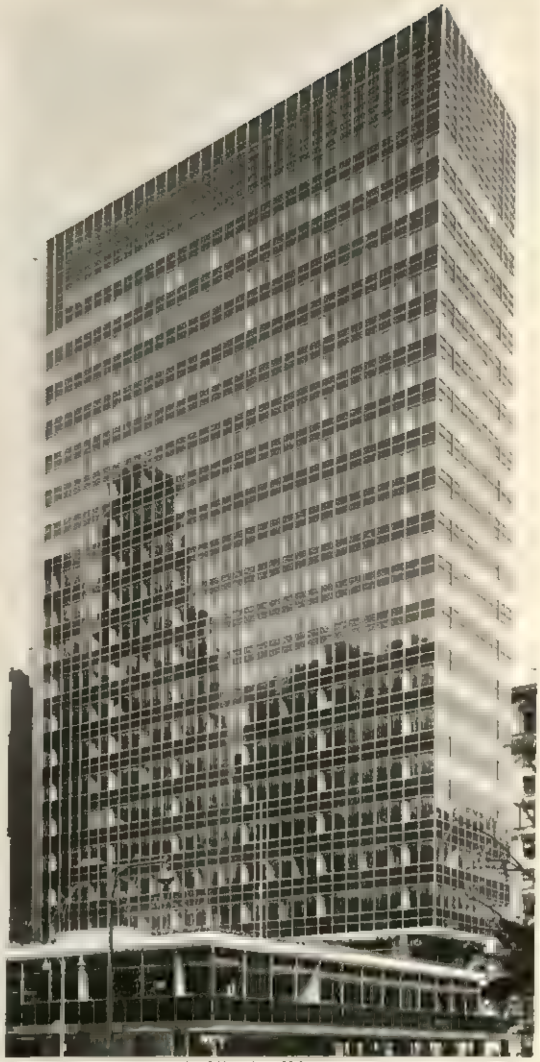
RECREATIONAL ARCHITECTURE

Perhaps the most unchanging structures in architectural history have been those used for recreation. While the diversions which draw people to public entertainments change, man's basic recreational interests remain the same: if his participation is passive, he wants to be comfortable and to be able to see and hear; if active, he wants suitable space in which to perform or compete. Thus the three theatres on this Plate, though built in the 1st or 2nd, 17th and 19th centuries, are remarkably similar in design; and the 19th-century British Museum (below) had antecedents in ancient Greece and Rome.


The British Museum, London; 1823–47

PHOTOGRAPHS, (TOP LEFT) LUCCA CHMEL, PHOTO RESEARCHERS, INC., (TOP RIGHT) ENRICO MARIANI, (CENTRE LEFT) ALINARI, (BOTTOM) CHARLES MAY FROM BLACK STAR

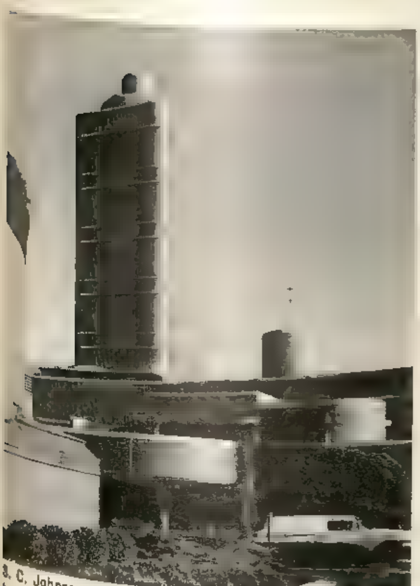
Christopher Wre[illegible] [illegible]ng at the College of William and Mary, Williamsburg, Va.; begun 1695



Lever House, New York City, by Skidmore, Owings and Merrill; 1952

COMME[illegible]L, INDUSTRIAL, WELFARE, AND E[illegible]ATIONAL ARCHITECTURE

Buildings int[illegible]d for commercial or industrial use are rarely disting[illegible]d architecturally: too often their practical purpose [illegible]lowed to overshadow their expressive function. I[illegible]ant exceptions are Frank Lloyd Wright's S. C. Johns[illegible]ilding complex (bottom left) and Lever House (right[illegible]e firm of Skidmore, Owings and Merrill. Structures b[illegible] promote public welfare and education have varied [illegible]cally with the prevailing concept of public responsi[illegible] Two distinguished examples are the 17th-century [illegible]ding at the College of William and Mary (above), des[illegible] by Sir Christopher Wren; and the Roman aqueduct (b[illegible] right), built in southern France



S. C. Johnson & Son, Inc., buildings at Racine, Wis., by Frank Lloyd Wright; 1936–49

Pont du Gard at Nîmes, in southern France

BY COURTESY OF (TOP LEFT) THE COLLEGE OF WILLIAM AND MARY; PHOTOGRAPHS, (TOP RIGHT) BEN SCHNALL, (BOTTOM LEFT) EWING GALLOWAY, (BOTTOM RIGHT) GEORGE HOLTON—PHOTO RESEARCHERS, INC

ARCHITECTURE

Buddhist stupa at Sarnath (near Benares), India, marking the site where the Buddha delivered his first sermon; 322–185 B.C.

Stave church at Borgund ... y; 12th century

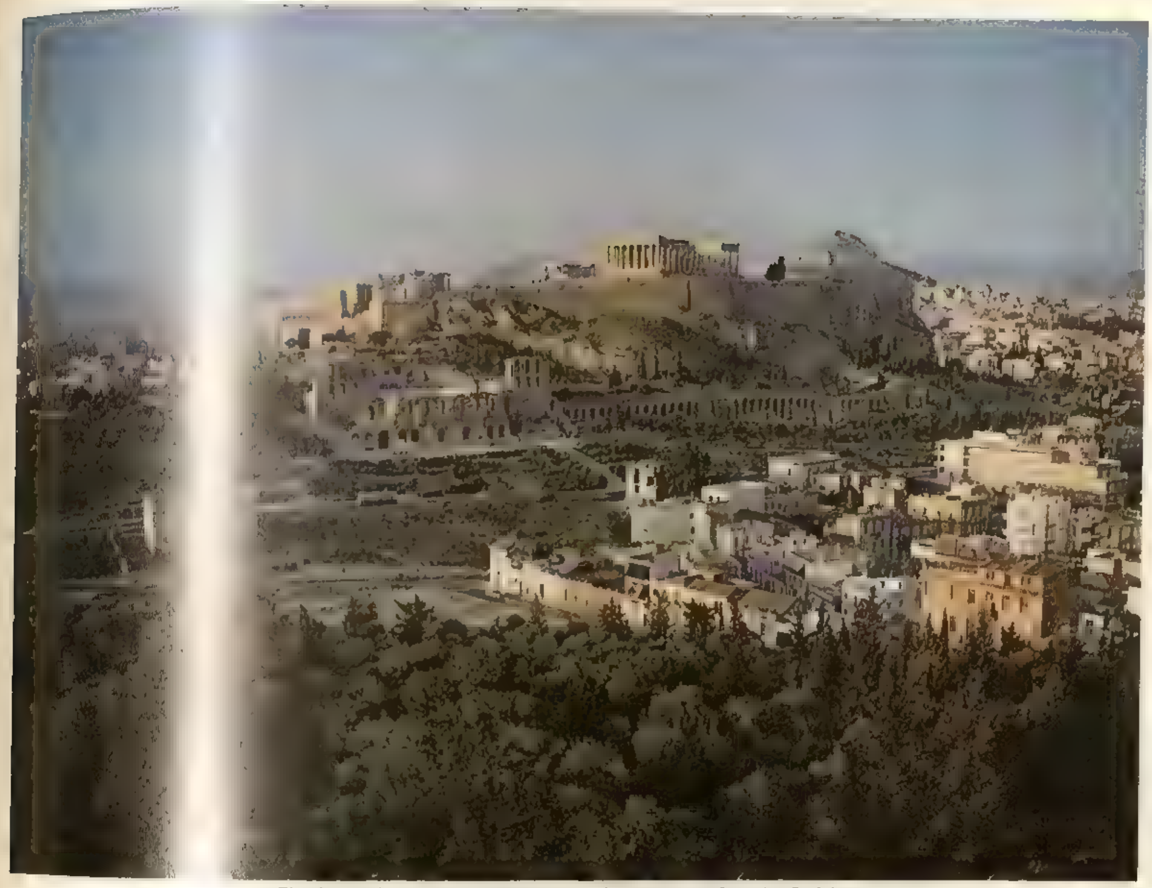
Tomb of a ruler of the Muslim Lodi dynasty (1451–1526), Delhi, India

RELIGIOUS AR... CTURE

Religious buildings histori... ave been the most permanent, expressive, an... ential buildings in the community and theref... lay an important role in the history of archi... ire. Temples and churches (above and below... elter images, deities, or sacred objects an... ovide a place in which to worship. Shrine... d memoria commemorate holy places (top left) and enshrine relics. Tombs often, as in the ...slim tomb at left, perpetuate and symbolize the power of dead rulers

North Shore Congregation Israel, Glencoe, Ill., near Chicago, by Minoru Yamasaki and Associates

PHOTOGRAPHS (TOP LEFT) MARILYN SILVERSTONE—MAGNUM, (TOP RIGHT) © ENCYCLOPÆDIA BRITANNICA, INC., (CENTRE LEFT) C. J. COULSON FROM PICTORIAL PARADE, (BOTTOM) HEDRICH BLESSI


The Acropolis at Athens, rebuilt in the 5th century B.C. under Pericles


United Nations headquarters, New York City; 1952


Armenian castle near Anamur, on the Mediterranean coast of Turkey; 13th century

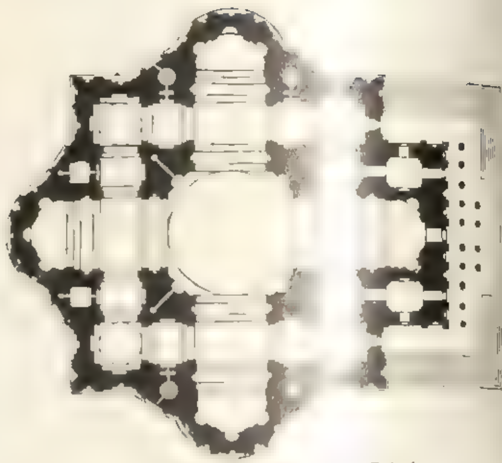
GOVERNMENTAL ARCHITECTURE

Governmental building has been almost as varied as governmental forms. The domestic scale of the Athenian Acropolis (top) reflected the simple, democratic processes of the government of the Greek city-state. The castle (right) near Anamur, Turkey, with its massive crenellated walls, symbolized the raw power of its medieval rulers. The growth of government bureaucracy in the 20th century has made governmental architecture more important than ever before. The United Nations complex in New York City (above), designed by a committee of architects headed by Wallace K. Harrison, is among the most distinguished modern examples

PHOTOGRAPHS, (TOP) BOB AND IRA SPRING, (CENTRE LEFT) PETER GRIDLEY FROM FPG, (BOTTOM RIGHT) AL NELLETT—MAGNUM

ARCHITECTURE

Colonnade of St. Peter's, Rome, designed by Bernini; 1656–67



Michelangelo's plan for St. Peter's

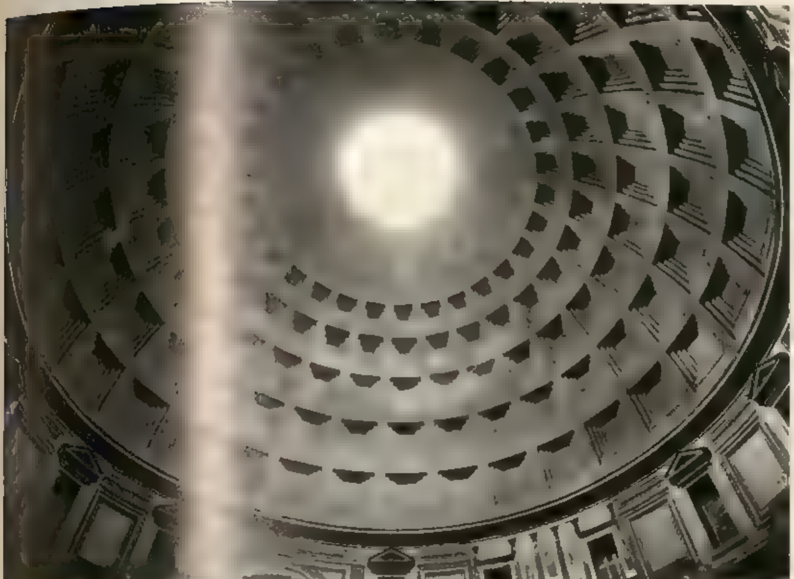
ARCHITECTURAL SYMBOLISM

Architecture conveys meaning through shape. Thus Michelangelo's plan for St. Peter's in Rome (above) combines the cross, the traditional Christian symbol, with the universal religious symbol, the circle. The most important symbols of elevation have been the colonnade, stairway, portal, dome, and tower. The colonnade (left) and stairway (bottom left, and below) serve to heighten the importance of what lies at their end, as the monumental portal (Plate VII, center left) magnifies the importance of what lies beyond it. Both the dome (Plate VII, top left) and the tower (Plate VII, top right, and bottom) have traditionally symbolized both religious and secular power in a wide variety of cultures

Renaissance staircase in the garden of the Villa d'Este at Tivoli, Italy; 1550

Rococo staircase of the château at Fontainebleau, France

BY COURTESY OF (BOTTOM LEFT) ARCHITECTURAL FORUM; PHOTOGRAPHS, (TOP LEFT) D. ANDERSON, (TOP RIGHT) THE BETTMANN ARCHIVE, (BOTTOM RIGHT) PHOTO VIZZAVONA


Dome of the Pantheon (no[illegible] Church of Sta. Maria Rotunda), in Rome; 2nd century A.D.


The Porcelain Pagoda near Peking, China; late 12th or early 13th century


Tymp[illegible] of central portal of the Romanesque Church of La M[illegible]ne at Vézelay, France; c. 1130


Minaret and walls of the Great Mosque of Samarra, Iraq; A.D. 852

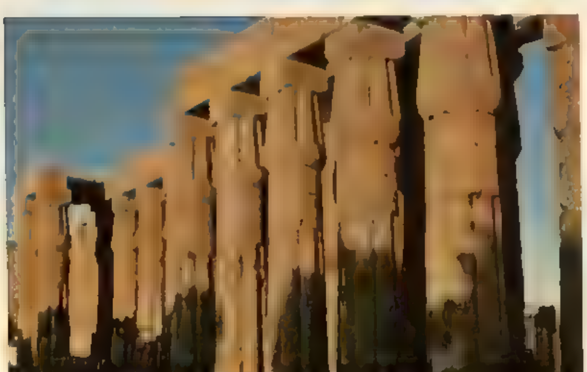
PHOTOGRAPHS, (TOP LEFT) JOHN G. ROSS—PHOTO RESEARCHERS, INC.; (TOP RIGHT) L. TAGER FROM BLACK STAR, (CENTRE LEFT) GIRAUDON, (BOTTOM) EWING GALLOWAY

ARCHITECTURE

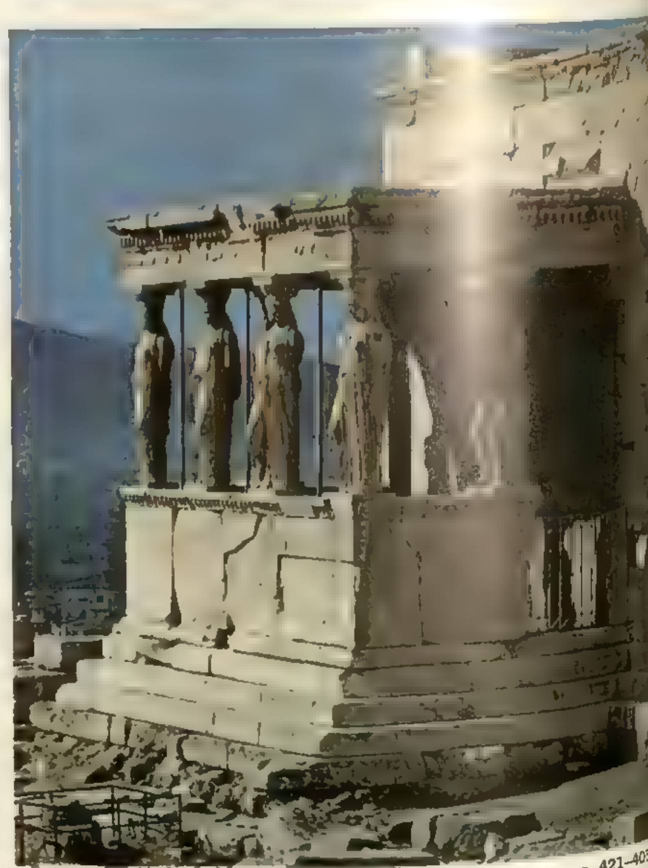
Buttresses of the Cathedral of Notre-Dame, Paris: begun 1163

EXPRESSION OF T[illegible]IQUE

Building methods may [illegible]er frankly stated or disguised. The [illegible] buttresses which help support the l[illegible]hes of the great Gothic cathedrals [illegible]amples of frankly expressed techniq[illegible] So, too, are the caryatids (below) and t[illegible]tly tapered Doric columns (Plate IX, [illegible]m). This open statement of structu[illegible] also characterized much 20th-cen[illegible]chitecture, as may be seen in the 19[illegible]s and steel tower at Hartford, Conn[illegible]te IX, top right). More often, ho[illegible] structural methods have been disgu[illegible]—sometimes crudely, as in the Egyptia[illegible]ns (centre left), which are carved to [illegible]le clusters of papyrus buds, somet[illegible] with great subtlety, as in the multi[illegible]mes of the Blue Mosque at Istanbul [illegible], (Plate IX, top left), which actually re[illegible]endentives but appear to float without [illegible]rt

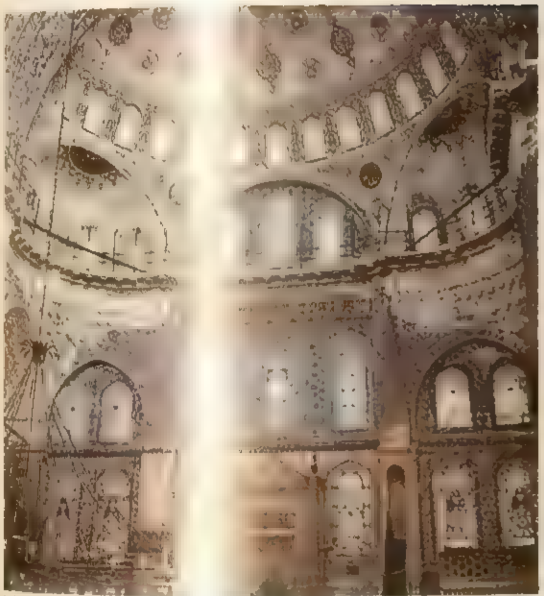


Egyptian columns in the Temple of Amon-Re at Luxor (Thebes); 1567–1320 B.C.



Porch of the Maidens of the Erechtheum, on the Acropolis at Athens; c. 421–405 B.C.

PHOTOGRAPHS, (TOP) ROBERT MORTON, (CENTRE LEFT) F. CLOSS FROM SHOSTAL, (BOTTOM RIGHT) KEYSTONE



Interior of the Mosque of Ahmed (the Blue Mosque) at Istanbul, Turkey; early 17th

The Phoenix Mutual Life Insurance Building in Hartford, Conn., designed by the firm of Harrison and Abramovitz; 1963

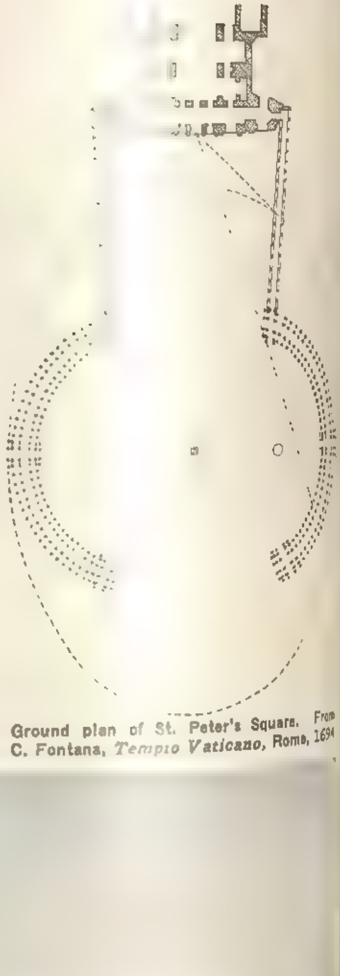
Doric columns at Olympia, Greece; c. 460 B.C.

PHOTOGRAPHS, (TOP LEFT) BILDARCHIV H. V. IRMER, (TOP RIGHT) VAN NASSAR FROM BLACK STAR, (BOTTOM) INGE MORATH—MAGNUM

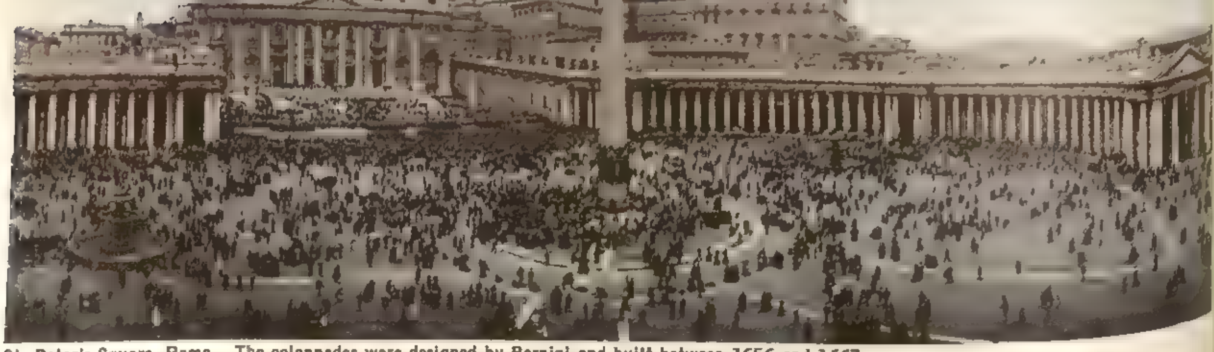
Mont-Saint-Michel, France. The abbey was founded in the 8th century and built and rebuilt over a period of several centuries

COMPOSITION

The harmonious arrangement of planes, surfaces and spaces and their intersections is the basis of all great architecture and has traditionally been achieved in two equally expressive ways. The Gothic abbey of Mont-Saint-Michel (above), which stands atop a granite islet a mile off the Normandy coast, is a handsome example of asymmetry. Successful symmetry is seen in the Baroque piazza of St. Peter's in Rome (right and below), with its semicircular colonnades that lead the eye to the perfectly symmetrical church itself



Ground plan of St. Peter's Square. From C. Fontana, *Tempio Vaticano*, Rome, 1694



St. Peter's Square, Rome. The colonnades were designed by Bernini and built between 1656 and 1667


Dome of St. Peter's Rome; designed by Michelangelo; completed 1590

LIGHT

Although it is the most ephemeral means of architectural expression, light is also among the most powerful. On this Plate are shown two examples of its dramatic use. The light that streams in from the dome of St. Peter's makes the dome seem even loftier than it is. In Gothic churches such as Sainte-Chapelle (below) the magnificent stained-glass windows make the walls themselves seem to dissolve and disappear.


Sainte-Chapelle, Paris; consecrated in 1248

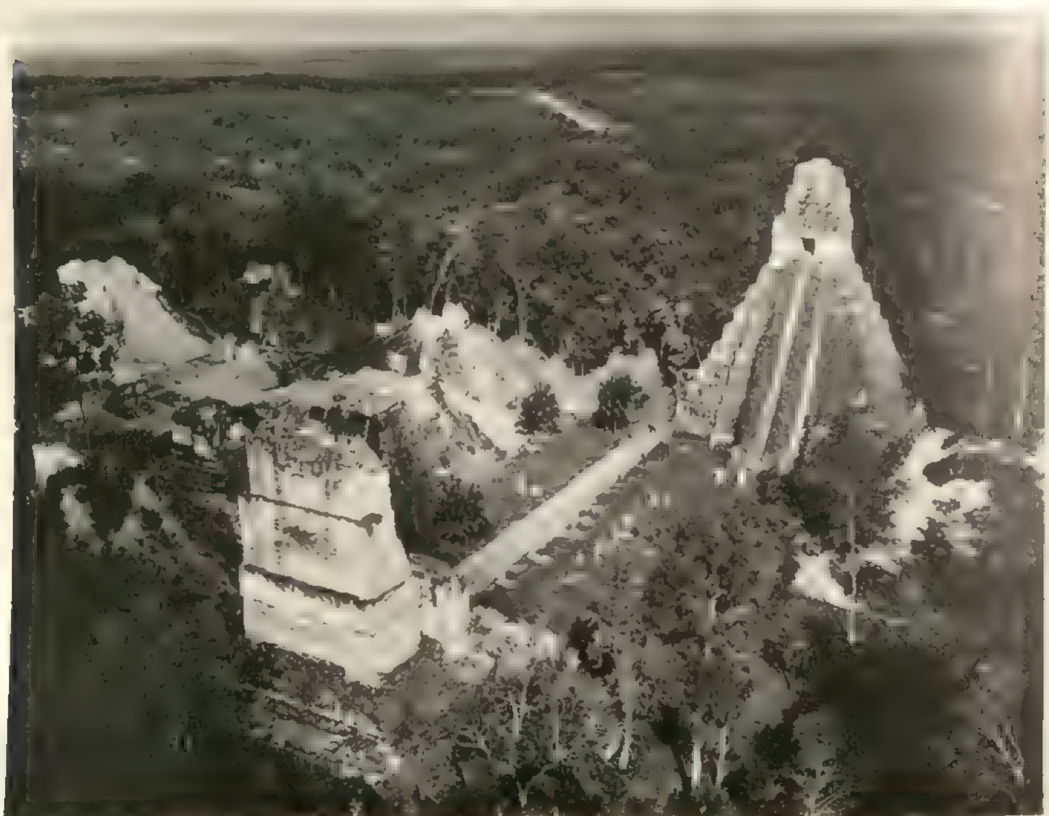
PHOTOGRAPHS, (TOP) PICTORIAL PARADE, (BOTTOM) PETER P. KLOSE—PHOTO RESEARCHERS, INC.

ARCHITECTURE

Interior of Hagia Sophia; Istanbul 532–537

SPACE AND MASS

The monuments on this Plate show extreme cases of what is meant by space and mass in architecture. The 6th-century Byzantine church of Hagia Sophia (right), like most Byzantine monuments, is a shell which holds and forms a soaring space. The Mayan temples (below) at Tikal, Guatemala, atop towering pyramids, contain no meaningful space and depend almost entirely on the expression of mass; they are sculptural rather than architectural in effect



Mayan ruins at Tikal, in central Petén Department, Guatemala; c. A.D. 300–900

BY COURTESY OF (TOP) THE ARCHIVES OF THE ARCHAEOLOGICAL MUSEUM, ISTANBUL, TURKEY; PHOTOGRAPH (BOTTOM) GEORGE HOLTON—PHOTO RESEARCHERS, INC

also the proportioning of expenditures among land, materials and labour in order to produce the most effective solution to an architectural problem.

II. TECHNIQUES

The techniques of architecture in the sense that they will be considered here are simply the methods by which structures are formed from particular materials. These methods are influenced not only by the availability and character of materials but also by the total technological development of society. For architecture depends on an organized labour force and upon the existence of the tools and skills necessary to secure, manufacture, transport and work durable materials.

The evolution of techniques is conditioned by two forces. One is economic—the search for a maximum of stability and durability in building with a minimum of materials and labour. The other is expressive—the desire to produce meaningful form. Techniques evolve rapidly when economic requirements suggest new expressive forms or when the conception of new forms demands new procedures. But they remain static when architects avoid the risk of pioneering with untried and possibly unsuccessful methods and depend instead on proved procedures, or when the need for the observance of tradition, for the communication of ideas or for elegance and display is best fulfilled by familiar forms.

The ultimate purpose of building techniques is to create a stable structure. In mechanical terms, structures are stable when all their parts are in a state of equilibrium or rest. Walls and roofs can buckle, crack or collapse if they are not properly designed. These movements are caused by forces which tend to push or pull bodies in a given direction. Forces acting on any member (part) of a building are, first, its own weight and, second, the loads it carries, principally from other members but also from persons, furnishings, wind, etc. Their action encounters a reaction in opposing forces that hold the member in place by resisting at its joints. These forces may be active in all directions, and they must always be balanced for stability. They tend to crush, pull apart and bend the member—in other words, to change its size and shape.

Within the member itself there are forces, too, that tend to resist any deformation. They are called stresses, and they vary according to the strength of materials and the form of the member. The kinds of stress under consideration are compression, which resists crushing; tension, which resists pulling apart; and bending, which occurs when one part of a member is in compression and the other is in tension. A column (fig. 1) is put into compression by the loads it carries; in a trussed roof (fig. 13), the piece that forms the base of the triangle is put into tension by the outward-pushing forces in the sides; and a lintel or beam (the member that spans a space) is put into bending by loads and forces that push down on its top and encounter a reacting force at its ends (figs. 1 and 15). Some materials are strong only in compression (stone, brick, cast iron, concrete), and others in tension as well (wood, steel, reinforced concrete), so the latter are more efficient in resisting bending forces.

Finally, the stability of the total structure whose single members are all in equilibrium is achieved by diverting the loads from all of them downward so that they may be resisted by the upward-supporting forces of the ground.

Techniques will be discussed in terms of the characteristics of building materials and the methods by which they are used in architecture.

A. MATERIALS

1. Stone.—In most areas where stone is available, it has been favoured over other materials for the construction of monumental architecture. Its advantages are durability, adaptability to sculptural treatment and the fact that it can be used in modest structures in its natural state. But it is difficult to quarry, transport and cut, and its weakness in tension limits its use for beams, lintels and floor supports.

The simplest and cheapest stonework is rubble, roughly broken stones of any shape bonded in mortar. The strongest and most suitable stonework for monumental architecture is ashlar masonry, which consists of regularly cut blocks (usually rectangular). Because of its weight and the precision with which it can be shaped, stone masonry (in contrast with brick) does not depend on strong bonding for stability where it supports only direct downward loads. Entablatures of Greek temples, for example, are bonded by small bronze dowels. But the weight creates problems of stability when loads push at an angle: stone vaults and arches require more support and buttressing than equivalent forms in other materials.

The best stone (and brick) bonding is that in which blocks are placed so that the vertical joints in one course are not above the joints in the courses above and below, since the stone resists deformation better than any bonding material. Many stones are strong enough to provide monolithic supports (columns and piers) and beams (lintels); and in some styles stone slabs are employed even for roofing (Egyptian temples, early Syrian basilicas). But this roofing requires so many columns that unvaulted masonry buildings are almost always combined with floors and covering in wood. Stone has been consistently used for building since the Stone Age (Stonehenge in England). Although it has generally been replaced as a structural material by cheaper and more efficient manufactured products, it is still widely used as a surface veneer for its practical and expressive qualities. (*See* STONE.)

2. Brick.—Brick compares favourably with stone as a structural material for its fire- and weather-resisting qualities and for the ease of production, transportation and laying. The size of bricks is limited by the need for efficient drying, firing and handling, but shapes, along with the techniques of bricklaying, have varied widely throughout history. Special shapes can be produced by molding to meet particular structural or expressive requirements (for example, wedge-shaped bricks are sometimes employed in arch construction, and bricks with rounded faces in columns). Bricks may be used in construction only in conjunction with mortar, since the unit is too small, too light and too irregular to be stabilized by weight. Each course must be laid on an ample mortar bed with mortar filling the vertical joints. The commonest Roman bricks were cut into triangles and laid with the base out and the apex set into a concrete filling that provided additional strength. Rectangular bricks are bonded either as "headers" (short side out) or "stretchers" (long side out). Standard modern types provide a ratio of width to length of slightly less than 1:2 to permit a wide variety of bonding patterns within a consistent module, or standard of measurement. Brick, which has been used since the fourth millennium B.C., was the chief building material in the ancient near east. The versatility of the medium was expanded in ancient Rome by improvements in the manufacture of both bricks and mortar and by new techniques of laying and bonding. Employed throughout the middle ages, brick gained greater popularity from the 16th century on, particularly in northern Europe and Great Britain. It is widely used today, often for nonbearing walls in steel frame construction. (*See* BRICKWORK.)

3. Wood.—Wood is easier to acquire, transport and work than other natural materials. All parts of a building can be efficiently constructed of wood except foundations; its disadvantages are susceptibility to fire, mold and termites. The strength of wood in both tension and compression arises from its organic nature, which gives it an internal structure of longitudinal and radial fibres that is not impaired by cutting or long exposure. But like all organisms it contains moisture and is not uniformly strong, so it must be carefully selected and seasoned to prevent warping, splitting and failure under loads. Wood is used in building both solid and skeletal structures. The principal solid system, called log construction, is employed when only primitive cutting tools are available. Four walls must be built up together in horizontal layers of single hewn or uncut logs and jointed at the corners. The stability of the log building depends entirely on the mutual support of the walls, and the method is suitable only for simple structures of limited size. The skeletal system requires precise cutting and shaping of lumber. It provides a rigid framework of jointed or nailed members (fig. 14) independent of the walls, which are attached to the exterior and interior surfaces after completion.

Almost all masonry buildings of the past had wood floors and

coverings, since wood is the lightest, the most practical and the most inexpensive material for spanning spaces.

The monumental architecture of the west has typically employed materials rarer than wood for expressive purposes, but the history of wood construction can be traced consistently in China and Japan and in the domestic architecture of northern Europe and North America. Wood continues to be used in a growing number of techniques and products: heavy framing systems with compound beams and girders, interior and exterior facing with plywood and other composite panels, and arch and truss systems with laminated members that can be designed to meet particular structural demands.

4. Iron and Steel.—The development of construction methods in iron and steel was the most important innovation in architecture since ancient times. These methods provide far stronger and taller structures with less expenditure of material than stone, brick or wood and can produce greater unsupported spans over openings and interior or exterior spaces. The evolution of steel frame construction in the 20th century entirely changed the concept of the wall and the support.

In architecture before 1800, metals played an auxiliary role. They were used for bonding masonry (dowels and clamps), for tension members (chains strengthening domes, tie rods across arches) and for roofing, doors, windows and decoration. Cast iron, the first metal that could be substituted for traditional structural materials, was used in bridgebuilding as early as 1779. Its ability to bear loads and to be produced in an endless variety of forms, in addition to its resistance to fire and corrosion, quickly encouraged architectural adaptations, first as columns and arches, and afterward in skeletal structures. Because cast iron has much more compressive than tensile strength (for example, it works better as a small column than as a beam), it was largely replaced in the late 19th century by steel, the product of improved purification processes (Bessemer furnace, open hearth). Steel is more uniformly strong, more elastic and workable, and its high resistance in all stresses can be closely calculated.

Steel structural members are rolled in a variety of shapes, the commonest of which are plates, angles, I beams and U-shaped channels. These members may be joined by steel bolts or rivets, and the development of welding in the 20th century made it possible to produce fused joints with less labour and materials. The result is a rigid, continuous structure in which the joint is as firm as the member and which distributes stresses between beams and columns (fig. 15). This is a fundamental change in architectural technique, the effect of which cannot yet be estimated.

Normally, steel must be protected against corrosion by surface coverings, but alloys such as stainless steel have been developed for exposed surfaces, and these alloys may even be used in exterior curtain walls. Aluminum and other light metal alloys have come to be favoured for curtain-wall construction because of their weather resistance. (*See* also Ironwork.)

5. Concrete.—Concrete is a manufactured mixture of cement and water, with aggregates of sand and stones, which hardens rapidly by chemical combination to a stonelike, water- and fire-resisting solid of great compressive (but low tensile) strength. Because it can be poured into forms while liquid to produce a great variety of structural elements, it provides an economical substitute for traditional materials, and it has the advantages of continuity (absence of joints) and of fusing with other materials.

Concrete was employed in Egypt and was highly developed by the Romans, whose concrete made with volcanic ash cement (pozzolana) permitted a great expansion of architectural methods, particularly the development of domes and vaults (often reinforced by brick ribbing) to cover large areas, of foundations and of structures such as bridges and sewerage systems where waterproofing was essential. The technique of manufacture declined in the middle ages and was regained in the 18th century, but concrete had a limited importance for architecture until the invention of reinforced concrete (*q.v.*) in the 1860s.

Reinforced concrete was developed to add the tensile strength of steel to the compressive strength of mass concrete. The metal is embedded by being set as a mesh into the forms before pouring, and in the hardened material the two act uniformly. The combination is much more versatile than either product; it serves not only for constructing rigid frames but also for foundations, columns, walls, floors and a limitless variety of coverings, and it does not require the addition of other structural materials. Although the making of the forms is a slow and costly process, the technique competes economically with steel frame construction because the mesh, composed of thin, bendable rods or metal fabric, employs far less steel, and concrete is itself inexpensive.

The steel reinforcement is employed to take full advantage of the plastic character of concrete. It can be jointed or bent to unify supporting members with the floors and coverings they carry. Furthermore, stresses produced in floors, domes and vaults may be distributed within the slabs themselves to reduce load, and the diminished load may be concentrated at desired points so that the number and size of supports is greatly reduced.

Three 20th-century developments in production are destined to have a radical effect on architecture. The first, concrete shell construction, permits the erection of vast vaults and domes with a concrete and steel content so reduced that the thickness is comparatively less than that of an eggshell. The second development, precast concrete construction, employs bricks, slabs and supports made under optimal factory conditions to increase waterproofing and solidity, to decrease time and cost in erection and to reduce expansion and contraction. Finally, prestressed concrete provides bearing members into which reinforcement is set under tension to produce a live force to resist a particular anticipated load. Since the member acts like a spring, it can carry a greater load than an unstressed member of the same size. (*See* also Concrete.)

B. Methods

1. Wall.—The two types of wall are (1) load bearing, which supports the weight of floors and roofs; and (2) nonbearing, which at most supports its own weight.

The load-bearing wall of masonry is thickened in proportion to the forces it has to resist: its own load, the load of floors, roofs, persons, etc., and the lateral forces of arches, vaults, wind, etc., that may cause it to crack or buckle. Its thickness often can be reduced at the top, because loads accumulate toward the base; in high buildings this is done by interior or exterior setbacks at the floor level of upper stories. Walls that must resist lateral forces are either thickened along the whole length or at particular points where the force is concentrated. The latter method is called buttressing. Doors and windows weaken the resistance of the wall and divert the forces above them to the parts on either side, which must be thickened in proportion to the width of the opening. In multistory buildings, windows—unless they are very small—must be placed one above the other so as to leave uninterrupted vertical masses of wall between them to transfer loads directly to the ground. The number of openings that can be used depends on the strength of the masonry and the stresses in the wall. Walls in light, wood-framed structures and in reinforced-concrete construction may have a bearing function also. But the nature of the material admits other means of resisting forces than the increase of mass.

The placement of walls is determined by the type of support for floors and roofs. The commonest support is the beam, which must be jointed to walls at both ends; consequently, its maximum permissible length establishes the distance between bearing walls. All floors and coverings are most easily supported on straight, parallel walls except the dome (*see* below).

The nonbearing wall (excluding the independent garden variety) appears only where loads are carried by other members, as in heavy timber and other skeletal structures. Modern steel and reinforced-concrete frames require exterior walls only for shelter, and sometimes dispense with them on the ground floor to permit easier access. Since the wall rests or hangs upon members of the frame, it becomes a curtain or screen and admits treatment in any durable, weather-resisting material. Traditional materials are often used, but light walls of glass, plastic, metal alloys, wood products, etc., can be equally efficient. This freedom of choice extends also to the form of walls and offers greatly expanded opportunities for creative expression.

2. Post and Lintel.—The simplest illustration of load and

support in construction is the post and lintel system, in which two upright members (posts, columns, piers) hold up a third member (lintel, beam, girder, rafter) laid horizontally across their top surfaces (fig. 1). This is the basis for the evolution of all openings. But in its pure form, the post and lintel is seen only in colonnades and in framed structures, since the posts of doors, windows, ceilings and roofs are part of the wall.

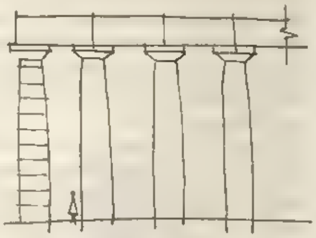


FIG. 1.—POST AND LINTEL

Stone construction; the Parthenon, Athens, 5th century B.C.

The job of the lintel is to bear the loads that rest on it (and its own load) without deforming or breaking. Failure occurs only when the material is too weak or the lintel is too long. Lintels composed of materials that are weak in bending, such as stone, must be short, while lintels in materials that are strong in bending, such as steel, may span far greater openings. Masonry lintels are inefficient because they must depend on the cohesiveness of mortar, which is weaker than the blocks it bonds; so in masonry construction, lintels of monolithic (single slab) stone, wood and stronger materials are employed.

The job of the post is to support the lintel and its loads without crushing or buckling. Failure occurs, as in lintels, from excessive weakness or length, but the difference is that the material must be especially strong in compression. Stone, which has this property, is more versatile as a post than as a lintel; under heavy loads it is superior to wood but not to iron, steel or reinforced concrete. Masonry posts, including those of brick, may be highly efficient, since the loads compress the joints and add to their cohesiveness. Although monolithic stone columns are used, they are extravagant to produce for large structures, and columns are usually built up of a series of cylindrical blocks called drums.

From prehistoric times to the Roman empire, the post and lintel system was the root of architectural design. The interiors of Egyptian temples and the exteriors of Greek temples are delineated by columns covered by stone lintels. The Greeks opened their interior spaces by substituting wooden beams for stone, since the wood required fewer supports. The development of the arch and vault challenged the system but could not diminish its importance either in masonry construction or in wood framing, which by its nature is dependent on posts and beams (fig. 14).

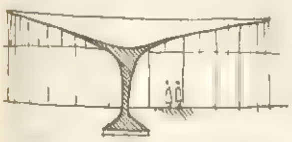


FIG. 2.—POST AND LINTEL

Reinforced concrete construction; restaurant, the Lido, Rome, by P. L. Nervi, 20th century

Ancient uses of the post and lintel were refined but not fundamentally altered until the production of cast-iron columns, which, offering greater strength and smaller circumference, greatly reduced the mass and weight of buildings. Much construction in modern materials is based on the post and lintel system of the past. Steel and concrete skeletons restore to modern architecture the formal simplicity of the oldest structures known. But, because they are rigid frames, they abandon the fundamental concept of the duality of post and lintel by fusing them into a unit throughout which stresses are distributed. The "mushroom" column is a further departure, since the unit can be extended into a covering slab and becomes a ceiling as well as a support (fig. 2).

3. Arch.—The arch can be called a curved lintel. Early masonry builders could span only narrow openings because of the necessary shortness and weight of monolithic stone lintels. With the invention of the arch, two problems were solved: (1) wide openings could be spanned with small, light blocks, in brick as well as stone, which were easy to transport and to handle; (2) the arch was bent upward to resist and to conduct into its supports the loads that tended to bend the lintel downward. Because the arch is curved, the upper edge has a greater circumference than the lower, so that each of its blocks must be cut in wedge shapes that press firmly against the whole surface of neighbouring blocks and conduct loads uniformly (fig. 3). This form creates problems of equilibrium that do not exist in lintels. The stresses in the arch tend to squeeze the blocks outward radially, and loads divert these outward forces downward to exert a resultant diagonal force, called thrust, which will cause the arch to collapse if it is not properly buttressed. So an arch cannot replace a lintel on two free-standing posts unless the posts are massive enough to buttress the thrust and to conduct it into the foundations (as in Roman triumphal arches). Arches may rest on light supports, however, where they occur in a row, because the thrust of one arch counteracts the thrust of its neighbours, and the system will remain stable as long as the arches at either end of the row are buttressed by walls, piers or (as in fig. 4) earth.

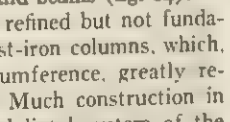


FIG. 3.—THE ARCH

Basic construction, showing direction of thrust

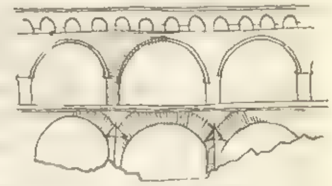


FIG. 4.—THE ARCH

Stone construction; the Pont du Gard, Nîmes, France, early imperial Roman

The size of arches is limited only by economy; large arches exert large thrusts, and they are hard to buttress and to build. The form may be varied to meet specific problems; the most efficient forms in masonry are semicircular, segmental (segment of a circle) and pointed (two intersecting arcs of a circle), but noncircular curves can be used successfully.

Arches were known in Egypt and Greece but were considered unsuitable for monumental architecture. In Roman times the arch was fully exploited in bridges, aqueducts (fig. 4) and large-scale architecture. New forms and uses were found in medieval and particularly Gothic architecture (flying buttress, pointed arch), and baroque architects developed a vocabulary of noncircular forms for expressive reasons.

Steel, concrete and laminated wood arches of the present day have changed the concept and the mechanics of arches. Their components are completely different from wedge-shaped blocks; they may be made entirely rigid so as to require only vertical support; they may be of hinged intersections that work independently, or they may be thin slabs or members (in reinforced concrete) in which stresses are so distributed that they add the advantages of lintels to those of arches, requiring only light supports (fig. 5). These innovations provide a great freedom of design and a means of covering great spans without a massive substructure.

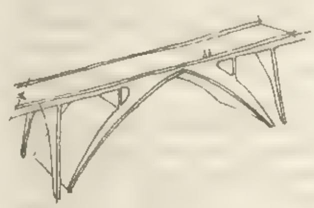


FIG. 5.—THE ARCH

Reinforced-concrete construction: bridge over the Thur river, Switz., by R. Maillart, 20th century

4. Vault.—The evolution of the vault begins with the discovery of the arch, because the basic "barrel" form which appeared first in ancient Egypt and the near east (fig. 6) is nothing more than an arch deep enough to cover a three-dimensional space. Since the barrel vault exerts thrust as the arch does, it must be buttressed along its entire length by heavy walls in which openings must be limited in size and number. This is a disadvantage, since it inhibits light and circulation.

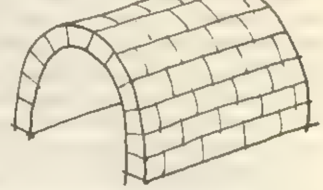


FIG. 6.—THE VAULT

Barrel construction

But Roman builders discovered that openings could be made by building two barrel vaults that intersected at right angles to form the groin vault (fig. 7), which is square in plan and may be repeated in series to span rectangular areas of unlimited length. This vault has the additional advantage that its thrusts are concentrated at the four corners, so that the supporting walls need

not be uniformly massive but may be buttressed where they support the vault.

Two disadvantages of the groin vault encouraged Gothic builders to develop a modification known as the rib vault (fig. 8). First, to build a groin vault, a form must be made to pour or lay the entire vault, and this requires complex scaffolding from the ground up; second, the groin vault must be more or less square and a single vault cannot span extended rectangular areas. The rib vault provided a skeleton of arches or ribs along the sides of the area and crossing it diagonally; on these the masonry of the vault could be laid; a simple centring sufficed for the ribs. To cover the rectangular areas, the medieval mason used pointed arches, which, unlike round arches, can be raised as high over a short span as over a long one. Thus the vault could be composed of the intersection of two vaults of different widths but the same height.

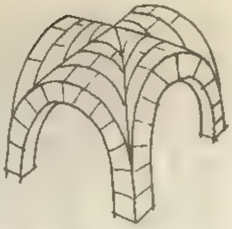


FIG. 7.—THE VAULT
Groin construction

To reduce further the thickness of the wall (to the point of substituting large areas of glass for masonry) Gothic builders developed the flying buttress, which counteracts vault thrust not by continuous wall mass and weight but by counterthrust created by exterior half-arches placed at the height of the vaults at the points of greatest stress. These buttresses conduct stresses to heavier wall buttresses below the window level.

The next important development in vaults, as in arches, came with 19th-century materials. Great iron skeleton vaults were constructed as a framework for light materials such as glass (Crystal palace, London, 1851). The elimination of weight and excessive thrust, the freedom in the use of materials and the absence of centring problems favoured the simple barrel vault and made more complex types obsolete. But in many of the modern frame systems the vault itself loses its structural function and becomes a thin skin laid over a series of arches.

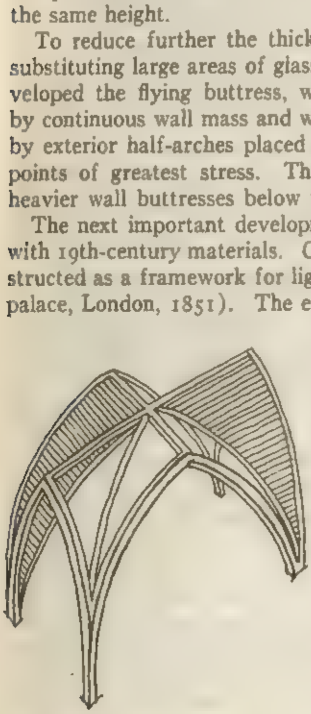


FIG. 8.—THE VAULT
Rib construction

While the arch is supplanting the vault in one area of technique, the vault has abandoned the arch principle in another. The reinforced-concrete shell vault, based on the principle of the bent or molded slab, is one of the most important innovations in the history of architecture. It has all the advantages of load distribution of the concrete floor slab, plus the resistance to bending provided by its curved form. The shell is reinforced in such a way that it exerts no lateral thrust and may be supported as if it were a beam or a truss (fig. 9). So the form no longer is controlled by the necessity to conduct loads into the wall, and the vault may be designed with great freedom. (*See* ARCH AND VAULT.)

FIG. 9.—THE VAULT
Reinforced-concrete construction: a laboratory at the National University of Mexico, Mexico City, by J. González Reyna, 20th century

5. Dome.—Domes appeared first on round huts and tombs in the ancient near east, India and the Mediterranean, but as solid mounds or in techniques adaptable only to the smallest buildings. They became technically significant with the introduction of the large-scale masonry hemisphere by the Romans. Domes, like vaults, evolved from the arch, for in their simplest form they may be thought of as a continuous series of arches, with the same centre. Therefore the dome exerts thrusts all around its perimeter, and the earliest monumental examples (fig. 10) required heavy walls. Since the walls permitted few openings and had to be round or polygonal to give continuous support, early domes were difficult to incorporate into complex structures, especially when adjacent spaces were vaulted.

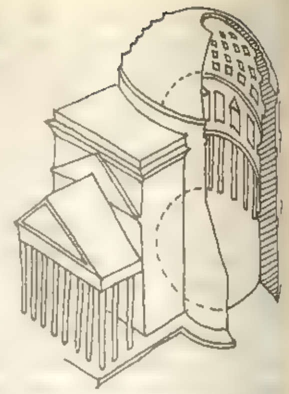


FIG. 10.—THE DOME
Construction on a circular plan; the Pantheon, Rome, 1st–2nd century

Byzantine architects perfected a way of raising domes on piers instead of walls (like groin vaults), which permitted lighting and communication from four directions. The transition from a cubic plan to the hemisphere was achieved by four inverted spherical triangles called pendentives—masses of masonry curved both horizontally and vertically (fig. 11). Their apexes rested on the four piers, to which they conducted the forces of the dome; their sides joined to form arches over openings in the four faces of the cube; and their bases met in a complete circle to form the dome foundation. The pendentive dome could rest directly on this circular foundation or upon a cylindrical wall, called a drum, inserted between the two to increase height.

The dome was unsuited to the lightness and verticality of late medieval styles but was widely used in the Renaissance and baroque periods. Renaissance builders adapted the Gothic rib system to dome construction and found new means to reduce loads and thrust (concentric chains, etc.) that permitted high drums and variations in the curvature of the dome. The awkward, tunnel-like effect produced on the interior by high domes was often hidden by an internal shell built on the same foundations.

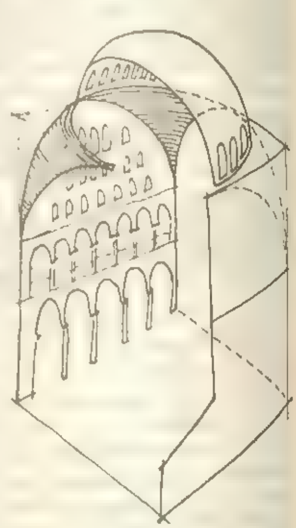


FIG. 11.—THE DOME
Pendentive construction; Hagia Sophia, Constantinople, 6th century

The effort and ingenuity devoted to doming rectangular buildings can be explained principally by the symbolic character of the form, since vaulting is a simpler alternative. So it was chiefly the desire to observe tradition that preserved the dome in the early era of iron and steel construction, and with rare exceptions (Halle aux Blés, Paris; the Coal Exchange, London) 19th-century examples retained masonry forms without exploiting the advantages of metal.

Newer techniques, however, have added practicality to the expressive advantages of domes. The reinforced concrete slab used in vaulting can be curved in length as well as width (like an inflated handkerchief or a parachute). And in this development the distinction between vaults and domes loses significance, being based on nothing but the type of curvature in the slab. Geodesic domes, developed by Buckminster Fuller, are spherical forms in which triangular or polygonal facets composed of light skeletal struts or flat planes replace the arch principle and distribute stresses within the structure itself, as in a truss (fig. 12). Geodesic domes can be supported by light walls and are the only

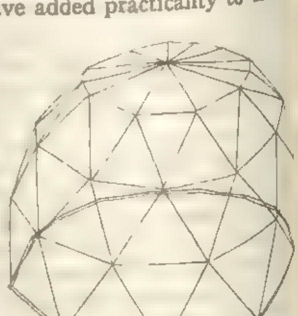


FIG. 12.—THE DOME
Geodesic construction by B. Fuller, 20th century

large domes that can be set directly on the ground as complete structures. (*See* also DOME.)

6. **Truss.**—By far the commonest covering throughout history is the trussed roof, constructed upon a frame composed of triangular sections spaced crosswise at intervals and made rigid in length by beams. Trusses formerly were principally of wood (fig. 13) and were used to cover masonry as well as framed structures, even when these were vaulted. The variety of trusses is so great that only the general principle of the form can be given here.

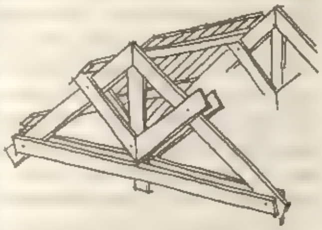


FIG. 13.—THE TRUSS
Traditional wood construction

The truss is based on the geometric law that a triangle is the only figure that cannot be changed in shape without a change in the length of its sides. So a triangular frame of strong pieces firmly fastened at the angles cannot be deformed by its own load or by external forces such as wind pressure. These forces, which in a vault thrust outward against the walls, are contained within the truss itself because the piece (chord) at the base of the triangle resists by tension the tendency of the two sides to behave like a vault. With its forces in equilibrium, the truss exerts only a direct downward pressure on the walls, so that they need not be thickened or buttressed. This explains why most roofs are triangular in cross section.

In trusses that are too large to be constructed of three members of moderate size, the simple triangle must be replaced by a complex system of smaller triangles within the frame.

Not all peaked roofs are trusses, for in primitive building, in ancient Greece and in much oriental wood architecture the chord is omitted and the sides exert thrust. Nor are all trusses triangular, since the principle may be modified (as in modern steel and heavy timber construction) to apply to arches and vaults if strong enough chords can be found.

7. **Framed Structures.**—A framed structure in any material is one that is made stable by a skeleton that is able to stand by itself as a rigid structure without depending on floors or walls to resist deformation. Materials such as wood, steel and reinforced concrete, which are strong in both tension and compression, make the best members for framing. Masonry skeletons, which cannot be made rigid without walls, are not frames. The heavy timber frame, in which large posts, spaced relatively far apart, support thick floor and roof beams, was the commonest type of construction in the far east and northern Europe from prehistoric times to the mid-19th century. It was supplanted by the American light wood frame, composed of many small and closely spaced members that could be handled easily and assembled quickly by nailing instead of by the slow joinery and dowelling of the past (fig. 14). Construction is similar in the two systems, since they are both based on the post and lintel principle. Posts must rest on a level, waterproof foundation, usually of masonry or concrete, on which the sill (base member) is attached. Each upper story is laid on crossbeams supported on the exterior wall by horizontal members. Interior walls give additional beam support.

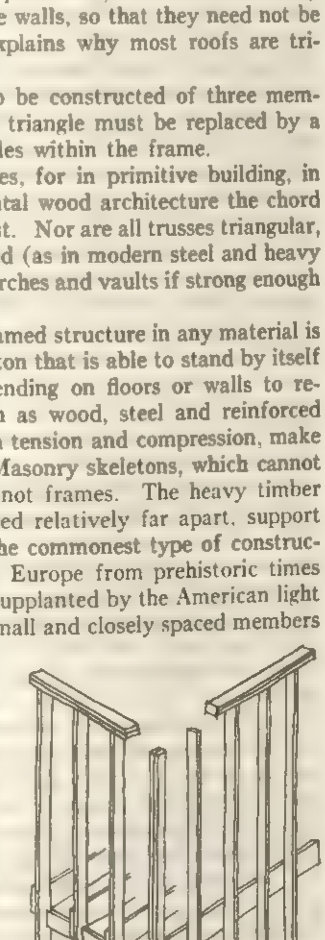


FIG. 14.—FRAMED STRUCTURES
Light wood construction

In the heavy timber system, the beams are strong enough to allow the upper story and roof to project beyond the plane of the ground-floor posts, increasing the space and weather protection. The members are usually exposed on the exterior. In the orient the spaces between are enclosed by light screen walls, and in northern Europe partly by thinner bracing members and partly by boards, panels or (in half-timbered construction) bricks or earth.

The light frame, however, is sheathed with vertical or horizontal boarding or shingling, which is jointed or overlapped for weather protection. Sheathing helps to brace as well as to protect the frame, so the frame is not structurally independent as in steel frame construction. The light frame system has not been significantly improved since its introduction, and it lags behind other modern techniques. Prefabricated panels designed to reduce the growing cost of construction have not been widely adopted. Modern heavy timber and laminated wood techniques, however, provide means of building up compound members for trusses and arches which challenge steel construction for certain large-scale projects in areas where wood is plentiful.

Steel framing is based on the same principles but is much simplified by the far greater strength of the material, which provides more rigidity with fewer members (fig. 15). The load-bearing capacity of steel is adequate for buildings many times higher than those made of other materials. Because the column and beam are fused by riveting or welding, stresses are distributed between them, and both can be longer and lighter than in structures where they work independently as post and lintel. Thus, large cubic spaces can be spanned by four columns and four beams, and buildings of almost any size can be produced by joining cubes in height and width. Since structural steel must be protected from corrosion, the skeleton is either covered by curtain walls or surfaced in concrete or, more rarely, paint. The steel frame is used also in single-story buildings where large spans are required. The simple cube then can be abandoned for covering systems employing arches, trusses and other elements in a limitless variety of forms to suit the functions of the building.

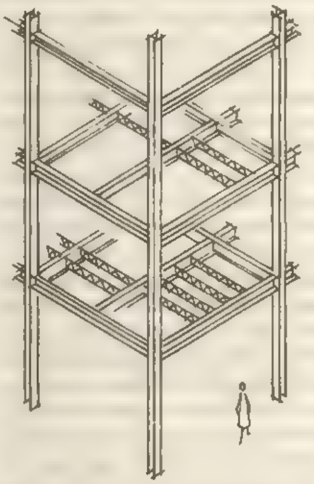


FIG. 15.—FRAMED STRUCTURES
Steel construction

Differences between reinforced-concrete and steel framing are discussed in the section on materials. The greater rigidity and continuity of concrete frames give them more versatility, but steel is favoured for very tall structures for reasons of economy in construction and space. An example is the system called box frame construction, in which each unit is composed of two walls bearing a slab (the other two walls enclosing the unit are nonbearing curtain walls); this type of construction extends the post and lintel principle into three dimensions. Here again, concrete crosses the barriers that separated traditional methods of construction.

III. EXPRESSION

Expression in architecture is the communication of quality and meaning. The social functions and the techniques of building are interpreted and transformed by expression into art, as sounds are made into music and words into literature.

The nature of expression varies with the character of culture in different places and in different times, forming distinct modes or languages of expression which are called styles. Style communicates the outlook of a culture and the concepts of its architects. The boundaries of a style may be national and geographical (Greek, Roman, Mayan) or religious and intellectual, embracing distinct linguistic, racial and national units (Gothic, Buddhist, Renaissance, modern), and different expressions within each of these boundaries are produced by the particular style of regions, towns, groups, architects or craftsmen. The life span of styles may be long (Egyptian, over 3,000 years) or short (baroque, less than 200 years) according to the changeability of cultural patterns. The

principal forces in the creation of a style are tradition, the experience of earlier architecture; influence, the contribution of contemporary expressions outside the immediate cultural environment; and innovation, the creative contribution of the culture and the architect. These forces operate to produce an evolution within every style and ultimately to generate new styles which tend to supplant their predecessors.

The components of expression, which communicate the particular values of style, are content and form. Since content can be communicated only through form, the two are organically united, but here they will be discussed separately in order to distinguish the specific and concrete meaning (content) from the abstract expression of qualities (form).

A. Content

Content is the subject matter of architecture, the element in architectural expression that communicates specific meanings which interpret to society the uses and techniques of buildings.

1. Symbols of Use.—Society requires that architecture not only communicate the aspirations of its institutions but also fulfill their practical needs. Differences in expression, apart from differences in planning, distinguish the forms of architectural types (the house from the church, etc.), the kinds of use (the Catholic from the Protestant church) and the traditions and customs of users (the English from the Swiss Protestant church). When architectural forms become the vehicles of content—in plan, elevation and decoration—they are symbolic. We understand their symbolism, consciously or unconsciously, by association (*e.g.*, spire = church), having seen something like it before, and by the fact that it suggests certain universal experiences (vertical forms "rise"; low roofs "envelop"; we speak of "perfect" circles and squares). We comprehend the meaning of symbols that are new to us, as well as those we know, by association, because the laws of statics restrain builders from putting them into forms so completely unfamiliar that they do not suggest some tradition, just as the structure of language permits endless new meanings but retains a fairly constant vocabulary. The meaning of architectural symbols—or of words—may even change, but the process must be both logical and gradual, for if the change is irrational, the purpose—communication—is lost.

The architectural plan, when used symbolically, communicates through its shape. From prehistoric times and in many cultures, the circle, with its suggestion of the planets and other manifestations of nature, gained a symbolic, mystical significance and was used in the plans of houses, tombs and religious structures. By slow processes it came to be employed for memoria and shrines and for hero cults (such as the pagan Pantheon and Christian martyrs) in both the east and the west. When building techniques permitted, its symbolism often merged with that of the dome. In Hindu temples, the square (and the cross plans developed from it) expressed celestial harmony. The central plan church (circle, polygon, Greek cross, ellipse) fascinated the architects of the Renaissance by its symbolic and traditional values, and it is found in their drawings and treatises to the virtual exclusion of the more practical longitudinal basilicas that they were often commissioned to build.

Plan symbolism remained almost exclusively in the sphere of religion after antiquity, and its traditions gradually disappeared in the course of the 19th century. The modern plan is determined by problems of form (space-mass relationships, etc.) and by the practical demands of use rather than by symbolic communication.

In elevation the most consistent symbolic forms have been the dome, the tower, the stairway, the portal and the colonnade. Domes imply the meanings of the circle and more, since a dome is a covering. Long before masonry domes could be built, the hemisphere was associated with the heavens as a "cosmic canopy," and throughout history domes have been decorated with stars and astrological symbols.

In Rome, Indian Buddhism and Christianity the dome came to mean universal power. In the Renaissance it spread from religious structures to palaces and government buildings, retaining some of its implications of power. In the United States there are few state capitols without domes; the symbol has survived the loss of its original meanings.

The tower, with origins in primitive nature rites, has consistently symbolized power. The Chinese pagoda extends central plan symbolism into towers; many towers and spires rose from the northern Gothic cathedral; and the medieval Italian city was a forest of towers erected by nobles in constant competition to express their supremacy. This meaning survives in our skyscrapers; we boast of their height more than of their efficiency or beauty.

Architectural elements conceived to facilitate the use of buildings may also take on symbolic significance. The stairway, employed in the past to give "monumentality" to important buildings, frequently became more expressive than convenient. Portals, from the time of Egyptian temple pylons and Babylonian city gates, became monuments in themselves, used to communicate a heightened significance to what lay behind them. In the Gothic cathedral they became the richest element of the façade—a translation of biblical doctrine into stone. Since the classic development of the Greek temple, the colonnade on the exterior of buildings has borne similar implications.

Such symbols have become archaic in modern culture and appear as a sign of resistance to new forms. This resistance is especially evident in the popular symbolism of domestic architecture, where the atmosphere of the home is often expressed by cottagelike roofs, shutters, trellises, mullioned windows, grilles and other associations to a more peaceful past.

Decoration, the most easily recognized medium of content, communicates meaning either through architectural elements or through the figural arts (sculpture, painting, mosaic, stained glass, etc.). The architectural elements used decoratively, such as the classical orders, usually originate in technique and in time lose their structural significance to become symbols. In Rome, and from the Renaissance to the 20th century, the formal Grecian orders were applied to buildings of many different techniques as expressions of the continuing influence of Greek institutions. Similarly the new vocabulary of Gothic architecture, developed with new building techniques (the pointed arch, the flying buttress, etc.), became in later periods a source for religious and romantic symbolism. The *art nouveau* of the turn of the 20th century, a system of ornament based on floral and other organic forms, survived for only two decades, perhaps because its symbols were neither drawn from a tradition nor derived from a structural system.

The function of the figural arts in conveying content is a subject outside the scope of this article, but its importance for architecture must be mentioned. The figural arts not only offer the means of expressing more specific ideas than any architectural symbols, but in many styles they define the character of mass and space. The sculptures of the Hindu temple, the mosaics of the Byzantine church and the stuccoes of Moorish palaces are not ornamental applications; they determine the form of the building itself.

The virtual absence of traditional symbols in modern architecture is evidence of the failure of these symbols to express the cultural patterns of the 20th century. In these times architecture, like painting, sculpture and other arts, has tended to be abstract, to emphasize qualities of form rather than the communication of familiar ideas through symbols.

2. Expression of Technique.—The second aspect of content is the communication of the structural significance of materials and methods. Its purpose is to interpret the way in which architecture is put together. The characteristics of materials that are important in expressing design techniques are the properties of their composition (structure, weight, durability) and the way they are used in structure. Their properties may be expressed and interpreted by the treatment of the surface, and their use may be expressed by emphasis on the dimensions and joining of the building units into which they are formed.

The hardness, weight and crystalline composition of stone masonry has traditionally been emphasized by devices not necessarily connected with structural methods: rustication (finishing in rough uneven surfaces), drafting (more refined, linear cutting) and polishing. Niches and other indentations, projecting courses of

frames around openings suggest massiveness. In nonbearing walls, a smooth, unbroken surface implies thinness. The use of stone or brick masonry in construction is emphasized by clarifying the limits of each block, and by the amount of mortar used, and by distinguishing lintels, arches and other specific members from the construction of the wall. The properties of wood are suggested by revealing and emphasizing its texture in load-bearing members and by treating the sheathing of light wood frames in patterns (of shingling or boarding) that communicate thinness. The plasticity of concrete is shown by freedom in modeling and its use in construction by emphasizing the impressions of the wooden forms in which it is cast. The sections of light metal curtain walls are frequently stamped into geometric patterns to illustrate their nonbearing character. Materials that must be covered for protection, such as unfired brick and the steel used in framing, are not adaptable to this type of communication.

At times building methods are demonstrated simply by exposing the structure, as in the heavy timber frame, but in many styles the functions of structural systems have been interpreted by designing their members in forms that are often more explanatory than efficient. The Greek column, which is narrower at its summit than at its base, is diminished by a curve beginning slightly below the midpoint, giving it an effect of an almost muscular power to resist loads. The expression is more explicit in the caryatid, a human figure that replaces the column, and in the burdened animals and dwarfs that support the columns of Romanesque portals. Many elements in the Gothic cathedral serve as diagrams of structure: the supporting piers are clusters of shafts, each of which extends upward without interruption to become the rib of the vault, and the ribs themselves are an elucidation of technique; the flying buttress and the window tracery are elegant interpretations of their functions. In the steel frame building, the hidden forms of the skeleton are often repeated on the façade to enable us to "see through" to the technique, but the system also permits the alternative of expressing the lightness and independence of the curtain wall by sheer surfaces of glass and other materials. The work of the concrete slab is made explicit by projecting indications of the placement of reinforcement or of the distribution of stresses.

The expression of technique is characteristic not of all architectural styles but only of those such as the Gothic and modern in which new techniques excite a search for the interpretive design of their materials and methods. More often than not, both materials and methods have been disguised by decorative forms or surfacing such as veneers, stucco or paint, because of emphasis on the expression of content or of form. Most early stone architecture in Egypt, Greece and India retained as decoration the forms developed in wooden forerunners. The precious marble of Greek temples was disguised under painted stucco; Roman brickwork was hidden by slabs of coloured marble; and 19th-century cast-iron columns were molded into classic or Gothic forms. The history of domes is filled with examples of the successful disguising of method, of giving the ponderous mass the effect of rising from the exterior and of floating from within.

Technical content has been one of the foundation stones of 20th-century architectural theory, particularly in its early phases, and has represented a reaction against 19th-century symbolic content. It is essential for the understanding of modern architecture that the expression of technique be seen as an art—a creative interpretation that heightens awareness of the nature of architecture.

B. Form

In the sphere of use and technique, the architect is responsible to the patterns of his culture on one hand and to the patterns of technology on the other; but in the expression of form, he is free to communicate his own personality and concepts. Not every architect has the gift to exercise this prerogative to the fullest. As in other arts and sciences, a few individuals generate new styles, and others follow, interpreting these styles in original and personal ways. But the majority accepts styles as given and perpetuates them without leaving its mark. The architect's principal responsibility in the formation of style is to create meaningful form. When we speak of form in the arts we mean not only the physical shape, size and mass of a work but also all the elements that contribute to the work's aesthetic structure and composition. Many of these may be without a fixed form of their own—a rest in music, a line in painting, a space in architecture—and gain significance only as they are organized into the finished product. The basic formal elements of architecture in this sense are space and mass. The process of organizing these elements into an ordered form we call composition, and the principal means by which they are given expressive quality are scale, light, texture and colour.

1. Space and Mass.—Space, that immaterial essence which the painter suggests and the sculptor fills, the architect envelops, creating a wholly human and finite environment within the infinite environment of nature. The concept that space can have a quality other than emptiness is difficult to grasp. When we enter a building we see a floor, supports, walls, a ceiling, all of which can be studied and perhaps enjoyed, while the space, in the sense that we are accustomed to think of it, is void: the absence of mass, filled by air.

But spatial experiences that express something are common to everyone, though they are not always consciously grasped. We feel insecure in a low cave or a narrow defile, exhilarated and powerful on a hilltop; these are psychological and motor reactions that result from measuring our potential for movement against the spaces that surround us, and the same reactions take root even in our language (we speak of "confining" circumstances, "elevating" experiences). An infinite variety of such reactions may be summoned by the architect, because he controls the limits above, below and on all sides of us. As we enter his space we measure it in terms of the degree and the quality of our potential for movement. The concept of potentiality is important, first, because we can anticipate where we may move by merely looking about us, and, second, because we can conceive movements that we cannot execute. So, in the nave of a Gothic cathedral, the high walls closely confining us on two sides restrict our possible movements, suggesting advance along the free space of the nave toward the altar; or their compression forces us to look upward to the vaults and the light far overhead, and there we feel a physical sense of release, though we are earthbound. We call the experience of Gothic space "uplifting" because it urges us to rise.

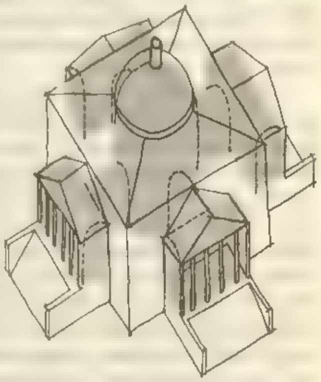


FIG. 16.—SPACE AND MASS

Diagram showing the interior (space) and exterior (mass) of the Villa Rotonda, Vicenza, Italy, by A. Palladio, 16th century

Renaissance space, on the other hand, attempts to balance its suggestion of movement, to draw us to a focal point at which we can sense an equilibrium of movement in all directions, a resolution of the conflict of compression and release (fig. 16). At this point we feel physically at rest, at the opposite extreme from the elevating sensation of the cathedral.

Of course, we do not use our eyes alone to feel spatial quality, because only the simplest spaces—a cubic room, for example—can be wholly experienced from one standpoint. In a complex of spaces, like that of the cathedral, we walk about, gaining new sensations, seeing new potentials for movement at every step. Most modern architecture, in its free organization of space sequences, demands mobility; its techniques have made it possible to remove the heavy walls and supports of the past, reducing the sense of compression. Walls become membranes to be arranged at will for spatial experience, and some are transparent and so extend our potential for movement into the limitless out-of-doors.

Spatial experience is not restricted to the interiors of buildings. The sensations we have in nature's open spaces may be re-created by art. City squares and streets, even gardens, achieve a variety of expression comparable with that of interiors. The

baroque piazza of St. Peter's in Rome, which directs us along its great embracing arcs toward the entrance, is at least as moving as the church interior. Wherever buildings limit or direct our vista we are in an architectural environment, an outdoor room.

The exterior of a single building, particularly one that is isolated from other architecture, does not create a space. It occupies the space of nature. Thus, it may be experienced as sculpture, in terms of the play of masses in a void. The aesthetics of masses, like that of spaces, is rooted in our psychology. When we call a tall tree or a mountain "majestic," a rocky cliff "menacing," we are projecting onto them attributes that are ours, not theirs. We inevitably humanize inert matter and so give the architect the opportunity to arouse predictable patterns of experience which are universal.

The appreciation of mass, like that of space, depends on movement, but this movement must be physical. It cannot be experienced in anticipation because no matter where we stand to observe even the simplest building, part of it is out of sight. The mass of a complex building is differently composed from every point of view. The critic Sigfried Giedion, emphasizing the need for movement in experiencing modern architecture, suggested that architecture may be four-dimensional, since time (for movement) is as meaningful as the spatial dimensions.

Some architecture depends much more on mass expression than on space expression. The Egyptian pyramid and the Indian stupa have no meaningful interior spaces; they are architectural in function and technique, sculptural in expression. The interior of a Greek temple is of little interest compared with the wonderful play of forms on its colonnaded exterior, while early Christian and Byzantine architecture reverse the emphasis, making the simple exterior a shell for a splendid and mystical space. Gothic architecture balances the two, partly in order to express a dual content: earthly power over the world outside, spiritual power inside. Modern techniques permit a reduction of the contrast between space and mass expressions by reducing the mass of walls and the size and number of supports and by allowing the interpenetration of interior and exterior space.

2. Composition.—Space and mass are the raw materials of architectural form; from them the architect creates an ordered expression through the process of composition. Composition is the organization of the whole out of its parts—the conception of single elements, the interrelating of these elements and the relating of them to the total form.

The simplest architectural element is a plane, the flat, two-dimensional surface that limits masses and spaces. The simplest plane is a rectangular one without openings or decoration—the wall of a room, for example. This wall is given quality solely by the proportion of its width to its height. Now a door is put into the wall; the door itself has a certain proportion, and a third element is injected, the relation of two proportions. A window is added, and the composition becomes more complex; then a row of windows, and sequence becomes a factor in addition to proportion and relation. Sequence again involves the concept of motion; we say of the row of windows that it "runs along" the façade or that it is "rhythmically" designed.

Finally, our wall may gain rich subleties of composition within its proportions and rhythms. It can be modeled—into a complex of planes, irregular or curved surfaces—to provide the dimension of depth to its proportions; or symbols of use or of technique can become part of its expressive form.

No architectural planes stand alone, of course; they always intersect other planes. Our room wall meets two other walls, the floor and the ceiling, and a façade wall meets the ground, the roof and two other walls. So the total composition of this wall must be harmonized with the composition of other planes in a three-dimensional whole.

The means of achieving this harmony differ in every style. Greek architects developed a system of proportions based on the lower diameter of the temple column, from which spatial intervals and the measurement of masses were derived by multiplication and division. Medieval architects first used arithmetical modules based on the measurements of areas in the cathedral plan, and in the Gothic period changed to a geometric system that employed chiefly the equilateral triangle and the square, figures which had a symbolic and mystical value. In Renaissance theory, proportions and harmonies were developed from systems of musical composition, since architects believed that relationships in all the arts depended on an all-pervading celestial harmony. Several modular and proportional systems have been evolved by modern architects (*e.g.*, Le Corbusier's "Modulor"), but none has been widely adopted.

Behind these changing theoretical methods, however, there seems to be a constant human reaction to spatial relationships that distinguishes harmony from cacophony, that makes us bored with a perfectly cubic room, or prefer certain rectangular forms to others. This psychological response to form probably is connected to our mechanisms of balance, our movements and stature—in short, to our own composition—but the scientific analysis of the process is still at an early stage of development.

Some buildings have only a single, simple interior space (the Pantheon in Rome) or exterior mass (the pyramids of Egypt) and are not less expressive on this account. But composition carries on into a richer dimension as soon as two or more spaces or masses are organized into the whole. Such a complex composition must give a co-ordinated form to connecting spaces and masses, each of them in itself a unique harmony. We must be made to feel, in moving through the spaces and around the masses, not only that each is related to the one that precedes and follows it but that every one is contributing to a concept of the whole: a form that is greater than the sum of its parts. In the Gothic cathedral the nave, the aisles alongside it, the transept that crosses it toward one end, the choir and apse beyond, may each be experienced separately for its own quality. But the experience gains its full meaning only when the form of the total expression is realized: the low aisles giving grandeur to the high nave, the three together leading to the confluence of the two transept arms at the crossing in a vast climax that prepares for the resolution or finale at the altar. In the same way, the significance of a total mass composition unfolds as we move about its separate parts. At St. Peter's in Rome, the three projecting apses are gathered into a unity by the undulating walls; they prepare for the cylindrical drum, the drum for the dome, the form of which leads to the culminating lantern, which is harmonized with the drum. Toward the façade, two little domes frame and prophesy the great one, as the cathedral aisles do the nave. While these particular examples from the past illustrate symmetrical compositions with a climax, others of equal quality might be chosen to show irregular unity that is no less expressive (the Erechtheum in Athens; Mont St. Michel abbey in France).

In modern architecture, as in modern painting, Renaissance laws of composition, which emphasized the symmetry and balance of semi-independent units, have been supplanted by principles that imply the continuity of the whole and remove distinctions between parts. The biological term "organic" is sometimes used to describe a process of composition that seeks to develop interdependent spaces and masses that function expressively as members of an organism.

If composition were merely a matter of organizing a certain number of relationships, the process would be mechanical, not creative, and all architecture would be equally good, or, more likely, bad. The purpose of composition is to express particular concepts and experiences, and it is successful only when these are fully communicated to the observer.

3. Scale.—When the proportions of architectural composition are applied to a particular building the two-termed relationship of the parts to the whole must be harmonized with a third term—the observer. He sees not only the proportions of a door and the relationship to those of a wall (as he would in a drawing of the building), but he measures them against his own dimensions. This three-termed relationship is called scale.

A well-scaled building such as a Greek temple will serve for illustration. If it were to be magnified to the size of St. Peter's in Rome, with its proportions remaining unchanged in their own relationships, the temple would be out of scale with us, and the

result would appear monstrous. If the columns were to be doubled in width while the temple remained the same size, they would be out of scale with us and out of proportion with the whole. We can understand what makes the proportions of the temple satisfactory as they are, because they are based on certain aesthetic principles established by the Greeks, principles that are partly rooted in our psychological make-up and partly accepted by custom, like musical consonances. But it is more difficult to understand why their scale is successful within a certain range of size, for neither the Greeks nor anyone else established laws to relate scale to size. They found their solution by experiment and subjective judgment.

It may be that the success of scale depends upon our ability to comprehend proportions in relation to some unit or module that is roughly man-sized and close enough to us in a building to permit us to measure it against ourselves. The Greeks, in employing the base of the column as a module for all the proportions of a temple, give us a unit of a size that we can grasp easily, and one that is close to eye level as we approach the temple. This module is a key to relationships among elements too far away to measure. This can be done in much larger buildings, too, where the elements close to us are too massive to be measured easily. Roman and Renaissance architecture retained the Greek orders as decoration partly for this reason, using them to break up huge masses into more comprehensible parts. In entirely different styles of architecture, such as the Gothic, where the expressive function requires immeasurable proportions, we are still given a measurable module in the base of the pier. But piers and columns are not always a source of the module. In masonry construction, the single block can serve the same purpose. In frame construction, the bay (distance between floors or columns) or doors and windows may make a better key. The most successful modern skyscrapers retain a comprehensible scale, in spite of their size, by the repetition of some such module, and this is one reason why the skeleton is so often expressed on the exterior even when it is hidden behind walls.

4. Light.—We think of light as that which makes it possible for us to see: a necessity and, in architecture, a utility. But light is also a powerful, though ephemeral, vehicle of expression. Because it moves, changes character, comes and goes with its source, light has the power to give to the inert mass of architecture the living quality of nature. The architect, though he does not quite control it, can predict its behaviour well enough to catch its movements meaningfully. He channels it through openings into his spaces and molds it on the surfaces of his masses by changes of plane, making it enliven his forms by contrast with shadow.

The sunlight that falls on the exteriors of buildings cannot be directed or changed in quality, but it can be reflected or absorbed in a wide range of modulation by the relief and texture of surfaces. So the planes and decoration of a façade are not just the lines the architect makes on his working drawings but receptacles of light and shadow that change in character, even in form, as the earth moves about the sun.

Because of this link between nature and art, an important part in the formation of local architectural styles is played by the variation in the quality and intensity of light in different climatic regions.

The architect controls interior light better than exterior light since he can select the position, size and shape of its source. With glass and other transparent materials he transforms even its colour and intensity and so gives light a new meaning independent of that which it imparts to the structure. We realize this most powerfully in the Gothic cathedral, where the stained glass windows transform the rays of the sun into a mystical diffusion that descends on us from above like a supernatural vision.

Furthermore, light may be illusory, dissolving rather than clarifying form. When it comes to us out of darkness in great intensity it seems to spread outward from its architectural channel. This illusion may be employed to express meanings, as at Hagia Sophia in Istanbul, where the light from the base of the dome hides the supports, giving the impression that the whole massive canopy floats on air.

5. Texture.—Texture plays a dual role in architecture: it expresses something of the quality of materials and it gives a particular quality to light. Although we absorb both qualities simultaneously by eye, the first has tactile, the second visual associations.

Specific tactile textures are peculiar to every material by virtue of its manufacture or natural composition, but they may be altered to produce a variety of expressive qualities. Any stone may be used in its natural, irregular state, it may be chiseled in a rough or smooth texture or highly polished, to convey a range of meanings from vigour to refinement.

Visual textures are produced by the patterns given to the lighting of the surface both through the way the materials are worked (vertical or horizontal chiseling of stone, a carved frieze) and through the way they are employed in building (vertical or horizontal boarding, projection and recession of courses of brick). Like all patterns, visual textures create associations of movement, giving rhythm to the surface.

A single texture is rarely employed in building. The variety of materials and treatments typically produces a complex of textures that must be composed and harmonized like the forms and spaces of architecture into a consistent expressive whole.

6. Colour.—Since colour is a characteristic of all building materials it is a constant feature of architecture. But building materials are selected primarily for their structural value, and their colours are not always suited to expressive requirements. So other materials chosen for their colour are frequently added to the surface. These include pigments, which usually preserve the texture of the original surface, and veneers of stone, wood and a variety of manufactured products that entirely alter the surface character.

But colour, regardless of how it is produced, is the most impermanent element in architecture. It changes with the weathering and staining of materials (the white Gothic cathedrals are now deep gray) or, if it is superficial, it can easily be altered or removed (as the coloured stucco veneers of Greek temples or the bright marble facing on Roman brickwork).

The values that we associate with colour (we call yellow and red "gay," black and deep blue "sombre") are independent of materials and forms, and they give the architect a range of expression not provided by other means at his disposal. A different expressive device is provided by the great range of light reflection in the colour scale. Colours that reflect light brilliantly appear to advance and those that absorb light to recede. So the degree of projection and recession of architectural forms may be altered, emphasized or subdued by the colours of their surfaces.

Architecture, unlike most of the other arts, is not often conceived independently of particular surroundings. The problems of design extend beyond the organizing of space and mass complexes to include the relating of the total form to its natural and architectural environment.

In site planning, a primary function of architectural design, the architect aims to create harmonies with pre-existing elements in the landscape and "townscape."

But the province of the architect is not limited to the conception of single structures in harmony with a given setting. Throughout history architects have been employed in giving a new form to the environment itself: planning the natural surroundings by the design of parks, roadways, waterways, etc.; designing complexes of related buildings; and organizing the urban environment into areas of residence, recreation, assembly, commerce, etc., both to increase their utility and to give them unique expressive qualities through the interrelationship of groups of buildings to the open areas about them.

For a résumé of articles dealing with specific subjects in this field, *see* ARCHITECTURE (ARTICLES ON).

See also Index references under "Architecture" in the Index volume.

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ARCHIVES. The term archives designates the organized body of records produced or received by a public, semipublic, institutional, business or private entity in the transaction of its affairs and preserved by it, its successors or authorized repository through extension of its original meaning as the repository for such materials. The terms records and record office are used in the United Kingdom and in some parts of the British commonwealth.

Although the institution of archives and something of archival administration may be traced from antiquity, as they are understood today they date from the French Revolution. With the establishment of the Archives Nationales in 1789 and of the Archives Départementales in 1796, there was for the first time a unified administration of archives which embraced all extant repositories and record-producing public agencies. The second result was the implicit acknowledgment that the state was responsible for the care of its documentary heritage. The third result was the principle of accessibility of archives to the public. It was not until 1840, however, that the basic canon of modern practice, *respect pour les fonds*, was developed in France and Belgium and subsequently refined by the Dutch and Prussians to include stability within the *fonds*.

HISTORY

Antiquity.—It is generally agreed that archives have been in existence among oriental peoples and among the Greeks and Romans since the written word came into common use. Archives are known among the Hittites, Assyrians, Medes, Persians, Babylonians and Egyptians. It is important to remember, however, that the survival of records clearly archival in nature does not by itself establish the existence of archives as an institution.

There is no evidence of archives among the early Greeks. The first regular archives, at least for the originals of laws, is usually considered to have been founded by the Athenian general and statesman Ephialtes about 460 B.C., but it was not for another 100 years that Athenian public records were centralized in a single place, the temple of the Mother of the Gods (the Metroon). This choice of a religious edifice, as a place providing both physical security and sanctity, recurs in the middle ages, when the records of secular authorities were often safeguarded in monasteries. In the Metroon were deposited laws, decrees, reports of meetings of the senate and of the people, decisions of the criminal courts, financial records and copies of decisions taken by the highest magistrates of the state. Exceptional private documents occasionally found a place there also. It is highly probable, although the evidence is not conclusive, that other cities had their archives too. The oracle at Delphi possessed an archive of earlier pronouncements.

In the strict sense it was only the original or the draft of a document that went into the archive. The public, or published, version inscribed on some durable substance was a copy, and it is therefore erroneous to assume that the temples or other public places in which these were displayed were archives. Government agencies held their own records but eventually transferred them to the archives. These originals they could borrow again for official use; private citizens could get copies. The formal responsibility for the safekeeping of the archives was given to various officials at various times, but the actual work was performed by a staff of archivists and clerks.

Much more is known of Roman archival practices than of Greek. In the earliest times records were kept in the house of the king, subsequently in the houses of the consuls, but by the 5th century B.C. they had been transferred for reasons of security to a public building. The main archive, established by the statesman Valerius Publicola (fl. 509 B.C.), was in the aerarium, or treasury, of the temple of Saturn. There were housed national laws and decrees, the acts of the senate, the censors' lists, reports of officials from senatorial provinces and financial records. International documents were housed in the Capitol.

Even during the republic there were a number of other archives in Rome, under various officials, and in the empire there was created the *tabularium Caesaris*, or archive of the emperor, wherein were housed not only the personal papers of the imperial household but also official records. In this latter period archives existed throughout the empire. There were municipal archives in which were deposited annually the acts of the municipal councils, the financial records, records of births, adoptions, property and similar matters of concern to individuals. Provincial archives contained in addition to the usual administrative records, records of land, censuses, contracts and births. There were military archives in each camp, and each priestly college had its records.

Toward the end of the republic archives were but poorly safeguarded and the early emperors gave much attention to restoring faith to public records. The code of Justinian I (A.D. 529) has a section on archives and archivists. The archives, administered by career officials and their clerks, were usually arranged by series in a chronological order and numbered. Certified copies could be obtained and records were used by researchers.

Middle Ages and Early Modern Period.—In the west the archives of the bishops and popes of the Christian church formed a bridge from antiquity to the middle ages in archival practice. In Byzantium, because of the static situation, there was some secular continuation of Roman archival organization, whereas in the west the mobile court of the rulers made this impossible. The *archiva viatoria*, or mobile archives, found from the 12th century, necessarily were limited to the minimum essentials and undoubtedly contributed to the destruction rather than the preservation of masses of documents. At least from the 10th or 11th century onward the powerful secular figures put their papers in ecclesiastical archives and what has survived is largely the result of this practice.

There were papal archives before there was a papal archival repository. There is some doubt about the references to an archive established in the late 4th century, but none about that of the mid-6th century. Pope Paul V is the founder of the privy Vatican archives in the first years of the 17th century. Numerous church archives date from the 8th and 9th centuries. The *gesta municipalia* of the Roman empire were continued in France and Italy under the name of *archivum curiae*, until the 9th and 10th centuries respectively. In Germany the cities followed upon the organization of the church and are, therefore, not directly related to the ancient practices. Venice and some other Italian cities had archives dating from the 11th century and by the end of the 13th century Florence, for example, had a statute on the regulation of the public archives.

There is reference to a royal archive in England from the 9th century, but this (if it existed) probably formed part of the treasury and had no fixed location. In any case, the oldest series in the archives of the exchequer dates from 1130. In 1323 the

first inventory in England was completed. This was regarded as a model of its kind by contemporary archivists, and it served as the pattern for the inventory prepared 25 years later for the Trésor des chartes in France which had been founded by Philip the Fair. The emperor Maximilian I attempted to set up a central archive for the Holy Roman empire, but without success. In 1543 the archives of the crown of Castille were founded at Simancas by Charles V. The growing concern for archives in the 17th century is manifested by the appearance of numerous handbooks on archival administration. The archives of the Austrian dynasty and empire, the Haus-, Hof- und Staatsarchiv, were not founded until 1749. The Archivo de Indias was created in Seville in 1785. The scheme of Napoleon I to establish a central archive of Europe at Paris did not succeed.

EUROPE

The British Isles.—The English Public Record act of 1838 brought all separate collections together and placed them under the master of the rolls. England, therefore, is the outstanding example of centralization, whereas the more usual practice is decentralization of archives to the domestic area in which they originated. By an order of 1854 the basic authority was extended, with the result that the public record office now houses two main divisions of archives, judicial and state papers, with the second including the records of ministries and similar agencies which have ceased to serve administrative needs. In these collections are intermingled many documents not strictly of a public nature, and outside them are many collections of vast importance which, though strictly public, were by the laxities of earlier days retained in private hands. The problem of securing the papers of retiring public officials is one which, in spite of enabling legislation, still plagues archivists of all lands. The second quarter of the 20th century brought a greatly increased awareness of local records, with the result that county record offices are widespread, records have been given intelligent shelter by libraries and private papers have been the object of organized public concern. On the national level, following World War II, elimination of records claimed much attention, as did storage in intermediate repositories, the revision of the *Guide* to the public record office and the continued preparation of lists; and, more particularly, the National Register of Archives (1945), the primary purpose of which is the discovery of location and extent of all archival collections in England except those of the central government; and the work of the Historical Manuscripts commission which started its studies in the 19th century. Publication was extensive on all levels. In Scotland the principal collection of public records has been assembled in the General Register house (1784), which, like many another repository, is full to overflowing. Many essential records, of course, are to be found in England, as is true also with respect to Ireland, whose public record office (1867) was seriously damaged in 1922.

The Continent.—Practice and principle have varied somewhat in the several countries, but the pattern has been a central repository and, if conditions warrant them, provincial repositories. France has kept in the departmental archives not only the modern archives relating to the area but also those from the prerevolutionary period. The Netherlands has a central state archives and the provincial archives. The former state of Prussia maintained not only its privy state archives in Berlin but also repositories for records of the central administration which were kept in the areas to which they pertained. The other sovereign states, such as Bavaria, Württemberg and Baden, each maintained their own central (and sometimes area) archives. The Reichsarchiv at Potsdam dated only from 1919. The schism following World War II gave the Federal Republic of Germany a Bundesarchiv at Coblenz and the German Democratic Republic a central archive at Potsdam. In Switzerland the treasures for research are found in the archives of each of the cantons rather than in the Bundesarchiv (1798) at Berne. Italy has no single, central institution for state archives, but has a series of important repositories, united under the ministry of the interior, which reflect the earlier divisions of the country. The modern Vatican city has within its confines some of the oldest extant archives, dating from the 4th century. Legislation in most European countries with highly organized central governments has given the central archives the right to inspect other archives. In Germany there has been, in addition, the system of honorary curatorships of local archives as means of safeguarding such materials. Wars have wreaked havoc with archives and have presented problems to archivists. Many modern states have their origins tied with other states in whose archives have reposed vital records in many cases inextricable, in others subject to transfer in accord with treaty agreements, in others procurable through microcopy. Much has been written on the fate of archives as the result of World War II, but in no single source is it possible to get the composite story. Archives have been destroyed (Naples), passed from original sovereignty (free city of Danzig), sequestered for a period by occupying powers (German foreign office) or confiscated (Nazi party records). Later, the state archives of Florence were gravely damaged by flood in 1966.

NORTH AND SOUTH AMERICA

United States.—The national archives was established in 1934 to house the retired records of the national government. In 1952, when the Declaration of Independence, the constitution and the records of the continental congress were transferred from the Library of Congress, the building contained roughly 800,000 cu.ft. of records. The responsibilities and authority of the national archives were considerably extended by law in 1949, especially by the Federal Records act of 1950 which authorized the archivist to survey government records, records management and disposal practices; to promote improved records practices and controls including the creation, organization, maintenance, use and ultimate disposal of current records; and to establish and operate centralized intermediate records repositories. By the end of 1952 federal records centres had been established in eight of the ten regions into which the country had been divided by the General Services administration, and in two years time had received 1,400,000 cu.ft. of records and had released expensive space and filing equipment worth $5,400,000. A convenient yardstick by which to measure the growth of modern record making is the considered estimate that in the department of the army the period from the establishment of the national government to the start of World War I (1789–1917) had produced 20% and the period 1917–19 had produced 80% of the records. Under the federal system of government each of the states independently has its own archival agency established in various forms and operating in various ways. Recommendations toward uniform archival legislation and practices had not met with success by the middle of the century. The tremendous mass of county and municipal archives first came under adequate control as the result of the operations of the Historical Records survey (1936–43), which likewise had inventoried large numbers of church archives and had prepared guides to collections of historical manuscripts. Work on the National Union Catalog of Manuscript collections started in April 1959. In common with other countries in the Americas the United States has its archival roots in Europe, and early in the 20th century the Carnegie institution of Washington sponsored a series of *Guides to the Materials for American History* in many countries.

Canada and Latin America.—The public archives of Canada (1872) have extensive holdings of original materials which in the middle of the 20th century were being supplemented through long-term copying programs of pertinent Canadiana found in the public record office in London and elsewhere. The provinces maintain their own archives. Throughout the country the usual archival problems had arisen, and considerable attention was given to control and administration. The archives of almost all the 20 Latin-American republics have as their bases the records of the colonial government prior to independence. This relates them intimately with the archives of European (especially of the former parent) countries. Like many of their counterparts in Europe, the archival institutions (a number of which are at the century mark) often have been housed in former palaces or other structures not originally intended for the storage and exploitation of archives. Climate has been a variable factor. In Brazil, for example, the hot humid air of Rio de Janeiro is one of the reasons why many of

the colonial records no longer exist. In Chile, on the other hand, the climate has been favourable, and for this and other reasons the colonial period is well represented in the archives. Panamá, the newest of the republics (1903), was the first (1924) to erect a building intended expressly as a national archive; it was established in 1912. Colombia was among the countries which early provided for the elimination of useless archives. El Salvador was the only one of the Latin-American countries which had not, by the early 1960s, established a national archive. Many of the records of the colonial period still remained in Guatemala, although some had been turned over to El Salvador. Cuba, which did not win its independence from the European parent country till 1899, owed the foundation of its national archive to the Spanish period of its history. Because of the climate and removals of entire collections at the close of the Spanish regime, few archives in Cuba antedate 1800. Probably the largest collection of colonial archives in Latin America survived in Mexico.

AFRICA, ASIA AND AUSTRALASIA

These areas were distinguished by new developments in the mid-20th century. The Union of South Africa, which maintains a central archives and a repository in each state, was engaged in extensive microfilming projects for assembling south Africana in Europe and North America. The central African archives at Salisbury, Southern Rhodesia, created in 1935, necessarily confined its activities largely to planning and organization until after World War II, but then also embarked upon microcopying projects. The archival service of the Republic of the Congo was established in 1947 with photocopying equipment and a documentation centre. Israel had established a national archives and from 1933 was the locale of the Zionist central archives which was founded in Berlin in 1919. India and Pakistan each had established a national archives; each shared the problems of a new sovereign state in tracking down records; each had its administrative roots in a century or more of British records. Pakistan had the added problem of copying in the Indian national archives those records which bore directly upon its history but which could not be separated from those relating also to India. India had the problem posed by the imperial record department. The archives of the Republic of the Philippines suffered severely as the result of World War II, but subsequently efforts were made to rehabilitate these records and to preserve a considerable quantity on microfilm. Archival administration in Australia, which really came into being only at the start of World War II, was complicated by the fact that not only had many of the states prior to the establishment of the commonwealth in 1901 performed functions normally reserved to a national government, but subsequently had continued those functions for several decades; that libraries (in the absence of archives) had taken over public records; and that the principle of provenance had been but imperfectly followed in earlier activities. Japan had no national archives or archival administration. Those records, still in the custody of the ministries, which had survived the earthquake and fire of 1923 suffered severely as the result of the bombings of Tokyo during World War II. A considerable number of the archives of the foreign office were microfilmed (about 2,200 reels of 100 ft. each), and the films were available at the Library of Congress in the United States.

INTERNATIONAL ARCHIVES

The records of international governmental organizations which have continued in being or which have been succeeded directly have presented no problem. Records of defunct agencies such as the International Refugee organization (IRO) and the United Nations Relief and Rehabilitation administration (UNRRA) have been provided for through the fortuitous existence of the United Nations and its archival administration. The records of the many hundreds of international governmental conferences and of professional congresses which have not been sponsored by continuing organizations usually have been given shelter by the host country.

MANAGEMENT

Records Control.—Three elements are essential to archival control of modern records: (1) the determination of types of records to be removed from agency of origin; (2) the time of disposition; and (3) the manner of disposition. Practice has varied, but elimination usually has occurred before records have been transferred from the agency of origin. Some countries, especially those whose history reaches back many centuries, have prohibited the elimination of records made before a specified date. Regular schedules which provide (in accord with the laws of the country, the needs of administration and historical values) for regular movement by type of record with a view to elimination, temporary storage in an intermediate records centre or permanent preservation in an archival repository have come into rather general use.

Technology and Special Types of Records.—The inventiveness of man has brought newer problems as it has solved older ones. Archivists had to add specialization in photographic records, motion pictures, sound recordings and kinescopes. They turned, albeit only slowly, to conversion of their papers to film. Microfilm, the legal status of which as record copy usually has had to be determined by special legislation, is a practical medium for making additional copies of records as security against risk through acts of warfare; as preservation against normal deterioration or damage; for use in international exchange; in lieu of loan or as a convenience to scholars; for reducing costs of repair, binding (or its equivalent) and storage; as a means of supplementing by collateral materials the main bodies of records; and as a form of publication. Practice as well as belief varied from country to country. As the concepts of social, economic and cultural history developed, as industrialization played an increasingly prominent role in national and international affairs, as democratization spread over the surface of the globe, so there was an increasing awareness of the significance of business archives, institutional archives and the papers of persons not necessarily distinguished. Germany was the first to recognize the value of business archives; Belgium, Switzerland and the Netherlands followed shortly; France, England, Denmark and the United States are examples, in varying degree and nature, of later recognition.

Protection.—National and international measures, especially in time of war, have been devoted to the protection of archives. Notable in modern times are the annexes to The Hague convention of 1907, the Roerich pact signed in 1935 by countries of the Americas, and the convention drafted by the United Nations Educational, Scientific and Cultural organization (UNESCO) in 1950–53. UNESCO likewise prepared a manual for the protection of cultural properties in peace or war which superseded the one motivated by the civil war in Spain in 1936. During World War II neutrals and belligerents alike took passive measures of defense with greatly varying degrees of success. Although some entire collections of archives were wiped out, some *fonds* in larger institutions destroyed or otherwise lost and countless archival structures damaged or destroyed, the losses (so far as the political events subsequent to the termination of hostilities permitted assessment) were less than might have been expected in total war and postwar reconstruction. The Allied armies, notably the British and the United States, organized the Monuments, Fine Arts and Archives service, published numerous lists and directories of cultural buildings and materials which were to be respected, issued cultural maps to the air forces in an attempt to safeguard these from attack and did what they could to preserve that which they found in dire need. During the occupation of Germany each of the western Allies continued the Monuments, Fine Arts and Archives service not only as the medium for restitution of looted art and archives but as that for rehabilitation. At an earlier date the Monuments, Fine Arts and Archives personnel in the Allied commission for Italy had performed the same services.

PROFESSIONAL DEVELOPMENT

Schools.—Although there had been a chair of archival science at the University of Mainz as early as 1790, modern specialized training of archivists may be said to begin with the establishment in 1821 of the École Nationale des Chartes in Paris, the first of the three internationally famous schools. The Institut für österreichische Geschichtsforschung was founded in Vienna in 1854, and

the Institut für Archivwissenschaft und Geschichtswissenschaftliche Fortbildung was organized in its final form at Berlin-Dahlem in 1930. This last was revived in 1949 at the state archives in Marburg. Czechoslovakia opened its school in Prague in 1923, the U.S.S.R. started its school in 1938, and formal training in the United States dates from the same year. After World War II the trend was toward school training. The Dutch and Bavarian schools were revived and the English, long the distinguished proponents of direct appointments, developed university courses for archivists. Curriculums were varied but, except in the United States where problems arose almost entirely from modern records, they regularly included not only history, administration and methodology but also paleography, diplomatics, sphragistics, chronology and languages. Modern records problems led to the creation of new techniques and to the need to propagate those techniques through instruction such as that given not only in the United States in courses on records management and archival administration but also in the stages techniques, lectures and laboratory exercises established in Paris by the Direction des Archives de France, the purpose of which was to provide the traditionally trained archivist with the understanding which would enable him to cope with the avalanche always about to slide upon his institution.

Literature.—In common with many subject fields, archival administration is less documented by basic texts than by periodical literature. The Dutch produced the first modern treatise, entitled *Handleiding voor het Ordenen en Beschrijven van Archieven,* in 1898, and this filled so obvious a lacuna that it was translated into German (1905), Italian (1908), French (1910) and subsequently, from the second edition, into English (1940). *Archivistica,* by Eugenio Casanova, had never been translated although, in many ways, its second edition (1928) was the most complete general text on the subject. Sir Hilary Jenkinson treated the subject in his *Manual of Archive Administration* (1937) in a manner generally different from that of his continental colleagues. Adolf Brenneke in his *Archivkunde: ein Beitrag zur Theorie und Geschichte des europäischen Archivwesens* (1953) devotes four-fifths of the book to the historical development of archives and archival practices in many countries outside as well as in Europe. The Spanish-speaking world produced a number of manuals, many of which were of local application. *Modern Archives: Principles and Techniques* (1956) by Theodore R. Schellenberg already has been translated into several foreign languages. Of historical interest is the treatise *De archivis* (1632) by Baldassarre Bonifacio (who was a bishop, lawyer, college president and *littérateur* extraordinary, but not an archivist by profession), as are the works of the Württemberger Jakob von Rammingen, who set forth his practical ideas on the importance of archives, the duties of the archivist and the arrangement of archives in 1571. Periodical literature began early and has flourished, if not continuously at least richly. In the first half of the 19th century all archival periodicals were given over to publication of research; by the mid-20th century, in spite of the demises and suspensions resultant from two world wars and a cold war, more than 75% of the archival periodical literature was devoted to technical matters. Especially significant titles among the older periodicals are the *Bibliothèque de l'école des Chartes,* the *Archivalische Zeitschrift, Archivi, Nederlandsch Archievenblad* all of which survived World War II. Postwar developments of outstanding importance were *Indian Archives* (India), *Archives* (England), *ABCD—Archives, Bibliothèques, Collections, Documentation* (France), *Der Archivar* (Germany), *Mitteilungen des österreichischen Staatsarchivs* (Austria) and *Archivum* (international). Almost all significant periodicals contain not only articles on national history, technical matters, development in theory, book reviews and news notes but also articles on archival matters in other countries. Some likewise report on professional literature over the world. Outstanding in this respect is the annotated and classified list which appeared annually in the *American Archivist* (established 1938) after 1943 and in *Archivum* after 1952. At mid-20th century, after 150 years of modern theory and practice, the universal and definitive bibliography of archival administration, records management and manuscript curatorship had yet to be compiled.

Organizations.—Professional associations have been formed in many but by no means all countries in which archival administration and the status of archivists has been fully developed. There is no handbook which lists these, and there are no criteria for divining their existence—wealth of archival resources, independent age of country, size of country and nature of administration all are invalid guides. The Vereniging van Archivarissen in the Netherlands, which was founded in 1891, drew its members only from professional archivists. The British Records association, on the other hand, numbered among its members after it was established in 1932 not only practising archivists but curators of manuscript collections, institutions, librarians and "friends of archives." In some countries, such as Spain, Belgium and Poland, for example, the archivists united with their neighbours, the librarians and museum curators, in a combined association. Whatever the precise nature of the organization, the trend in the middle and latter part of the 20th century clearly was toward association for mutual development. Mexican archivists held their first national congress in 1944. In the United States, though the first conference of archivists was held in Dec. 1909, the Society of American Archivists was not organized until 1936. The Associazione Nazionale Archivistica Italiana, founded in 1950, held its first national meeting that same year. The programs and the viewpoints vary considerably as evidenced by the published papers and minutes of meetings. The Society of American Archivists, which had a vigorous committee on international relations from its inception, was the primary sponsor of the movement to found the International Council on Archives. This was created under the auspices of UNESCO in June 1948 as a professional organization to strengthen relations among archivists of all lands and among all agencies concerned with the custody of archives; to promote the preservation and to facilitate the use of archives; and to promote and co-ordinate international activities in archival administration. The first International Congress on Archives was held in Paris in 1950 and was followed by others at three- or four-year intervals. Archivists participated also in the International Congress of Librarians and Archivists held in Brussels in 1910 and in the permanent International Commission of Historical Sciences (1923–) that created in 1929 a commission on archives which, understandably, dealt with the subject from the point of view of the research scholar. The first meeting of the committee on archives of the Commission on History of the Pan American Institute of Geography and History was held in 1950 in Havana, where it considered such fundamentals as an inter-American training school; the collection of information on archival laws, buildings and microfilm facilities; the development of a co-operative microfilming project for acquisition of correlative materials; and the establishment of an inter-American periodical for dissemination of professional information. The Ibero-American-Philippine Congress on Archives, Libraries and Copyright held in Madrid during the fall of 1952 had much in common with the regional meeting just mentioned and with the International Congress of Archivists, Librarians and Museum Curators of the Caribbean area which was held about a decade earlier.

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ARCHON, "leader" or "ruler," a term used widely among the ancient Greek city-states for the chief magistrate or magistrates. It had its origin in the period (somewhere between *c.* 1000 B.C. and 682 B.C.) when the kings (basileis) were being superseded by aristocrats.

At Athens executive power was in the hands of nine archons by the middle of the 7th century B.C. They were not a college, but the religious, military and judicial functions once discharged by the kings were divided among them. Probably the first to be instituted was the archon (later known as eponymous archon since he gave his name to his year of office; the list of annual archons began in 682/681 B.C.). He was the principal civil and judicial officer and may have presided over both council (boule) and assembly (ecclesia) (*see* BOULE; ECCLESIA). Next came the polemarch, commander in war and judge where foreigners were involved. Third, the kingship survived in the person of an annual basileus, who was the chief religious officer, and in that capacity presided over the Areopagus (*q.v.*) when it sat as a homicide court. Lastly there were six thesmothetae (determiners of customs), probably set up to relieve the other archons of certain not readily definable judicial functions. It is uncertain whether at this stage the archons were elected by the Areopagus or by the ecclesia. Only nobles by birth (eupatridae) were eligible. Probably no one was allowed to hold any of the various archonships twice. Archons became life members of the Areopagus, and this body exercised a general supervision over their administration, especially in the judicial sphere.

Solon (*q.v.*) in 594/593 B.C. removed the eupatrid monopoly of the archonships by making eligible members of the top or of the top two property classes. Rivalry for the office continued, and in 580/579 B.C., after a 14 months usurpation by Damasias, archon during 582/581, the contending parties reached a temporary compromise, under which the powers either of the eponymous or of all nine archons were exercised by a board of ten archons whose membership was shared between the factions. The Pisistratid tyrants (561–510 B.C.) managed to fill the archonships with their own adherents, their one violation of constitutional forms.

Under the Cleisthenic constitution (508–487/486) archons were elected directly by the ecclesia and leading politicans held the office. But from 500 B.C. the election of ten tribal commanders (strategoi), free from the ban on iteration, began to sap the authority of the polemarch, and at the battle of Marathon in 490 B.C. he was overshadowed by the prestige of the strategos, Miltiades.

In 487/486 mixed sortition was introduced (or restored) for elections. The archons were chosen by lot from 500 previously elected candidates. Since eligibility was still restricted to the two top classes, the change was not prima facie democratic. At about the same time the archons lost their more important functions; from this time onward no archon made any mark in politics and the polemarch played no part in army command. In the administrative sphere the archons were replaced by the strategoi, who could be re-elected. The archons were now primarily judicial officers, the eponymous archon dealing with family and property matters, the polemarch with litigation involving foreigners, the basileus with homicide and certain religious cases and the thesmothetae with a miscellany, particularly constitutional trials. Here too, however, their powers were lessened by the gradual conversion of the popular courts (*dikasteria*) from courts of appeal to courts of first instance. By the middle of the 5th century the magistrate no longer gave his own judgment. He merely conducted a preliminary inquiry (*anakrisis*) into such matters as the status of the litigants, the nature of the plea and of the defense and then brought the case before a jury, presiding over the hearing, but with none of the modern judge's responsibility for directing the jury on matters of law.

In 458/457 B.C. eligibility was extended to the third property class. Between that date and the time of Aristotle (384–322 B.C.) two further changes were made: (1) members of the fourth property class were admitted in fact, though they remained theoretically ineligible; (2) selection by lot was substituted for the preliminary selection of candidates, so that election was by double sortition. Before entering office archons had to undergo an examination (*dokimasia*) by boule and law courts into birth qualifications, physical fitness, etc., and on laying down office another examination (*euthuna*) into their conduct, especially financial, while in office. Misconduct might involve penalties inflicted by a court.

The importance of the archons in the fully developed democracy at Athens has perhaps been unduly depreciated. Their judicial function was never pure routine, and the Areopagus, composed entirely of former archons, retained a certain esteem, especially in times of political trouble.

At Delphi eponymous archons can be traced back to the beginning of the 6th century B.C., and archons are found elsewhere in Greece, in Phocis and in eastern and western Locris at an early date; for example, there were three at Halae (on the Euboean channel) in the early 5th century. At Plataea there was probably already an archon with religious functions at about this time. During the 5th century the institution spread widely in the Aegean islands, no doubt mainly because of the influence of Athens, and thence in the Hellenistic period to the cities of Asia Minor. A parallel to the Athenian ban on iteration is found in Drerus and Gortyna, in Crete, where the chief magistracy could not be held a second time within ten and three years respectively. From the 4th century B.C. archons functioned as the highest titular magistrates in the Boeotian and Thessalian confederacies side by side with archons of their constituent cities, and communities of the Aetolian confederacy had boards of three archons. An archon was head of the Roman emperor Hadrian's organization for furthering Panhellenic unity, the Panhellenium, which had its headquarters at Athens.

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ARCHPRIEST, a title, known since the 4th century, of a Christian priest holding office over other priests. At first his duty was to assist the bishop of a city, but as Christianity ceased to be confined to the towns the priest who, like a rural dean, presided over a group of parishes in the countryside was also called archpriest (6th century). Later the title became an honorary one, as it still is, being the highest rank a married priest can reach in the Orthodox Eastern Churches. The head clerics of the three chief Roman basilicas became cardinal archpriests, but since the 18th century only the cardinal archpriest of St. Peter's has retained any special powers.

See A. Armanien in R. Naz (ed.), *Dictionnaire de droit canonique*, vol. i, col. 1004–26 (1935). (H. M. W.)

ARCHYTAS (fl. 400–350 B.C.), of Tarentum in southern Italy, Greek scientist and philosopher, was a close friend of Plato. An influential figure in the public affairs of Magna Graecia, he was several times commander in chief of his city.

Archytas was a Pythagorean and among the first and the most gifted leaders of that school (*see* PYTHAGORAS AND PYTHAGOREANISM). He solved the geometrical problem of doubling a cube, the so-called Delian problem, by an essentially kinematic construction in three dimensions.

In acoustic theory, whereas the notes emitted by a stringed instrument had been correlated with the length or tension of the strings, Archytas maintained that they were due to a movement or perhaps displacement of air and correlated with the speed of impact on the strings and on the ear. For such reasons he has been called the originator of mathematical mechanics. It is quite possible that we owe to him the main contents of Book viii of Euclid's *Elements*. For he advanced the study of continued proportion ($a:b = b:c = c:d \ldots$), providing definitions of arithmetical, of geometric and of harmonic means and a proof that there is no geometric mean between n and $n + 1$. These were contribu-

tions to musical theory, since they enabled him to obtain enharmonic intervals in addition to those of the chromatic and diatonic scales (*see* GREEK MUSIC [ANCIENT]).

Of the nonmathematical fragments handed down under his name few are likely to be genuine. But in some the philosophical anachronisms may be due only to rewriting in later times (*e.g.*, the fragment of *On Law and Justice* from Stobaeus, *Florilegium*, iv, 1, 135–138; 5, 61). Although Plato made use of his mathematical work, we should neither expect nor infer from the evidence that Archytas was influenced by Plato's philosophy.

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ARCOT, a town in Madras state, India, is on the Palar river 70 mi. W.S.W. of Madras city and 4 mi. S. of the nearest station, Walajah Road, on the Madras-Bangalore line of the Southern railway. Pop. (1961) 25,029. Arcot was the capital of the Muslim nawabs of the Carnatic (*q.v.*). In the 18th century it changed hands between Delhi, Maratha, Mysore, French and British regimes. It was the scene of the 50-day defense by Robert Clive (*q.v.*) in 1751. It was finally annexed in 1801 by the British, who in 1867 imposed the title "prince of Arcot" on the head of the nawab family, who by then had no jurisdiction. Arcot gives its name to two districts, North Arcot and South Arcot, and is in the former.

NORTH ARCOT DISTRICT is mountainous in the north and in the west, where the Javadi hills rise to 3,800 ft. The population, which includes many Christians, was 2,859,157 in 1951 and 3,146,326 in 1961. Area 4,942 sq.mi. It is drained by the nonperennial Palar (which rises in the Javadis and flows eastward to the Bay of Bengal) and its tributaries. The district headquarters are at Vellore (*q.v.*), 8 mi. W. of Arcot town. Essentially agricultural, with rice and millet crops, North Arcot also has several traditional and modern industrial centres. Vellore, Ranipet (22,974), 4 mi. E. of Arcot, and Ambur (39,455), 27 mi. S.W. of Vellore, have tanneries, and the name "Ranipet variety" is given on the London market to leather exported from the region. Arni (31,351), 21 mi. S.E. of Vellore, and Walajahpet (13,179), 9 mi. E. of Arcot, are ancient silk-weaving centres. Ranipet also manufactures ceramic ware, sulfuric acid and superphosphates; and metal poles, guttering and shafting are produced at Arkonam (30,658), 37 mi. E.N.E. of Vellore.

The most notable monument is the Hindu "Holy Beacon" temple at Tiruvannamalai, 48 mi. S. of Vellore, so-called from the large lamp lit there during one of the festivals. It is an ancient foundation, extended *c.* 1300 A.D. and greatly enlarged under the 17th-century Naik dynasty. The shrine is approached through three concentric walled enclosures, pierced by massive sculptured *gopuras* or gate towers, and a thousand-pillared *mandapam* or hall. At Mahedravadi, 30 mi. E.N.E. of Vellore, are the ruined town and rock-cut temples built in the early 7th century A.D. by Mahendra-varman I of the Pallava dynasty.

SOUTH ARCOT DISTRICT is mainly a low lying sandy tract, with loamy areas on the coast and in the south. Pop. (1961) 3,047,973. Area 4,204 sq.mi. It is irrigated extensively by wells, both artesian and ordinary, and drained by the Ponnaiyar and Vellar rivers and in the south by the Coleroon, the main deltaic distributary of the Cauvery (*q.v.*). Rice and millets are grown but the district's specialized crop is peanuts. The district headquarters are at Cuddalore (*q.v.*). Cotton and silk weaving, especially of coloured cloths for export to Malaya, is carried on in many places, and at Nellikuppam (22,168), 6 mi. N.W. of Cuddalore, are a large distillery and a sugar refinery.

Neyveli, on the Southern railway 20 mi. W.S.W. of Cuddalore, is the centre of a lignite field with estimated reserves of 2,000,000,000 tons. The more easily workable deposits, about 200,000,000 tons, with an average seam thickness of 55 ft. at a mean depth of 180 ft. are, however, confined to an area of 5½ sq.mi. An integrated mining and power project was begun in 1961, involving the mining of 3,500,000 tons of lignite and its utilization to generate 200,000 kw. of electricity.

Chidambaram (*q.v.*) is the seat of Annamalai university. At Gingee (Jinji), 45 mi. N.W. of Cuddalore, is the great rock fortress which, captured by Sivaji in 1676, was the centre of Maratha revival against the Moguls in the late 17th and early 18th centuries. Built by the Hindu dynasty of Vijayanagar (*q.v.*) in the 15th century, it was improved by the British in the early 19th. (G. KN.)

ARCTIC, THE, the area of the far north characterized by distinctively polar conditions of climate, plant life, etc. The term is derived from the Greek *arktos*, "bear," referring to the northern constellation of the Bear. It has sometimes been used to designate the area within the Arctic circle—a mathematical line, drawn at 66° 30′ N., marking the southern limit of the zone in which there is at least one annual period of 24 hours during which the sun does not set and one during which it does not rise. However, this line is without value as a geographical boundary, since it is not keyed to the nature of the terrain.

While no dividing line is completely definitive, a generally useful guide is the irregular line marking the northernmost limit of the stands of trees. The regions north of the tree line include Greenland, Spitsbergen and other polar islands; the northern parts of the mainlands of Siberia, Alaska and Canada; the coasts of Labrador; the north of Iceland; also, a strip of the arctic coast of Europe. However, the last-named area is classified as subarctic because of other factors. The criterion of temperature range for designating regions as arctic is discussed below in *Climate,* and methods used for classifying oceanic areas in the *Arctic Ocean* section.

Conditions typical of arctic lands are extreme fluctuations between summer and winter temperatures; permanent snow and ice in the high country, and grasses, sedges and low shrubs in the lowlands; and permanently frozen ground (permafrost, *q.v.*), the surface layer of which is subject to summer thawing. Three-fifths of the arctic terrain is outside the zones of permanent ice. The brevity of the arctic summer is partly compensated by the long daily duration of summer sunshine.

International interest in the arctic and subarctic regions has steadily increased during the 20th century, and particularly since World War II. Three major factors are involved: the advantages of the north pole route as a short cut between important centres of population; the growing realization of economic potentialities such as mineral and forest resources and grazing areas; and the importance of the regions in the study of global meteorology.

Arctic research was one of the major activities of the International Geophysical year (IGY) (*q.v.*) of 1957–58, when data were gathered and exchanged by more than 300 experimental stations. In the Aug. 1958 transpolar voyage of the U.S. submarine "Nautilus," over 1,800 mi. of the journey were made under the ice pack. In the same month the U.S. submarine "Skate" crossed the north pole and surfaced at an IGY drifting station. Many of the polar research projects were continued, with exchange of information through International Geophysical Co-operation—1959, after the close of the IGY. The most intensive program of arctic research and development, before and after IGY, was that of Soviet Russia.

The article below is divided into the following sections:

III. Peoples of the Arctic
  1. Northern America
  2. Northern Asia
  3. Arctic Europe
IV. Economic and Social Development
  1. Role of Location
  2. Natural Resources Utilization
  3. Transportation
  4. Social and Political Characteristics
V. Political and Strategic Aspects
VI. Future Development

(X.)

I. EXPLORATION

1. The Beginnings.—The earliest references to arctic exploration are shrouded in superstitious beliefs concerning the uninhabitable "frigid zone," and also in an obscurity resulting from inaccurate ideas of the shape of the earth and from primitive navigation techniques, which make it very difficult to interpret early maps and accounts of voyages. Probably the first to approach the arctic regions was a Greek, Pytheas, who in the 4th century B.C. made an astonishing voyage from the Mediterranean around Britain, and reached a place he called Thule, variously identified as the Shetlands, Iceland and Norway. The accounts of this remarkable explorer were for centuries discredited but the idea of his Thule, shrouded in fog and believed to be the end of the earth, caught the imagination of many.

Iceland is known to have been visited by Irish monks in the 8th and 9th centuries, but it was the Vikings from Norway who settled the island, late in the 9th century. In the course of the next four centuries these hardy seamen established trade routes to the White sea; discovered Greenland (*c.* 982) and founded two settlements on the southwest coast (which disappeared, for unknown reasons, before the 16th century); reached the coast of North America; and probably also reached Spitsbergen and Novaya Zemlya. Unfortunately, however, they left scant records of their voyages, and many of the places they visited had later to be rediscovered by others.

2. The Northeast Passage.—After a long period of inactivity following the decline of the Norsemen, leadership in arctic exploration was assumed in the early 16th century by the Dutch and the English. The motive was trade with the far east. The known sea routes around the southern tips of Africa and South America were claimed as a monopoly by Portugal and Spain respectively, and besides were long and arduous; the overland routes were even worse. There remained, however, the northern latitudes, and the attempts of English and Dutch merchants to find a northeast and northwest passage gave a strong stimulus to exploration of the arctic.

In 1553 the English sent three ships to the northeast under the command of Sir Hugh Willoughby, with Richard Chancellor as chief pilot. Willoughby, with two ships, wintered in a harbour on the Kola peninsula, where he and his men all perished. Chancellor, who in the "Edward Bonaventure" had become separated from the others in a gale, reached what is now Archangel, and made an overland journey to Moscow (1,500 mi. in all) before returning home. It is interesting to note that these waters were already well known to Russian seamen, who used the route around North cape to western Europe as early as 1496, but this was not generally known at the time.

After Chancellor's voyage the Muscovy company was formed and there grew up a very lucrative trade with Russia, the success of which rather distracted the minds of the English from the northeast passage. Nevertheless, in 1556 Stephen Borough sailed in the "Searchthrift" to try to find the Ob river. He was stopped by ice and fog at the entrance to the Kara sea, which he described in such discouraging terms that it was not until 1580 that another English expedition, under Arthur Pet and Charles Jackman, attempted its passage. They, too, failed to penetrate it and England lost interest in the northeast passage.

In the meantime, however, the Dutch had taken up the search, largely because of the efforts of Olivier Brunel, who in 1565 established a trading post at Archangel, to the consternation of the English traders. In the course of an eventful career Brunel made an overland journey to the Ob, and in 1584 tried to reach it by sea, but like Pet and Jackman he got no farther than Yugorski strait. He was followed by Willem Barents, an outstanding seaman and navigator, who in 1594 discovered Novaya Zemlya and sailed to its northern tip; his two companions, Cornelis Nai and Brant Tetgales, penetrated a little way through Yugorski strait into the Kara sea. In 1596, with Jan Cornelisz Rijp and Jacob van Heemskerck, he was more successful. Heading due north from Norway instead of following the coast around, Barents discovered Bear Island (Bjørnøya) and Spitsbergen, which, however, he mistook for Greenland. Rijp then went home with one ship, but Barents and Heemskerck in the other headed east and rounded the north of Novaya Zemlya. They were forced to winter in Ice Haven on the northeast coast and thus became the first Europeans to winter successfully in the arctic. They built a house of driftwood and passed the season with remarkable fortitude and success, although they were in almost every way unprepared for it. In the spring, the ship being hopelessly damaged, they escaped across the open Barents sea in two small boats. Barents died on the journey. In 1609 Henry Hudson, the Englishman, sailed in the "Half Moon" to the Barents sea in the service of the Dutch East India company, but his crew, afraid of having to winter like Barents, mutinied and forced him to sail west, where he explored the coast of North America north of Virginia and discovered the Hudson river.

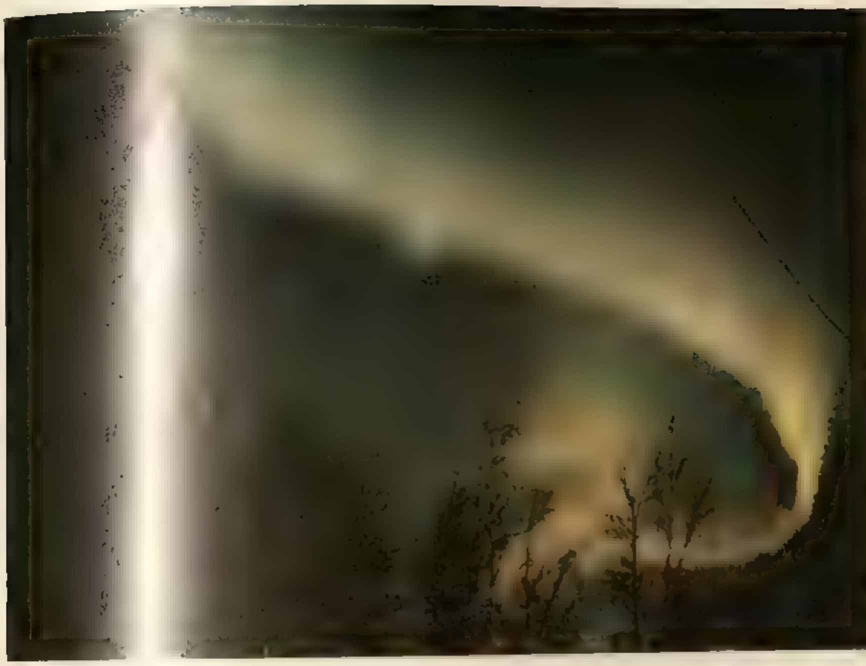
While the English and the Dutch were thus engaged, Siberia was gradually being annexed to Russia by bands of Cossacks spreading slowly eastward from the Urals. Conquering and trading, they reached the Pacific by the middle of the 17th century and traversed the northern coast line in small, flat-bottomed boats. One of these hardy wanderers, Semen Dezhnev, is believed to have sailed through Bering strait in 1648. Like the Norsemen, however the Cossack settlers made few records, and only rumours of the existence of a strait separating Asia from America reached the ears of Peter the Great. In order to find and above all to map the sea route to the east, this remarkable ruler conceived a series of expeditions which culminated in the Great Northern expedition (1725–42), and which under Peter's successors mapped the arctic coast line of Siberia as far east as the Kolyma river. The work of the expeditions was planned by Vitus Bering, a Dane with long service in the Russian navy, and directed by the admiralty college. In 1728 Bering, who himself took charge of activities in the Pacific sailed through Bering strait from the south, but because of bad weather failed to recognize its significance. In 1741 he crossed the North Pacific and landed on the coast of Alaska. Other important figures among the many who made up the Great Northern expedition are Lieut. S. Chelyuskin, who in 1741 reached the cape named after him, the most northern point of the Siberian mainland; and the brothers Laptev, who charted the coast from the Taimyr peninsula to the Kolyma river.

The question of the existence of a strait separating the continents remained uncertain until 1778 when Capt. James Cook, the great British explorer, sailed through Bering strait and reached North cape (now Cape Schmidt) on the Siberian coast. Unlike Bering, he was able to see both sides of the strait and so establish fairly conclusively that the continents were separate.

Attempts to complete the mapping of the north coast were made by a Russian merchant named Shalaurov in 1760–62 and by Joseph Billings, an Englishman in the Russian service, in 1787; it was eventually done by Baron Ferdinand von Wrangel, a Russian of Swedish parentage, in a series of sledge journeys (1820–24).

Wrangel's companion, P. F. Anjou, worked in the New Siberian Islands. These strange islands of silt and ice were discovered in 1770 by a merchant named Lyakhov, who saw caribou coming south to the mainland and followed their tracks north. The islands produced a fortune in mammoth ivory and were further explored and mapped in the years that followed, notably by an official survey party under an exile called Hedenström.

The main features of the northeast passage were now discovered and mapped; it remained to navigate it successfully. One attempt to do so, by an Austrian expedition under Julius Payer and Karl Weyprecht in 1872–74, led to the accidental discovery of



The aurora borealis over Fairbanks, Alaska, in April 1960

SCENES OF THE ARCTIC

Shore ice at Point Barrow, [illegible]

Low, matted vegetation growing on the tundra near Fairbanks

Coast of Greenland

Eskimos coming ashore after seal hunting at Gambell on St. Lawrence Island, Alaska

PHOTOGRAPHS, (TOP, CENTRE LEFT, CENTRE RIGHT) V. F. HESSLER—PUBLIX, (BOTTOM LEFT) MARTIN HELFER FROM SHOSTAL, (BOTTOM RIGHT) WARD WELLS FROM SHOSTAL

ARCTIC

The North Pole, photographed at an altitude of 18,000 ft. The visible cracks are huge crevasses in the ice

Greenland in mid-July, the warmest season of the year; even then the sea is covered with great chunks [illegible] ice. The children are Eskimo

A lead-mining settlement in northeast Greenland, well within the arctic circle

Ericsfiord, in southwestern Greenland, named [illegible] the Red, the Icelandic viking who established a settlement in Greenland in 985

A view of the Greenland inland ice, the largest glacier in the northern hemisphere

ARCTIC SCENES

PHOTOGRAPHS, CAMERA PRESS—PIX FROM PUBLIX

Franz Josef Land. While trying to sail around the north end of Novaya Zemlya their ship, the "Tegetthoff," became caught in the ice and drifted helplessly north and west for over a year, to be deposited by the ice on the shore of a new land. In the spring of 1874 Payer made a long sledge journey, reaching the northernmost point of the archipelago. The ship had to be abandoned, and the party sailed in small boats to Novaya Zemlya, where they were picked up by a Russian fishing vessel.

The first successful navigation of the passage was accomplished in 1878–79 by one of the greatest of arctic explorers, the Swedish Baron A. E. Nordenskiöld, who saw in it not so much a route to the far east as an avenue of trade between Siberia and the rest of the world. After two reconnaissance trips to the Yenisei in 1875 and 1876, Nordenskiöld set out in 1878 in the "Vega" accompanied by three cargo ships, two bound for the Yenisei and one for the Lena. Aided by a good ship and a year of rather light ice conditions, he managed to reach the Chukchi peninsula before being forced to winter only 120 mi. from the Bering sea. The passage was next navigated from east to west by Comdr. B. A. Vilkitski of the Russian navy, who was engaged in hydrographic work. In 1913, while trying to pass Cape Chelyuskin, he was forced north and discovered Severnaya Zemlya, first called Nicholas II Land. He had to turn back and winter on the Pacific coast but succeeded in completing the passage in 1914–15. Two west-east attempts in 1912 by G. L. Brusilov and V. A. Rusanov ended disastrously with the almost complete loss of both expeditions. In 1932 the icebreaker "Sibiryakov" was the first to make the passage in one season, sailing from west to east.

3. The Northwest Passage.—The search for the northwest passage may be said to have begun with the discovery of America, for the voyages of Cartier and his successors to the St. Lawrence, and the Cabots and Corte Reals to Newfoundland and Labrador, were all undertaken with the aim of finding the passage. The first such voyage to enter the arctic, however, was that of Sir Martin Frobisher in 1576. At this time the map was a blank between southern Labrador and Greenland. To complicate matters further, there existed a spurious map published in 1558 of the voyage of Niccolò Zeno in 1380, which showed an entirely imaginary country called Friesland lying between Iceland and Greenland. Because of the supposed existence of this land confusion in mapping and identifying newly discovered lands persisted for 200 years.

Frobisher set out with the "Gabriel" and "Michael" and a tiny pinnace of ten tons. He made his North American landfall on the southeast coast of Baffin Island, after weathering terrible storms in which the pinnace was lost with all four of its crew and the "Michael" deserted and went home. In the "Gabriel" Frobisher sailed about 60 mi. up the long inlet named after him, which he took to be a strait, and brought home among his trophies a rock sample which was identified wrongly as containing gold. The northwest passage was forgotten, and in the next two years Frobisher made two further voyages for the sole purpose of establishing a gold mine. The last voyage was an astonishing enterprise

FIG. 1.—SIGNIFICANT GEOGRAPHICAL LOCATIONS OF THE ARCTIC

involving 15 ships, and had the aim of founding a settlement of 100 men. Included in the cargo was a prefabricated house. The ships, however, were scattered by storms, at least one was sunk, and Frobisher, unable to set up his colony, loaded the remaining ships with ore and returned home, only to find that his cargo was worthless.

Next to seek the passage was John Davis, one of the finest of the early seamen and something of a scientist as well. In three voyages, 1585–87, Davis rediscovered Greenland (lost since the decline of the Norse settlements); he visited the southeast coast and sailed up the west coast to beyond Disko Island (72° N.). He also traced the coasts of Baffin Island and Labrador from Cape Dyer south. Davis showed great imagination in his dealing with the Greenland Eskimos. He took musicians with him and had his sailors dance to the music, thus immediately establishing cordial relations with these sociable people.

In 1602 George Weymouth sailed a short way into Hudson strait, and in 1610 Henry Hudson made his last voyage, sailing the "Discovery" into Hudson bay and down to James bay, where he was forced to winter. In the spring there was a mutiny aboard; Hudson and about eight of his crew, including his young son, were set adrift in a small boat to die, while the mutineers sailed the ship home. Retribution, however, overtook the ringleaders in Hudson strait, where they were killed by Eskimos in one of the rather rare instances when these peaceful and good-natured people have attacked explorers. The remnant that reached England in September was imprisoned; nothing was ever heard from the deserted men.

The discovery of Hudson bay led to a long series of voyages seeking a western outlet to this large inland sea, and at the end of 20 years its shores were fairly well known. Sir Thomas Button in 1612–13 (with Robert Bylot, a Hudson survivor, as pilot) was the first to reach the west coast of the bay, wintering near the site of York Factory and discovering Roes Welcome sound; William Baffin, again with Bylot, sailed halfway up the northeast coast of Southampton Island in 1615; Jens Munk, a Dane, wintered at the mouth of the Churchill river in 1619–20, where nearly all his men died of scurvy, only Munk and two others surviving to sail one of the two ships home; and in 1631 Luke Foxe sailed into Foxe channel.

In the meantime Baffin, the outstanding navigator of his day, had explored Baffin bay (1616), but the significance of this exploration was not recognized for 200 years. With Bylot as master of his ship (Hudson's old "Discovery") Baffin sailed up the west coast of Greenland to the head of Baffin bay (78° N.) and down the west side of the bay, discovering the three sounds that lead out of it, Smith, Jones, and Lancaster. Unfortunately, he reported that all three were merely bays and that there was no passage out of Baffin bay. Even more unfortunately, his map was never published, and in time the very existence of "Baffin's bay" came to be doubted. Search was continued in the Hudson bay area up to the end of the 18th century, but at a greatly reduced pace. By that time traders were opening up the interior and hope of a passage by this route was fading.

The 19th century brought an entirely new era. Up till that time the search had been undertaken mainly by merchants; now it was the turn of governments. The end of the Napoleonic Wars had left the British navy relatively unemployed and the British government, spurred by the enthusiasm of Sir John Barrow, secretary to the admiralty, was persuaded to equip a whole series of large naval expeditions for the discovery of the northwest passage. The first of them, under Capt. John Ross in 1818, retraced almost exactly Baffin's journey of two centuries earlier, and repeated his error of mistaking the sounds for bays. Second in command to Ross was Lieut. W. E. (later Sir William Edward) Parry. He was not convinced that no sound existed, and in 1819–20, in H.M.S. "Hecla" and "Griper," he made a voyage through Lancaster sound to Melville Island in the western part of the archipelago, where he wintered. Blocked by ice in McClure strait, which he could not penetrate, he next (1821–23) tried the route through Foxe channel, spending two winters in Foxe basin. Again he was stopped by ice in the narrow Fury and Hecla strait (named after the two ships he used on this expedition). A number of rather unsuccessful ventures followed. Parry on a third voyage (1824–25) explored Prince Regent inlet; Capt. G. F. Lyon and Capt. George Back made unsuccessful attempts to reach Repulse bay; and Capt. John Ross, on a privately financed venture in 1829–33, sailed down Prince Regent inlet into the Gulf of Boothia, passing by one of the keys to the northwest passage, the narrow Bellot strait, which washes the northernmost tip of the North American continent. The latter expedition added greatly to the extent of mapped territory, mostly through the work of Ross's nephew, J. C. Ross, who established the position of the north magnetic pole in southwest Boothia peninsula. After three winters trapped in the ice, Ross had to abandon his ship, the "Victory," and retreat by sledge and boat, spending a fourth winter on the way before being picked up by a whaler in Lancaster sound.

In the meantime the British were also attacking the problem from the west by both sea and land. In 1819–22 and 1825–27 two expeditions under Capt. John Franklin, working over land and by boat from wintering bases in the Mackenzie basin, surveyed the coast line from Turnagain point, about 200 mi. E. of the Coppermine river, to Cape Beechey, Alaska. There Franklin almost made contact with the survey of Lieut. F. W. Beechey, who in 1825–26 reached Point Barrow from the west. In 1833–35 Capt. George Back discovered the Back river and mapped it to its mouth in Chantrey inlet, and in 1837–39 P. W. Dease and Thomas Simpson, Hudson's Bay company employees, made three coastal journeys by boat, filling in the gap in the Alaska coast line left by Franklin and joining Franklin's survey to Back's at Chantrey inlet. In 1847 another Hudson's Bay company employee, John Rae, joined Parry's Fury and Hecla strait to Ross's survey in the Gulf of Boothia. Rae was a most remarkable traveler, far ahead of his time in adopting Eskimo methods and living off the land.

Most of the continental coast line and a considerable amount of the Canadian arctic archipelago had now been charted, and still the northwest passage remained elusive. The British government was getting tired of the project but prepared to send out one last expedition. This was the famous and tragic last voyage of Sir John Franklin, who sailed into Lancaster sound in 1845 in H.M.S. "Erebus" and "Terror" and was never seen again. The loss of this expedition produced a reaction of profound shock and resulted in a 12-year search which contributed tremendously to geographical knowledge. At its peak in 1850 as many as 14 ships were in the area at the same time and a further expedition was at work from the mainland. The story eventually pieced together was that Franklin had wintered at Beechey Island at the west end of Lancaster sound, after sailing up Wellington channel to 77° N and in the spring of 1846 turned south down Peel sound, hitherto unnavigated, to Victoria strait, off the north tip of King William Island, where his ships eventually had to be abandoned. There were no survivors.

The first to become anxious was Sir John Richardson, a veteran of Franklin's earlier expeditions, who in 1847–49 conducted a search along the northwest mainland coast, accompanied by Rae. The first official search parties were sent out in 1848; Sir James C. Ross, with "Enterprise" and "Investigator," was to enter from the east, and Capt. Henry Kellett, with the "Herald" and "Plover" had orders to stand by in Bering strait to meet Franklin on his way out. Ross wintered in Somerset Island and traced most of its coast line before returning in 1849 without news. In an atmosphere of mounting alarm a more thorough search was made in 1850. Capt. Horatio Austin wintered with four ships, the "Resolute," "Assistance," "Intrepid," and "Pioneer," off the south coast of Cornwallis Island, from which base extensive sledge trips traced many miles of coast line. Two more ships, under Capt. William Penny, a whaler, were in the same area, as was also Sir John Ross, now 73 but still active. The first U.S. expedition to the arctic, financed by Henry Grinnell and led by Lieut. E. J. de Haven, sailed in the "Advance" and "Rescue" to Wellington channel. Franklin's winter quarters at Beechey Island were found by Austin's and Penny's expeditions, but no record had been left to point the way from there.

At the same time, in 1850, Capt. Richard Collinson was to enter from the west and meet Austin in a pincer movement. His two

ships became separated in the Pacific, however, and operated independently. Comdr. Robert McClure in the "Investigator" discovered Prince of Wales strait, rounded Banks Island by the west and entered Mercy bay on the north coast, where the ship remained frozen in for two years and was finally abandoned. McClure and his men were rescued by another expedition and returned home in 1854 by the eastern route. He was thus the first to make the northwest passage, though in more than one ship and partly on foot. Collinson in the "Enterprise" spent three years in Victoria Island, reaching Victoria strait. There he was within a short distance of the place where Franklin's ships had been abandoned, as was also Rae, traveling by boat two years earlier. Neither found any clues. In 1852 a private expedition financed by Lady Franklin and led by a whaling captain, William Kennedy, discovered Bellot strait, named after a French volunteer in the search.

After this the search moved north, which was generally thought to be the most likely direction; only Lady Franklin held firmly, and correctly, to the view that her husband had gone south as directed by his orders. In 1852 Capt. E. Inglefield in the "Isabel" sailed north up Smith sound to 78° 35′ N., and another large expedition, under Sir Edward Belcher and Henry Kellett, sailed into Lancaster sound with Austin's four ships, plus a supply vessel, the "North Star." Splitting into an eastern and a western party and spending two winters in the arctic, this expedition mapped many miles of new coast line north of Lancaster sound, rescued the survivors of McClure's expedition, and then without apparent justification abandoned all four ships in the ice and sailed home in the "North Star." One ship, the "Resolute," was later found drifting in good condition in Davis strait by a whaler, sailed to New England, refitted and returned to the British government by the United States.

In 1853 an American, E. K. Kane, sailed in the "Advance" to Kane basin, wintering twice and searching northward to Kennedy channel. In the same year Rae was sent by the Hudson's Bay company to complete the charting of the mainland coast between Chantrey inlet and Boothia. The company had given up the search as hopeless, but ironically it was this expedition that brought back the first real news, obtained by Rae from Eskimos in Pelly bay and backed by identifiable relics. The British government considered the search closed, but Lady Franklin was not satisfied; she financed a final expedition in the "Fox" under Capt. F. L. McClintock, who had been on three previous expeditions and was largely responsible for developing the sledging techniques used during the search. He traveled around the coasts of King William Island, finding many bodies and relics of the expedition, and also the only record left by it, at Victory point.

So the northwest passage was at last found to be a reality, and official recognition went to McClure as its discoverer, though Franklin too had proved its existence and should share the honour. An unsuccessful attempt to navigate it was made by Allen Young in the "Pandora" in 1875. In 1903 Roald Amundsen, the great Norwegian explorer, sailed down Peel sound in his tiny yacht "Gjöa" and passed around the east side of King William Island, where he spent two winters taking magnetic and other scientific observations. After a third winter spent west of the Mackenzie he passed through Bering strait in 1906, the first to navigate the northwest passage. It was navigated again in 1940–42 and in 1944 by Henry A. Larsen of the Royal Canadian Mounted Police in the "St. Roch," west-east by way of Bellot strait and east-west in one season by Prince of Wales strait. In 1954 the first passage by a deep-draught vessel was made by H.M.C.S. "Labrador," a Canadian naval icebreaker.

4. Whale Fisheries and the Fur Trade.—Many advances in geographical knowledge were due, directly or indirectly, to the whale fisheries that flourished in the arctic for three centuries. On his first voyage in 1607, in the service of the Muscovy company, Henry Hudson sailed up the east coast of Greenland in search of a direct polar route to Cathay. Reaching 73° 30′ N., he turned east along the edge of the pack ice to Spitsbergen, and on his way home discovered Jan Mayen Island. He was impressed by the number of whales he saw and as a result of his recommendation a thriving whaling industry grew up, being carried on by English, Dutch, Danish, French and other companies, and continuing until the whales were gone. In the 18th century the whaling spread to East Greenland waters and in the 19th to Baffin bay, Hudson bay, and, after 1850, the Beaufort sea, where U.S. whalers played a prominent part. By 1920 the industry was dead.

Much of the geographical knowledge accumulated by the whalers was never recorded and died with them; some, especially in the early days, was deliberately suppressed so as to keep it from competitors, but a great deal also found its way onto the maps. The coasts of Spitsbergen were first mapped by Dutch and English whalers, and the Dutchman Cornelis Giles discovered an island east of Spitsbergen which was long known as Giles (Gillis) Land, now White Island. Later details were added by Norwegian sealers. The considerable part played by whaling captains in the Franklin search has already been noted; in addition, the names of many whalers are perpetuated on the maps of Baffin Island and Hudson bay. A whaler, William Adams, established the insularity of Bylot Island, and another, George Comer, made the first complete map of Southampton Island. Going farther west, Wrangel Island was discovered by Thomas Long, a U.S. whaler.

By far the most famous of the whalers were the William Scoresbys, father and son. Scoresby Sr., a farmer's son, was a first-rate navigator, inventor of the crow's-nest and other aids to ice navigation, and the first to suggest the use of sledges to reach the pole. His son, who inherited his father's talents and added to them a scientific education, wrote two important books on the arctic. In 1806 the Scoresbys reached 81° 12′ N., north of Spitsbergen, a record northing at the time, and in 1822 made a detailed map of the east coast of Greenland from 75° to 69° N.

Just as whaling led to improved knowledge of the coast lines, the fur trade helped to open the interiors of arctic lands. The Cossacks who settled Siberia were mainly engaged in this profitable trade, and the interior of Spitsbergen was first frequented by Russian hunters, who in the 18th century hunted the fur bearers almost to extinction. But it was in North America that the influence of the fur traders was greatest.

The formation of the Hudson's Bay company (*q.v.*) was a direct result of the 17th century voyages into Hudson bay in search of the northwest passage. Following an exploratory voyage by Capt. Z. Gillam in 1668, the company was incorporated in 1670 and a trading post established at the foot of James bay. Soon posts were set up on the west side of the bay at York Factory and Churchill, and these served as bases for further exploration. It was a hundred years, however, before the Hudson's Bay company made any real attempt to explore the hinterland, when Samuel Hearne was sent to look for a source of copper reported by Indians who traded at the coast. Hearne set out from Churchill with a band of Indians in 1770–71, and with them made a remarkable journey to the mouth of the Coppermine river, returning by way of Great Slave lake. In 1789 Alexander Mackenzie of the rival North-West company of Montreal traveled by canoe from Lake Athabasca down the Mackenzie river to the sea, establishing a second known point on the arctic coast. By the time the two companies merged in 1821 there were trading posts on Great Slave lake and down the Mackenzie to Ft. Good Hope; it was the existence of these posts that made possible the overland expeditions of Franklin and his successors, among whom were many Hudson's Bay company men.

Pushing westward from the Mackenzie through the mountains and into Alaska, the Hudson's Bay company met Russian traders working from the west coast. The Russians had established a colony in Alaska toward the end of the 18th century and carried on a vigorous trade at Kodiak, Sitka and other settlements. In 1831 Baron von Wrangel, governor of the colony from 1829 to 1834, established a post on St. Michael's Island and had the lower Yukon explored. Competition and strife between the Russian and British traders was ended by the purchase of Alaska by the United States in 1867 and the joint survey of the Alaska-Yukon boundary.

5. The North Pole.—The north pole did not become in itself a goal of exploration until fairly late; the few early expeditions that tried to reach the pole were looking for a polar route to the east rather than for the pole itself. After Hudson's first attempt in 1607, nearly 200 years elapsed before the British government

sent another expedition, under Capt. C. J. Phipps in 1773, to try to sail across the north pole. He got only as far as the north of Spitsbergen, and Capt. David Buchan in 1818 did no better. In 1827 Parry was the first to try the sledging technique suggested by Scoresby, breaking the latter's record by reaching 82° 45′ N.

All these attempts had been in the area between Greenland and Spitsbergen, which actually is not the accessible route to the Arctic ocean that it appears to be, owing to the strong southerly drift of the ice. The Franklin search opened a new route, up the west coast of Greenland. In 1860 I. I. Hayes attempted to reach the pole by this route in the schooner "United States." Hayes was a firm believer in a theory, then prevalent, that the polar sea was ice-free and that it could be reached by breaking through the fringing belt of pack ice. Ironically, he met with unusually heavy ice conditions and got only as far as Etah on the coast of Smith sound. In 1871 Charles Francis Hall, another American, with more luck and a better ship, reached 82° 11′ N. and charted both sides of the channel to its northern end at the entrance to the Lincoln sea. Hall himself died during the winter and his ship, the "Polaris," was caught in the ice on the voyage south and drifted to Smith sound, where it was almost wrecked. A party of 19, including an Eskimo mother with a two-month-old baby, became separated from the ship and drifted all winter on an ice floe, being picked up by a whaler in April 1873 off the coast of Labrador. In 1875–76 a British expedition under Capt. G. S. Nares in the "Alert" and "Discovery" reached the Lincoln sea by ship, the "Alert" wintering near Cape Sheridan on the north coast of Ellesmere Island, the "Discovery" farther south at Lady Franklin bay. Sledge parties in the spring traced the coasts of Ellesmere Island and Greenland to Yelverton bay and Sherard Osborn fjord respectively, and one, under Comdr. A. H. Markham, reached 83° 20′ N. over the pack ice, a new record northing.

In the meantime the Spitsbergen route was not neglected. In 1869–70 a German expedition under Karl Koldewey in the "Germania" sailed up the east coast of Greenland to 72° 30′ N. and traced it by sledge to Cape Bismarck. A second ship, the "Hansa," became separated and was crushed in the ice, and the crew drifted south on a floe and around Cape Farewell, reaching the settlement of Frederiksdal in safety. A. E. Nordenskiöld, the great Swedish explorer, made two journeys toward the pole from Spitsbergen, in 1868 by ship and in 1873 by reindeer sledge.

An entirely new approach was tried in 1879 by a U.S. expedition in the "Jeannette," led by Lieut. Comdr. G. W. de Long. At that time it was believed by many that Wrangel Island was a large land mass stretching far to the north, and de Long hoped to sail north as far as possible along its coast and then sledge to the pole. Accordingly, he sailed through Bering strait, but his ship was caught in the ice near Herald Island and drifted west for 22 months, passing north of Wrangel Island and revealing its limited extent. The "Jeannette" sank near the New Siberian Islands and the crew reached the Lena delta on foot, where many of them died, including De Long himself. A search expedition under Lieut. R. M. Berry surveyed Wrangel Island.

Wreckage from the "Jeannette" was found a year or two later on the southwest coast of Greenland, having apparently drifted right across the Arctic ocean, and Fridtjof Nansen, one of the greatest explorers of all time, conceived the daring idea that a ship might be made to do the same, thus providing a base for scientific investigation of the Arctic ocean and incidentally a means of reaching the pole. In a new vessel, the "Fram," specially designed to rise under lateral pressure and so avoid being crushed, Nansen left Norway in 1893 with Otto Sverdrup and sailed into the Kara sea. Near the place where the "Jeannette" sank they drove the "Fram" into the pack and began a drift that lasted almost three years and ended with the safe release of the vessel north of Spitsbergen in 1896; a formidable amount of scientific data was collected. Nansen himself left the "Fram" in 1895 with one companion, Hjalmar Johansen, in an attempt to reach the pole by sledge, starting from 84° N. in the longitude of Franz Josef Land and setting a new record of 86° 13′ N. before having to turn back and winter in Franz Josef Land. In the spring, by a strange and lucky coincidence, he met Frederick Jackson, a British explorer, and returned home in his ship. Jackson was investigating Franz Josef Land as a possible steppingstone to the pole, but on hearing Nansen's account gave up the polar attempt. In his three-year stay, however (1894–97), he revolutionized the map of this complicated collection of islands and did a great deal of valuable work.

Up to that time the desire to reach the pole had been coupled with that of mapping unexplored territory and collecting scientific data; after the "Fram" expedition there was no longer any doubt that the central part of the polar basin was an ice-covered sea, and that any land still to be discovered would be peripheral. The race for the pole then degenerated into an international sporting event. Several expeditions, following in Jackson's footsteps, tried to reach the pole from Franz Josef Land. Three were American: Walter Wellman in 1898–99, the Baldwin-Ziegler expedition in 1901–02, and the Fiala-Ziegler expedition in 1903–06. An Italian expedition led by the duke of the Abruzzi set a new record in 1900, when Capt. U. Cagni reached 86° 34′ N.

Robert E. Peary started working toward his polar journeys in 1891–92 and 1893–95 when he made two long journeys across northwest Greenland, discovering the largely ice-free Peary Land. He intended to use north Greenland as his jumping-off place, but later changed this to north Ellesmere Island, farther from the pole but more accessible. In 1898–1902 he laid a large supply cache in Lady Franklin bay from bases in Smith sound, sledged around the north coast of Greenland, and reached 84° 17′ N. from Cape Hecla, Ellesmere Island. In 1905, aided by the expert ice navigation of Capt. Bob Bartlett, he sailed in the "Roosevelt" to Cape Sheridan, near the "Alert's" old winter quarters, and from Cape Hecla set a new record of 87° 6′ N. He also sledged around the north coast of Ellesmere Island, mapping the coast from where Nares left off. In 1908–09 he returned and from Cape Columbia in 1909 made a sledge journey to the pole. His technique was to start with a large party and set up depots at regular intervals, the support sledges turning back one by one as the depots were laid. With Peary on the final dash were his Negro dog driver Matthew Henson and three Eskimos.

Just before Peary's return to the United States in Sept. 1909, Frederick A. Cook, an American who had been with Peary in Greenland in 1891–92 and who had spent 1907–09 in the arctic, announced that he had reached the pole the year before with two Eskimos, from the north point of Axel Heiberg Island. The matter aroused considerable controversy and to substantiate his claim Cook submitted his journal to the University of Copenhagen, which considered it inadequate proof; he did not appear to challenge the decision. The question of whether Peary or Cook, neither, or both, actually reached this theoretical point on the moving ice pack is hard to prove or disprove; but until there is fresh documentary evidence, or improved knowledge of the nature and movement of the ice in the Arctic ocean that supports a different interpretation of the existing documents, Peary's claim seems the more valid one. In any event, it was accepted by the U.S. congress and geographical institutions in many countries.

The first attempt to fly to the pole was made as early as 1897 when a Swedish scientist, S. A. Andrée, left Spitsbergen in a balloon. It was not until 1930 that the fate of Andrée and his two companions was known, when their bodies and diaries were found on White Island. In 1909 Walter Wellman made an unsuccessful attempt by dirigible, and in 1925 Amundsen, with two Dornier-Wal flying boats, reached 87° 44′ N. The first to reach the pole was Richard E. Byrd, who with Floyd Bennett as pilot flew from Spitsbergen to the pole and back on May 9, 1926. Two days later Amundsen and Umberto Nobile set off from the same base in a semirigid airship and flew across the pole to Alaska.

6. Scientific Exploration.—An important secondary motive in much of the exploration so far discussed was pure scientific curiosity, the desire to add to the general store of knowledge of the world. With the passage of time and the disappearance of the old dreams of gain and glory, this became more and more the primary motive of exploration, though it was sometimes combined with a hope of developing such mineral or other resources as may be found.

In 1875 an important proposal for international co-operation

in collecting scientific data was made by Karl Weyprecht, and the suggestion led to the setting up of the first International Polar year, 1882–83, during which stations throughout the arctic took observations and pooled the results. The countries participating were Norway, Sweden, Denmark, Finland, Russia, Holland, Germany, Austria, the United States and Great Britain. The 11 stations, reading eastward from Spitsbergen, were Ice fjord, Spitsbergen; Bossekop, north Norway; Sodankylä, Finland; west coast of Novaya Zemlya; Sagastyr Island, Lena delta; Point Barrow, Alaska; Great Slave lake; Lady Franklin bay, Ellesmere Island; Cumberland sound, Baffin Island; Godthaab, Greenland; and Jan Mayen Island. In 1932–33 a similar pattern was followed by the second International Polar year, but with more stations, and the technique was extended to cover the whole world in the International Geophysical year of 1957–58.

7. **Regional Exploration:** *Spitsbergen.*—Starting in 1827 a series of expeditions, most of them Swedish, surveyed Spitsbergen and studied its geology and natural history. Among those who carried out this work were B. M. Keilhau, Otto Torell and A. E. Nordenskiöld; the last-named made several visits between 1858 and 1873, when he sledged across North East Land. Sir Martin Conway crossed the interior of Vestspitsbergen in 1896–97, and in 1898 A. G. Nathorst explored the east coast and adjacent islands. Oceanographic and other work was done by the Dutch in the "Willem Barents" after 1878, by the prince of Monaco and W. S. Bruce (1898–1914), and by the Russian admiral S. O. Makarov in the icebreaker "Yermak" (1899). At the turn of the century coal mining was begun in Ice fjord and this led to further survey activity by Norwegian government expeditions and others. A British expedition from Oxford university under George Binney in 1924 was the first scientific expedition to make extensive use of an aircraft. (*See* also SVALBARD.)

The Russian Arctic.—Between 1821 and 1824 F. P. Litke of the Russian navy made four voyages to Novaya Zemlya, surveying the west coast and improving the mapping of Matochkin strait and the White sea coast, and in 1832–35 P. K. Pakhtusov surveyed much of the east coast of Novaya Zemlya. In 1880 Leigh Smith made the first of two voyages to Franz Josef Land, the first to sail a ship there under its own power. On his second voyage his ship, the "Eira," was nipped by ice and sank. Smith built a hut on the shore and wintered, surveying the south coast and collecting scientific data. In the spring the party sailed to Novaya Zemlya in small boats. In 1886 and again in 1893 and 1900–02 Baron E. von Toll, a Russian explorer, worked in the New Siberian Islands. He perished in an attempt to find Sannikov Land, an island reported north of the New Siberian Islands, which, like many similar "lands" in the arctic, probably does not exist. Some coordinated hydrographic work was done by the Russians in the Barents sea from 1898 to 1908, in the Kara sea from 1894 to 1904, and east of Cape Chelyuskin from 1910 to 1915.

In 1918 Amundsen set out in the "Maud" to emulate Nansen's drift in the "Fram" but with the hope of getting into a more northerly latitude by starting the drift nearer to Bering strait. He took three seasons to sail east through the northeast passage and it was not until 1922 that the "Maud" began its drift, under the scientific leadership of H. U. Sverdrup. In two years it was carried back to the New Siberian Islands, duplicating the path of the "Jeannette" rather than the "Fram," but useful scientific work was done throughout both phases of the expedition.

After the Russian Revolution in 1917 the scale and scope of exploration increased greatly, as part of the work of developing the northern sea route. Polar stations, of which five already existed in 1917, increased in number, providing meteorological, ice reconnaissance and radio facilities. By 1932 there were 24 stations, by 1948 about 80, and by the 1960s more than 100. The use of icebreakers, and, later, aircraft, as platforms for scientific work was developed. In 1929 and 1930 the icebreaker "Sedov" carried groups of scientists to Franz Josef Land and also to Severnaya Zemlya, the last major piece of unsurveyed territory in the Soviet arctic; it was completely mapped under G. A. Ushakov between 1930 and 1932.

The one-season voyage of the "Sibiryakov" through the passage in 1932 accomplished much scientific work and was the first to use the route north of Severnaya Zemlya. It gave a further stimulus to development of the sea route, and icebreaker operations to study sea and ice became annual. Particularly worth noting are three cruises of the "Sadko," which went farther north than most; in 1935 and 1936 the last unexplored areas in the northern Kara sea were examined and the little Ushakova Island discovered, and in 1937 the ship was caught in the ice with two others and forced to winter in the Laptev sea, adding valuable winter observations to the usual summer ones.

Greenland.—The history of modern Greenland may be said to begin with the voyage in 1721 of Hans Egede, a Danish-Norwegian missionary whose aim was to find and re-establish the Norse colonies. Traveling up and down the west coast, he found no survivors of the old colonists, but he stayed to found his own settlement at Godthaab and to begin the enlightened development of the country and its Eskimo people that has made Danish Greenland a model of colonial administration.

Greenland has received a great deal of study. The west and north coasts became fairly well known during the 19th century. The east coast was less easily conquered because of severe ice conditions, which make it hard to approach by ship. In 1806–13 Karl Ludwig Giesecke, a German mineralogist, used the native umiak, or women's boat, to study the southeast coast, and so did Lieut. W. A. Graah in 1829–30. In 1823 Capts. D. Clavering and E. Sabine, following in the steps of Scoresby the year before, carried the survey north to 76° N. and took pendulum observations. In 1876 the Danish Committee for the Geographical and Geological Investigation of Greenland was formed, and since then a consistent program of research has been carried out. The gaps in the southeast coast were filled in by naval expeditions under L. A. Mourier (1879), G. Holm (1883 and 1885) and C. H. Ryder (1891–92), and the rest by Lieut. G. C. Amdrup in the "Antarctica" (1898–1900), the duke of Orléans in the "Belgica" (1905), and Ludvig Mylius-Erichsen in the "Danmark" (1906–08). On the latter expedition long sledge journeys by J. P. Koch and Mylius-Erichsen traced the whole northeast corner of the island, but Mylius-Erichsen and two companions were lost. The last details were filled in in 1909–12 by Ejnar Mikkelsen, who traced the route followed by the dead men and found their records. A series of expeditions, known as the Thule expeditions because they were based on the little trading settlement of Thule in northwest Greenland, did considerable work in north Greenland between 1912 and 1921 under Knud Rasmussen and Lauge Koch.

The Greenland icecap presented a formidable barrier to travelers and at the same time a challenge to both adventurer and scientist. Early attempts to penetrate it from the west coast settlements were made by Edward Whymper in 1867, by Nordenskiöld in 1870 and 1883, by J. A. D. Jensen in 1878, and by Peary in 1886. Peary, the most successful, penetrated 100 mi. from the coast. In 1888 the young Fridtjof Nansen adopted the bold plan of starting from the uninhabited east coast, thus leaving himself no retreat but at the same time avoiding the necessity of retracing his steps. With five companions, using snowshoes and skis, he crossed the icecap from 64° 23′ N. on the east coast to Godthaab on the west. Since then the icecap has been crossed many times, even in its widest parts. Peary was the first to cross the northern part, from Inglefield gulf to Independence fjord in 1892. Other crossings have been made by Knud Rasmussen and by A. de Quervain in 1912, by J. P. Koch in 1913, by Lauge Koch in 1921, and by others.

In 1930–31 three expeditions, simultaneous but independent, maintained stations on the icecap throughout the winter, securing meteorological data vital to the study of world air circulation. They were the British Arctic Air Route expedition led by H. G. Watkins, the German Greenland expedition under Alfred Wegener, and the University of Michigan expedition under W. H. Hobbs. After World War II this work was continued on a larger scale by the French explorer Paul Emile Victor (1947–53) and the British North Greenland expedition under Comdr. C. J. W. Simpson (1952–54). (*See* also GREENLAND.)

The North American Arctic.—By the beginning of the first Polar year in 1882 most of the coast lines of the North American arctic

Far beyond the margins of the shields extensive plains have developed on soft sedimentary rocks. In North America these form the Mackenzie lowlands, Banks and Prince Patrick Islands, and the arctic plains section of northern Alaska; in northern Europe they form the Severnaya Dvina and Pechora plains. In Siberia the Ob delta, its northeastern extension to the Laptev sea, the north Siberian plains, the west Siberian lowlands and farther east the Lena-Kolyma plains (including the New Siberian Islands) have developed on sedimentary rocks. Although there are differences in degree these terrains are essentially flat, occasionally broken by low rock scarps and covered with numerous shallow lakes. The plains are crossed by large rivers which have laid down deep alluvial deposits.

The strongly folded rocks associated with the two periods of mountain building in the arctic form separate physiographic regions. The original mountains of the older, Paleozoic folding were long ago destroyed by erosion but the rocks have been recently elevated and renewed erosion, often by ice, has produced a landscape of plateaus, hills and mountains very similar to the higher parts of the shields. In Ellesmere Island the mountains are nearly 10,000 ft. high. In Peary Land and Vestspitsbergen maximum heights are about 6,000 ft., while in east Spitsbergen and on Novaya Zemlya and Severnaya Zemlya the plateaus rarely exceed 2,000 ft.

The younger group of fold mountains of northeast Siberia and Alaska are generally higher. Peaks of 10,000 ft. are found in the Cherski range, 15,000 ft. in Kamchatka and even higher in southern Alaska. Characteristic of this physiographic division are the wide intermontane basins often drained by large rivers such as the Yukon and Kolyma.

Throughout the arctic, excluding a few maritime areas, the winter cold is so intense that the ground remains permanently frozen except for a shallow upper zone, called the active layer, that thaws during the summer. This permanently frozen ground (permafrost) covers nearly one-quarter of the earth's surface. In northern Alaska and Canada scattered observations suggest that permafrost is 800–1,500 ft. deep; it is generally deeper in northern Siberia. The deepest known permafrost is at Nordvik, northern Siberia, where it is 2,000 ft. The depth of the permafrost depends on the site, climate, vegetation, and the recent history of the area, particularly whether it was covered by sea or glacier ice. The very deep permafrost was probably formed in unglaciated areas during the Ice Ages. To the south in the subarctic the permafrost thins and eventually becomes discontinuous, although it may locally still be 200–400 ft. thick; along its southern boundary permafrost survives under peat and bogs. In areas of continuous permafrost the active layer may be many feet thick in sandy well-drained soils with little vegetation; it is usually less than six inches thick beneath peat.

Permafrost occurs in both bedrock and surface deposits. It has little effect on rock but in fine-grained, unconsolidated sediments, particularly silts, lenses of ice, called ground ice, grow by migration of water and in extreme cases half the volume of arctic silts may be ice. Ground ice is often exposed in river banks and sea cliffs, when it may be 20 to 30 ft. thick. In northern Siberia fossil ice has been reported up to 200 ft. thick, although in these cases it may be glacier or lake ice that has subsequently been buried under river deposits. If ground ice melts, due to a change in climate, pits are formed in the ground and quickly fill with water to form lakes and ponds. In their frozen state the silts have considerable strength, but if they thaw they change in volume, lose their strength and may turn to mud. Variations in volume and bearing capacity of the ground due to changes in the permafrost constitute one of the major problems in arctic construction.

Permafrost totally inhibits underground drainage. Consequently shallow lakes are numerous over large areas of the arctic, and everywhere in early summer there is a wet period before the saturated upper layers of the ground dry out. During the summer waterlogged active layers on slopes may slide downhill over the frozen ground, a phenomenon known as solifluction. It is ubiquitous in the arctic but is particularly intense where the soils are fine-grained, as in the coastal plain of north Alaska, or where the precipitation is heavy, as on Bear Island (Bjørnøya) in the Norwegian sea. The effect of solifluction is to grade slopes so that long, smooth profiles are common; slopes are normally covered with vegetation, but if the soil movement is too fast plants may not be able to survive. Under these conditions the surface material is often graded, with narrow strips of pebbles and boulders separated by broader strips of finer particles.

Many soils in northern areas show distinctive patterns produced by complex processes of freezing and thawing, which cause frost heaving and sorting of debris; although permafrost is not essential to these formations, it is usually present. There are many different types of patterned ground. In some, coarser material, pebbles and boulders form polygonal nets with the finer materials concentrated in the centre. When sorting is widely spaced stone circles develop. Another kind of pattern, formed in sands and muds, is outlined by frost-crack fissures or strips of vegetation. Individual polygons vary from about 1 ft. to over 300 ft. in diameter. Mounds due to frost heaving in the soil are also widespread. They grow rapidly, disrupting leveled fields in a few years.

Many exposed rock surfaces in the arctic have been quickly broken up by frost action so that much rock is buried under a cover of angular shattered boulders. These mantles are known as *felsenmeer* (sea of rock) and are found principally on arctic uplands. Their continuity and depth varies with climate, vegetation and rock type but they may be as much as 12 ft. deep. *Felsenmeer* are especially well developed on basalts and are consequently numerous on the Icelandic plateaus. They also develop quickly on sedimentary rocks and are widespread in the Canadian arctic, all the way down to sea level.

2. Glaciation.—Although the arctic is commonly thought to be largely ice-covered, less than two-fifths of its land surface in fact supports permanent ice. The remainder is ice-free either because of relatively warm temperatures or scant snowfall. Glaciers are formed when the annual accumulation of snow, rime, and other forms of solid precipitation exceeds that removed by summer melting. The excess snow is converted slowly into glacier ice, the rate depending on the temperature and annual accumulation. In the arctic, where most glaciers have temperatures far below freezing point, the snow changes into ice slowly. In northwest Greenland a hole 1,400 ft. deep was made into the ice sheet

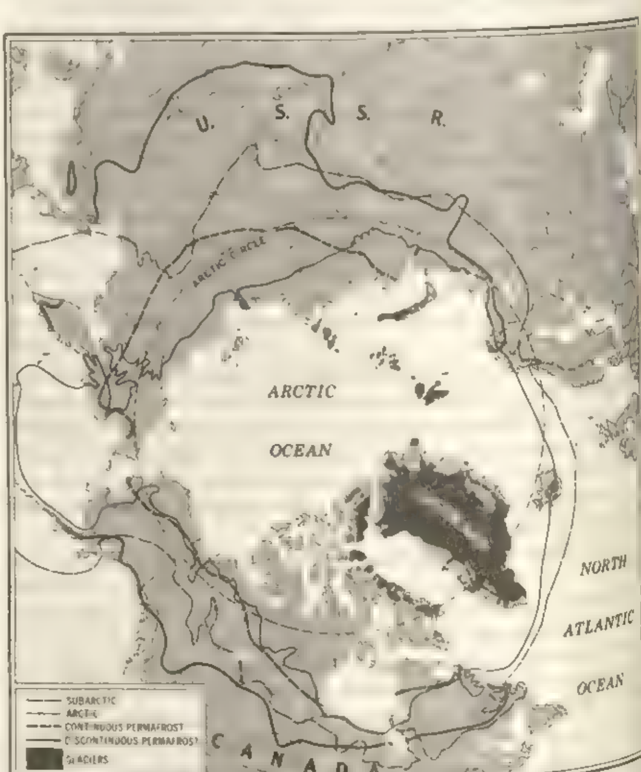


FIG. 3.—DIVISION OF SUBARCTIC AND ARCTIC REGIONS SHOWING DISTRIBUTION OF PERMAFROST AND GLACIERS

without reaching glacier ice. The hole showed over 800 annual snow layers, from which it was possible to determine precipitation changes for the last eight centuries.

The altitude at which ice accumulates over a period of years is known as the glaciation limit and is roughly equivalent to the snow line. It is often very variable within short distances. On Baffin Island the glaciation limit is a little over 2,000 ft. above sea level in the extreme southeast, rising to over 4,500 ft. in the Penny icecap 300 mi. to the north and descending to about 2,000 ft. in the north of the island. In Greenland the limit is at about 6,000 ft. in the south and decreases irregularly to about 3,000 ft. in the north. Nowhere in the arctic regions is the glaciation limit at sea level; glaciers found close to the sea have all flowed down from higher levels. The domes of some arctic icecaps are below the glaciation limit but they continue to survive because of their low internal temperatures; the winter snowfall melts completely but refreezes in contact with the cold ice. This phenomenon, first observed on the Barnes icecap of Baffin Island, is now known to be widespread in the high arctic.

The glaciers of the north polar regions can be divided into two groups depending on the source of their snow; the larger group is around the Atlantic and the smaller around the Pacific ocean. The largest ice mass, the Greenland inland ice, is part of the first group and is the largest glacier in the northern hemisphere. It extends 1,570 mi. from north to south, has a maximum width of 600 mi., an average thickness of about 5,000 ft., and covers an area of approximately 700,000 sq.mi., nearly 85% of Greenland. It is contained within an elongated saucer-shaped depression, the sides of which are mountains (called nunataks) that rise through the margins of the ice. In the centre the base of the ice is more than 1,000 ft. and may be as much as one mile below sea level. This discovery has led to the suggestion that Greenland is an archipelago rather than one large island. Although this might be so for a short time if the ice melted, the land would soon rise when the ice mass disappeared, forming a plateau at about 3,000 ft. The crest of the inland ice, which exceeds 10,000 ft. above sea level midway between the east and west coasts in the northern part of the island, is displaced to the east in the south. In the centre the surface of the ice is undulating and is frequently covered with wind-drifted formations of snow called *sastrugi*. The icecap slopes off to the sides, reaching the sea in a 240-mi. front along Melville bay in the west and along two smaller stretches in the northeast. Elsewhere huge outlet glaciers flow down to the sea. All combine to produce the vast numbers of icebergs that bar the coast of Greenland and are carried south in the Labrador current to the Atlantic shipping lanes. In summer the margins of the inland ice are covered with soft, sticky, granular snow. Three main ice-free areas are found in Greenland, in the southwest, where the inland ice is separated by 100 mi. from Davis strait; north of Scoresby sound in the east; and in Peary Land in the north.

In arctic Canada the permanent ice is restricted, with few exceptions, to the northeast, a result of the greater relief and precipitation around Baffin bay and Davis strait. The most southerly ice is found in the Torngat mountains of northern Labrador, where there are small cirque glaciers. Immediately north of Hudson strait on the plateau south of Frobisher bay there are two small icecaps. Larger icecaps and highland ice (through which mountains project) are present farther north along the east of Baffin Island and on Bylot Island; only the Barnes icecap lies west of the coastal group. North of Lancaster sound the ice is more extensive and large parts of Devon, Ellesmere and Axel Heiberg islands are glacierized. In many ways these icecaps are small versions of the Greenland inland ice, with a central dome-shaped section and outlet glaciers pouring down through the mountains toward the sea. The icecap on Meighen Island, the most westerly of the group, is an exception, as it is circular in shape and lies on low ground. Except for three small, unexplored glaciers on Melville Island there are no glaciers in the Canadian western arctic. Only a few of the Canadian glaciers reach the sea and form icebergs. In the Arctic ocean off northern Ellesmere Island there is an area of floating shelf ice that may at one time have been joined by glaciers, but the glaciers no longer reach the sea. This shelf ice has been the principal source of the ice islands of the Arctic ocean.

Other glaciers are found north and east of the Atlantic ocean and its continuation in the Norwegian and Barents seas. Iceland has five major icecaps, the largest of which, Vatnajökull, covers 3,400 sq.mi. All have small outlet glaciers although none reaches the sea. The icecaps owe their survival to extremely heavy precipitation. The western part of Vatnajökull buries a volcano, Grímsvötn, which erupts every six to ten years; the heat of the eruption forms a vast subglacial lake which bursts in great floods over the margins of the glacier.

North of Iceland, Jan Mayen Island supports a glacier on the volcano Mt. Beerenberg. The glaciers of Svalbard cover about 90% of the land. On the largest island, Vestspitsbergen, the plateaus are covered with highland ice from which outlet glaciers reach the sea; there are also numerous independent valley and cirque glaciers. North East Land, the second largest island, supports two icecaps on its plateaus. On the east side of the Atlantic ocean precipitation is heavy over the Scandinavian highlands, but temperatures are also high and the total area of ice is only about 2,000 sq.mi., a small part of which is in north Sweden and the remainder in Norway. To the northeast, beyond the Barents sea, precipitation is far less but the summer is shorter and permanent ice is widespread.

Farthest north in this group are the islands of the Franz Josef archipelago. Although at no point are they higher than 2,500 ft., probably more than 90% of their area is covered with ice; some of the smaller islands are completely buried by glaciers. The southern island of Novaya Zemlya supports a few small glaciers; on the northern island they become more numerous and the northern four-fifths of the island is ice-covered, with large outlet glaciers reaching the sea.

Weather disturbances penetrate into the Kara sea beyond Novaya Zemlya and produce sufficient snow for ice to form on Severnaya Zemlya (North Land). There are four major and many minor islands in the group. Although they are low lying, consisting primarily of plateaus less than 2,000 ft. high, all the larger islands have icecaps that cover rather less than half the total area. Outlet glaciers reach the sea and are an occasional source of icebergs. Elsewhere the Russian northern areas are remarkably free of ice. Small cirque glaciers are found in the Ural mountains and the mountains of northeast Siberia. Not until the Pacific is approached do the mountains again have alpine glaciers, another indication of the importance of moisture for the development of glaciers.

The glaciers around the North Pacific are concentrated in Alaska. Although the glaciers of southern Alaska are alpine rather than arctic, they are among the finest mountain glaciers in the world. All types of ice are present, from small valley glaciers to highland ice almost burying mountain ranges, with piedmont glaciers spreading out in the lowlands. The largest ice centres are around the Fairweather range, the St. Elias mountains and the Chugach mountains. Glaciers in these areas include the Hubbard, 90 mi. long, intermontane glaciers such as the Seward and piedmont glaciers such as the Malaspina. Smaller glaciers also occur inland on the Alaska range and in the Brooks range of northern Alaska; there is more ice farther east in the Romanzof mountains, where one glacier, the Okailak, is ten miles long. There are a few small glaciers in the Aleutian range and ice is found infrequently on the Aleutian Islands.

The overwhelming majority of arctic glaciers, except for the Greenland inland ice, are in retreat and many areas are more ice-free than ever before in the historical period. In Iceland, where glacier movements are well-recorded, the ice appears to have been restricted from the 10th until about the 14th century. The ice then advanced, reaching a maximum about 1750. A second advance followed a minor retreat, culminating about 1850, and a major retreat set in about 1890. The recession was slow at first but by the 1930s it was generally rapid and has continued since.

(J. B. Bd.)

3. Arctic Ocean.—The Arctic ocean consists of the North Polar sea (sometimes called the Arctic sea) (to approximately 80°

N.) and associated waters such as the Greenland, Norwegian, Barents, Kara and Laptev seas, Baffin bay and the waters of the Canadian arctic archipelago. The total area of this system is estimated at 5,427,000 sq.mi. Hudson bay and Hudson strait add about 480,000 more and the Bering sea a further 885,000.

The North Polar sea contains two basins, each over 13,000 ft. in depth, separated by a ridge or system of ridges, one of which, the Lomonosov ridge, extends from the north of Greenland to the New Siberian Islands. The Marvin ridge lies a little to the west of the Lomonosov and parallel to it, in the region between the pole and Ellesmere Island. These enormous submarine features rise from the floor depth to between 3,300 and 4,500 ft. below the surface. The Greenland and Norwegian seas, each somewhat over 9,800 ft. in depth, are separated by a ridge about 6,500 ft. deep, and the northern of the two (Greenland sea) is separated from the North Polar sea by the Nansen ridge about 5,000 ft. deep. The southern boundary of the Norwegian sea is the Wyville-Thompson ridge, extending from Scotland to Iceland and with an extension between Iceland and east Greenland. A similar ridge reaches across Davis strait, west of Greenland, forming the southern boundary of Baffin bay. This extensive southern ridge system, only about 2,000 ft. below the surface, effectively divides the Arctic ocean system from the North Atlantic proper.

Baffin bay has a maximum depth of just over 6,500 ft. and the waters between the Canadian arctic islands are much shallower, of the order of 1,600 ft. or less. Hudson bay has a general floor depth of only about 650 ft. and Hudson strait has a depth at its eastern end of a little over 1,300 ft. The continental shelf off the north Siberian coast is up to 435 mi. (700 km.) wide; elsewhere it is quite narrow, with the exception of Hudson bay and Foxe basin, which are of shelf depths entirely.

The water masses in this system are (1) the Arctic water; (2) the Atlantic water; (3) the Pacific water; and (4) the deep water of the several basins. The coastal water and upper layer of the North Polar sea are strongly influenced by drainage from the land.

The Arctic water is formed in the North Polar sea from three sources—Atlantic water, drainage from the land, and water from the melting of ice. The result is a layer of water of generally negative temperatures (centigrade) and salinities below 34 grams of salt per kilogram of sea water ($34^0/_{00}$). This layer is generally between 300 and 900 ft. thick. Below it is a thicker layer of Atlantic water, entering the North Polar sea between Spitsbergen and Greenland, with positive temperatures up to 3° C. (37.4° F.) but generally much lower, 0.5° C. (33° F.) to 1.5° C. (35.7° F.). This layer reaches down to a depth of 2,300–2,600 ft., below which is the mass of Arctic bottom water extending to floor depths, again with negative temperatures and salinities close to, but just below, $35^0/_{00}$. Recent research seemed to show that these three layers are not so distinct as formerly thought.

The currents in the Arctic ocean system form a pattern of inflow to, and outflow from, the North Polar sea, which is fairly stable and which allows the whole area to be divided into "arctic" and "subarctic" marine zones (which have little in common with the arctic and subarctic zones on land). By far the greatest inflow is the Atlantic drift water described above, which comes to lie beneath the Arctic layer. A much smaller inflow, about one-tenth in volume, passes north through Bering strait from the Pacific ocean. Allowing for evaporation from the surface, and for the land drainage, the corresponding outflow is shared between the East Greenland current and the Canadian current. There is also a small outflow through Fury and Hecla strait into Foxe basin. The Canadian current flows down the east coast of Baffin Island, drawing its water from the channels between the arctic islands. At the level of Hudson strait it is joined by contributions from West Greenland and from Hudson strait and forms the great Labrador current, which meets Atlantic drift water east and south of Newfoundland. The West Greenland current, flowing north and northwest, is formed by East Greenland current water rounding Cape Farewell and by Atlantic water from the Irminger current which strikes west from southwest Iceland toward southeast Greenland.

In both physical and biological terms, the northern marine environments can conveniently and realistically be divided into arctic, subarctic and boreal, on the criterion of the presence or absence of Arctic water from the upper layer of the North Polar sea. The arctic zone is that marine area lying north of the influence of Atlantic or Pacific water, in the upper layers; the subarctic zone is the area in which Arctic and non-Arctic (Atlantic or Pacific) water are mixed or are found in close relation; the boreal zone is the Atlantic and Pacific area south of the southern extension of the influence of Arctic water, whether mixed or not. The boreal zone extends southward to whatever limit may be conveniently set upon it. In general, the most productive parts of the waters, in terms of living substance, are the subarctic zone and the northern part of the boreal.

Surface temperatures in the Arctic ocean system are always low, seldom rising above 4° or 5° C. (39° to 41° F.) even at the height of summer. Wherever there is ice the temperatures are close to 0° C. (32° F.) or lower (sea water of salinity $34^0/_{00}$ freezes at about −1.8° C.). There is an area known as the "north water," in northern Baffin bay or southern Smith sound, which remains unfrozen all winter, and in this region the summer temperatures are often above 5° C. Hudson bay, which in summer is subject to considerable surface dilution from land drainage, can be as warm as 10° C. (50° F.) in its southern part for a brief period.

The North Polar sea itself is partly covered with sea ice at all times, the extent ranging from about $\frac{1}{10}$ cover to $\frac{9}{10}$ or $\frac{10}{10}$ cover, depending on season and locality. One-year-old ice is seldom more than 7 to 8 ft. thick but rafted ice can extend down to 40 ft. or even more. After one winter sea ice has lost its salt by a leaching process, and therefore when it melts it dilutes the surface layer. The East Greenland and Canadian currents carry both sea ice and icebergs, the latter from the Greenland icecap, southward to various latitudes but normally not farther than Newfoundland. (M. J. D.)

4. Climate.—The climates of northern lands are highly varied. It has been customary to divide them into two large groups corresponding to the climate of icecaps, in which no mean monthly temperature exceeds 32° F., and the tundra climates, with at least one month above 32° F. but no month above 50° F. A more satisfactory division is to classify them as polar maritime climates, located principally around the Atlantic and Pacific oceans, in which winter temperatures are rarely extremely low and snowfall is high; and the polar continental climates, as in north Alaska, Canada and Siberia, where winters are very cold and snowfall is generally light. Included in the polar continental climate type is the Canadian arctic archipelago, which is influenced only slightly by the sea in winter because of thick ice. In addition to these two climates there are smaller transitional zones, limited areas of "ice" climates and, adjacent to the arctic, the subarctic climates.

Although the polar continental climates have low winter temperatures they are not as cold as the subarctic. The lowest temperatures ever recorded in the northern hemisphere were measured in the subarctic of northeast Siberia, the coldest area being around Oymyakon. In North America a temperature of −81° F. was observed at Snag, Yukon territory. Temperatures below −80° F. have been recorded on the Greenland icecap. Colder temperatures have not been found in the tundra regions because generally windier conditions prevail.

Winter sets in toward the end of August in the far north and about a month later near the tree line. The temperature continues to drop rapidly until about December. January, February and early March have uniform conditions with mean temperatures about −35° F. in the central Siberian arctic and −20° to −30° F in North America. The lowest extreme temperatures in the winter are between −50° and −65° F. A better indication of low temperatures as they affect man is given by the windchill, a measurement of the cooling power of the atmosphere on human skin. It reaches a maximum north of Hudson bay, where strong and persistent northwest winds, typical of the Canadian eastern arctic, are combined with low air temperatures. This area is stormy in winter with moderately high snowfall (50–100 in.), rapidly changing temperatures, and even occasional rain. Elsewhere the winter continental climate is quiet, with long periods of clear sky and

low snowfall. Visibility may be poor locally if there are open channels of water in the sea ice and is universally reduced when the wind blows drifting snow. The lowest snowfall is in the northern Canadian islands and in north Greenland, where the total annual precipitation is frequently less than four inches of water.

Winter in the maritime arctic (the Aleutians, coastal southwest Greenland, Iceland and the European arctic) is a period of storminess, high winds, heavy precipitation either in the form of snow or rain (the latter at sea level) and moderate temperatures. The coldest month is rarely below 20° F. and extremely low temperatures are unknown.

Summer temperatures are more uniform across the whole of the arctic. On the southern margin the monthly mean temperature reaches 50° F. and in continental positions short spells of hot weather with temperatures in the 80s, continuous sunshine and calm weather are not uncommon; such weather often ends with thunderstorms. In the maritime climates, along the coasts, and on the northern islands when there is open water in the sea ice, the summer is relatively cool. In the south the temperatures are about 45° F. decreasing north to 40° F. or less; a maximum of 60° F. is hardly ever reached. Fog and low clouds are widespread and at this time of the year these areas are the cloudiest in the world. In areas that experience continental winters precipitation is heaviest during the summer months; light rain and snow showers are frequent but the average fall is rarely high. The summer is everywhere a time of sudden changes. Calm, clear weather with sunshine and temperatures of about 50° F. will be followed by sudden winds, often causing a temperature drop of 20° to 30° and accompanied by cloud and fog. These changes are often local and in the next valley or at the head of a fjord fine weather may continue.

The frost-free and growing periods are short throughout the arctic. For the most part there is no true frost-free period, frost and some snow having been recorded in every month. At a few places near the tree line, notably in the Canadian western arctic, the frost-free period may be the same as the less favourable parts of the prairies.

The polar basin has a winter similar to that of northern Alaska and Siberia with long, clear, cold periods and occasional storms, accompanied by a brief rise in temperature. The summers are cloudy and foggy, winter snow melts off the pack ice and the mean temperature rises to about 35° F. The climate of Svalbard and Novaya Zemlya is transitional between maritime and continental conditions with a cool rather than cold winter (mean temperature 0°).

The only extensive ice climate in the northern hemisphere is that of Greenland. In the south the icecap has maritime characteristics with heavy precipitation, mainly as snow from passing cyclone disturbances. In the north conditions are quieter and the snowfall consequently less. Although the air temperature may sometimes rise to 32° F. the mean temperature remains well below.

The polar climates have changed noticeably during the 20th century, the climatic amelioration that produced the retreat of the glaciers having been widely felt. Sea ice around Iceland, Svalbard and southwest Greenland has decreased in extent. The pack ice in the Arctic ocean is thinner. Birds, animals and especially fish have appeared farther north than before; in Greenland this led to a complete change in the economy, as its traditional dependence on seals gave place to dependence on fishing. Atlantic cod, in particular, have appeared in increasing numbers and are caught north of the 70th parallel. The cod, unlike the seal, does not provide fuel and clothing as well as food; consequently the economy has changed from an extraordinarily self-sufficient one to one based on cash and international trade. With the warming of the climate sheep farming also has been introduced successfully in the southern part of Greenland.

The main changes in the climate result from increases in air and sea temperatures. The increases in air temperatures have been greatest in winter around the North Atlantic ocean centred on Svalbard but are found at all seasons and in all areas. The warming began at the beginning of the 20th century, reached a maximum in the 1930s and declined briefly in many localities in the early 1940s, only to increase again subsequently. The basic cause is not known, although it results directly from increased penetration of southerly winds into the polar regions.

5. Vegetation.—Two main vegetation zones are found in the polar lands. In the south is the subarctic, formed by the northern subzones of the circumpolar boreal forest. To the north is the arctic proper, where the vegetation is generally referred to as tundra (*q.v.*), from the Finnish word for an open rolling plain; in North America the descriptive term Barren Grounds is frequently applied. The two zones are separated by the tree line. This is by definition the absolute northern limit of treelike species, although even beyond it the same species may be found in low shrubs and dwarfed forms. The tree line is composed of different species. In Alaska and northwestern Canada white spruce is dominant while in Labrador-Quebec it is black spruce and occasionally larch. By contrast, in northern Europe and Siberia the tree line is formed by larch, pine and fir. The tree line is related to summer warmth, which may be correlated closely with tree growth. Alexander Supan found good coincidence between the 50° F. July isotherm and the tree line, a figure later modified by Otto Nordenskjöld to allow for spring temperatures.

In North America the tree line extends from the shores of Bering strait along the Brooks range of Alaska to the Mackenzie delta and then curves southeastward across the Northwest Territories to Churchill and James bay. East of Hudson bay it crosses northern Quebec to Ungava bay and then continues into Labrador. In western Scandinavia, the tree line is within a few miles of the sea; it curves east and crosses northern Siberia 50–150 mi. S. of the Arctic ocean.

Arctic plants have to contend with a harsh environment including low temperatures, continuous daylight in summer, poor soil and permanently frozen ground, and in many areas strong, dry winds and blowing snow. The species that survive are few and are frequently dwarfed. Many plants grow in compact cushions for maximum protection from the climate. The growing season is so short that annuals are rare and perennials reproduce asexually by shoots or runners. Even so, arctic plants have a rapid seasonal life cycle. Spring growth often begins when snow is on the ground and there are still heavy frosts; the flower and seed stages follow in a period as short as six weeks. The sudden blooming of flowers is spectacular, particularly along the southern edges of the tundra, and for a short time in July the Barren Grounds are covered with a mass of flowers. The species vary but typical are those in the western American arctic, which include the blue-spiked lupine, wild crocus, mountain avens, arctic poppy and saxifrage. By late August the cycle is complete and the plants are awaiting winter.

At first sight many parts of the arctic are rocky wastes without soil or vegetation. Closer inspection shows that some plant life is always present and even on permanent ice there are often algae. The bare rock surfaces support thin brown, black, or gray crustaceous lichens which swell and become soft when wet; some of the larger black lichens are edible and are generally known as "rock tripe." In the past these lichens have been used by starving explorers for food. Higher plants grow in rock crevices and succeed in forming tussocks on patches of soil. Close to the southern edge of the arctic dwarf shrubs are found in protected sites on these rock deserts.

Tundra areas have a continuous cover of vegetation and many different tundra associations (plant communities) may be recognized. In the drier and better-drained parts, heath tundra is dominant, made up of a carpet of lichens and mosses with isolated flowering plants. In some areas, notably west of Hudson bay, a similar environment results in tundra grassland. When there is more moisture, sedges and grasses become important and form tussock or hillock tundra; willow and dwarf birch may be found between the individual mounds. This type of tundra reaches its greatest development on the north Alaskan coastal plain.

In the warmer parts of the arctic woody dwarf shrubs, willow, birch, juniper and, locally, alder are profuse. In the southern arctic, several of these shrubs modify the heath tundra, and low scrub woods may be quite extensive. On sheltered south-facing slopes, tall thickets of willow, birch and alder develop and, under

optimum conditions, these bushlike "trees" may be more than ten feet high. This type of vegetation is common in all circumpolar lands close to the tree line and is conspicuous in the inner fjords of southwest Greenland and in northern Iceland. The bushes may be used locally for fuel or for mats in the western Canadian arctic, and in former times were used by Eskimos for arrow shafts. The wood is unsuitable for bows, spears, or boat building; for these purposes the Eskimos either had to travel to the tree line or search for driftwood that was widely distributed along the arctic coasts.

The tundra vegetation is the source of food for the northern grazing mammals but contains few foods of direct value to man. Berries are found throughout the southern arctic. Most widely used by the native population has been the black crowberry (*Empetrum nigrum*), eaten either raw or mixed with animal oil. Europeans have found the cloudberry (*Rubus chamaemorus*), bilberry (*Vaccinium uliginosum*), and mountain cranberry (*V. vitis-idaea minus*) more palatable. Mushrooms are widely distributed and can be used for a welcome change of diet.

South of the tree line is the subarctic forest-tundra. Its bare wind-swept ridges are covered with tundra associations while in the sheltered valleys there are woodlands which may become continuous near large rivers and, if the rivers flow north, may project many miles into the Barren Grounds. These areas, known as *galeria* forests, are found along the Coppermine river of Canada and are frequent along the north Siberian rivers. The woods contain the same coniferous species as form the tree line, together with several broad-leaved species, notably birch.

Arctic soils are closely related to vegetation. Unlike soils farther south they rarely develop strong zonal characteristics. By far the commonest are the tundra soils, which are circumpolar in distribution. They are badly drained and strongly acid and have a variable, undecomposed organic layer over mineral horizons. Some of the drier heath and grassland tundras overlie arctic brown soils which have a dark-brown upper horizon with gray and yellowish-brown lower horizons. The active layer in the permafrost is normally deep in them. (J. B. Bd.)

6. Animal Life.—Compared with that of warmer parts, animal life in the arctic is poor in species but often rich in individual numbers. This is generally considered to be the result of at least two factors—the comparative novelty of polar glacial climates, allowing only a limited time for adaptation since their onset; and the much lesser variety of habitats available for colonization in the north as compared with the lower latitudes.

The fauna considered in this section is that of the true arctic zone only. On the land, this is the zone north of the tree line; in the sea, the area in which the upper water is of North Polar sea origin (see *Arctic Ocean*, above), without admixture of Atlantic or Pacific water. This excludes most of the west Greenland waters and the waters of west and southern Iceland, the Faeroe Islands and Norway; it also excludes the Labrador sea and the waters of the Labrador coast south of Hudson strait.

Animals of the Land and Fresh Water.—The typical and best known arctic land mammals and birds are those highly successful forms, most of them circumpolar in distribution, which survived the Pleistocene glaciations probably both south and north of the ice sheets, south along the ice perimeter and north in ice-free refuges such as northern Alaska, the Bering strait (then dry land), and northeast Siberia, certain of the Canadian arctic islands and probably northernmost Greenland. These include the polar bear (as much a marine as a terrestrial animal), caribou, arctic wolf, arctic fox, arctic weasel, arctic hare, and the brown and collared lemmings, ptarmigan, gyrfalcon and snowy owl. These, together with the vegetation that feeds the lemming, ptarmigan and caribou, form a tight ecological system which is virtually self-sufficient. During the winter, and during periods of low lemming population which occur every three to five years, the carnivores make some use of seashore life and (through the agency of the polar bear) of seal and fish. In extreme starvation conditions there is a tendency for the snowy owls and gyrfalcons to go south in winter and for the foxes and wolves to become scavengers.

The caribou is a migrant, but only between the arctic tundra and the conifer (subarctic) zone to the south, and there are far northern groups of caribou whose migrations are more restricted. The musk ox is a special case. Now restricted to the North American arctic (including north Greenland), it was formerly more widespread, and is probably to be regarded as a "refugee" species, chased into the far north and on the defensive in the evolutionary sense.

Hibernation is not a phenomenon of the arctic because frost-free refuges are not available; all the nonmigrant, warm-blooded animals therefore remain active all winter. Any incipient hibernation, shown for instance by the arctic ground squirrel, proves abortive, the animals shivering themselves awake after only a few days.

Most of the birds of the arctic zone are migrants, coming from wintering grounds as far away as the southern U.S., Central America, Brazil, or even the subantarctic zone. By migration the birds obtain the advantage of the long northern summer days and of the high productive capacity of plant foods in the short but intense growing season. There is increasing evidence that food is not a limiting factor on summer bird populations in the arctic, except in the case of strictly predaceous species during years of scarcity of prey. Typical land and fresh-water birds of the arctic zone are the redpoll, Lapland longspur, snowbird, wheatear, pipit, certain plovers and sandpipers, loons, rock ptarmigans, ducks and geese.

There are no reptiles in the arctic zone, owing to the absence of frost-free winter refuges, but one amphibian, the wood frog, does penetrate just north of the tree line in arctic Canada. It breeds in July and early August in ponds and small lakes, and spends the rest of the year buried in the mud at the bottom. The mud does not freeze and the frogs are able to breathe through the skin, which the reptiles cannot do.

Fresh-water fishes in the arctic are represented by a few species only: whitefish, lake trout and speckled trout, arctic grayling, two species of stickleback, the Alaskan blackfish and the arctic char. In some regions the burbot, northern pike and Atlantic salmon penetrate north of the tree line.

The invertebrate fauna of the land and fresh water consists largely of insects, including the chief scourges of the north, mosquitoes and black flies. Among the most northern navigators are certain spiders, which winter even in northern Ellesmere Island. Crustacea are represented by the branchiopods, which form an important part of arctic pond life, and by the copepods. There is in addition a very considerable number of smaller species belonging to many phyla.

Animals of the Sea.—In terms of the mass of living matter produced, the seas are by far the richer part of the arctic, and it is no accident that the Eskimo economy has traditionally been marine. The bowhead or Greenland whale was once hunted keenly by both white men and Eskimos; almost extinct at the beginning of the 20th century, it is now coming back in some strength. The sperm whale is also frequently seen. The commonest whales are of the porpoise group, the beluga or white whale, the narwhal and the killer whale, the last-named being possibly the fiercest and least friendly mammal alive. The pinnipeds are represented by the walrus, now recognized as two species, Pacific and Atlantic, which between them form an almost complete circumpolar ring; and by the hair seals, including the bearded seal or squareflipper, the little ringed seal, the northernmost of the harbour seal populations, the ribbon seal (a North Pacific rather than arctic form) and the migrant harp and hooded seals, both of which are North Atlantic species with summer feeding areas in eastern arctic Canada, Greenland and eastward.

The sea birds are represented by the auk family (murres, guillemots, auklets and little auk), the sea ducks (eider, scoter, old squaw), the gulls and terns (especially the glaucous and glaucous-winged gulls, many of the herring gull group of species, Sabine's gull, and the common and arctic terns), the jaegers (parasitic, pomarine and long-tailed), and the waders (sandpipers, etc.). One of the petrel group, the fulmar, breeds on certain arctic cliffs. These are all migrant species which fly south in the fall. The arctic tern makes a remarkable migration to subantarctic waters.

It is characteristic of arctic waters (as opposed to subarctic mixed waters) that they are poor in fish species. In the subarctic

the fishes are the dominant larger forms but the mammals dominate in the arctic. A few species of sculpins, eelpouts, snake blennies, sand launces and lumpsuckers are found in the arctic zone, but they are comparatively insignificant ecologically. Only three species can be said to be significant—the arctic cod, a small cod often found abundantly at the surface in the North Polar sea and also further south; the arctic char, an anadromous species related to the speckled trout, which moves upstream to spawn and spends perhaps two months or less in the sea per year; and the Greenland shark, which grows to a length of about 15 to 20 ft. and is common in the far north, especially off bold rocky shores in deep water.

The invertebrate life is well developed and sometimes astonishingly abundant, but it forms too specialized a topic to be discussed here. The polar basin itself, although much poorer in planktonic life than the waters immediately to the south largely owing to ice cover, nevertheless carries a comparatively large production associated with the ice itself, in the form of Crustacea which appear to feed upon organic material occluded or otherwise attached to the ice surfaces. (M. J. D.)

III. PEOPLES OF THE ARCTIC

1. Northern America.—All of the American arctic and much of the subarctic is occupied by a single people, the Eskimo (*q.v.*). With their territory extending over more than 6,000 mi. of coast line from south Alaska to east Greenland and Labrador, the Eskimos have the greatest linear distribution of any people in the world, though they number only about 50,000 individuals. Throughout this enormous territory there is a remarkable uniformity of language, culture and to some extent physical type. To the south of the Eskimos are two Indian groups, the Algonkian Cree and Naskapi of central and eastern Canada and the Athapaskans of interior Alaska and Canada, the northernmost of whom are the Koyukon, Tanana, Kutchin, Hare, Bear Lake, Dogrib, Yellowknife, and Chipewyan.

2. Northern Asia.—The peoples of arctic Asia, like the Eskimos and American Indians, are physically Mongoloid. On the other hand, northern Eurasia is an area of marked linguistic diversity. The lands bordering the Arctic ocean from Bering strait westward to Scandinavia are inhabited by peoples speaking many languages falling into no less than six separate linguistic stocks—Eskimo, Paleo-Siberian, Altaic, Ket, Uralic and Indo-European. The presence of numerous languages in arctic Eurasia shows that the region has been penetrated repeatedly by different groups of people in the past; the contrasting situation of a single language—Eskimo—on the arctic coasts of America shows that no such penetration occurred there. The primitive tribes of northern Eurasia have been subjected to strong Russian influence and their mode of life has changed considerably, especially in the Soviet period.

Eskimos.—The Siberian Eskimos or Yuit live in permanent villages on the east coast of the Chukchi peninsula facing Bering strait. They are related to the Yuit of St. Lawrence Island and are primarily sea mammal hunters. Archaeological evidence indicates that the Siberian Eskimos are not relatively recent migrants from Alaska, as was once thought, but the remnant of an ancient Eskimo population ancestral to that of Alaska.

Paleo-Siberians.—A number of primitive peoples in northeastern Siberia are referred to collectively as Paleo-Siberians on the assumption that they are the original inhabitants of the area, pushed there by pressure of Neo-Siberian (Altaic) peoples moving up from the south. There are four groups of Paleo-Siberians, each speaking its own language:

(1) The Gilyaks or Nivkhi who occupy the lower Amur river and Sakhalin Island and who live by hunting, fishing, sealing, trapping, and more recently cattle breeding and farming.

(2) The Chukchi group, with a total population of about 20,000 and by far the largest of the four groups. It comprises the Chukchi or Luorawetlan of extreme northeast Siberia; the Koryak or Koriaki, occupying the northern part of the Kamchatka peninsula and adjacent areas to the north; and the Kamchadals or Itelmen of the Kamchatka peninsula. The Chukchi and Koryak are divided into nomadic and sedentary groups, the former roaming the interior with their reindeer herds, the latter living in permanent settlements along the coast where they hunt sea mammals. The Kamchadals live mostly by fishing.

(3) The Yukaghir group, living between the Yana and Indigirka rivers and along the tributaries of the upper Kolyma, and including the Yukaghir or Odul and the closely related Chuvantsy or Etel and Omok or Omoki. Their language is probably related to Uralic.

(4) The Yeniseian group—hunters, fishers, reindeer breeders—living mostly along the Turukhan and middle Yenisei rivers, comprising the Kets, formerly known as the Yenisei Ostyak, and three small extinct groups, the Kots, Asans, and Arins.

Tungus.—More widely distributed than any other Siberian people, the Tungus (Evenki) extend south from the Arctic ocean to Manchuria and west from the Okhotsk sea to the Yenisei river. Numbering about 62,000, they live as reindeer herders and hunters in the north and as cattle breeders or farmers in the south. The Tungus language is one of the major divisions (Tungus-Manchu)

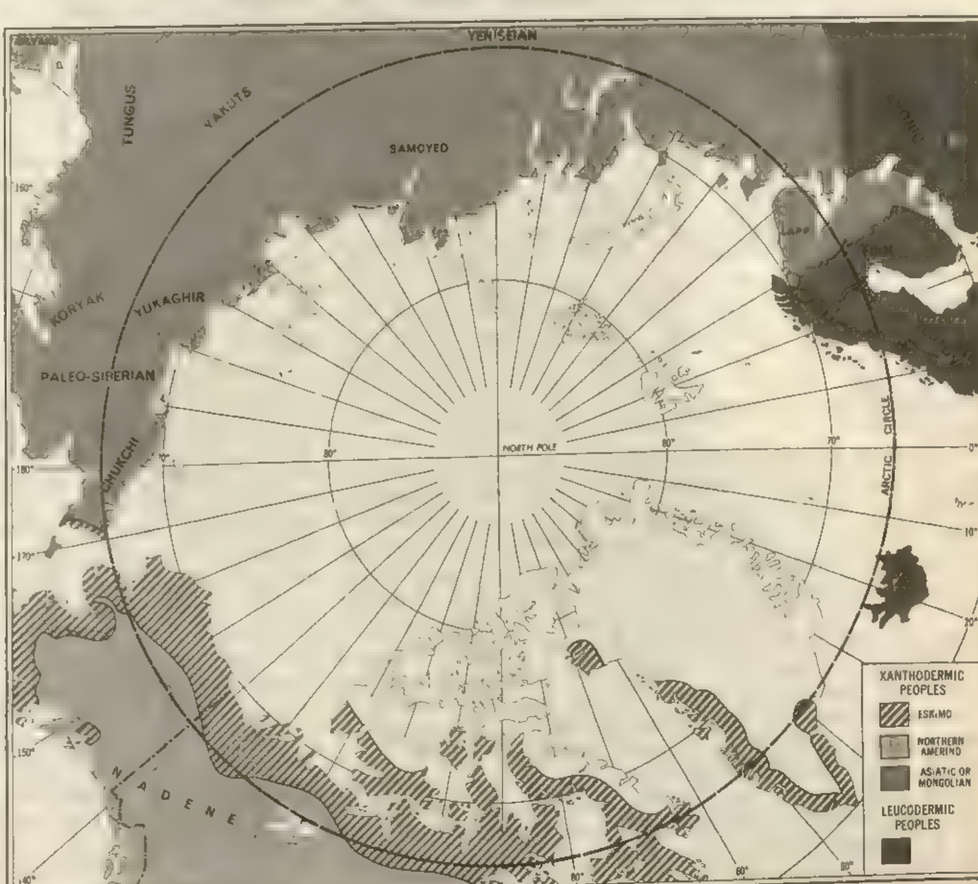


FIG. 4.—DISTRIBUTION OF NATIVE ARCTIC POPULATION

of the Altaic stock and is related to that of a number of tribes living in the Amur region: Gold (Nanai), Negidal, Orochon (Orochi), Oroki, Olchi (Ulchi).

Yakuts.—The most culturally advanced of the native Siberian peoples are the Yakuts (pop. about 236,000), who occupy the basins of the Lena river and its tributaries the Aldan and Vilyuy and farther to the north the Anabar, Olenek, Yana, Indigirka and Kolyma rivers, all within the Yakut Autonomous Soviet Socialist Republic (*q.v.*). In the south the Yakuts breed horses and cattle and practice agriculture; in the north they are mostly hunters, fishers and reindeer breeders. Their language is Turkic, one of the three divisions of the Altaic stock.

Samoyed.—The Samoyed or Nentsy (pop. about 16,000) occupy an extensive territory in northern Siberia and Europe from the Taimyr peninsula westward to the White sea. Subdivisions include the Tavgi-Samoyed (Nganasany), the Selkups and the Entsy. The Samoyed are a nomadic people who live by hunting, fishing, and reindeer herding. Their language is related to Finno-Ugrian, the two together forming the Uralic linguistic stock.

3. Arctic Europe.—Northernmost Europe and adjacent northwestern Siberia is occupied by peoples speaking either Indo-European (Russians and Scandinavians) or Finno-Ugrian. The latter substock is divided into two branches: the eastern or Ugrian, represented by the Ostyaks or Khanty and the Voguls or Mansi who live along the Ob river, and the Magyars in far distant Hungary; and the western or Finno-Permian branch, which includes the Finns, Lapps, and Zyrians. (H. B. Cs.)

IV. ECONOMIC AND SOCIAL DEVELOPMENT

The story of man in the arctic can be generalized as quests for shorter trade routes between East and West, exploitable natural resources, scientific knowledge and national security. These quests were given greater urgency by patterns of modern population concentration, population growth and human aspirations. Nine-tenths of mankind resides in the northern hemisphere, and, with the exceptions of China and India, the capitals of the major northern nations are closer to the Arctic circle than to the equator. The sea and air transportation revolutions of the 20th century have at least partly verified Vilhjalmur Stefansson's prophecy of the Arctic ocean as the new "mediterranean." Natural resources in the arctic gained greater significance by the increasing world population and the drive for better living standards.

The arctic lands are shared between Canada (approximately 37%), the Soviet Union (28%), Denmark (Greenland, 28%), the United States (Alaska, 6%), Iceland, Norway, Sweden, and Finland. Although the arctic is relatively definable physically, it cannot be delineated so easily in economic, political and social terms. Generally, the administrative and political units and the development programs merge the physical geographer's zones into more viable economic units that include southern extensions of the physically defined arctic. This review, therefore, will deal with the "far north" defined as the sum of present political and administrative units embracing the arctic proper within their boundaries.

1. Role of Location.—The spherical shape of the earth and the location and form of its main land masses provide the most dynamic factors in the development of the arctic and strongly influence that of the subarctic. Prehistoric man moved between the northern continents around the rim of the Arctic ocean, and modern man found the Pacific and Atlantic great circle routes and polar routes over the arctic the most feasible and shortest ways to travel between North America and Eurasia.

The military importance of the far north was long recognized and in part explains naval interest in polar exploration during the 19th century and the United States purchase of Alaska in 1867. During and after World War II the placement and manning of defensive and offensive facilities created new military settlements around the arctic and subarctic and required the stepping up of all manner of scientific investigations and research. The changes in the technology of warfare created continuing construction booms as widely scattered small landing fields were replaced by centralized launching facilities and detection progressed from direct human observation to ballistic missile early warning stations.

Commercial transportation and military developments created the need for a progressively expanding and elaborated system of navigational aids and scientific undertakings. Outposts for the study and forecasting of weather and sea ice conditions were essential for transpolar flights and for the safe use of the shipping lanes. As a by-product, the far north was discovered to be an ideal laboratory for research in a wide range of geophysical and biological fields.

2. Natural Resources Utilization.—Natural resources utilization took two broad forms—subsistence hunting, fishing and agriculture, and highly specialized commercial exploitation for export. Some isolated groups of people still depend upon hunting and fishing for varying degrees of their subsistence. Commercial exploitation and development for export has in general been sporadic, narrowly specialized, absentee in management and all too often ruthless and destructive. Economic factors of distance from markets and high costs determined that only resources of high contemporary scarcity value would be utilized and that the operations would be carried out with little regard for sustained yield of renewable resources and with wasteful production of only the richest deposits of nonrenewable resources. Public policy and government operation have played important roles in all northern development, ranging from the totally state-planned and -managed operations in the Soviet Union, through the state-operated trading monopoly in Greenland, to the heavy public subsidy of private development in western Europe, Canada and Alaska.

Renewable Resources.—Hard on the heels of the first explorers came whalers, and for generations the northern seas were a major source of whale oil and by-products until the resources were exhausted. Local coastal populations and larger numbers of seasonal workers of the distant-water fishing fleets of the U.S.S.R., the United States, Canada, Japan and most of the European nations engaged in the commercial harvesting and processing of marine resources organized on highly industrialized lines. These activities progressively broadened in scope from the selective exploitation of a few species and limited variety of processing to comprehensive harvesting and a greater diversity of product.

In international waters a number of treaties and arrangements attempted to minimize conflict and provide a degree of management. The Fur Seal Treaty of 1911 between Russia, Japan, the United States and Great Britain (later Canada) was unique in that it appointed Russia and the U.S. as agents to manage and harvest seal herds for the benefit of all four nations.

The great trading companies of the 16th and 17th centuries launched a stream of hunters, trappers and traders across the northern lands, opening the way for other developments and continually altering the indigenous economies. But depletion in supply and decline in quality of the fur resources, coupled with the fickleness of markets and prices, reduced the fur trade to a minor and unstable element in northern economies.

Agriculture has been dependent upon the creation of isolated local markets by military, mining and other economic developments. Soil, climate and cost factors have strictly limited crop raising and dairying. Commercial grazing of sheep has been successful on a small scale in Alaska, Greenland and Iceland, but the principal domestic animal of the far north is the reindeer, originally raised by the Lapps in the north of Scandinavia. Attempts to transplant the herding activities of the Lapps to Alaska in the last century for the benefit of the Eskimo population and more recently to northern Canada have had many reverses and are only moderately successful at a few localities, chiefly Nunivak Island in Alaska. In the Soviet Union and the Scandinavian far north reindeer husbandry is a major industry.

The boreal forests bordering the tundra zones are so extensive that the U.S.S.R. and Canada rank among the world leaders in forest resources. Except for the more accessible southern areas of these nations and the coastal forests of Alaska, however, lumbering has been limited to the meeting of local needs. Hydroelectric power potentials are impressively large, and some major developments have taken place on the southern fringes of the subarctic. Farther north, ambitious plans have been considered,

such as the Rampart Canyon project on the Yukon river and the reversing of the headwaters of the Pechora and Vichegda rivers into the Volga system.

The far north has long attracted big game hunters, sportsmen and travelers. Its still abundant wildlife, spectacular scenery and unusual wilderness constitute important assets that might lead to a significant growth in tourism.

Nonrenewable resources.—Gold has been mined in the Russian north since the 1840s and this region today is second only to South Africa in world production. The Soviet mining industry expanded into the far north following World War I and is strongly developed on the Kola peninsula, the Pechora valley and the lower Yenisei river. The U.S.S.R. also mines large amounts of copper, nickel, industrial diamonds, mica, tungsten and tin in its arctic and subarctic areas. More than half the world's nickel and large percentages of its lead, zinc, gold, silver, platinum and uranium come from the Canadian mining districts of northern Ontario, Yukon territory, Great Slave lake, Athabasca lake, northern Manitoba and the Labrador-Quebec border. Of the promising future large developments in northern Canada, the most immediate are iron ore on Ungava bay and base metals on Baffin Island and the northern mainland. Alaska's production of gold and copper slumped or disappeared before and during World War II, but there is immediate prospect of an important copper revival and long-range prospects for iron ore and other metals. Greenland produced cryolite and small quantities of lead and zinc, and northern Sweden has extensive high-grade iron ore deposits.

Conditions favourable to the formation of petroleum reserves exist in the sedimentary rock of most of the arctic and subarctic, and coal is known to exist in great quantities. The chief coal-producing areas are in the Soviet Union and the south-central and interior of Alaska, with minor production in Spitsbergen and in Greenland. Oil-producing areas include the northern Alberta fields, the Kenai peninsula-Cook inlet fields in Alaska and large areas west of the Ural mountains in the U.S.S.R. Exploration and development under U.S. government auspices have been conducted in the large naval petroleum reserves created in Alaska's arctic in 1923, and private activities are being conducted in the arctic of Alaska and Canada. Natural gas from producing fields in the far north is being piped into the industrial complex of the Urals and is also used locally in Alaska and Canada.

3. Transportation.—In economic and social terms the arctic and most of the subarctic are composed of several "islands" linked to their homelands by a few tenuous transportation lines. Within each national compartment, local systems have evolved independently in response to regional commercial and military needs. Only in the 20th century has there been serious consideration of overall transportation systems as keys to increased economic development.

The essential North American arctic sea routes are those linking Alaska to the continental United States and extending eastward to the Canadian arctic, those linking central Canada to the far north by way of Churchill on Hudson bay, and those from the Atlantic coast of Canada to the Canadian eastern arctic. Defense construction and maintenance operations caused a great upsurge in shipping after 1950, made possible by the construction of powerful new icebreakers, extensive hydrographic surveys, air reconnaissance, and large-scale mapping. For more than two centuries Denmark has had fairly regular shipping connections with west Greenland, expanding these as the economy developed and eventually maintaining them on a year-round basis. There is still a lack of good harbours on Greenland and east Greenland suffers from severe ice conditions, requiring the supplementing of far north ship transport by air carriers. On a seasonal schedule Svalbard is linked to northern Norway by ship and the Soviet Union has a similar route to Murmansk. The development of a sea route around northern Asia was a spectacular achievement of the U.S.S.R.

Within the several regional units of the far north, aviation has been the most flexible and useful mode of transportation. Civil aviation is best developed in Alaska, northern Canada and Siberia and least in Greenland and to Svalbard.

When economic development goes beyond the pioneer stage, need for surface transportation arises. In the U.S.S.R. railroads appear to be most important; new lines have been extended into the Pechora valley and to the Ob river and extensions have been made in the Murmansk area. In Alaska and northern Canada the extension of the road network is favoured. The Alaska highway with continuously expanding tributaries in Alaska and Yukon territory is a permanent part of the North American highway system. Topographic factors make it unlikely that surface land transport will ever be important in the eastern Canadian arctic and in Greenland.

4. Social and Political Characteristics.—Aboriginal populations were dispersed in kin groups, thinly spread and often on the move. Settlements were found at favourable fishing locations along the southern coasts, but it was not until the arrival of outside influences that the indigenous people lost their dominantly nomadic character and concentrated at a few places determined by trade, opportunities for employment and public services. Like the first settlers, European and American migrants and transients concentrated along coastal areas and river systems. The recent transportation and communications revolutions, however, rendered the concept of a continuous ground-contact frontier zone obsolete, and isolated islands of mid-20th-century technology and urban living can be found in the northern wilderness. Regardless of the national territory, these recent settlements present a uniform range of types: isolated technical stations (weather, ice island stations), military bases, outposts (missions, fur-trading posts), resource development settlements, regional administrative centres and multipurpose towns and cities. In the 1960s there was only one Canadian town north of latitude 60° N. with more than 1,000 inhabitants; Alaska had two with more than 10,000, while the Soviet Union had five cities with more than 100,000 inhabitants. Isolation and remoteness from population centres remained the commonplace of human life in the north.

Political development underwent frequent experimental reform during the 20th century. Although the Russians had been in the north for several centuries, only during the Soviet period was much attention paid to administration and local rule. The Russian Soviet Federated Socialist Republic stretches across the entire Asian coast of the Arctic ocean and far inland to the south. Instability of territorial patterns appear to be a permanent element in administration of the northern regions of this political unit. Administrative-territorial divisions responsible for cultural and political affairs and law enforcement have been reshuffled, with some indication of trends toward formation of more independent units across the north. Economic administration was decentralized in 1957 by creation of a network of economic administrative regions under local councils, but after 1965 there appeared to be a return to centralization.

The arbitrary boundary of the 60th parallel divides the Yukon and Northwest territories from the Canadian provinces. Within those territories the Canadian government has a dual responsibility to administer its regular federal programs as well as to perform functions of quasi-provincial administration and supervise a rudimentary legislative system. Constitutional and administrative reforms have skirted the problems of self-determination and/or self-sufficiency. However, more drastic steps toward increased self-determination were taken elsewhere. The republic of Iceland was proclaimed in 1944 after almost three centuries of Danish rule and 26 years as an associated "sovereign state." Under the 1953 Danish constitution the former colony of Greenland became an integral part of the commonwealth with representation in Parliament. A similar event occurred in 1959 when Alaska officially advanced from the limited self-rule of territorial status to become the 49th state of the U.S. (G. W. Ro.)

V. POLITICAL AND STRATEGIC ASPECTS

The arctic presents special problems with respect to ownership and control of the arctic islands lying between the mainland coasts of the surrounding continental areas and the north pole. Similarly, there are problems of jurisdiction relating to the waters between islands and the mainland, waters within the island systems themselves, the open arctic seas and that part of

the Arctic basin in a state of congelation, where pack ice and ice islands are to be found in great areas in the polar seas and comprising, of course, the polar icecap itself. Problems of jurisdiction include the question of sovereignty in the air space over the arctic and control, if any, of the waters under the pack ice.

Much of the complexity in arctic territorial claims has resulted from difficulty in applying traditional doctrines governing the acquisition of territory to these land, water, air and ice areas. Classically, international law has provided that the acquisition of territory may take place under several well-established conditions: conquest, accretion, discovery, occupation and prescription. As to the high seas, however, the doctrine of the freedom of the open sea has long been established rendering *res communes* all of the open sea except for a marginal coastal belt (the width of which varies somewhat in different countries), but even through this territorial sea ships of other nations have had rights of "innocent passage." Similarly, nations could make claims with respect to "historic bays" and, possibly, certain types of "historic waters," although in both cases the definition remains difficult. Finally, established doctrines with respect to jurisdiction in air space have provided for complete and exclusive control by a nation of the air space over its territory as well as over its territorial seas, and there are no rights of innocent passage in such territorial air space. These air law concepts, evolving from customary law through the Paris convention of 1919, were confirmed by the Chicago Convention on International Civil Aviation of 1944. Air above the open sea is as free as the open sea itself; the Geneva Convention on the High Seas (1958) reaffirmed the freedom of all states to fly there.

Because of the peculiar historical, geographic and strategic characteristics of the arctic areas, nations have not found it possible to apply these doctrines there with directness or simplicity. While discovery, apart from war, was perhaps the most important original basis for the acquisition of territory, it was replaced in the 18th and 19th centuries by the doctrine of "effective occupation." Discovery was regarded by then as providing only an inchoate or incomplete claim, to be effected by "a peaceful and continuous display of authority"; the quantum of "display" would vary, of course, with the topographical, economic and population realities in each case. Theoretically, the islands of the entire Arctic basin were open for discovery and occupation by all and ought to have been within the sovereignty of those who first discovered or effectively occupied them. However, there emerged very early in the developing boundary treaties of countries bordering the Arctic basin, specifically between Russia and the United Kingdom in their conventions of 1824 and 1825, the notion that the line of demarcation between British North America and Russian-American territory extended beyond their arctic coasts and ran ". . . in its prolongation as far as the Frozen Ocean . . . ." This language was repeated, with some modification, in the treaty between the United States and Russia in 1867 when Alaska was purchased by the United States.

This concept of sovereignty or jurisdiction extending northward beyond the mainland within longitudinal lines has become known as the "sector theory"; upon it both Canada and the U.S.S.R. appear to base their present claims to sovereignty over all lands within their triangular sectors up to the pole, whether discovered, effectively occupied or not. The nations most directly concerned with the sector theory are not only those that benefit from a long arctic coast line, such as Canada and the U.S.S.R., but also others such as Denmark in the case of Greenland and the United States in the case of Alaska. Presumably smaller sectors also are available to Iceland and Norway.

Most countries interested in the arctic seem to have accepted the sector principle with respect to land (that is, the arctic islands and territorial waters surrounding them), although the United States has at times maintained a noncommittal attitude. Consequently, it is unlikely that nations having sector claims would accept claims of any other state based on discovery or occupation; and conversely, nations making such discoveries are not likely to assert claims to lands or islands found in sectors of other states.

What remains very much in doubt, however, are the claims put forward by a number of Soviet scholars—with some apparent support from the government of the U.S.S.R.—over (1) the open waters between islands or between islands and the mainland; (2) that part of the Arctic ocean where no islands are to be found; (3) arctic ice islands and the ice pack; (4) the air space above the entire sector. Most nations and scholars would deny such broad claims by sector states. The problem may have been complicated, however, by the decision of the International Court of Justice in the Norwegian Fisheries case (1951), in which it was held that the great archipelago off the Norwegian coast could be treated as a geological formation integrated with the mainland and that, therefore, the waters of the fjords, extending in some cases 40 mi. from the mainland out to sea, should be regarded as national or internal waters, with territorial waters a further 4 mi. beyond a base line drawn from the outer rocks and shoals of the island system. While the decision may not be applicable to all the arctic islands, the reasoning does suggest, particularly in the case of Canada, the possibility of claims based on a "zone of attraction" or on the geological connection between the great Canadian arctic islands and the Canadian mainland.

With respect to the open seas of the arctic, such as Beaufort sea north of North America and the Barents and Laptev seas north of the U.S.S.R., claims of jurisdiction are not regarded as well founded either as to the waters themselves or the air space above them. Equally, there would seem to be no serious international acceptance of claims to sovereignty over the arctic ice islands or the icecap. The polar cap comprises pack ice at an average depth of 8 to 12 ft. with substantial areas now known to be open. While it does not have the solidity so often assumed for it previously, large areas are nevertheless sufficiently firm to be available for temporary use by meteorologists as well as for air navigation, general scientific work and presumably military purposes as well. The ice is in constant motion, moving in a counterclockwise direction around the pole, thus making it quite possible for Russian, U.S. or Canadian bases to move into each other's sector over a period of time if these were set up on the ice

Finally, the doubtful basis for any claims of jurisdiction over the pack ice within their respective sectors makes it impossible for any of the sector states to claim jurisdiction over the waters under the pack ice. The Russian claims there seem more determined than the Canadian, although some distinction is being drawn in Canadian government statements between the open Arctic ocean and the polar icecap.

Another modern development which may have commercial significance in the future is that of the "continental shelf" doctrine, given international recognition by the Geneva convention of 1958. The convention made it clear that states will be able to assert jurisdiction over a shelf of land covered by not more than 200 m of water for as far northward from the arctic mainland as that shelf may extend at such depth, and for even larger areas if the shelf can be exploited for its natural resources at a greater depth. The convention further provided, however, that exploitation of the shelf for its resources must not interfere with the legal status of the high seas or air space beyond territorial waters.

It may be concluded, therefore, that while the sector theory in the arctic has not been formally adopted by states other than those benefitting substantially from it, such as Canada and the U.S.S.R., it seems quite firmly established with respect to lands and their territorial waters but not to open waters, air space, ice islands and pack ice. It would not seem possible to apply to the Arctic procedures similar to those provided for by the Antarctic treaty. (MA. C.)

VI. FUTURE DEVELOPMENT

Vilhjalmur Stefansson lived to see his thesis "northward the course of empire" being verified. Great aircraft on international flights now range daily far over the Arctic ocean, while nuclear submarines can cruise almost at will beneath its shifting ice cover, Alaska has become a state of the U.S., Soviet icebreakers annually lead ships in substantial numbers along Siberia's northern coast between the western U.S.S.R. and the Pacific, and mining and petroleum exploration and development penetrate farther and

farther north in both the eastern and the western hemispheres.

Trevor Lloyd of McGill University has pointed out, "In spite of the map on the schoolroom wall the Arctic Ocean is not a strip of ice-filled water along the upper edge of the world, but a comparatively small, almost enclosed sea, in reality a gulf of the North Atlantic. From its shores the world's land masses radiate toward the south. It is in a literal sense a 'mediterranean' lying in the middle of the continents."

Of great importance in the opening of the Arctic is the situation also pointed out by the same authority that "Although the land areas surrounding the polar basins have a natural unity, their present-day political and socioeconomic diversity has been brought about by influences from farther south. These have extended northward from the mid-latitude lands, occupied by peoples of varying history and culture, creating striking circumpolar differences where uniformity or at least similarity might have been expected. The Eskimos, once a unified culture from west of Bering Strait to East Greenland, confront the world today as citizens of the United States, Canada, Denmark, or the Soviet Union and with only the most tenuous of links remaining between them."

Only a modest beginning has been made in the detailed geological mapping of the north polar lands, yet they have long been important sources of a number of minerals which have a great potential for further exploitation. In the Soviet Union development and exploitation of mineral resources have gone on apace—the great northward-flowing rivers like the Ob and the Yenisei have provided links between the Trans-Siberian railway to the south and the northern sea route. Settlements like Norilsk and Yakutsk have become cities and are gaining importance nationally. The Canadian north is stirring too; large iron deposits have been found and are being appraised in the east on Baffin Island and in the west in the Yukon Territory. Other minerals also are being exploited. It is reported, for example, that the total leaseholdings for petroleum exploration in the Yukon Territory and Northwest Territories of Canada now approach 160,000,000 ac. The ultimate reserves in those territories are estimated at nearly 50,000,000,000 bbl.

Alaska, too, is sharing in the surge of northern interest, exploration and development. Though it is true that not all of Alaska is properly considered arctic, the progress of the new state is indicative of northern gains in general. By the mid-1960s production in both the fisheries and mining industries had reached record levels.

Perhaps the least touched of all arctic resources are those that can be designated as recreational. Fishing and hunting are expanding as transportation and communication become cheaper and more widely available. In many parts of the Arctic, scenery is a valuable asset and is being exploited at an increasing rate. Cruises in the fjord regions of Norway have long been famous, and in time some of the similar fjords of Greenland may become well known to tourists. (J. C. R.)

See also references under "Arctic, The" in the Index.

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ARCTINUS (fl. 776 B.C.), of Miletus, one of the *Homeridae* ("Descendants of Homer") and traditionally the author of two poems in the lost Greek epic cycle. Proclus says in his *Chrestomathia grammatica* that Arctinus wrote the *Aithiopis* ("Ethiopian"), a sequel to the *Iliad* narrating the deeds and death of the Amazon Penthesilea, of Memnon the Ethiopian king and of Achilles, and the *Iliou Persis* ("Sack of Troy"). Both are assigned to other authors by other ancient sources, one of which attributes the *Titanomachia* ("Battle of the Titans") to Arctinus.

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ARCTURUS, one of the brightest stars in the northern hemisphere, situated in the constellation Boötes (*q.v.*) in an almost direct line with the tail of the constellation Ursa Major ("Great Bear"); hence its derivation from the Greek words for "bear guard." It is an orange-coloured giant star at a distance of about 40 light years from the sun. For the Greek myth of the origin of the star, *see* CALLISTO.

ARCULF, a Frankish bishop and pilgrim-traveler, who visited the Levant about 680, and was the earliest Western Christian traveler and observer of any importance in the Near East after the rise of Islam. On his return he was driven by contrary winds to Britain, and so arrived at Iona, where he related his experiences to his host Adamnan, abbot of Iona. The narrative of his journey, *De locis sanctis*, as written by Adamnan (*see* ADAMNAN, SAINT), came to the knowledge of Bede, who inserted a brief summary of it in his *Ecclesiastical History of the English Nation*, and also drew up a separate and longer digest that obtained great popularity throughout the Middle Ages as a standard guidebook to the holy places of Syria.

The *De locis sanctis* was edited and translated by D. Meehan (1959).

ARDABIL (ARDEBIL), the chief town of a district in Eastern Azerbaijan, or Third *ostan* (province) of Iran, lies about 105 mi. E. of Tabriz and 38 mi. from the Caspian sea. The population (1964 est.) of 87,196 is Turkish-speaking. It stands on an open plain at the eastern foot of Mt. Sabalan (15,784 ft.), at 4,500 ft. above sea level. The climate is one of extremes, cold spells occurring until late in the spring. Delicate fruit trees are therefore excluded, but cereals, pulses and melons are abundant. The town once served as an entrepôt for the exports of inner Azerbaijan through

the Caspian port of Astara to Russia but has stagnated since this port ceased to function. There is no significant industry except for carpets and rugs. Warm mineral springs found nearby are much frequented.

Ardabil was the capital of Azerbaijan after the Arab conquest but later lost this distinction to Tabriz. It was heavily sacked by the Mongols but rebuilt. In the 14th century it was the residence of Sheik Safi al-Din who died there; his shrine is an object of general veneration and is frequently visited by Iranians. The sanctuary also contains the tombs of several of his descendants including that of Shah Ismail (d. 1524), the founder of the Safawid dynasty. The European travelers Olearius (1637) and Chardin (1671) describe Ardabil as one of the most flourishing Persian towns of their time. The sanctuary suffered considerably in the sack of the town by the Russians in 1827, and the famous library of Sheik Safi, once the greatest in all Persia, was sent to St. Petersburg to become part of the imperial library. (H. Bo.)

ARDASHIR, the later Persian form of the royal name Artakhshathra (*see* ARTAXERXES), borne by the founder of the Sasanian dynasty of Iran and by two of his descendants.

ARDASHIR I reigned over Iran from *c.* A.D. 224 to *c.* 240. At the turn of the 2nd century the chief petty king in Persis was Gochihr, of the Bazrangi family, ruling at Istakhr. Among his vassals was Papak, son or descendant of Sasan and connected through his mother with the Bazrangi. He had charge of the temple of Anahita in Istakhr and obtained for Ardashir, one of his younger sons, the military post of *argabad* in the town of Darabgird. From there Ardashir extended his control over several neighbouring cities, killing their regent princes. His father meantime slew Gochihr and took the title of king. He sought leave from the Parthian king of kings, Artabanus V, to transmit the crown to his eldest son Shapur, but Artabanus refused, addressing him as a rebel. When Papak died soon after, Shapur nevertheless succeeded him. A struggle ensued between him and Ardashir, in which Shapur died. Ardashir was crowned king of Persis in A.D. 208, after which he put to death a number of his other brothers. Having suppressed a revolt in Darabgird, he gradually conquered the neighbouring province of Kerman (over which he set one of his sons, also called Ardashir) and the coast lands of the Persian gulf. He made his capital at Gur (modern Firuzabad), which he renamed Ardashir-Khurre.

Ardashir then moved against the west. He first took Isfahan; then conquered Ahvaz (Susiana), the ruler of which had been ordered by Artabanus to attack him, and Mesene. From there he withdrew again to Persis, before encountering in 224 the Parthian army at Hormizdagan (site unknown), where he won a decisive victory, slaying Artabanus. (According to one classical source, Ardashir defeated the Parthians three times; but this may only reflect these three western campaigns.) Soon after, Ardashir entered Ctesiphon in triumph and, as master of Babylon, was crowned with the imperial title "king of kings." The date of this coronation is generally held to be 226, but it is argued that it may have been 224, directly after the great victory. (For Ardashir's further conquests *see* PERSIAN HISTORY.)

With his son and successor, Shapur I, Ardashir established the Sasanian empire. Nothing is known of him except his deeds, which show him ruthless, a great soldier, and a strong and able king. He founded or rebuilt many cities, of which the following have been identified: Veh-Ardashir (ancient Seleucia) and Weh-Ardashir (Goasir in Kerman); Astrabad-Ardashir (ancient Karkha of Mesene); Hormizd-Ardashir (Ahwaz); Wahishtabad-Ardashir (later refounded as Basra); Rew-Ardashir (Rishahr by Arrajan); Ardashir-Khurre (Firuzabad); Bokht-Ardashir (possibly Bushire). He is also credited with digging canals and building bridges. Several great rock carvings commemorate his reign. Two investiture scenes, at Naqsh-i Rajab and Naqsh-i Rustam near Istakhr, show him receiving the kingly diadem from the god Ahura Mazda. The latter carving has a brief trilingual inscription, in Middle Persian, Parthian and Greek; in the Greek version the king's name appears as Artaxerxes. In this relief he is shown mounted, with a dead Parthian lying beneath his horse's hooves. Scenes from his victory over Artabanus are carved in a gorge near Gur and a third investiture scene exists there. The ruins of Ardashir's palace and castle also survive.

Ardashir made Zoroastrianism the state religion, and he and his priest Tosar are credited with collecting the holy texts and establishing a unified doctrine. Two 6th-century treatises, *The Testament of Ardashir* and *The Letter of Tosar*, are attributed to them for greater authority. They survive in Arabic and Persian versions. As patron of the church, Ardashir appears in Zoroastrian tradition as a sage. As founder of the dynasty, he is celebrated in a 5th-century Pahlavi book, the *Karnamag-i Ardashir*. This is largely a romance, which may embody in part old Persian oral traditions concerning Cyrus the Great, transferred to Ardashir. In it and in some versions of the official chronicles, Ardashir's ancestry is traced back to the Achaemenidae and Kayanians (patrons of Zoroaster).

ARDASHIR II reigned from 379 to 383. Under his brother Shapur II he had been king of Adiabene, where he took part in the persecution of the Christians. After Shapur's death he was set on the throne of Iran by the nobles, presumably at an advanced age. His investiture is commemorated in a rock carving at Taq-i Bostan. He tried to assert himself but was deposed after four years.

ARDASHIR III reigned from 628 to 629. The son of Kavadh II, he was made king of Iran when seven years old, under the regency of Mah-Adur-Gushnasp, but was killed by his general Shahrbaraz 18 months later. (MA. B.)

ARDEA, a village in the modern Italian *regione* of Lazio, 3 mi. from the coast and 23 mi. S. of Rome by the Via Ardeatina. An ancient town of the Rutuli, it is mentioned frequently by Virgil, who associates it with Danae and Juno (of whose cult it was an important centre). It was an early Iron Age settlement (early 8th century) which developed into one of the most important Latin cities, a member of the Latin leagues of the 6th and 5th centuries B.C. In 444 it signed a treaty with the Romans who, according to Livy, colonized it as a barrier against the Volsci. The decline of Ardea, from the 4th century onward, was hastened by malaria and the wars under Marius and Sulla in the 1st century B.C. Under Augustus only traces of the city survived, but villas and possibly a Hadrianic colony kept the village alive; nearby a herd of imperial elephants was maintained.

The early citadel lay at the end of a plateau between two valleys, with tufa cliffs about 60 ft. high; it was defended on the east by a fine tufa wall. The settlement spread farther south and east and was defended from 400 B.C. or earlier by mounds and ditches, of which impressive remains survive. There are also traces of two temples (from the 6th century) and a basilica (1st century B.C.). Ruins on the coast may be those of the ancient harbour Castrum Invi.

See B. Tilly, *Vergil's Latium* (1947); A. Andren, *Opuscula Romana*, vol. i (1954) and iii (1961). (H. H. SD.)

ARDÈCHE, a *département* of southern France astride the Cévennes edge of the Massif Central, is bounded on the east by the Rhône river, to the south by Gard, to the southwest by Lozère, and to the northwest by Haute-Loire and Loire *départements*. Area 2,145 sq.mi. Pop. (1962) 248,516, considerably less than at the end of the 19th century. The chief town is Privas. The *département* was formed in 1790 from the Vivarais district of Languedoc (*q.v.*). There is generally little lowland on the right bank of the Rhône and most of Ardèche is highland, built of ancient crystalline rocks and vigorously dissected by right-bank tributaries of the Rhône, which have torrential régimes and flow in deep, steep-sided valleys. The chief of these is the Ardèche river, which gives its name to the *département*. North of its valley the volcanic hills of the Coirons jut out southeast toward the Rhône valley, and on the western border of the *département* Mt. Mézenc (5,755 ft.) is part of the volcanic plateau of Velay. The upper Allier river forms part of the western boundary with Lozère.

In sheltered valleys near the Rhône the climate is warm, but on the higher ground winters are long and severe. Cereals, potatoes, and especially fodder crops are cultivated, the meadows often being irrigated to produce a succession of hay-cuttings during the sum-

mer. Fruit trees, vines, and even olives are grown in the lower parts of the valleys, and at a higher level, up to about 2,500 ft., the sweet chestnut is an important crop, although it is no longer an important staple of the peasant diet. Mulberry cultivation (for silkworms), for which the hillsides were extensively terraced, has greatly declined. Above the limit of cultivation are upland pastures that provide summer grazing for sheep and goats, but the highlands have been largely denuded of former woodlands. Although sericulture is no longer important, several textile mills remain active, now using hydroelectric power. There are also glove and paper industries. Ore deposits have been worked at several places on a small scale, and medicinal springs are numerous, the chief being Vals-les-Bains, Saint-Laurent-les-Bains, Celles, and Neyrac.

The main road from Le Puy to the Rhône valley at Montélimar traverses the *département* by the Ardèche valley through Aubenas. The towns of Privas (the capital), Largentière, and Tournon give their names to the three *arrondissements*. The *département* forms the diocese of Viviers in the archbishopric of Avignon; it is in the educational area of Grenoble, and under the court of appeal at Nîmes. Privas was extensively destroyed in the religious wars of the 17th century, but there are many interesting Romanesque churches elsewhere, as at Bourg-Saint-Andéol and Thines, and the cathedral at Viviers has a fine rock site that dominates the town. (Ar. E. S.)

ARDEE (Baile Átha Fhirdiath), a town in County Louth, Republic of Ireland, lies on the river Dee, 42 mi. N.N.W. of Dublin by road. Pop. (1961) 2,710. The town is of great antiquity and its Gaelic name means "the town of the ford of Ferdia," who, according to legend, was slain here by Cú Chulainn. To the southeast is a large rath, or encampment, with remains of fortifications. Roger de Pippard, lord of the manor early in the 13th century, is said to have founded the church (the present Protestant church) and to have built Ardee castle, now used as a courthouse. The adjacent Hatch's castle is also medieval. Ardee received its first recorded charter in 1377. It was sacked by Edward Bruce in 1315 and by Conn O'Neill in 1538, taken by the Irish and recaptured by the English in the wars of 1641, and occupied later by the forces of James II and of William III. Besides being a market and shopping centre, Ardee manufactures textiles and furniture.

ARDEN, FOREST OF, a district in the western part of Warwickshire, Eng., originally part of a huge forest tract that covered the county from the Avon river north to the present site of Birmingham and stretched westward far beyond the present county boundary. The name is still preserved in Henley-in-Arden and Hampton-in-Arden. Wide lands in the district were held in Edward the Confessor's day by Alwin (Aelfuine) whose son, Turchil of Warwick, or of Arden, founded the family of the Warwickshire Ardens who still held several of the manors in the time of Queen Elizabeth I; Mary Arden, Shakespeare's mother, claimed to be of this family. Shakespeare knew the district well and was probably inspired by it when he depicted forest life in *As You Like It*. Though not a royal forest, it was subject to forest laws at the time of the Domesday survey but now no trace of the original forest of Arden remains.

ARDENNES, a district covering some portion of the ancient forest of Ardenne, extends over the greater part of the Belgian province of Luxembourg, part of the grand duchy and the French *département* of Ardennes. One derivation of the name is from a word meaning "the forest," turned into Latin as Arduenna Silva and derived from the Celtic word *ardu* ("dark," "obscure"). Another derivation is from *ar-Denn* or *ar-Tann*, Breton for "the, or among the, oaks," whence Ardenne would be a forest of oaks. A. Carnoy derives it from a Celtic form for high-land, *Ardu-enna* being from the Indo-European *arduos* ("high"). The Arduenna Silva was the most extensive forest of Gaul, and Caesar's *Commentarii de bello Gallico* describes it as extending from the Rhine and the confines of the Treviri to the limits of the Nervii. At the division of the empire of Charlemagne between the three sons of Louis the Débonnaire, under the pact of Verdun in 843, the Ardenne forest became the district pagus Arduensis. It was part of Lothair's share, and charters of 843 specify certain towns as in this pagus. In the 10th century the district had become a comitatus, subject to the powerful count of Verdun, who changed his style to that of count of Ardenne.

The geographical region of the Ardennes comprises the western part of a group of uplands lying across the basin of the Rhine. They consist of Lower Paleozoic rocks, mainly Devonian sandstones and quartzites, with some outcropping masses of Cambrian and Silurian slates (notably in the Stavelot massif in the northeast), and limestones in the north near Dinant. The Ardennes owe their structural features to the Hercynian orogeny of late Carboniferous-Permian times, producing a series of major upfolds and downfolds trending broadly from northeast to southwest. Since this folding, alternations of prolonged denudation with uplift and tilting have produced an upland area standing prominently above the surrounding lowlands. Several continuous surfaces can be distinguished at 1,800, 1,500 and 1,300 ft. The higher parts form rounded summits (the highest, the Botrange, attains 2,277 ft.). Rivers flow rapidly outward over the impermeable rocks, becoming incised within narrow and sinuous valleys. The high Ardennes form a major watershed between streams flowing west and north to the Meuse, which is trenched across the uplands from south to north, and those flowing east and south to the Moselle. In the limestone areas of the Famenne is considerable underground drainage, notably in the case of the Lesse (*q.v.*) near Han.

The plateau surface consists of gentle heath-covered eminences, separated by shallow depressions, often containing peat bogs, or wet moorlands, notably the Hautes Fagnes (Hohe Venn) in the northeast. Woodland covers about one-half the total area, occurring both in the deeply cut valleys, with mainly oak-birch and beech forests, and also on the plateau, with plantations of spruce and Scots pine. The forest is best developed in Belgium, because of the compulsory law of replanting, but coniferous plantations were extended in Luxembourg, especially after 1945. There is an immense quantity of game, including red and roe deer and wild boar; shooting is strictly preserved.

The thin acid soils developed on the siliceous rocks are for the most part infertile, and waterlogging is common, for precipitation is heavy (Chiny, with a 49.6 in. mean, is the wettest place in Belgium). Some of this precipitation is in the form of snow, which lies for about 30 days each year at heights of more than 1,000 ft. Low clouds, hill fogs and frequent frosts make the Ardennes distinctly bleak. Most of the small extent of farmland is under permanent grass; beef cattle are bred to be sent to the lowlands for fattening, and there is dairying in sheltered valleys. Arable farming, mainly the cultivation of oats, rye, trefoil and potatoes, is carried on in the valleys and basins, and tobacco is grown in the sheltered valley of the Semois, a tributary of the Meuse.

The density of population is well below 100 per square mile, and much of the area is unpopulated. A few small market towns stand on the plateau, mainly along the railway lines: Butgenbach, Bullange, St. Vith, Bovigny, Libramont and Bastogne. The chief town in the French Ardennes is Charleville-Mézières (*q.v.*), and in Luxembourg is Wiltz, in the river valley of the same name. Industry is limited to quarrying, particularly of quartzite for road metal, timber cutting, leather tanning at such towns as Malmédy and Stavelot (*q.v.*), and woolen manufacturing at small towns in the northeast. Some towns are tourist centres, utilizing the wooded valleys and attractive walking country; the most famous resort is Spa (*q.v.*), once called "the café of Europe," with its mineral springs.

In World War I, the Ardennes became a battleground, the scene of bitter fighting (1914 and 1918). During World War II several of the towns were partly or wholly destroyed during the German Ardennes offensive of Dec. 1944, but have been rebuilt. (F. J. M.)

ARDENNES, a *département* of northeastern France bounded by Belgium, comprises the southwestern margin of the Ardennes highland and the adjacent lowlands in the valleys of the Meuse and Aisne rivers, which are connected by the Ardennes canal. Area 2,028 sq.mi. Pop. (1962) 300,247. After traversing Lorraine in a south-north valley cut in a limestone plateau, the Meuse turns

northwest as it approaches the Ardennes. Its course was superimposed upon this mass of hard, ancient rocks from a cover of younger sediments that were stripped away, and from Mézières to the frontier town of Givet the river flows in deeply entrenched meanders, some of which provide defensive sites for castles and towns, such as Mézières and Revin. Slate quarrying is carried on along the valley, notably at Fumay. In the southeast of the *département* is the northern part of the rugged massif of the Argonne, drained by the Aisne river, which emerges toward Rethel into a fertile valley in the chalklands of northern Champagne. The Aisne valley and the flanking chalk country of the western, low-lying part of the *département* are well cultivated, but the Argonne and Ardennes are extensively forested. Elsewhere the Ardennes uplands, with poor soils and an inclement climate, are used for sheep pasture. Sedan (*q.v.*) on the Meuse and Rethel on the Aisne have old-established woolen manufactures. Charleville-Mézières, besides being an important railway junction, has iron industries.

Mézières is the capital of the *département*, which is divided into the *arrondissements* of Mézières, Rethel and Vouziers. It lies in the archbishopric and in the educational province of Rheims, but for judicial purposes is served by the appeal court at Nancy. (Ar. E. S.)

History.—In spite of the unsuitability of the terrain for the rapid movement of troops the area was the scene of several important battles: the campaign of 1794 in the French Revolutionary Wars (*q.v.*); the Franco-German War (*q.v.*), with the surrender of Napoleon III at Sedan in 1870; the battle of the Ardennes in World War I and the bitter fighting between the Germans and the Americans in the Argonne in 1918 (this was the first area in which large U.S. forces were committed); and, in World War II, the German breakthrough near Sedan in May 1940 which marked the battle of France and the short-lived penetration in the Ardennes of the Germans (their last offensive action) in Dec. 1944.

ARDMORE, a city of south central Oklahoma, U.S., about 100 mi. S.E. of Oklahoma City; seat of Carter county. (For comparative population figures *see* table in Oklahoma: *Population.*) Founded in 1887 following the arrival of the Santa Fe railroad, the town was named for the Philadelphia suburb that was the home of one of the line's officials. It was incorporated in 1898 and the commission-manager form of government became effective in 1921. It developed as the business centre of a large cattle and farming region. After the discovery of oil nearby in 1905, the city grew rapidly. During the 1930s Ardmore became a tourist and recreational centre.

The city has an oil refinery, processing and fabricating plants for other raw materials and factories that produce leather goods, clothing and wood products.

Ardmore is the site of a medical and agricultural research centre, Carter Seminary for Indian children and a war veterans' home. Lake Murray state park and the Arbuckle mountains are nearby vacation areas. Ardmore maintains an industrial aviation centre 16 mi. to the northeast. (J. D. Mo.)

ARDROSSAN, a seaport and small burgh in Ayrshire, Scot., lies on the Firth of Clyde 29 mi. S.W. of Glasgow by road. Pop. (1960) 9,573. The town is under a provost and council. It has a ruined castle with a dungeon known as Wallace's Larder. Both town and harbour were created in 1806 by Hugh Montgomerie, 12th earl of Eglinton, but the intended canal connection with Glasgow never materialized, as there is an excellent rail service between the two places. During summer months there are also regular steamer services to Arran, the Isle of Man and Belfast. The 17-ac. harbour accommodates vessels of up to 12,000 tons. Shipbuilding and repairs are among Ardrossan's main industries. It has an oil refinery and imports metal products, naphthalene, fertilizers, oil and gasoline. Coal and iron are exported. (W. R. W.)

AREA RULE. Bodies which pass through the so-called transonic zone, the zone separating speeds below from those above the speed of sound, suffer a great increase of drag coefficient as they approach the critical speed. During World War II the German aircraft designer D. Kuchemann advanced the theory that drag could be reduced by remolding such bodies (for example, fuselages) to follow the local streamlines. After the war, designers tackled these problems and, in April 1952, working in the transonic wind tunnel of the U.S. National Advisory Committee for Aeronautics, Richard T. Whitcomb was able to express his "area rule" thus: "If a wing/body combination (including external paraphernalia) be so designed that the axial distribution of cross-sectional area normal to the airflow is the same as that of a minimum-drag body, the design will have minimum drag." In applying the area rule, additions to cross-sectional area (such as engine nacelles) are compensated for by subtractions from it elsewhere (*e.g.*, by narrowing parts of the fuselage). *See* Aerodynamics; Mechanics, Fluid. (D. Cr.)

ARECIBO, a municipal district on the north coast of Puerto Rico, about 50 mi. W. of San Juan, the capital of the island. Its population in 1960 (urban and rural combined) was 69,879, a sharp drop from 75,361 in 1950. The city proper had a population of 28,659 in 1950 and 28,828 in 1960. Arecibo serves as a commercial and industrial centre for a varied agricultural district and is the largest, in area, and one of the oldest municipalities of the island. It is located at the mouth of the Río Grande de Arecibo, one of the more important island rivers and is connected by highways and railroads to the other cities of the island.

The municipality was authorized as early as 1537 by the Spanish crown. The town itself was founded in 1616 by Felipe de Beaumont, the Spanish governor, who gave it the name of San Felipe Apóstol del Arecivo. The fertile plains to the east and south are rich in sugar and pineapple. Farther into the interior coffee is grown, and to the south and west small farms produce cotton, fruits and vegetables. At least 12 small industries have been established in the town with government help. A small but little-used landing strip is available for commercial and private planes. (T. G. Ms.)

ARENARIA or Sandwort, a genus of plants of the pink family with small white flowers. They are annual or perennial, mostly weedy herbs and the majority inhabit sandy soil in temperate, arctic or alpine regions. There are about 160 species; some are cultivated for ornament.

ARENBERG (Aremberg), the name of a European princely family that formerly held extensive lands in what is now Belgium and in northwestern Germany. It took its name from that of Arenberg, a hamlet about 27 mi. S.S.W. of Bonn in Germany, which came into the possession of the house of La Marck (Mark) through the marriage, in 1299, of Engelbert II of La Marck and Matilda, heiress of its former lords. Passing to Engelbert's third son Everard (Eberhard), the title of lord of Arenberg remained with the latter's descendants till 1547, when Jean de Ligne, baron de Barbançon (d. 1568) assumed it by virtue of his marriage with the sister of Robert III of La Marck-Arenberg. Raised to a countship of the Holy Roman empire in 1549, the Arenberg lands were in 1576 made a principality of the empire for Jean's son Charles (d. 1616). Charles, moreover, greatly increased the family possessions by his marriage to Anne de Croy-Chimay, which brought the duchy of Aerschot to the house. His grandson Philip Francis was granted the title of duke of Arenberg by the emperor Ferdinand III in 1664.

In the course of the Napoleonic reorganization of western Europe the 6th duke, Louis Engelbert (d. 1820), lost his lands west of the Rhine in 1803, but was given Meppen and Recklinghausen and recognized as a sovereign duke in compensation. He abdicated, however, in the same year and was succeeded by his son Prosper Louis (d. 1861). Deprived of his duchy in 1810, Prosper Louis recovered it at the Congress of Vienna in 1815 but was mediatized (*see* Mediatization), Meppen being made subject to Hanover and Recklinghausen to Prussia.

See E. Laloire, *Généalogie de la maison princière et ducale d'Arenberg (1547–1940)* (1940).

ARENSKI, ANTON STEPANOVICH (1861–1906), Russian composer of instrumental music, operas and songs, was born at Novgorod on Aug. 11 (new style; July 30, old style), 1861. He studied composition with Rimski-Korsakov at the St. Petersburg conservatory and from 1882 to 1895 taught harmony, and later

composition, at the Moscow conservatory. He was also active as a conductor in Moscow. From 1895 to 1901 he was director of the imperial chapel in St Petersburg. The last years of his life —shortened by dissipation and ill-health—were devoted to composition. He died at Terijoki, Finland, Feb. 25 (N.S., 12, O.S.), 1906. Although a pupil of Rimski-Korsakov, Arenski was more akin to Tchaikovsky; the predominant moods of his not very individual music are lyrical and elegiac. He excelled in the solo song. Of his three operas only the first, *A Dream on the Volga* (after a play by A. N Ostrovski; Moscow, 1892), was successful; the one-act *Raphael* (Moscow, 1894) was stillborn and *Nal and Damayanti* (composed 1899; performed Moscow, 1904) failed to keep the stage. Other stage-music includes music to Pushkin's *Fountain of Bakhchisarai* and Shakespeare's *Tempest*, and a ballet, *Egyptian Night*. Arenski's orchestral music, which includes two symphonies, a violin concerto and a very early piano concerto, is seldom heard. He was more at home in chamber music, and his Piano Quintet in D major, his well-known Trio in D minor and his two string quartets (of which the second, in A minor, contains the fine variations on Tchaikovsky's *Christ in His Garden*, also arranged for string orchestra) show him at his best. (G. Ab.)

AREOPAGUS, a low hill northwest of the acropolis in ancient Athens, noted as the meeting place of the city's earliest, aristocratic council, the name being extended to denote the council itself. This council probably went back to the regal period. When monarchy gave way to aristocracy (at some date between *c.* 1000 B.C. and 682/681 B.C., when the list of archons begins), membership was for life and was secured by having served as archon (*q.v.*). Archons were elected either by the people or more probably by the Areopagus itself. Only nobles (*eupatridai*) were eligible. The Areopagus exercised a general religious authority and expounded the law. In the absence of a written code this latter function gave it great power, which must have been curtailed by Draco's publication of the law *c.* 621 B.C. Solon (*q.v.*), archon 594 B.C., materially altered its composition and authority. He deprived the *eupatridai* of their monopoly of membership by opening the archonship to all with a certain property qualification. Election was to be, on one view, directly by the people, on another by sortition from 40 candidates elected by them. Solon allowed appeal in certain unspecified cases from magistrates' judgments to the court of the people (*heliaia*), which must have weakened indirectly the authority of the Areopagus as expounder of the law. Finally he may have set up a rival council of 400 (*see* BOULE). Nevertheless the Areopagus retained "guardianship of the laws" (perhaps a kind of legislative veto); it tried prosecutions under the law of *eisangelia* (impeachment) for unconstitutional acts and homicide cases. Since the tyrants who ruled Athens from 561 to 510 B.C. secured the archonships for their own adherents, on their fall the Areopagus must have been full of their nominees, and its prestige therefore at a low ebb. Cleisthenes (*q.v.*) in 508 B.C. made no direct attack on it. But he set up a council of 500 and it is probable that impeachment could proceed by way of this council and the assembly (ecclesia). On the other hand, from that time until 487 B.C. archons were directly elected by the people, so that by 480 B.C. the Areopagus was made up of prominent politicians and its patriotic posture during the Persian invasion restored its prestige. Thus, with its dormant rights of legislative veto and impeachment, it could form the rallying point of resistance to democratic advance. Hence in 462/461 B.C.—although the personal prestige of the Areopagites was again declining as a result of the fact that from the archonship of 487/486 B.C. archons were chosen by lot from 500 elected candidates and had lost much of their importance—the radicals Ephialtes and Pericles (*q.v.*) deprived the Areopagus of virtually all its powers save jurisdiction on homicide. In 458/457 B.C. the property qualification for archons was lowered and later every citizen was deemed to be qualified. Nevertheless the Areopagus retained something of its esteem so that in the political struggles at the end of the 5th century B.C. both oligarchs and democrats contemplated a restoration of some of its powers. From the middle of the 4th century B.C. its importance began to revive, and by the period of Roman domination in Greece it was again discharging significant functions, administrative, religious and educational.

As a homicide court the Areopagus, under the presidency of the archon called *basileus* (king), tried cases of premeditated unjustifiable homicide. Other homicide cases went before a body of 51 jurors called *ephetai*, who may originally have been a commission of the Areopagus, but from the late 5th century B.C. onward were ordinary judges (*dikastai*). Which of these courts heard a case was probably determined by the plea of the defendant (*see* GREEK LAW).

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AREQUIPA, a coastal department of southern Peru (1958 pop. est., 375,126; area 24,528 sq.mi.), bounded north by the departments of Ica, Ayacucho, Apurimac and Cuzco, east by Puno and Moquegua, southwest by the Pacific ocean. The department is made up of an arid, sandy, coastal region, cut intermittently by streams flowing from the western ranges, and a mountainous upland zone, in part of volcanic character. The climate falls within two classifications depending upon elevation: tropical desert (or arid tropical) and mountain climate. On the coast are the important ports of Matarani (completed in 1941) and Mollendo and the minor ports of Yauca, Atico and Quilca. Coastal streams include the Lomas, Yauca, Ocoña, Majes and Vitor. The northern area is watered by the Apurímac and its tributaries. The southeast of the department is traversed by the Southern railway of Peru, connecting Mollendo, via Arequipa city, with Cuzco, Puno and La Paz. The Pan American highway provides access to Chile and Bolivia.

Cotton, sugar, olives and grapes are grown in the valleys, whereas maize, potatoes and cereals are cultivated in the uplands. The latter area is also important for livestock grazing, mainly sheep, and a large quantity of wool is exported. Mineral products are gold, silver, copper, lead, coal, sulfur, manganese, rock salt, alum, borax, gypsum and kaolin clay. (J. L. Tr.)

AREQUIPA, a city of southern Peru (1958 pop. est., 121,896), capital of the department and province of the same name, stands at 8,041 ft. above sea level on the Río Chili. As a city of the Inca empire, it was an important point on the route from Cuzco to the seacoast. The city was refounded in 1540, incident to the Spanish conquest, on orders from Francisco Pizarro to establish a stronghold in this region. It was originally named Villa Hermosa de la Asunción ("beautiful town of the Assumption"). It lies in a fertile oasis amid arid uplands at the foot of El Misti, also known as El Volcán de Arequipa, an extinct volcano having a snow-capped cone 19,096 ft. above sea level. Also within view are the great peaks of Chachani (19,931 ft.) and Pichu-Pichu (18,298 ft.). Earthquakes, usually associated with volcanic activity, severely damaged the city in 1868 and 1877.

The air is dry and the climate pleasant. Rainfall is about four inches per year, and the annual average temperature is 57° F. with a range of $\pm 2.3°$ F. Flowers bloom the year around. The weather is at its best between April and September, with sunshine almost every day; the nights are generally cool. The volcanic soil of the surrounding district, watered by the Río Chili, produces cereals, grapes, sugar cane and pasturage. The abundance of water permits an intensive cultivation of crops for food and feed, most of which are consumed locally. Livestock fattened on alfalfa are exported in limited numbers. Arequipa is the great wool market of Peru, and the major part of the country's clip passes through the city, where the wool is sorted, cleaned, graded and baled. Other industries of the city include textile milling, leather, tobacco, cigarette making, brewing, printing, gold and silversmithing, soap and candlemaking, canning and flour milling. The engineering shops of the Southern railway are also there. Mineral resources of the district are gold, silver, copper, borax, mica and sulfur.

Arequipa, the political and military as well as the commercial centre of southern Peru, is located on the railway running from Mollendo to the interior. Mollendo, the seaport of Arequipa about 100 mi. distant, is also the port of entry for the Cuzco region, Lake

Titicaca and northern Bolivia. A considerable volume of traffic from northern Bolivia passes through Arequipa by way of Titicaca. A small amount of commerce reaches Arequipa by railroad from the Peruvian montaña and the eastern border valleys of the south via Cuzco. The port of Matarani competes with the older port of Mollendo as the outlet for Arequipa and these other regions.

Arequipa is an attractive city with picturesque old Spanish buildings and many interesting religious edifices constructed of "sillar," a local white volcanic stone. The houses, generally of one story, are also built of this material. The larger façades are adorned with elaborate ornament suggesting Spanish baroque. The city, being the seat of an archbishopric, has a cathedral and several historic churches, notably the Jesuit church of La Campañía, Santo Domingo, San Augustín, La Merced and San Francisco. The University of Arequipa, built in 1612, the Colegio Naciónal de la Independencia and a branch of the National Conservatory of Music have helped to keep the city in the forefront of the cultural and intellectual life of the nation. The Plaza de Armas presents a colourful spectacle, for Arequipa is the metropolis for Indians of the district. Arequipa is a popular tourist centre, and good highways provide access to the nearby resorts of Sabandia, Jesús, Socosani and other points of interest. The Pan American highway traverses the department and air service is maintained.

(J. L. Tr.)

ARES, in ancient Greek mythology, the god of war, or more properly the spirit of battle. (For the Roman god identified with Ares *see* Mars.) He may be of foreign origin, quite possibly from Thrace (*Odyssey* viii, 361). Unlike his Roman counterpart he was never very popular; his worship was not extensive in Greece except at Thebes and to a more limited extent at Athens. He represents the distasteful aspects of brutal warfare and slaughter, which he loves for their own sake. From at least the time of Homer, who establishes him as the son of Hera and Zeus, he is one of the Olympian deities, but his fellow gods and even his parents are not fond of him (*Iliad* v, 889 ff.). He is accompanied in battle, however, by his sister Eris ("Strife") and his sons Deimos and Phobos ("Panic" and "Rout"). Associated with him also are two lesser war deities: Enyalius, virtually identical with Ares himself, and Enyo, a female counterpart (*cf.* the Roman Bellona; *q.v.*). As a war god Ares has no monopoly. Both Athena and Zeus (*qq.v.*) have war attributes, which, while less sanguinary, are usually more potent. Strangely enough Ares' appearances in battle are often inglorious. In the *Iliad* he is bested by Athena and even wounded by Diomedes, a mortal. He also is bound by the Aloadae (*q.v.*), who imprisoned him for 13 months, and eventually rescued by Hermes (*Iliad* v, 385 ff.). When he tried to avenge the murder of his son, the highwayman Cycnus, Heracles wounded him and sent him off to Olympus (Hesiod, *Shield of Heracles*, 457 ff.).

Ares' worship was largely in the northern areas of Greece, where it may easily have spread from Thrace. Although devoid of the social, moral and theological associations usual with major deities, his worship has many interesting local features. At Sparta, in early times at least, human sacrifices were made to him from among the prisoners of war (a practice that had also been current in Scythia, an early seat of his worship). At Sparta also a nocturnal offering of dogs—an unusual sacrificial victim, which might indicate a chthonic deity—was made to him as Enyalius (Pausanias iii, 14, 9; Plutarch, *Roman Questions*, 290 d). During his festival at Geronthrae in Laconia no women were allowed in the sacred grove (according to Pausanias), but at Tegea he was honoured in a special women's sacrifice as *Gynaikhothoinas*, "Entertainer of Women" (also Pausanias). At Thebes he was an ancestral deity both through his daughter Harmonia, wife of Cadmus (*q.v.*), and also through another offspring, the dragon whose teeth Cadmus sowed to create the race of Thebans. At Athens he had a temple at the foot of the Areopagus ("Ares' hill"). On this hill the Areopagus council, oldest council of the Athenians, sat as a homicide court. By tradition Ares had been tried there by the gods for the murder of Halirrhothius, son of Poseidon, who had offered violence to his daughter Alcippe.

The mythology surrounding the figure of Ares is not extensive. Of interest is his association from earliest times with Aphrodite (*q.v.*). Indeed, Aphrodite is known locally (*e.g.*, at Sparta) as a war goddess, apparently an early facet of her character. Undoubtedly an original religious connection gave rise to later myths linking the two romantically. The most famous story of their relationship is humorously recorded in *Odyssey* viii. The husband of Aphrodite, Hephaestus, caught the pair *in flagrante delicto*, cast an invisible net over them and summoned all the other gods to witness their shame, causing great hilarity on Olympus. According to some versions it is the jealous Ares who, disguised as a boar, slew Aphrodite's beloved Adonis. Occasionally (*e.g.*, at Thebes) Aphrodite is his legitimate wife. By Aphrodite he fathered Deimos and Phobos and Harmonia (*see* above). He is sometimes also the father of Eros and Anteros. By Aglauros, the daughter of Cecrops (*q.v.*), he was the father of Alcippe. He was the sire of at least two of Heracles' adversaries: Cycnus and Diomedes of Thrace.

The artistic representations of Ares are not numerous. One of the earliest is on a fragment of a Lemnian vase of the 8th century B.C. depicting the affair with Aphrodite described above. On vases he is usually the typical armed warrior. There were statues by Alcamenes, Scopas and Leochares, but extant works (*e.g.*, Ares Ludovisi and Ares Borghese) are mostly Roman and cannot successfully be identified with Greek originals. The Parthenon frieze contains a group of Olympians, among whom Ares, in unwarlike garb, has been tentatively identified. He also appears on the great frieze of the altar at Pergamum.

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ARETAEUS of Cappadocia, a Greek physician, who lived at Rome in the second half of the 2nd century A.D. Two treatises by him are extant, each in four books, in the Ionic dialect: *On the Causes and Indications of Acute and Chronic Diseases*, and *On Their Treatment*. Aretaeus' work was founded on that of Archigenes; like him, he belonged to the eclectic school, but he did not ignore the theories of the "pneumatists," who asserted that life is associated with vital air, or pneuma.

ARETHUSA, in Greek mythology, a nymph who gave her name to a spring in Elis and to another in the island of Ortygia near Syracuse. The river god Alpheus fell in love with Arethusa, one of the retinue of Artemis; Arethusa fled to Ortygia, where she was changed into a spring; Alpheus made his way beneath the sea, and united his waters with those of the spring. In Ovid's *Metamorphoses* Arethusa, while bathing in the Alpheus, was seen and pursued by the river god in human form; Artemis changed her into a spring which, flowing underground, emerged at Ortygia.

In an earlier form of the legend, it is Artemis, not Arethusa, who is the object of the god's affections, and who escapes by smearing her face with mire, so that he fails to recognize her. The story probably originated from the fact that Artemis Alpheiaia was worshiped in both Elis and Ortygia, and also that the Alpheus in its upper part runs underground, as is confirmed by modern explorers. In Virgil's *Eclogues* Arethusa is addressed as a divinity of poetical inspiration, like one of the Muses, who were themselves originally nymphs of springs.

ARETHUSA (*Arethusa bulbosa*), a common North American plant of the orchis family, found in bogs and swampy regions during May and June from Newfoundland south to North Carolina and west to Indiana and Minnesota. The flowers are magenta-crimson, having a crest formed of three hairy ridges, white or yellow in colour, and with a lower lip spotted with magenta. They grow on single stalks five inches to ten inches in height. The leaves appear after the flowers open and are long, narrow and single. The root is bulbous. A common name for arethusa is Indian pink.

ARETINO, PIETRO (1492–1556), Italian author who wrote in unconventional language and who has been described as the first "journalist" of his century, was born in 1492 at Arezzo. Thence he called himself "Aretino"; the name of his family is

unknown. When still very young he went to Perugia, where he practised painting, then to Rome, where he published some scandalous *pasquinate* (satirical poems), and finally to Venice (1527), where he remained until his death in 1556. There he found the appropriate milieu for using his pen as a means for blackmailing rulers (Ariosto called him "the scourge of princes"). The six volumes of his letters (1537–57) are evidence of his power and cynicism. His realistic *I Ragionamenti* (2 parts; 1534–36), written in dialogue form, show his sensual and unscrupulous nature as well as his colourful style. Of lesser interest are his poems and religious writings. He also wrote a remarkable tragedy, *Orazia* (1546) and five comedies (1525–42). He had great influence on some 16th-century writers, but to modern readers he is mainly important as a moral phenomenon of his times.

Il I e il II libro delle Lettere di Pietro Aretino was edited by F. Nicolini (1913–16) and *I Ragionamenti* by D. Carraroli (1914); an edition of the *Commedie di Pietro Aretino, aggiuntavi l'Orazia* was published by E. Camerini (1876) and another *Commedie*, by N. Macarone (1914).

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AREZZO, a city and capital of Arezzo province, north central Italy, lies in a fertile plain in eastern Toscana near the junction of the Chiana and Arno rivers, 54 mi. (87 km.) by road southeast of Florence. Pop. of commune (1961) 75,209. The medieval walls almost completely surround the city, the oldest part of which is built on a hill 1,053 ft. high. On its summit stands the Fortezza Medicea, built in 1541–69 by Antonio Sangallo (*q.v.*). The splendid Piazza Grande close by was once the city centre; the sides of the square are formed by a variety of palaces and houses dating from the 14th century among which are the Palazzo delle Logge, with open balconies, by G. Vasari, the Palazzo della Fraternità of mixed styles, the Palazzo del Tribunal by R. Cerrotti, and the Palazzo Pretorio (14th century), decorated with coats of arms on the façade and five Renaissance windows, and now containing the public library. The Giostra del Saracino, a tournament dating from the 13th century, is held every year in the Piazza Grande between June and September. The Gothic cathedral was begun in 1286 and finally completed in 1914. The Romanesque church of Sta. Maria della Pieve, which backs on to the Piazza Grande, contains a beautiful polyptych by Pietro Lorenzetti. The church of S. Domenico (13th–14th century) contains a crucifix painted on wood by Cimabue. These and the Renaissance churches of Sta. Maria delle Grazie and SS. Annunziata (by Sangallo) bear witness to the city's splendid past, but of the greatest importance is the work of Piero della Francesca (*q.v.*) seen in his series of frescoes depicting the "Legend of the True Cross" in the church of S. Francesco. This church also contains a series of frescoes by Spinello Aretino, a native of Arezzo. In the town are remains of a Roman amphitheatre, and the Etruscan museum and the Pinacoteca contain many rare objects and works of art.

Arezzo was the home of Francesco Petrarch (1304–74), Pietro Aretino, Giorgio Vasari (1511–74) and Guido of Arezzo (d. 1050) (*qq.v.*).

Arezzo is a centre of road communications. Its economy is basically agricultural, but the goldsmiths export their goods throughout Europe and there are clothing and footwear factories.

The city, already important in Etruscan days, was known to the Romans as Arretium. In the middle ages it was a flourishing town which fell to Florence in 1384. Later it became part of the grand duchy of Tuscany. After a short period of French rule in the early 19th century it became part of the Italian kingdom in 1861. It was severely damaged during World War II and was captured by the Allies in July 1944. (D. Os.)

ARGALI, the largest living wild sheep, *Ovis ammon* and its many races, found in the highlands of east central Asia. It may stand four feet high at the shoulders and weigh over 300 lbs. Large horns, present in the rams, are especially massive in the Pamir argali, or Marco Polo sheep, in which they may be 70 in. or more in length. *See* Sheep.

ARGAND BURNER, the first scientifically constructed oil burner, was invented by Aimé Argand of Geneva in 1784. It consisted of a cylindrical wick confined between two concentric tubes; this device gave a circular flame with a current of air brought to play upon its inner surface. A glass chimney increased the draft and improved the illumination. William Murdock, the pioneer of gaslighting, adapted the Argand idea of two concentric circular pipes in the designing of gas burners.

See Lighting: *Gas*.

ARGEI, the name given by the ancient Romans to a number of rush puppets (24 or 27), resembling men tied hand and foot, which were taken down to the ancient bridge over the Tiber on May 14 by the *pontifices* and magistrates, with the wife of the Flamen Dialis in mourning guise, and there thrown into the Tiber by the Vestal virgins. There were also in various parts of the four Servian regions of the city a number of *sacella Argeorum* (chapels), round which a procession seems to have taken place on March 17, and where the puppets were probably kept until the second procession.

The Romans had no historical explanation of these curious rites, and the theory of the common people that the puppets were substitutes for old men who used at one time to be sacrificed to the river is not generally accepted. Various explanations have been suggested by scholars.

ARGELANDER, FRIEDRICH WILHELM AUGUST (1799–1875), German astronomer, famous for his great catalogue in which are determined the positions of thousands of stars, was born at Memel, then in East Prussia, on March 22, 1799, and studied at Königsberg, where he was later the successor of F. W. Bessel. Argelander was appointed director of the Åbo observatory in 1823 and of the Helsinki observatory in 1827. In 1837 he published the first major investigation of the sun's motion in space, which had been previously pointed out by Sir Frederick William Herschel, and in the same year he was appointed director of the new Bonn observatory. His greatest achievement was the publication of the *Bonner Durchmusterung* (1859–62), which catalogues the position and brightness of nearly 325,000 stars from the north celestial pole to 2° S. of the celestial equator and which was completed after 25 years' continuous work. The corresponding atlas was issued in 1863. The importance of this work is indicated by the fact that it was, by demand, reissued in 1950. In 1844 Argelander drew attention to the importance of variable stars, of which there were then only six known. His method of visual estimation of the brightness of stars—the "step method"—is still in general use. His treatise on the comet of 1811 appeared in 1822 and his subsequent observations fill the first seven volumes of the *Durchmusterung*. He died at Bonn, Ger., on Feb. 17, 1875.
(O. J. E.)

ARGENS, JEAN BAPTISTE DE BOYER, Marquis d' (1703–1771), French novelist and occasional writer, who helped to disseminate the ideas of the *philosophes*, was born at Aix-en-Provence on June 27, 1703, of a noble family. He traveled in Spain, Turkey and Italy in his youth, leading a life of dissipation. Settling thereafter first in the Netherlands, then at the Prussian court, he devoted himself to literature. He produced a number of works inspired by Montesquieu's *Lettres persanes*, the most important being his *Lettres juives* (1736–38), *Lettres cabalistiques* (1737) and *Lettres chinoises* (1739–40). His *Philosophie du bon sens* (1737), a well-written work of popularization, owes much to Bayle and Fontenelle, and stimulated French interest in Locke. The best-known novel attributed to him is the scurrilous but often reprinted *Thérèse philosophe* (1748). He was a friend of D'Alembert and Voltaire, and a protégé of Frederick the Great. He died at Toulon on Jan. 12, 1771.

See E. Johnston, *Le Marquis d'Argens* (*c.* 1928) and D'Argens' own *Memoires*, ed. by L. Thomas (1941). (Rt. S.)

ARGENSOLA, LUPERCIO LEONARDO DE (1559–1613), Spanish dramatist and poet, was baptized at Barbastro, on Dec. 14, 1559. He was appointed historiographer of Aragon in 1599, and in 1610 accompanied the count de Lemos to Naples, where he died in March 1613. Between 1581 and 1585 he wrote three romantic tragedies—*Filis* (lost), *Isabela* and *Alejandra* (the

two latter printed in 1772). These are uninspired imitations of Seneca, dealing with Christian subjects and showing Italian influence. They were praised by Cervantes, Lope de Vega and Vicente Espinel. His poems were published with those of his brother in 1634; they consist of odes, sonnets, *canzoni*, satires and translations from Latin, some being of high quality.

His brother BARTOLOMÉ LEONARDO DE ARGENSOLA (1562–1631), Spanish poet and historian, was baptized at Barbastro on Aug. 26, 1562. He was attached to the suite of the count de Lemos, viceroy of Naples, in 1610 and succeeded his brother as historiographer of Aragon in 1613. He died at Saragossa on Feb. 4, 1631. His principal prose works are the *Conquista de las Islas Molucas* (1609), and a supplement to J. Zurita's *Anales de la Corona de Aragon*, published in 1630. He was a gifted and skilful poet. (J. Gs.)

ARGENSON, the name of a French noble family from Touraine, prominent in national affairs in the 18th and in the first half of the 19th century.

MARC RENÉ DE VOYER, marquis de Paulmy and marquis d'Argenson (1652–1721), was born in Venice on Nov. 4, 1652. After holding a succession of legal offices at the French court, he was in 1697 appointed lieutenant general of police of Paris. In 1718 he was made keeper of the seals by the regent, Philippe duc d'Orléans, who wanted him to break the opposition of the *parlement* of Paris to John Law's financial system. He was also made temporary president of the council of finance. In fact he joined forces with the opponents of Law and found himself obliged to resign in 1720. He died in Paris on May 8, 1721.

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RENÉ LOUIS DE VOYER DE PAULMY, marquis d'Argenson (1694–1757), was born in Paris on Oct. 18, 1694, the oldest son of Marc René, and was also a member of the legal profession. Between 1720 and 1724 he served as intendant in Hainaut. Returning to Paris, he became a patron of the Club de l'Entresol, in which, through discussions with Voltaire and Viscount Bolingbroke, he learned to think deeply about political problems. He was also influenced by the ideas of Charles Irénée Castel, abbé de Saint-Pierre (*q.v.*), and, having been appointed minister of foreign affairs in Nov. 1744, tried unsuccessfully to implement his own doctrinaire schemes for international arbitration. His plans were directed against France's ally Spain, whose influence in Italy was to be undermined by a confederation of the Italian states; against Austria, whose preponderance in Germany was to be counterbalanced by alliances with Prussia and with Saxony; and against Russia, which was to be held in check by a league of Baltic states. These schemes were frustrated by the secret diplomacy of Louis XV and by court intrigue. D'Argenson's persistence in his ideas was a major factor in prolonging the War of the Austrian Succession (*q.v.*) after he had failed to prevent the election of Maria Theresa's husband Francis as emperor in 1745. In Jan. 1747 he was compelled to resign. As president of the Académie des Inscriptions he spent the rest of his life in literary pursuits. His *Journal et Mémoires* (published in 1859) form one of the major sources for the literary and political history of Louis XV's reign, while his *Considérations sur le gouvernement ancien et présent de la France*, with its suggestion that municipal and provincial assemblies should be revived, had great influence on physiocratic schemes for the reform of local government under the *ancien régime*. He died in Paris on Jan. 26, 1757.

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MARC PIERRE DE VOYER DE PAULMY, comte d'Argenson (1696–1764), born on Aug. 16, 1696, the younger brother of René Louis, held office as lieutenant general of police, as intendant in Touraine, as *conseiller d'état* and as secretary of state for war. He was responsible for the foundation of the École Militaire in 1751. Like his brother, he was a patron of the *philosophes*, and Denis Diderot dedicated to him the first volume of the *Encyclopédie*. He spent the last six years of his life in exile from the court, after being dismissed through the influence of Madame de Pompadour. He died in Paris on Aug. 22, 1764.

MARC ANTOINE RENÉ DE VOYER (1722–1787) was born at Valenciennes on Nov. 22, 1722, the son of René Louis. He served as ambassador to Switzerland (1749–51), to Poland (1759–65) and to Venice (1766–70). After retirement he occupied himself with literary and historical studies and collected one of the finest private libraries in Europe; sold in 1785 to the comte d'Artois, the future Charles X of France, it became the nucleus of the Bibliothèque de l'Arsenal in Paris. He died in Paris on Aug. 13, 1787.

MARC RENÉ, marquis de Voyer (1722–1782), the son of Marc Pierre, was born in Venice. He fought in the War of the Austrian Succession and in the Seven Years' War and was later military governor in Saintonge and Poitou. He died at Ormes Saint-Martin in Poitou on Sept. 16, 1782.

MARC RENÉ, marquis d'Argenson (1771–1842), the son of the last-named, was born in Paris on Sept. 19, 1771. He embraced the principles of the French Revolution and entered the army in 1791, becoming aide-de-camp to Lafayette. However, after the latter's defection, he retired to his estates in Poitou and took up scientific agriculture. Between 1809 and 1813 he was prefect of the *département* of Deux Nèthes (Antwerp) and helped to repel the British invasion of Walcheren. After 1815 he devoted himself to the cause of liberalism in the chamber of deputies and under the July monarchy was a member of the republican opposition. He died in Paris on Aug. 1, 1842. (A. GN.)

ARGENTEUIL, a town in northern France in the *département* of Val-d'Oise, lies on the north bank of the Seine, 8 mi. (13.5 km.) N.W. of Paris. Pop. (1962) 82,007. Argenteuil grew up around a monastery, originally (7th century) a convent in the village of Parisis. A daughter of Charlemagne was possibly abbess of the convent, which later received *Heloïse* (*see* ABELARD, PETER); she became prioress, but was expelled in 1129 and the convent was made a monastery. Enshrined in its church is *la Sainte Tunique*, claimed to be the seamless robe of Christ, given to the convent by Charlemagne. After World War I the growth of industry (metallurgy, electrical manufacture, aircraft construction, artificial silk) and the increase in its residential area caused what had been a village to rank as a town. The district has long been celebrated for its vineyards, representations of which are in the museum, and the first Sunday in October is still kept as the feast of the wine harvest. Fruit and vegetable growing, especially asparagus, is still a minor activity. (H. DE S.-R.)

ARGENTINA (REPÚBLICA ARGENTINA), a country occupying most of the southern part of the continent of South America, is shaped like a wedge with the point toward the south. The length of Argentine territory from north to south is 2,294 mi.; its greatest width is about 884 mi. The area is 1,072,067 sq.mi., not including the Falkland Islands (*q.v.*), various lesser islands in far southern waters, and a 49° sector of Antarctica of about 475,000 sq.mi. to all of which Argentina lays claim. The population was 20,008,945 in 1960. On the north and northeast the country adjoins Bolivia, Paraguay, Brazil and Uruguay, with the Pilcomayo, Paraguay, Paraná and Uruguay rivers constituting the greater part of the boundary itself. Argentina is bounded on the west and south by Chile and on the east and southeast by the Atlantic ocean. The capital is at Buenos Aires (*q.v.*).

This article is divided into the following sections and subsections:

There are separate articles on all the Argentine provinces and territories and on the more important cities.

I. PHYSICAL GEOGRAPHY

The Republic of Argentina includes a wide variety of kinds of land. From the point of view of geology and surface features there are four different physical divisions: (1) the Andes; (2) the alluvial plains east of the Andes; (3) a small piece of the Paraná plateau; and (4) the plateaus of Patagonia. These differentiate the national territory into contrasted kinds of terrain; but there are also great climatic contrasts, and the climates are reflected in the pattern of vegetation. The far north of Argentina is north of the Tropic of Capricorn at 21° 46′ 55″ S.; the far south of Argentina in Tierra del Fuego is 55° 03′ 30″ S. Parts of the national territory receive abundant rainfall, but a large part of the area is very arid.

1. **Geology and Structure.**—*The Andes.*—The Andes mountains form the greater part of the western border of Argentina. About as far south as latitude 36° S. the Andes are very high; the pass routes over the ranges are over 10,000 ft. above sea level. As far as 27° S. the mountains are made up of numerous high intermontane basins separated by short but steep-sided ranges. In this part of the Andes there are two major cordilleras. The western one lies generally within Chile; the eastern one is a southward continuation of the Eastern Cordillera of Bolivia. Essentially the Andes are a huge block of the earth's crust underlain by folded and faulted sedimentary formations mostly Mesozoic and Tertiary. The block is lifted on the west and tilted toward the east. Its surface, especially in the west where it is little dissected, is remarkably level at the higher altitudes, but is surmounted by numerous small ranges running more or less in a north-south direction. Toward the east the rivers have cut long fingers of canyons back into the high country, and near the eastern margin of the range the whole surface is sharply dissected by the streams. The steep-sided valleys separated by sharp-crested ridges are known as *quebradas.* Along the eastern margin of the mountains there is a zone of front ranges, tilted cuestas (ridges) of sedimentary strata that face toward the mountains and slope more gently toward the eastern plains. Between the cuestas are long, parallel valleys. These front ranges continue southward as far as Tucumán.

At about latitude 27° S. the character of the Andes changes. Running southward there is only one single commanding range. In Argentina between Tucumán and about latitude 36° S. discontinuous desert ranges push out east of the main range into the eastern plains, holding between them a number of typical desert bolsons. The main range reaches its highest point to the west of Mendoza in Mt. Aconcagua (*q.v.*), 22,831 ft., loftiest in the western hemisphere. As far as 36° S. the passes over the main range are all very high. Glaciation, however, was more and more vigorous toward the south during the glacial period. The mountains take on the characteristic forms of glaciated mountains: cols, horns, cirques, glacial troughs and hanging valleys. The glaciers gouged out the valleys so that south of 36° S. the passes are all low. South of 46° S. the Andes are still covered with near icecaps, and glaciers descend to the heads of the fiords on the Chilean side and to the ends of the glacial lakes on the eastern side. During the glacial period the ice spread out to the east of the mountains in southern Argentina, as far as the Atlantic ocean along the Strait of Magellan. In the southern Andes, before the glacial period, rivers draining westward to the Pacific had cut back through the heart of the range so that the drainage divide was actually east of the Andes. When the ice invaded these valleys the drainage was blocked, and for a time the rivers drained eastward to the Atlantic. Large lakes were formed where the ice blocked the outlets to the Pacific. At the present time two lakes—Viedma and Argentino—are still blocked by ice and drain eastward, but all the other lakes drain westward. The fact that the highest crest of the Andes and the drainage divide are not the same gave rise to an important boundary dispute between Chile and Argentina. (*See* also ANDES.)

Alluvial Plains.—The second of the chief physical regions of Argentina includes the great alluvial plains that stretch out eastward from the base of the Andes from about latitude 38° S. northward. A deep accumulation of debris brought down by the rivers from the erosion of the Andes has been spread out like a great sheet to the east. In northern Argentina the slope eastward is scarcely perceptible. Rivers, such as the Pilcomayo and the Bermejo, meander in shifting channels across the alluvial plains, spreading out in extensive floods during the rainy season (October to April) and then forming braided channels with many sand bars during the dry season. The water table is not far below the surface in this part of Argentina, yet finding surface water in dry season may be difficult. The similarity of these plains to the Ganges valley of India is striking.

All the drainage of this area is gathered by the Río Paraguay-Paraná-Plata (*see* PLATA, RÍO DE LA). But south of the Río Carcarañá, which carries the drainage from the Sierra de Córdoba to the Paraná, no major streams reach the sea. This is the Argentine humid pampas (Spanish *pampa*), a deep accumulation of alluvial material (985 ft. deep at Buenos Aires) overlain by a layer of fine, wind-blown dust or loess brought by the westerly winds from the deserts of Patagonia. Two ranges of low mountains protrude through the covering of alluvium and loess: (1) the Sierra del Tandil is 1,772 ft. above sea level; (2) the Sierra de la Ventana is 4,078 ft. high. Around the base of each of these ranges and of the Sierra de Córdoba (an outlier of the Andes) there is an apron of alluvial material. At Córdoba, which is built at the base of the mountains on this alluvial apron, the elevation is 1,300 ft. above sea level. The greater part of the pampas, however, stands only 100 ft. or so above the sea, and its surface is so nearly level that drainage is poor. The soil is entirely free from pebbles.

So great is the volume of alluvium supplied to the Río Paraná that this main drainage line has certain notable peculiarities. Downstream from Posadas, where the Paraná emerges from the Paraná plateau, the river is braided and shifting. At the high-water period the floods cover the whole of the flood plain, in some places more than 30 mi. wide; but at low water, sand bars clog the channels, and the river is split into a maze of minor rivulets. The main channel often shifts from one season to the next, with disastrous results for river ports. River boats must make many miles of sailing around the meanders to make only a short distance in a direct line. When the Paraná is joined to the Uruguay to make the Plata there is a wide swampy zone threaded by many small channels. The main channel of the Plata is near the Uruguay shore. Between it and the Argentine shore on either side of Buenos

Aires there is a wide zone of shallow water; and when the southwest wind is especially strong the water is blown northward, revealing the wide area of mud flats. Constant dredging is required to keep the port of Buenos Aires open.

Paraná Plateau.—A small part of Argentine territory is included within the area of the Paraná plateau. This is the territory of Misiones, which extends like an arm between Paraguay and Brazil. The Paraná plateau is made up of successive flows of diabase lava. This rock is so resistant to the forces of erosion that it stands up with cliffs, and the rivers descend from the plateau in great falls, such as the Guaíra falls or the Iguaçu falls (*q.v.*), or in long stretches of rapids, as along the Río Uruguay. Between the rivers the plateau surface is flat-topped.

Patagonia.—Patagonia is the general regional name given to the part of Argentina south of the Río Colorado at about latitude 40° S. The whole width of the country east of the Andes is occupied by a series of steplike plateaus rising from the edge of the ocean, where cliffs make landing difficult. The plateau steps rise toward the west, the highest being well over 5,000 ft. above sea level. The plateaus are formed on nearly horizontal sedimentary strata, mostly sandstones. In northern Patagonia crystalline rocks emerge from the sedimentary cover; where they do so, they hold up low hills that stand somewhat above the level of the plateaus. The plateaus are crossed by a succession of deep canyons, steeply cliffed on the sides and flat-bottomed. These canyons carried the drainage from the west during the glacial period, but now the amount of water in them has been much reduced. Along the eastern front of the Andes the west-flowing rivers have excavated a discontinuous belt of lowlands, known as the pre-Andean depression, between the westernmost plateau and the mountains.

The Patagonian coast generally lacks harbours. In the south, however, there are embayments such as those on which Santa Cruz and Puerto Gallegos are situated. But the utility of these places as ports is reduced by the great tidal range—as much as 48 ft. in the spring tide. (*See* also PATAGONIA.)

2. Climate.—*Temperature.*—The territory of Argentina extends approximately from latitude 22° S. to 55° S. A similar position in the northern hemisphere would include the area between Cuba and Hudson bay. Since most of the Argentine territory lies within the middle latitudes, temperature extremes and great weather variability might be expected. In North America the range of temperature between summer and winter increases toward the north; at Edmonton, in Alberta, a little less than 55° N., the average monthly temperatures range from 5.5° F. in January to 61.1° in July, a range of near 56°. No such differences between summer and winter are found in South America because the continent tapers sharply toward higher latitudes and the ocean has the effect of moderating the temperatures. Ushuaia, Argentina's southernmost town at about 55° S., ranges from 33.3° in June to 49.6° in January, a range of only a little over 16°.

Cool summers and mild winters characterize all of Argentina as far north as the Río Negro valley in northern Patagonia. Cool summers also are experienced in the exposed easternmost part of the humid pampas, which is bathed by the cold Falkland Island current. At Mar del Plata, for example, the warmest month averages only 66.9°.

On the other hand, very hot summers are experienced throughout the northern part of Argentina. At Santiago del Estero, for example, the temperature averages 83.1° in January, higher than any place in the low latitudes. North of Santiago del Estero in the Chaco is the only area in South America in which temperatures of 110° and over are experienced. In this same area the average temperature of the coldest month is about 56°. At Buenos Aires, located a little south of latitude 34° S., the average temperature in January is 73.6°, compared with an average of 81.4° in Charleston, S.C., in July. The average temperature in July at Buenos Aires (48.9°) is about the same as that in January at Charleston (49.8°). In other words, compared with places at about the same latitude in eastern North America, Buenos Aires has winters of about the same average temperature and summers that are not nearly so hot. Actually the average summer temperature in Buenos Aires is similar to that in New York city, at about latitude 40° N.

Frosts occur occasionally in almost all parts of Argentina except the far north. In every winter there are frosts in Patagonia. In the northern part of the humid pampas the length of the frost-free season is about 300 days. Tucumán is located in a small frost-free "island" where the low temperatures of winter nights are moderated by a cloud cover. Farther away from the mountains, where night skies are clear, frosts occur every winter, even well to the north of Tucumán.

Rainfall.—A very large part of Argentina is arid or semiarid. Abundant year-round rainfall is found only in southernmost Tierra del Fuego and in the northeast, north of Bahía Blanca. The line between semiarid and humid climates runs north and south through the Chaco a little to the east of Santiago del Estero. It passes a little to the west of Córdoba and reaches the Atlantic coast just south of Bahía Blanca. The rainfall of the humid pampas is evenly distributed throughout the year. At Buenos Aires, for example, the average annual rainfall is 37 in.; the driest month, June, receives an average of 2 in., and the rainiest month, April, receives 4.8 in. But the interior of the northeast, in the Paraguay-Paraná valley north of Santa Fe, has most of its rain in summer. In that region the rainiest month is January or February, averaging more than five inches; the driest month is June, averaging less than an inch.

The belt of aridity in South America crosses the Andes in southern Bolivia and northern Argentina. South of latitude 20° S. the dry belt extends over the plains east of the Andes. Mendoza averages only 7.7 in. Dry conditions extend southward through Patagonia to the Strait of Magellan. The average rainfall at Santa Cruz, for example, is only 5.5 in. North of the Río Negro the desert is hot and sunny; in Patagonia it is cool and often cloudy.

Weather.—All of Argentina has changeable weather. The storms in this part of the world are brought by polar outbursts (cold air masses) emerging from the antarctic continent. The cold waves cross the South Pacific ocean, where the temperatures

EWING GALLOWAY

IGUAÇU FALLS, ONE OF ARGENTINA'S GREAT NATURAL WONDERS, LOCATED ON THE ARGENTINA-BRAZIL BORDER

are moderated especially in the lower layers. Unstable and moisture-laden, these air masses bring heavy rains to the west coast of southern Chile. The Andes, however, keep most of this moist air from reaching Argentina, except for a few spots where the rain spills over to the eastern side of the mountains through the deeply cut valleys. Some of the cold air masses reach the continent of South America east of the Andes, setting up cyclonic whirls of air along the advancing cold fronts. The cyclones rotate clockwise in the southern hemisphere. But even when northerly winds reach Patagonia, they must travel over wide expanses of cold water off the east coast of the continent (Falkland Island current). The result is that the Patagonian weather is characterized by shifting, blustery winds, by rolls of gray cloud, but little rain or snow. The typical Patagonian landscape is indistinct and hazy because of the great quantities of dust picked up from the desert surface by the violent winds.

Winds.—The common winds of Argentina are given special names. The cold air masses advance from the south or southwest, and this wind is known as the pampero. The warm, muggy air on the front of the advancing cold air, coming from the north, is known as the *norte*. When a cold air mass spills over the Andes and descends as a warm and dry air mass on the eastern side (a typical chinook or foehn), the Argentines speak of it as a *zonda*. Each of these winds brings weather that is familiar to people in North America. Anyone who has experienced the parching effect of a chinook in the plains east of the Rocky mountains would find nothing strange about the *zonda*. The warm, depressing weather associated with a cyclonic storm is brought by the *norte*. The cold front gives rise to thunderstorms and tremendous displays of lightning, after which the pampero brings clear and bracing weather.

3. **Vegetation.**—The various climatic features are reflected in the cover of natural vegetation. Where rainfall is abundant there are forests. Where rainfall is less abundant there are woodlands, consisting of low, scrubby trees. Where rainfall is insufficient there are deserts. And in the humid pampas there is a tall grassland, apparently a man-made formation.

The alluvial plains in northern Argentina, between the Andes and the Paraguay-Paraná, are covered with a scrubby deciduous woodland and with patches of savanna. This is the region known as the Gran Chaco (*q.v.*) or the "hunting ground." There are places where thorny deciduous trees grow so close together that they form almost impenetrable thickets. In other places, especially near the rivers, there are belts of tall trees—the semideciduous tropical forest characteristic of the regions farther north. There are places where the scrubby trees are widely spaced and there is grass on the woodland floor. And there are places where, unaccountably, the woodland is interrupted by patches of pure savanna. Throughout this Chaco woodland are found different species of the red quebracho tree or *quebracho colorado* (*Schinopsis*), a source of tannin. *Schinopsis lorentzi* is found chiefly in the eastern part of the Chaco along the western side of the Paraguay-Paraná. It occurs in dense stands only in those places where the ground water is salty. In the western part of the Chaco is found *S. balansae*, which contains much less tannin but which is of great value for firewood and for fence posts. The Chaco woodland contains few other commercially valuable species.

The southern limit of the Chaco woodland is roughly the valley of the Río Salado, which enters the Paraná near Santa Fe. To the south a woody xerophytic scrub, known in Argentina as *monte*, occupies the semiarid areas. The drier parts of the country have only scattered xerophytic shrub, with bare ground between the plants. Only where streams descend from the mountains was there originally a dense growth of *monte*, which has now been cleared away to make room for irrigated crops.

When the Spaniards first arrived on the shores of the Plata in the early 16th century they found an apparently endless sea of tall, plumed grass, grass that grew so high in the rainy season that to see out over it a man had to stand on the back of his horse. The grasses of the pampas grow in bunches in the better-drained spots, and the many wet spots on the pampas were covered with coarse marsh grasses. The geographer Oscar Schmieder, who

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ARAUCARIA PINE IN THE ANDEAN LAKE REGION

studied the region intensively, reached the conclusion that the original vegetation of most of the pampas was probably the same kind of scrubby, woody plants (*monte*) found farther west and farther north. Perhaps grass was mixed with the woody plants. A very small population of hunting Indians, who set fire to the grass just before the beginning of the rainy season in order to round up the game, could have created a pure grassland. Fire has the effect of killing the woody plants, leaving the grasses to grow each year without competition. The Spaniards introduced cattle and horses to the part of the pampas along the Paraná-Plata shore between Buenos Aires and Santa Fe, and unintentionally they brought the seeds of European grasses. In a short time the whole northeast part of the pampas was covered with European grasses that formed a thick sod instead of growing in bunches. As long as cattle grazed, or fires raged, the woody plants were kept out of the pampas. Yet ornamental trees planted around estate headquarters grew without difficulty.

The grasslands continue northward into the part of Argentina that lies between the Paraná and Uruguay rivers and eastward into Uruguay and south Brazil. But where the arm of Argentine territory is extended northward along the eastern side of the Paraná onto the Paraná plateau the grasslands give way to forest. In the deeper valleys, protected from frosts, is found a tropical semideciduous forest. On the plateau surface is a forest consisting of *Araucaria* pine mixed with broadleaf deciduous trees.

In Patagonia the desert surface is covered with xerophytic shrub. Drought-resistant low shrubs fight for existence in the face of aridity and high winds. Some ribbons or islands of *monte* occupy canyon bottoms and sheltered spots in the lee of cliffs. On the higher plateaus, where a thin blanket of snow falls each winter, there is a quick-maturing growth of short grass in the spring. A short grass steppe runs in the belt along the eastern Andean piedmont, the pre-Andean depression, where the rainfall is somewhat greater than it is farther to the east. In southern Tierra del Fuego the lower mountain slopes are covered with the Chilean evergreen broadleaf forest. (P. E. J.)

4. **Animal Life.**—Many tropical animals enter northern Argentina in the forests and marshes of the Paraguay and Paraná basins. These include the howling monkey, tapir and marsh deer, giant anteater and jaguar and the largest of rodents, the aquatic capybara, with the still more aquatic coypu. The great variety of grassland and desert animals gives the Argentine fauna its special character. Most conspicuous are the guanaco (the wild cameloid

ancestral of the llama) and the ostrichlike rheas. Large and small rodents in vast numbers and considerable variety characterize the plains.

The Patagonian cavy (*Dolichotis*) is long-legged and graceful. The viscacha (*Lagostomus*), about 30 in. long, is a gregarious burrower, and its colonies attract a wide variety of other animals (including birds), much as do those of the North American prairie dog. The small tuco tuco everywhere riddles the soil. The hairy armadillo, the three-banded armadillo and the molelike and mole-sized pichiciago of the Andean deserts are characteristic. The puma is the most widespread carnivore. Azara's fox and the hog-nosed skunk are ubiquitous.

The condor (*Vultur gryphus*) glides majestically through the bleak valleys of the high Andes. The largest of the plains birds, next to the rhea, is the crested screamer. Native and migrant shore birds are numerous. The various kinds of tinamous, with wailing voice and eggs like purple porcelain, are known as *perdiz*. The ovenbird with its mud nest is everywhere conspicuous.

Caymans, turtles, lizards, small snakes and a few types of frogs are present. A magnificent game fish, the dorado, is found in the larger streams. (K. P. S.)

II. GEOGRAPHIC REGIONS

The national territory of Argentina may be divided into five major geographic regions: (1) the northwest; (2) the Chaco; (3) Mesopotamia; (4) Patagonia; and (5) the humid pampas. The first four regions are all oriented toward the humid pampas in the economic and social life and in the institutions of government. In the humid pampas, and especially in the "Great City" of Buenos Aires, is concentrated most of the productive capacity of the nation.

1. Northwest.—The northwest includes the Andes and the eastern piedmont of the Andes north of the Río Colorado, or about latitude 36° S. It includes all or part of the following provinces: La Pampa, Mendoza, San Luis, San Juan, La Rioja, Catamarca, Tucumán, Salta and Jujuy (*qq.v.*).

This was the first section of what is now Argentina to be settled by the Spaniards. The people who came to this part of the continent came directly or indirectly from Peru, and their economic connections during most of the colonial period remained oriented toward Lima and the silver-mining communities of the Andes. Santiago del Estero was founded in 1553. Other settlements in the region were made soon after: Tucumán in 1565; Salta in 1582; La Rioja in 1591; Jujuy in 1593. Settlers from Santiago del Estero also occupied the site of Córdoba in 1573. Meanwhile the piedmont towns farther south had been settled by people from Chile: Mendoza in 1561–62, San Juan in 1562 and San Luis in 1596. During most of the colonial period Tucumán was the major focus of all the country east of the mountains. There the mules from the humid pampas were concentrated and fitted with pack harness before being driven to the annual fair held at Salta. Only after Argentina became an independent country were these economic connections gradually broken.

The economic orientation of the northwest has turned definitely toward Buenos Aires. In the late 1850s one of the Argentina's first railroads was built from Rosario to Córdoba and Tucumán. Almost at once the stagnant economy began to show new signs of life. In the 1860s sugar cane plantations were laid out south of the city of Tucumán along the eastern base of the mountains. This is the southernmost area in Argentina where absence of killing frost makes cane cultivation possible. Railroad development led to a rapid increase of the cane area, which spread out eastward until it was stopped by the winter frosts. Although this area receives enough rain to permit agriculture without irrigation, water actually is used to moisten the cane fields during the dry winters. As the railroad was built northward to Jujuy, sugar cane plantations extended in that direction. The chief crops from Tucumán northward are sugar cane and corn (maize).

South of Tucumán, where the whole piedmont is very dry, agriculture and settlement are dependent on water and all limited to places where rivers descend from the mountains into the eastern plains. The oases are proportional in size to the volume of water available. The largest ones are Mendoza, San Juan and San Rafael, but there are several smaller irrigated areas, such as La Rioja and Catamarca. In all these oases the crops include wine grapes and alfalfa. At San Rafael there is a considerable acreage of pear orchards.

Mendoza is important not only as an agricultural and wine-processing centre but also as a pass city. Just to the west is the Uspallata pass, over which railroad and highway provide connection with Chile. Actually the traffic over these facilities is small, for the two countries exchange little with each other.

In the high Andes are a few small mining communities. Argentina mines asbestos, beryllium, lead, zinc, copper, silver, tungsten, mica, fluorspar, asphalt and sulfur. Near Mendoza are some beds of low-grade lignite; and along the Andean front in Mendoza and also in Salta and Jujuy oil wells are in production.

2. Chaco.—The Chaco includes the northern part of Santa Fe, Santiago del Estero, the eastern part of Salta and the two provinces of Chaco and Formosa (*qq.v.*). It is an area that remains thinly populated excepting along its eastern and southern margins.

The oldest of the settlements on the margins of the Chaco are those that are strung along the courses of the Río Salado and the Río Dulce. Long before the arrival of the Spaniards the Indians had grown crops on the flood plains of these rivers. When the floods of the rainy season had receded, certain wet spots on the flood plains remained, and these could be planted with maize or other crops. The same method is still used. The wet spots, known as *bañados*, differ in arrangement each year because each flood results in a new pattern of gravel and sand. The Río Dulce, however, occupies a narrow channel upstream from Santiago del Estero, and there the pattern of *bañados* cannot shift from year to year. The chief commercial centre of this area owes its location to the stability of the channel.

The settlements along the eastern margin of the Chaco began as quebracho lumbering centres. The quebracho tree is cut and hauled to tannin-extracting plants located close to the Paraná. After the quebracho cutters had cleared the forest—in bands running northwestward into the interior of the Chaco—agricultural settlers came in and created small farms along the railroad lines. The chief areas of farm settlement run inland from Resistencia and Formosa, and the chief commercial crop is cotton. In the south, on the other hand, after the quebracho cutters had cleared the forest in Santa Fe state, the land was divided into large ranches and used for the pasture of cattle. These kinds of economic development are restricted by rainfall to the eastern half of the Chaco.

3. Mesopotamia.—Mesopotamia includes the part of Argentina that lies between the Uruguay river and the Paraná (hence the name). The region includes the provinces of Entre Ríos, Corrientes and Misiones (*qq.v.*).

Because of the difficulty of crossing the wide flood plain of the lower Paraná river, this part of Argentina has always suffered from isolation. It did not share in the moderate prosperity brought by the raising of mules on the southern shore of the Paraná. The region north of the Paraná is still connected with Buenos Aires only by ferry. The southern part of Mesopotamia has been developed for farming, and is today the major area of linseed production. The greater part of Mesopotamia, however, is used for pasture. It has become the leading area of wool production in Argentina. Some tobacco is grown around Corrientes in the northwest corner of the region. Where Misiones extends onto the Paraná plateau the Argentines have developed a string of yerba maté (Paraguay tea) plantations; this is the world's chief source of Paraguay tea, which is widely used in this part of South America.

4. Patagonia.—Patagonia (*q.v.*), the region south of the Río Colorado, includes four provinces: Neuquén, Río Negro, Chubut and Santa Cruz (*qq.v.*), and the federal territory of Tierra del Fuego (*q.v.*). This southern region makes up about 28% of the national territory, but it is occupied by only about 2.5% of the Argentine population.

The settlement of Patagonia by people of European origin oc-



(TOP LEFT) DAVIS PRATT FROM RAPHO GUILLUMETTE, (TOP RIGHT) PAAR—PIX FROM PUBLIX, (BELOW) RENE BURRI FROM MAGNUM

(Top left) Marking cattle for auction at the stockyards in Buenos Aires; (top right) harvesting wheat, one of Argentina's leading crops; (below) gaucho breaking in horse on a cattle ranch in the pampas

curred late. Until the Indian campaigns of 1879–83, most of Patagonia was left to the native peoples, and the only settlements were at Punta Arenas (*q.v.*) in Chile on the Strait of Magellan and at Carmen de Patagones and Trelew in the northeast. As soon as the Indian menace had been eliminated, however, pioneer colonists began to move into Patagonia. The pioneer settlers included many Welsh, Scottish and English and also many Chileans from Punta Arenas and from Neuquén. The only agricultural area in Patagonia lies along the valleys of the Río Colorado and Río Negro, where summers are still warm enough to make the growing of grapes and pears profitable. South of the Río Negro the temperatures are too cool to support anything but alfalfa for animal feed. The traditional product of Patagonia is wool; the chief use of the land is for sheep grazing. During the winters the herds are sheltered in the canyons or in the lee of cliffs, but in spring they are driven to places where there has been enough winter snow to support a growth of grass. A major concentration of sheep is in the pre-Andean depression, especially in Chile north of Punta Arenas. The wool clip is brought by train or truck to the little ports and shipped by small vessels to Buenos Aires. Only in the north of Patagonia, in the Río Negro valley and around Neuquén and Bariloche, are cattle more important than sheep.

Patagonia is important, also, because of its oil. Oil was discovered in 1907 at Comodoro Rivadavia (*q.v.*) and this oil field has now become the largest source of oil in Argentina. In the 1940s a pipeline was built from Comodoro Rivadavia to Buenos Aires to supply that city with natural gas. Another kind of economic activity is the development of recreation facilities around Lake Nahuel Huapí. This beautiful lake on the Andean piedmont southwest of Neuquén has long been used as a summer route across the Andes to Chile. Many tourists stop at the lake to enjoy the scenery, fishing and other recreational attractions, and the area has been developed for skiing in winter.

5. Humid Pampas.—The concentration of people and wealth in the humid pampas and in the metropolitan area of Buenos Aires is the outstanding fact of Argentine geography. The humid pampas includes the whole of the province of Buenos Aires and parts of Santa Fe, Córdoba and La Pampa (*qq.v.*).

The humid pampas as a geographic region is a modern development, dating only from the last half of the 19th century. For the first three centuries of Spanish settlement the humid pampas was considered a poor region, good only for pasturage of range cattle and breeding of mules. The only permanent settlement of the humid pampas was along the northeast margin on the Paraná-Plata. Buenos Aires, Rosario and Santa Fe date back to the 16th century. Inland from these places the land was used for unfenced pastures on which the animals grazed on the native grasses. A little less than 100 mi. S. of the Paraná-Plata shore the surface of the humid pampas is marked by a chain of marshes, known in North American writings as the Salado slough. Spanish settlement did not penetrate to the south of these sloughs. A line of forts along the northern margin of the sloughs gave some protection for the settlers from Indian raids.

The occupation and development of the humid pampas beyond the Salado slough began only in the late 1870s. The first railroad in Argentina had been built out of Buenos Aires in 1857, and shortly thereafter the line from Rosario to Córdoba and Tucumán was constructed. Railroads were rapidly extended across the level plains during the decades between 1860 and 1880. The Indians were finally wiped out in a series of military campaigns between 1879 and 1883. By that time the potential productivity of the humid pampas had been vastly increased through a series of more or less related inventions. First was the railroad itself, which made possible the bulk transportation of goods of low value per unit of weight. Second was the steamship, which vastly reduced the cost of ocean shipping, and the refrigerator ship, which made it possible to ship meat across the equator. A fundamental invention was barbed wire, which in the 1870s suddenly made it possible to combine farming and grazing on the world's grasslands, where fencing had been impossible before. Other inventions include the windmill, well-drilling machinery, the steel plow, the harvesting combine and many others. In Argentina, when these new products were available, the land rapidly increased in value and, in accordance with Spanish tradition, it was quickly divided into vast private properties. The greater part of the humid pampas came into the hands of some 300 families, each family with an *estancia* measured in hundreds of thousands of acres.

Argentine landlords have always been chiefly interested in stock-

raising; their greatest prestige comes from owning a fine herd of purebred cattle, or fine horses or the best-quality sheep. But when the large British beef cattle were introduced to the humid pampas during the 1870s and 1880s, it was found that a feed crop had to be grown, for the native grasses were not adequate. Alfalfa proved to be ideally suited to this region, but to eliminate the native grasses and plant alfalfa it was found that the land had to be prepared by several years in wheat. To grow the wheat and plant the alfalfa, the landlords hired tenant farmers—mostly Italian, Spanish and other European immigrants—who grew the wheat for three or four years, then planted alfalfa and moved elsewhere. Alfalfa remains productive (four or five cuttings a year) for four or five years, after which another tenant is hired for the next cycle of wheat or corn or other grain.

Great Britain provided a constantly increasing market for both meat and grain. British capital, invested in railroads, grain elevators, packing plants, docks and shipping lines, provided the transportation facilities on which the whole prosperous system rested. As a result, Argentina became by far the leading commercial nation in Latin America.

The humid pampas was created as a geographic region in the process. Without the spread of wheat and cattle, the present outlines of the region could not have been determined. But wheat was grown as far toward the south and west as the rainfall made possible. With decreasing rainfall, yields of wheat and alfalfa declined. If the price of wheat or of cattle had been higher in the 19th century when this process of development was going on, the outline of the humid pampas would have been developed farther toward the dry areas. Once established and supported by railroad lines, the humid pampas appeared as a region distinctly different in agriculture from the semiarid lands farther west, which the Argentines know as the "dry pampas." The humid pampas itself has become differentiated into subregions. The eastern part, which is cool and poorly drained, is still used chiefly for animals grazing on grass—for sheep and cattle breeding. The cattle are fattened on alfalfa (not corn as in the United States), which is associated with wheat in a crescent extending from Bahía Blanca to Córdoba along the western boundary of the area. Around Rosario, where the rainfall is most dependable, corn is more important than wheat, but the corn is raised chiefly for export to be used as poultry feed in Europe. A zone of intensive dairy and truck farming has developed around Buenos Aires for the supply of the city population.

Buenos Aires began its modern development as a centre of manufacturing industry during World War I, and the development was intensified during World War II. During these wars, when the British chose to use their ships to carry meat rather than wheat, the wheat acreage was cut in Argentina and many tenants left the rural areas to seek employment in the cities. At these times new industries were built in Buenos Aires to process the products of the humid pampas and of the outlying regions of the country.

The humid pampas remains the lowest-cost producer of grain and meat in the world. The moist, mild winter climate, the level surface, the productive loess soil and the easy accessibility to a port combine to reduce the costs of sending food to the world markets. But the absence or scarcity of fuel and minerals makes Buenos Aires a high-cost producer of manufactured products.

(P. E. J.)

III. THE PEOPLE

1. Ethnic Groups.—The racial stock of Argentina is overwhelmingly white European, the Indian and Negro strain, so important in the composition of many Latin-American countries, being almost wholly absent. Although the mestizo (mixture of Indian and white) element is considerable in the provinces contiguous with Chile, Bolivia and Paraguay, and there are pure Indian communities in the northwest, the populated centres of Argentina, and in particular the metropolis of Buenos Aires, are almost pure white.

The formation of such an Argentine racial type is a comparatively recent development, occurring largely since 1870. Prior to that there was a considerable mestizo and even mulatto strain in the national composition. Although the region was never densely populated with Indians, there are thought to have been about 400,000 in the Río de la Plata at the start of the Spanish colonial period. Interbreeding with the Spanish conquerors resulted in the mestizo element, so characteristic of the early 19th century gaucho. Negro slaves brought to Buenos Aires in the 18th century added another mixture to the racial make-up. As the 19th century progressed certain alterations took place. The centre of population moved from the mestizo areas of the north and west toward the coast, where Spanish and newly arrived European elements formed the majority. A large portion of the pure Indian stock was eliminated in savage frontier warfare, while the mestizo and mulatto strains continued to grow fainter through intermarriage. The major racial change came as a result of the economic expansion of the pampas and the coast. The development of meat refrigeration and of the productivity of cereal grains on the pampas necessitated an enormous working force to raise cattle and, more important, to harvest the wheat and corn. The result was a flood of European immigration concentrated in the three decades following 1880 and amounting to a total addition of 3,500,000 from 1860 to 1940. Nearly three-fourths of these immigrants were Italian and Spanish, with Poles, Turks, French, Russian Jews and Germans contributing their share in that order. The centre of population came to be definitely located in the littoral and pampas regions and the composition of the population to be southern European.

2. Languages.—The language of Argentina is Spanish, although sharply distinguished from Castilian in pronunciation. The frontier and gaucho existence added new words to the language, and the influx of a large Italian element created many variations in accent and speech.

An underworld language called Lunfardo has developed in Buenos Aires composed of words from many languages, but principally Italian. This argot has been widely used in the words of Argentine popular songs, especially the tango. Large foreign settlements have maintained their languages both in the family and in private schools. French, German and English form large influential groups of the community, at least in Buenos Aires, and use of those languages follows the same order. Indian dialects still exist along the fringe of Argentina bordering Chile, Bolivia and Paraguay but contribute no significant addition to the national tongues (*see* SOUTH AMERICAN LANGUAGES).

3. Religion.—Approximately 95% of the Argentine population is Roman Catholic. The church is particularly strong in rural areas and in the older colonial centres such as Córdoba, Tucumán and Salta. Although the constitution requires that the president be a Catholic, and Roman Catholicism is supported as the official religion of the country, complete religious freedom was instituted as part of the 19th-century effort to attract European immigration. As in most Latin-American countries, women are the strength of the Catholic religion.

4. Culture.—A distinctive Argentine culture is hard to define since it has so many composite immigrant elements and is continually changing. The basic heritage is Spanish, and in many ways Spanish culture is the primary force in a national cultural pattern. The male is the dominant member of the family and of society, despite legislation under the Perón regime (1946–55) that gave women legal and political equality. Although industrialization and urbanization have weakened family bonds, loyalty and unity within a large family clan remain important social forces. The influence of the factory and the city has not completely destroyed the demand for a personal and sometimes almost paternal touch in business and politics and an extreme reliance on the leadership of the strong individual. The gaucho heritage of the country is largely relegated to story and poetry, and many Argentines rarely come closer to their frontier past than an occasional maté or *asado* (barbecue). Just as the recent population has been European in origin, its culture is mainly European. France is the cultural ideal of Argentina, and many aspects of art and culture follow French models.

The economic development of Argentina has created a large middle class, which in turn has fostered some individual cultural values. Though material gain and money values are dominant in

the minds of this class, as well as in those of the lower class, considerable respect is paid to artistic and intellectual values. A university education is sought after, and the average man has a marked interest in and knowledge of music, art and philosophy. Nationalism has not been diluted by the European origins, and the immigrant son has emphasized Argentine nationalism.

(Js. R. S.)

IV. HISTORY

1. Prehistory.—When the settlement of present-day Argentina by Europeans began shortly after 1500, all parts of it were inhabited by aboriginal Indians. How long they had been there, and how they got there in the first place, are questions about which scholars disagree. The best opinion seems to be that, like all other American Indians, they were sprung from Asian peoples who came to the new world perhaps 20,000 years ago by way of Bering strait and whose descendants gradually spread southward across both American continents and reached southernmost Argentina 5,000 to 8,000 years ago. It is also believed that not long after the beginning of the Christian era the aboriginal Americans who lived on the Pacific coast of South America somehow established transpacific contacts, received cultural influences from southeast Asia and perhaps Polynesia and passed these on to their neighbours in Argentina.

The total number of Indians living in Argentina about 1500 is estimated at 300,000, divided into many small tribes and speaking many different languages. Their various cultural levels covered a wide range, but none of them had developed a high civilization with large cities, great architectural monuments and accumulated wealth such as those that aroused the astonishment and cupidity of the Spaniards in the Aztec and Inca empires.

Compared with the latter, all the Indians of Argentina were relatively poor and backward. The most advanced of them lived in the northwest, under the cultural influence and, in part, the political control of the Inca empire. Many of them spoke the official Inca language, Quechua, and had acquired Inca skills in making pottery, working metals and farming with the aid of irrigation. At the other extreme, culturally as well as geographically, were the Indians of southernmost Argentina, whose primitive fishing and hunting culture had advanced little if any since their ancestors first settled the area.

Between these two extremes were most of the other Indians, who lived by hunting and by gathering roots and berries. Farming was confined largely to the lower slopes of the Andes and the borders of the Río de la Plata and its tributaries; it yielded barely enough for the Indians' subsistence, and this was a major cause of friction when the Spaniards arrived in the country and expected the Indians to feed them.

Most of the Argentine Indians were good and willing fighters, for intertribal warfare was common and prowess in battle rated high among the values of their culture. Their weapons were mainly of the Stone Age. But they were adaptable, as they proved by the rapidity with which they learned to excel in the use of the horses and firearms which were introduced into the country by the Spaniards. (*See* also INDIAN, LATIN-AMERICAN; SOUTH AMERICA: *Anthropology*.)

2. Discovery and Settlement.—Amerigo Vespucci (*q.v.*) is credited by some historians with the discovery of the Río de la Plata in 1501–02. Other historians deny this, but it is well established that Vespucci later stimulated the Spanish search for a southern strait which led to the discovery both of the Río de la Plata by Juan Díaz de Solís in 1516 and of the Strait of Magellan by Ferdinand Magellan in 1520. These two voyages revealed the main outlines of the Atlantic coast of what is now Argentina.

Sailing up the Plata, which he called the Mar Dulce, or Freshwater sea, Solís, with a small party, landed and was ambushed by Indians. Solís and most of his followers were killed; several disappeared. The survivors of the expedition returned to Spain.

The Río de la Plata was not explored again until Magellan arrived in 1520 and Sebastian Cabot in 1526. The latter picked up two survivors of the Solís expedition, who told glowing tales of the wealth of the region. Cabot discovered the Paraná and Paraguay rivers and established the fort of Sancti Spíritus (the first Spanish settlement in the Plata basin). He also gathered and sent home reports of the existence of a silver mountain and a rich people in the interior, together with some silver trinkets to support the story. Hence the main stream was renamed when Charles V created the Adelantazgo of the Río de la Plata (*plata*, "silver").

In 1528 Cabot met another expedition from Spain under Diego García (who had commanded a ship in the Solís expedition). Both Cabot and García had been supposed to sail for the Moluccas but altered their courses, influenced by excited tales about an "enchanted City of the Caesars," a variant of the Eldorado (*q.v.*) legend, which later incited many explorations and conquests in Argentina. As Cabot himself was preparing to search for the fabled city, a surprise attack by the Indians in Sept. 1529 wiped out his Sancti Spíritus base, and he and the survivors returned to Spain the following year.

Inspired by the conquest of Peru and the threat from Portugal's growing power in Brazil, Spain in 1535 sent an expedition under Pedro de Mendoza (equipped at his own expense) to settle and hold the country. Mendoza, a favourite of Charles V, belonged to one of the great families of Spain; his expedition was the largest sent to America up to this time (11 ships, 2,150 men, 100 horses). Ulrico Schmidel, the first historian of the region, accompanied the expedition. Mendoza was initially successful in founding Nuestra Señora Santa María del Buen Aire, or Buenos Aires (1536), but lack of an adequate food supply proved fatal. Bad treatment antagonized the primitive Indians of the neighbourhood, and they cut off supplies. Discouraged by Indian attacks and mortally ill, Mendoza sailed for Spain in 1537, dying on the way.

In the same year a party from Buenos Aires under Juan de Ayolas and Domingo Martínez de Irala, lieutenants of Mendoza, pushed a thousand miles up the Plata and Paraguay rivers. Ayolas was lost on an exploring expedition, but Irala founded Asunción among the Guaraní (*q.v.*), a sedentary, agricultural people. In 1541 the few remaining inhabitants of Buenos Aires abandoned it and moved to Asunción, which was the first permanent settlement in this area. In the next half-century Asunción played a major part in the conquest and settlement of northern Argentina.

Until the late 18th century the population of Argentina was heavily concentrated in this northern area, which was bounded on the south by a line running from Rosario, on the Paraná, through San Luis to Mendoza, on the eastern slopes of the Andes. Buenos Aires, re-established in 1580 by Juan de Garay with settlers from Asunción, was largely isolated from this area as well as the rest of the world, except for smuggling. As a result, as late as 1725 it had a population of only 2,200.

Northern Argentina as well as Buenos Aires was settled mainly by the overflow from neighbouring Spanish colonies, Chile, Peru and Paraguay (Asunción). There was little direct migration from Spain, probably because the area lacked the attractions of Mexico, Peru and other Spanish colonies, such as rich mines, a large supply of tractable Indian labour, accessibility and the privilege of direct trade with Spain.

The dependence of Argentina on neighbouring colonies for its first Spanish settlers is shown by the following summary: Santiago del Estero, the first permanent settlement by Europeans in Argentina, was founded in 1553 by an expedition from Chile under Francisco de Aguirre, other groups coming from Chile founded San Juan and Mendoza (both 1562) and San Luis (1596). From Paraguay came the founders of Corrientes and Paraná (both 1588), Santa Fe (1573) and the second Buenos Aires (1580), while Peruvians founded Tucumán (1565), Córdoba (1573), Salta (1582) and La Rioja (1591). These dozen communities, all established within 43 years after 1553, continued to be the main centres of Argentine life throughout the colonial period, and very few important additions were made to the list in the national period.

In these communities a simple but vigorous society developed on the basis of Indian labour and the horses, cattle and sheep imported by the Spaniards, as well as native products such as corn and potatoes. Some of the Indians worked as virtual serfs (not slaves) under the encomienda system, others in free villages

and others in missions established by the Roman Catholic Church, which played a notable role in the whole colonizing process. As few Spanish women accompanied the early settlers, there was much intermarriage with the Indians. Of the offspring (mestizos), some achieved high positions in society, but many became gauchos, or cowboys (see *The People*, above). On the fringe of the conquered zone, Indian warfare continued as late as 1883.

3. Colonial Development.—Politically, Argentina was a divided and subordinate part of the viceroyalty of Peru until 1776, but three of its cities—Tucumán, Córdoba and Buenos Aires—successively achieved a kind of leadership in the area and thereby sowed the seed of community feeling that much later grew into the idea of Argentine national union. Each of the three cities achieved leadership in a different way, and each way represents a distinct stage in the history of Argentina, though the three stages overlapped.

Tucumán came first. Its leadership lasted from the latter part of the 16th through the 17th century. Its political and ecclesiastical jurisdiction extended over most of northern Argentina, including Córdoba; the chief exceptions were San Juan and Mendoza, which depended upon Chile. Tucumán also dominated the chief economic activity of Argentina at that time, which consisted in supplying the rich silver-mining area of Upper Peru (Bolivia) with foodstuffs and livestock in return for European manufactures and other goods brought from Spain via Panamá and Lima, Peru.

Under the same economic system Córdoba rose to leadership in the 17th and 18th centuries because the expansion of settlement gave the city a central location and because the University of Córdoba, founded in 1613, put the city in the intellectual forefront in Argentina and Spanish America in general. Administered by the Jesuits until their expulsion from the Spanish empire in 1767, and best known for its theological studies, the university made Córdoba a symbol of conservatism.

On the other hand, Buenos Aires, which rose to leadership in the late 18th century, symbolized three important reorientations of Argentine life from west to east. The first, economic, was the shift from trade with the now declining silver mines of Peru to direct transatlantic trade with Europe. Another, intellectual, resulted from the rise of interest in the new ideas of the European Enlightenment, which found fertile soil in cosmopolitan Buenos Aires and challenged the old order represented by Córdoba. The third, political, was brought about by detaching Spain's possessions in the Plata basin (modern Argentina, Uruguay, Paraguay and southern Bolivia) from the viceroyalty of Peru and erecting them into the new viceroyalty of La Plata, with Buenos Aires as its capital (1776).

Spain created the new viceroyalty mainly for the purpose of putting its Plata dominions in a better defensive position. The chief threat came from Brazil, which was growing rapidly in population, wealth and military potential and whose metropolis, Portugal, was the traditional ally of Great Britain, the traditional enemy of Spain. Though the creation of the viceroyalty of La Plata thus was primarily a measure of imperial defense, it conferred important benefits on Buenos Aires. Besides making the city a viceregal capital, with all the prestige and profit attached to that status, it for the first time threw the port of Buenos Aires open to transatlantic trade with Spain and, through Spain, with other countries. This resulted in a great increase not only in the legal trade of Buenos Aires but also in its already flourishing smuggling trade with Brazilians, Frenchmen and Britons (the enemies of Spain were not necessarily the enemies of Buenos Aires).

The city continued its rapid growth (from a population of 2,200 in 1726 to 33,500 in 1778 and 45,000 in 1800). It also became cosmopolitan: in addition to foreign trade, merchants and books, its growing wealth and cultural sophistication in the later years of the century attracted French and Portuguese teachers of dancing and music, an Italian painter and a French musician who built for the cathedral an organ that lasted for nearly a century.

The growth of commercial Buenos Aires stimulated an increase in the number of gauchos. One of the main occupations of these half-wild cowboys, "centaurs of the pampa," who seldom if ever saw the city, was the killing of cattle for their hides and horns major items in the Buenos Aires export list. Accustomed to frontier fighting and, though hostile to discipline, easily led by a strong man, the gauchos provided much of the manpower for the succession of Argentine revolutions, civil wars and dictatorships that occurred between 1810 and 1880. In retrospect, they appear as an ambivalent factor in Argentine life. On the one hand, they represented the barbarism of the title of Domingo Faustino Sarmiento's (*q.v.*) book *Facundo*, or "The Conflict Between Civilization and Barbarism" (1845); on the other, they are also regarded as the embodiment of some of the most highly prized traits of the Argentine people, such as independence of spirit, courage, and pride in their country.

4. Independence.—In Argentina, as in most of Spanish America, the independence movement was precipitated mainly by Napoleon's intervention in Spain, beginning in 1808 (*see* SPAIN: *History*). The way had been prepared for it, however, by the deep-rooted antipathy between "peninsular" Spaniards and American-born creoles; by the examples of the American Revolution of 1776 and the French Revolution of 1789; and by ideas drawn from earlier Spanish sources as well as from Rousseau and other French and English writers of the Enlightenment. Other important factors in the case of Argentina were Great Britain's invasion of the viceroyalty of La Plata in 1806–07, the ignominious flight of the Spanish viceroy and the defeat and expulsion of the British army from Buenos Aires by the Argentine people. The result was to weaken ties with Spain and nourish a nascent Argentine patriotism; a poem written in celebration of this victory gave currency to the name Argentina.

The break began in 1808 when Napoleon's intervention plunged Spain into a civil war between two rival governments. One was set up by Napoleon, who forced the rightful king, Ferdinand VII, to abdicate, placed his own brother Joseph Bonaparte on the throne and supported him with a French army. The other was created by the union of a number of patriotic juntas in Spain under a regency, which governed in the name of the exiled Ferdinand VII and was aided by a British army under the duke of Wellington. Both governments claimed authority over all the Spanish empire; in most of Spanish America, however, while there was general sympathy with the regency, its claim as well as Joseph's was rejected, mainly on the ground that an interregnum existed and that under ancient principles of Spanish law the king's dominions in America had as much right as those in Spain to govern themselves pending the restoration of a lawful king.

In Argentina this view was sustained by the creoles rather than by the "peninsular" Spaniards, and it was given effect by the Buenos Aires *cabildo*, or municipal council. This ancient Spanish institution had existed in all the colonies since the 16th century. It was aristocratic and its powers were very limited, but it was the only organ that had given the colonists experience in self-government. In emergencies it was converted into an "open" *cabildo*, a kind of town meeting, by adding to the regular members all the men of substance in the community; even then it was not a fully democratic body, since the common people were not included.

On May 25, 1810, such an "open" *cabildo* in Buenos Aires set up an autonomous government to administer the viceroyalty of La Plata in the name of Ferdinand VII, pending his restoration. This was not a declaration of independence but, on the contrary a profession of loyalty to the king. The profession was probably sincere on the part of most of the *cabildo* members who made it, but when Ferdinand was restored in 1814 he promptly proved himself one of the worst kings Spain had ever had. Thereupon an assembly representing most of the country met at Tucumán and on July 9, 1816, declared the country independent under the name of the United Provinces of the Río de la Plata.

In the meantime the government at Buenos Aires had taken the lead in grappling with the problems facing the country. The main problems, and their development down to 1829, when the long dictatorship of Juan Manuel de Rosas (*q.v.*) began, may be summarized as follows:

a. Defense. At no time after May 25, 1810, was Buenos Aires directly threatened by the Spanish royalists, but it took several years of hard fighting to defeat them in northern Argentina and even after that they were a constant threat from their main base in Peru. This problem was solved by the flanking strategy of Argentina's great liberator, José de San Martín (*q.v.*). He first led his army in an epic march from Mendoza across the Andes to Chile, where he helped the local patriots win their independence (1817–18), and then, with the support of a fleet organized in Chile, sailed up the coast of Peru and began its liberation. He withdrew in 1822 in favour of the Venezuelan liberator Simón Bolívar (*q.v.*), who completed the task two years later.

b. Territorial integrity. The Buenos Aires government tried to maintain the integrity of the old viceroyalty of the Río de la Plata, but the outlying portions, never effectively controlled, soon were lost: Paraguay in 1814, Bolivia in 1825 and Uruguay in 1828. Even the remaining core, modern Argentina, frequently was disunited until 1860. The root cause of the trouble, the question of the relation of Buenos Aires to the rest of the country, was not settled until 1880, and even after that it continued to cause dissatisfaction, though never again to the point of disrupting the union.

c. Form of government. Until 1820 a small but influential group sought secretly to establish a monarchical government in Argentina, but in that year the exposure of their plan led to a revolution that defeated it—permanently, as it proved. Thenceforth there was general agreement that the government should be republican but violent disagreement as to whether it should be centralized or federal. This was literally a fighting question between the two groups, who were identified respectively as Unitarists and Federalists. Unitarian power reached its peak under Bernardino Rivadavia (*q.v.*), who was named president in 1826 but resigned the following year partly because of the unsatisfactory course of the war of 1825–27 with Brazil over Uruguay. After a chaotic interlude, a long period of Federalist domination began under the leadership of Rosas.

d. Extent of the revolution. The question was whether the revolution should stop with the winning of independence or be continued within the country with a view to reforming Argentine society. Rivadavia urged the latter; for example, he wished not only to liberalize the system of great landed estates inherited from the colonial period but also to bring about a cultural revolution by replacing the Spanish-Catholic traditional culture with a modern, secular and scientific culture borrowed from France, Great Britain and the United States. This reform program had the misfortune to become identified, through Rivadavia, with Unitarism and the luckless war with Brazil. When Rivadavia fell in 1827 the reform movement collapsed with him, and it was not revived until a quarter-century later.

5. Rosas Regime.—Rosas came to power partly as a representative of the conservative reaction against these reforms, partly as the *caudillo* (military leader) of the gauchos and the champion of "order and discipline," a motto that appealed strongly to many people in a country that had suffered much from disorder and violence most of the time since 1810. At first his power was confined to the province of Buenos Aires, of which he was elected governor in 1829, and other provinces had their own *caudillos.* By 1835, however, he had subordinated or eliminated his rivals, and from that time until his overthrow in 1852 he was master of Argentina.

Rosas' success was due to several factors in addition to the forces that had sustained him at the outset. One of the most important was the Mazorca, an organization founded in 1833, whose members included respectable citizens as well as the scum of society. The ways in which the Mazorca supported Rosas ranged from staging popular demonstrations in his honour to assassinating his opponents. Clergy and magistrates joined in the demonstrations, paraded Rosas' portrait through the streets as if in a religious procession, and sometimes even placed it on church altars. Another major factor was the strong appeal that Rosas made to Argentine patriotism by his defense of national interests against all comers, including the greatest powers: against Great Britain in the controversy over the Falkland Islands (*q.v.*), which Argentina claimed but which Britain seized at this time and never gave up, and against both Britain and France during their armed interventions in the Plata between 1838 and 1850.

On the other hand, Rosas' regime suffered from defects that ultimately proved his undoing. He carried nationalism to the point of a xenophobia that excluded not only the foreign cultural influences that Rivadavia had wished to promote but also foreign immigration, enterprise and capital. As a result, the late colonial economic system continued with little change. This pleased lovers of the *status quo,* but not forward-looking Argentines interested in the country's economic development. Partly on this ground, but still more in defense of freedom, many of the intellectual elite turned against Rosas. Among them were Juan Bautista Alberdi, Bartolomé Mitre (*qq.v.*) and Domingo Faustino Sarmiento, who later were to lead in remaking Argentina. Forced to flee Rosas' tyranny, they kept up a vigorous literary barrage against him from Chile, across the Andes, and Montevideo, across the Plata. Their journalistic attacks did not bring about his overthrow, but they prepared the way for it by weakening his moral authority.

What overthrew Rosas was the combination of a revolt in his own army with intervention from Brazil and Uruguay, and in both cases Rosas himself was largely to blame. Once a vigorous field officer, he left it to others, chiefly Gen. Justo José de Urquiza (*q.v.*), to put down the revolts that plagued the last decade of his regime. He also made the mistake of favouring the commerce of Buenos Aires at the expense of Urquiza's part of the country, the provinces of Entre Ríos and Corrientes, in Mesopotamia. Finally, Rosas incensed the Brazilian government and many of the Uruguayan people by his political and military intervention in Uruguay; this was dramatized by his long siege of Montevideo ("the second siege of Troy" in local histories), where Argentine exiles were writing and conspiring against him.

On May 1, 1851, Urquiza proclaimed his revolt against a "despot" who had violated a long-standing promise to establish constitutional government in Argentina. Four weeks later Urquiza formed an alliance with Brazil and Uruguay. The allies first forced Rosas' troops to raise the siege of Montevideo and then defeated his main army in the short but decisive battle of Caseros (Feb. 3, 1852). Rosas fled with his son and daughter in an English ship and never returned. He died at Southampton, Eng., a quarter-century later.

6. National Consolidation.—Needing to justify his rebellion against Rosas, Urquiza called a constitutional convention, which met at Santa Fe in 1852. Jealous and suspicious Buenos Aires abstained, but the convention adopted a constitution for the whole country. This was proclaimed in effect on May 25, 1853, the anniversary of the famous *cabildo* of 1810.

In an effort to reconcile Unitarists and Federalists, the framers of the constitution of 1853 made it a compromise between the two extremes. It was modeled mainly on the constitution of the United States, though with some important modifications, most of them proposed by Alberdi in a book written for the occasion, *Bases and Starting Points for the Political Organization of the Argentine Republic.* Two major differences related to the presidency and religion. The president of Argentina was not permitted to succeed himself, but he was given a six-year term and even more extensive powers than the president of the United States. In religion, the constitution of 1853 set up a system somewhat like that of England with its established Anglican Church, for the Argentine government was required to support the Roman Catholic Church; but religious freedom for other faiths was stipulated, and, in the sequel, enforced.

The province of Buenos Aires refused to join the new union, whose first elected president was Urquiza and whose first capital was Paraná. Serious friction soon developed. One source of it, as under Rosas, was a conflict of economic interest, which Urquiza now sharpened by trying to build up the port of Rosario as a rival to Buenos Aires. Related causes of friction were the questions whether, if the province of Buenos Aires came into the union, its capital, the city of Buenos Aires, should be made the

national capital, and what disposition should be made of its customs revenues.

Urquiza decided to impose union by force. Led by Mitre, Buenos Aires accordingly went to war in 1859, was defeated and in 1860 joined the union, though only after the adoption of a number of constitutional amendments proposed by the recalcitrant province was assured. One of these relaxed tension over the Buenos Aires question by providing that the location of the national capital should be determined by congress at a later date. Another amendment legalized all the successive names, each with its own political connotation, under which the country had gone since the beginning of independence—United Provinces of the Río de la Plata, Argentine Republic and Argentine Confederation—but stipulated that all laws should be adopted in the name of the Argentine Nation.

The terms of settlement were unacceptable to many, and new rancors were added soon after Urquiza was succeeded in the presidency in 1860 by Santiago Derqui, an ambiguous figure who had no strong support in either camp. Another civil war broke out; this time Buenos Aires won, defeating the federal forces led by Urquiza at the battle of Pavón (1861). Derqui resigned and Mitre was elected president in 1862. Buenos Aires became the seat of government.

Despite the continuance of domestic turmoil and a costly war with Paraguay, notable progress in carrying out the liberal program of economic and cultural development was made during the presidencies of Mitre (1862–68) and his next two successors, Sarmiento (1868–74) and Nicolás Avellaneda (1874–80). With the aid of foreign capital and technology, railroads were built; alfalfa, barbed wire, better breeds of cattle and sheep, and the refrigeration of meat were introduced. The country became a large-scale exporter of pastoral products to Europe. As commerce grew, so did the revenues of the government, which used them to foster the rising tide of immigration and to lay the foundations of the best system of public education in Latin America, first under Mitre but principally under Sarmiento, well named the "schoolteacher president." Both enlisted the aid of foreign scholars and scientists. Also during this period two newspapers were established that won and still enjoy high esteem for their quality: *La Prensa*, founded in 1869 by Ezequiel Paz; and *La Nación*, founded in 1870 by Mitre, who edited it for many years.

Sarmiento greatly admired the United States, which he had visited twice (first in 1845 and later as Argentine minister, in 1865–68), and even urged Argentina to "North Americanize" itself. The two outstanding developments in the country's foreign relations during this period, however, took place in Mitre's administration. First, on the occasion of a conference of Spanish American states at Lima in 1864–65, Mitre made a classic statement affirming his country's traditional opposition to multilateral security arrangements. The flexibility of this rule was shown by the second outstanding development· his commitment of Argentina, in alliance with Uruguay and Brazil, to the war of 1865–70 with the dictator of neighbouring Paraguay. The allies had great difficulty in winning, and as late as the 1960s Argentina had never fought another foreign war.

Avellaneda's administration was distinguished by two domestic events occurring near its close, the combined effect of which was a powerful stimulus to the further development of Argentina. In 1879 Gen. Julio A. Roca, "the last of the conquistadors," brought the long cycle of Indian wars to a close with a victory that opened the rich wide-spreading pampas to settlement. In 1880, following another revolt by Buenos Aires and its suppression, the perennial question of the city's status was definitively settled by its federalization. Its new status was much the same as that of the District of Columbia, with the important exception that its citizens have always been permitted to vote in national elections. This solution ushered in a long period of relative peace and order, which increased the attractiveness of Argentina to foreign capital and business enterprise. They found golden opportunities in the newly opened pampas.

7. The Oligarchy, 1880–1916.—The hero of the Indian war of 1879, General Roca, was elected president in 1880. His administration marked the beginning of the domination of Argentina by a new oligarchy, which lasted a third of a century. This oligarchy contained many members of the old patrician class of great landowners. At its core were the big ranchers or *estancieros*, who possessed great social prestige as well as economic and political influence in this traditionally pastoral country. They functioned as a power group through the exclusive Argentine Rural society organized in 1866, which has been described as probably the most powerful farmers' organization in the western hemisphere. But the oligarchy also contained men who had made their fortunes in other ways as well. and it was oriented toward the foreign commerce, capital and enterprise, mainly British, to which it largely owed its prosperity. Its members were not entirely united, however, as the revolution of 1890 showed.

Keeping control of the government through fraud and force, the oligarchy enriched itself in a way reminiscent of the "gilded age" of the Grant administration in the United States. The tide of immigration continued to mount, and an abundant supply of cheap labour aided in bringing about a great expansion of cereal production; wheat was first regularly exported from Argentina in the 1880s. By 1900, agricultural products had already caught up with pastoral products in value of exports.

An outstanding feature of Argentine political life in this decade was an anticlerical campaign launched under the influence of European liberal and positivist thought. The most spectacular results were the passage of laws secularizing public instruction and providing for civil marriages and burials, the expulsion of the papal nuncio, and a breach in relations with the Vatican that lasted from 1884 to 1900.

Miguel Juárez Celman, Roca's brother-in-law, who had led the anticlerical movement, was elected president in 1886, but mounting Catholic resentment contributed to a revolution that unseated him, though not his government. Other factors in bringing it about were the general disgust with the corruption of the regime which was shared by many of the military, headed by Gen. Manuel J. Campos; an economic recession; and unrest among the growing proletariat led by Leandro N. Alem and the recently organized labour unions. The various groups of malcontents joined together in an organization called the Civic union, whose heterogeneous elements soon fell apart, but not before it had played a major part in precipitating a revolt in July 1890. The revolt won a sweeping success in the first two days, and then was as quickly put down; some attribute the reversal to desertion of the rebel cause by its military leaders in protest against the growing power of its left-wing civilian element headed by Alem.

As a concession to the critics of the regime, Juárez Celman was forced to resign, but this made no substantial change in its nature. Vice-President Carlos Pellegrini, who, with General Roca had mobilized the government forces against the revolt, succeeded to the presidency, and he and his successors maintained the oligarchy in power for more than two decades. The government was bankrupt when Pellegrini took over, but he restored its solvency on a sound basis by a series of far-reaching measures that caused him to be compared with Alexander Hamilton.

Economic difficulties in the 1890s and the resultant political discontent produced two new parties of protest, both of which played important roles in Argentine public life thereafter and both of which derived strength from the "new Argentines," the Spanish and Italian immigrants who had poured into the country in the past generation. The stronger of the two was the Radical Civic union, often called simply the Radical party, which split off from the Civic union in 1892. It was headed first by Alem and then, after his death in 1896, by his nephew, Hipólito Irigoyen who ruled it until 1930. By way of protest against the oligarchy's system of force and fraud, the Radicals adopted a double policy of "absention" (boycotting elections) and revolution.

The Socialist party, the second of the two, was organized in 1895 by Juan B. Justo. In contrast to the Radicals, who claimed to speak for all right-thinking Argentines, of whatever class or condition, the Socialist party aspired to represent only a single class, the workers. Perhaps because its doctrinal roots were not Argentine, it never gained mass support even in its stronghold.

Buenos Aires, where its hold on labour was shared by Radicals, anarchists and other groups.

In 1898 Roca was elected for a second term, marked by three notable developments in foreign policy: in 1900, the resumption of diplomatic relations with the Vatican; in 1902, the settlement of a dangerous boundary controversy with Chile, and in the same year the pronouncement of the Drago doctrine (*q.v.*) which, like the earlier Calvo doctrine, was an Argentine protest against intervention.

Roca's second administration coincided with a renewal of economic expansion and prosperity in Argentina, but political unrest continued to grow. By 1906 it had assumed such alarming proportions that Pellegrini, in his last speech, warned his fellow oligarchs of the danger of civil war if they did not "open the flood-gates" to democracy by permitting free and honest elections. They were opened in 1912 when a conservative president, Roque Sáenz Peña, forced his reluctant party in congress to pass the electoral reform law that bears his name. It established secret and compulsory voting (for males) and the system of the "incomplete list"—a system designed to assure minority representation—and provided for a new registration of voters. By these simple provisions the Sáenz Peña law opened a new period in the political history of Argentina. In the next national election, 1916, the oligarchy was at last turned out and the Radicals came to power, with Hipólito Irigoyen (*q.v.*) as president.

Despite the political turmoil, a number of talented writers appeared at this time. Headed by Ricardo Rojas, they expressed in various ways the new nationalism stimulated by the centennial celebration of independence in 1910. This was a generation that looked back as well as forward; it was at this time that the 40-year-old gaucho poem *Martín Fierro* gained recognition as a national epic, though the gauchos themselves had disappeared before the march of progress.

8. Radical Regime, 1916–30.—As World War I was in progress when Irigoyen took office, foreign affairs had first claim on his attention. The preceding conservative administration had committed Argentina to a policy of neutrality, and Irigoyen adhered to it even after the United States' entry into the war in 1917, as did several other Latin-American governments. He also sought to strengthen his position by convoking a conference of Latin-American neutrals (which never met). As a result, he was charged with pro-Germanism, but proof of the charge is lacking. Rather, his course seems to have been determined by the traditional nationalism of Argentina and his own anti-imperialism, the latter strongest against Great Britain, though the United States shared his disfavour.

Irigoyen added substantially but not spectacularly to the small volume of social legislation built up since it was initiated by the Socialist Alfredo Palacios in 1902. Organized labour was the principal beneficiary, but Irigoyen's sympathy for labour had definite limits, as he showed by his suppression of a dockworkers' strike at Buenos Aires in 1919. A reform and extension of the university system was begun the same year.

Irigoyen made liberal use of the practice of federal intervention in the provinces, a practice that already had gone far toward converting Argentina from a federal union into a centralized national state. Such interventions enabled him to control provincial elections and thus to strengthen his position in his own party as well as in the federal government. His measures alienated some of the best elements in his own party, but by such tactics as opening the executive offices in the Casa Rosada to all comers, he convinced the masses that he was their champion.

Unable to succeed himself, in 1922 he passed the presidency on to his fellow Radical, Marcelo T. de Alvear, a member of one of the country's old patrician families. Alvear's administration is notable chiefly for the culmination of party tensions in a schism between its conservative wing, the Antipersonalists, led by Alvear, and the rest of the Radical party, which remained under the control of Irigoyen. This administration also was marked by the beginning of a long controversy with the United States over the latter's exclusion of Argentine beef through a sanitary regulation (1927) aimed against foot-and-mouth disease.

BURTON HOLMES FROM EWING GALLOWAY

"CHRIST OF THE ANDES," A STATUE ERECTED ON THE BORDER BETWEEN ARGENTINA AND CHILE IN 1902 TO COMMEMORATE THE PEACEFUL SETTLEMENT OF A BORDER DISPUTE BETWEEN THE TWO NATIONS

Irigoyen was re-elected president in 1928 by a margin of two to one in the popular vote (800,000 to 400,000), although he did not announce his candidacy until the eve of the election. This was a great personal triumph but, since it was interpreted by friends and enemies alike as giving him carte blanche, it contributed to his undoing and that of his party, of which he was now the master. On the one hand, it aroused among his followers expectations that he failed utterly to fulfill. They expected him to move forward rapidly with projects of social reform and nationalization that Alvear had been blamed for neglecting. Instead, Irigoyen concentrated his attention on political maneuvers, such as his interventions in San Juan and Mendoza, which were carried out in a way that shocked all but blindly loyal Radicals. On the other hand, important elements among the opposition became alarmed lest Irigoyen use his carte blanche to make himself a dictator and cripple the opposition permanently. Such fears were felt by some who were good democrats and also by the increasing number of those who were antidemocratic but who still would not tolerate a Radical dictatorship.

This increase of antidemocratic sentiment was one of the major features of Argentine history in the 1920s. It was due partly to contagion from abroad—mainly the Italy of Mussolini and the Spain of Primo de Rivera, and to a less extent from the Catholic right in France and Communist headquarters in Moscow. It was also due to the revival of Argentina's own Rosas tradition and to the spread of a new doctrine among some of the military—the doctrine that it was their mission to regenerate a nation debased by generations of inept and corrupt civilian government.

The crisis was hastened by the world-wide economic depression that began in 1929. Deriving nearly one-third of its gross national product from an export trade consisting mainly of agricultural and pastoral products, Argentina was one of the first countries to suffer severely. Action was urgently called for, but it was not forthcoming from Irigoyen. Now an old man, he had never been a good executive, knew little about economics and finance and

was too jealous of his own power and suspicious even of his own lieutenants to let anyone act for him. The government was paralyzed while the country drifted to ruin.

9. Conservative Restoration.—On Sept. 4, 1930, a part of the army, led by Gen. José F. Uriburu (*q.v.*), removed Irigoyen and took over the government in an almost bloodless revolution and amidst a popular acclaim in which almost everyone except the more resolute Radicals joined. As a young subaltern Uriburu had taken part in the abortive revolt of 1890; blaming that failure on the civilians, he kept firm control of this revolt and of the provisional government that followed it, which was military. He had been converted to fascist ideas and planned to establish a corporative state governed by the elite, but this plan naturally had no popular appeal and a large part of the army, led by Gen. Agustín P. Justo, an Antipersonalist and former minister of war under Alvear, refused to go along with him. The Radical party soon re-formed, the pressure on Uriburu became irresistible, and late in 1931 he permitted the holding of an election to restore normal constitutional government.

General Justo was nominated by a combination of Conservatives and Antipersonalists. The Radicals made a serious mistake by nominating Alvear, who had just rejoined them. Uriburu declared Alvear constitutionally ineligible on the good ground that less than a full term had passed since the end of his previous term in 1928; but the Radicals refused to nominate anyone else, and most of them abstained from voting, though some voted for a candidate who did not have a chance. Justo was elected by a large majority.

Shortly after Justo took office early in 1932, a formal alliance or *Concordancia* was established by the Conservatives and the Antipersonalists, who controlled Argentina until the military again took over in 1943. Since the Antipersonalists, like their allies, occupied a position to the right of centre, this may be called the period of conservative restoration. It resembled the pre-Irigoyen regime in some important respects. There was again a pro-British oligarchy controlled by and governing for the great landowners who sold their products abroad, mainly in Great Britain. A typical measure was the Roca-Runciman agreement of 1933, which assured British purchases of Argentine beef in return for preferential treatment of British goods imported into Argentina. On the fringe of the oligarchy a new industrial interest had developed since 1914, but government policy still favoured the cattle interests.

The early years of Justo's administration were marked by constructive measures, such as those by which his minister of finance, the former Socialist Federico Pinedo, promoted recovery from the depression and, in his own words, "completed the economic unification of Argentina," but the regime soon slipped back into the practices of the Roca and Juárez Celman period. The election of 1937, by which the *Concordancia* kept itself in power, was as scandalous as any in the country's history. The new president, Roberto M. Ortiz, deplored these practices and sought to correct them, but ill-health forced him to resign, and they were renewed under his successor, Ramón S. Castillo, who was believed to be planning to dictate his own successor when the military revolt of 1943 drove him from office. Finally, the *Concordancia* showed little or no interest in the welfare of the masses. The Roosevelt New Deal of the 1930s had no counterpart in the Argentina of the *Concordancia*.

In foreign affairs, the record of the conservative restoration was checkered, but one constant factor in it was a certain antagonism toward the Pan-American system and its chief sponsor, the United States, which was making a determined effort to strengthen the system. At all times this antagonism reflected resentment of the implicit challenge of the United States to the leadership of Latin America to which Argentina aspired; but it was due also to other factors, which changed greatly from Justo's administration at the beginning to Castillo's at the end. Under Justo and his talented minister of foreign affairs, Carlos Saavedra Lamas, foreign policy was oriented mainly toward Great Britain and the League of Nations; the universality of the latter was greatly preferred to Pan-American regionalism. By Castillo's time, however, World War II had broken out, the League of Nations had virtually disappeared, Great Britain was fighting for its life, and a German victory seemed almost certain. Consequently, Castillo's policy was dominated by a determination to remain neutral and to protect Argentina's position by keeping on good terms with Germany. The antagonism generated by this policy was accentuated by the United States entry into the war.

10. Perón Regime.—On June 4, 1943, Castillo was overthrown by the Grupo de Oficiales Unidos (G.O.U.), composed of high-ranking officers of the German-trained army, among them Castillo's own minister of war, Gen. Pedro P. Ramírez. A provisional military dictatorship was established that in 1945–46 evolved into a pseudoconstitutional regime headed by one of its members, Col. (later Gen.) Juan Perón (*q.v.*).

The G.O.U. had many grievances, such as that Castillo was letting Argentina fall behind its traditional rival, Brazil, in military strength, and that the political parties had proved themselves unfit to govern the country. The parties had indeed failed to respond to the challenge of recent years and had lost the respect of the public at large. The democratic labour unions, too, were divided and demoralized, and Communism was making rapid headway among the workers.

In short, the G.O.U. moved into a power vacuum. It did so with the same sense of the army's mission to regenerate the nation that had inspired General Uriburu's coup of 1930, in which Perón had taken part, but in their conception of its mission its members differed widely, ranging from democratic to dictatorial and totalitarian, from anticlerical to ultra-Catholic and from pro-Ally to pro-Axis. There were also personal rivalries. As a result, an internal struggle for power broke out at once and continued until Perón finally won out in 1945 with the backing of the "colonels' clique" of younger officers and his mass following of *descamisados* ("shirtless ones"), which he won by demagogic appeals and wage increases and regimented in a greatly expanded Confederación General del Trabajo (C.G.T.).

At the end of World War II a strong reaction developed against Perón from many quarters, including the army, and early in Oct. 1945 he was forced to resign all his offices (vice-president, minister of war and secretary of the labour department); but a few days later a well-organized mass demonstration overawed his enemies and brought him back to power on Oct. 17. Perón did not resume any of his public offices, but he became candidate for the presidency in the election already announced but postponed and finally held in Feb. 1946. Perón won by a substantial majority and his followers (not yet organized in a single party) gained control of both houses of congress by wide margins. His opponents claimed that he had won through force and fraud, but the evidence does not support the charge.

On the eve of the election the United States department of state published a so-called Blue Book on Argentina. Containing documentary proof of Perón's Axis ties, the Blue Book apparently was expected to hurt his chances, but it appears rather to have helped him by bringing him votes that were in effect protests against this act of "Yankee intervention."

During his first term (1946–52) Perón in the main developed his regime along lines already indicated during his rise to power. He continued to base it on the army and labour; followed a policy characterized by economic and political nationalism and social reforms ostensibly aimed at a redistribution of wealth in favour of the masses; and suppressed the opposition.

Perón's most unconstitutional acts were draped with a mantle of legality, and he claimed to be giving Argentina "genuine democracy" in place of the "plutodemocracy" under which it had hitherto been exploited by what he called an "unholy alliance" between its own traitorous oligarchy and foreign capitalist-imperialism, an allusion mainly to Great Britain and the United States. The relations of the regime with the Roman Catholic Church, apparently friendly at first, had cooled by 1952, but this change was more apparent than real, for there was in fact no close alliance at the start and there had still been no open break by 1952.

Some new terms were invented and there were many new developments in detail. The terms included "justicialism" for Perón's domestic policy and "third position" for his foreign policy, the latter signifying, it was said, not neutralism but a middle way

between communism and capitalism. Also, on July 9, 1947, on the anniversary of Argentina's declaration of political independence in 1816, and at the same place, Tucumán, he issued a formal "Declaration of Economic Independence." His execution of the policies implied, however, was highly opportunistic and far less challenging to most vested interests, both foreign and domestic, than Fidel Castro's execution of similar policies was to be in Cuba in the 1960s. Though Perón asserted the right of expropriation, he made very limited use of it, preferring to purchase. In the leading case, that of the British-owned railways, comprising 70% of the total network in Argentina and bought in 1947, the price he paid, £150,000,000 ($600,000,000), was regarded by experts as generous. Similarly, he expropriated very few of the great estates that dominate the Argentine rural scene, but in this case neither did he purchase; he left the land problem largely untouched.

Perón applied more vigorously the doctrine that "the state may intervene in the economy and monopolize any given activity to safeguard the general interest" (constitution of 1949, article xxxviii). Even in this, however, he left a way open to private capital and private enterprise; all the mining and metallurgical industries, for example, were by 1950 in the hands of "mixed companies" combining private with government capital. The most thoroughgoing application of the doctrine was made in the case of the Argentine Trade Promotion institute, known as I.A.P.I. (Instituto Argentino de Promoción del Intercambio), which was given the right to purchase all Argentina's major crops at its own price and resell them abroad. Abusing these powers, I.A.P.I. forced Argentine farmers to accept ruinously low prices and used its handsome profits during the postwar boom period either to support the industrialization program or for graft. By 1952 Perón's policy of rapid industrialization at the expense of agriculture, combined with droughts and other misfortunes, had crippled the country's economy.

In 1949, mainly in preparation for the next election, Perón had a duly elected convention amend the constitution of 1853 so as to permit his re-election. Other amendments, too, were adopted, including one that made it easier for him to complete the purge of the federal courts which he had begun in 1947 by impeaching the unco-operative justices of the supreme court.

In 1951, women voted for the first time in an Argentine national election. Of the 7,500,000 votes cast, two-thirds went to Perón's ticket, which had the support of the Peronista party and the separate Peronista Women's party, founded in 1947 and 1950, respectively. The Radical candidates, Ricardo Balbín for president and Arturo Frondizi for vice-president, polled nearly 2,500,000 votes, a remarkable achievement in view of the fact that the Radicals were forced to campaign under constant harassment.

Perón began his second administration in June 1952 in the midst of a severe depression. The death of his wife the following month deprived him of his best liaison with the *descamisados* and his best adviser on political strategy. He now reversed some of his major policies and committed important political blunders. The first reversal came in 1953 when he abruptly abandoned his policy of handing out successive wage increases to the *descamisados* and shifted to a policy of *rapprochement* with Argentine business, foreign capital and the United States government. Late in 1954 he began an attack on the Catholic Church which he pressed through the first six months of 1955. In May of the latter year he gave great offense to Argentine national pride by signing an agreement with the Standard Oil Company of California for exploitation of the petroleum resources of a large part of Argentina. Then, after putting down a revolt in the air force in June, Perón threw himself back on the *descamisados*, inciting them to violence in support of his regime.

11. Radical Restoration.—On Sept. 16, 1955, the armed forces started a "Liberating" revolution at various points in the provinces under the leadership of Gen. Eduardo Lonardi at Córdoba. Perón's support crumbled so quickly that on Sept. 19 he resigned and took refuge on a Paraguayan gunboat, subsequently leaving the country. Until the restoration of constitutional government in 1958, the country was governed by a military junta representing the three services and headed by a provisional president—General Lonardi until Nov. 1955, and Gen. Pedro E. Aramburu thereafter. Throughout, Adm. Isaac Rojas was vice-president. This was a military dictatorship, but it was aimed at the restoration of constitutional government and in the meanwhile governed with the aid of advice from a civilian consultative council.

Argentina was politically divided and in serious economic difficulties. Peronism was still strong, especially among the workers, and the anti-Perón coalition dissolved with the fall of his regime. The pre-Perón Radical split occurred again; Balbín now headed the People's Radical party, Frondizi the Intransigent Radical party. Opposition to Lonardi on two issues forced him out within eight weeks: he was judged too conciliatory toward the Peronistas (his motto was the traditional Argentine phrase "neither victors nor vanquished") and too responsive to ultra-Catholic influence. The reversal of both policies by Aramburu did not bring tranquility. A plan for economic recovery and development, based on austerity, was prepared by a special adviser, Raúl Prebisch, chairman of the United Nations Economic Commission for Latin America, but concessions had to be made to insistent calls for wage increases, and nationalist feeling was opposed to terms that would attract foreign capital and enterprise.

Despite these and other difficulties, Aramburu ultimately effected the transition to constitutional government. In Aug. 1957 an elected convention failed in its major task of amending the constitution, but ratified an earlier decree by the provisional government re-establishing the constitution of 1853. Then, in Feb. 1958, national government elections were held. The Intransigent Radical party, headed by Frondizi, won both the presidency and overwhelming majorities in both houses of congress.

Frondizi was duly inaugurated on May 1, 1958. During the early part of his administration he made concessions, as expected, to Peronistas and Communists and to demands for a wage increase; took an unexpectedly hospitable attitude toward foreign investors; carried on the provisional government's policy of developing trade with "iron curtain" countries; and reaffirmed the Intransigent Radical principles of devotion to peace and democracy.

After Frondizi's inauguration Argentina returned to the practice of constitutional democracy, but it knew no peace at home. The country continued to live in an atmosphere of permanent political crisis. The roots of the trouble lay in social tensions antedating the Perón regime and in the mass aspirations and fervent nationalism encouraged by Perón and communicated even to anti-Peronistas. The immediate cause of conflict, however, was the economic program of stabilization—with its accompanying austerity—adopted by Frondizi in Dec. 1958 under the auspices of the International Monetary fund and with support from the United States. Reversing his former position, he even permitted foreign oil companies to exploit the petroleum resources of Argentina (see *The Economy*, below), thus alienating the Peronistas, Communists and nationalists who had supported him in 1958, and yet not appeasing his enemies among the Popular Radicals. In the congressional election of March 1960 Frondizi's party suffered a crushing defeat, though his own term still had four years to run.

Several times, both before and after the election of March 1960, revolution threatened, sometimes from the left wing through strikes and riots, sometimes from the right in the form of a *coup d'état* by extremists among the military. Frondizi's situation became paradoxical. Elected by an overwhelming majority, he became a "minority" president; formerly an extreme left winger and champion of civilian supremacy, he had come to steer a middle course that he could hold only with military help. He lost that support in March 1962 when he was removed from office in a *coup*, led by Gen. Raúl A. Poggi and other military officers, and placed under arrest. The action followed the elections of March 18, in which the Peronistas, permitted on the ballot for the first time since 1955, won substantial victories. On March 30 José María Guido, former head of the senate, was sworn in as president.

Guido's 18-month administration, though nominally civilian and constitutional, was in fact dominated by the armed forces. The latter, however, were divided among themselves, mainly over the issue of how to treat the Peronistas, who made up about one-third of the adult population and controlled most of the labour

organizations. Both of the main military factions, called Reds and Blues, were anti-Peronista, but the Reds demanded harsh treatment, even to the point of outlawing Peronism and maintaining outright military dictatorship for several years, whereas the Blues advocated less draconian measures and an early return to constitutional normality. The Blues ultimately prevailed, partly because moderation was counseled by the fact that the Peronistas and other labour groups were weakened by their own internal divisions and partly because most other Argentines were weary of the protracted domestic strife and wanted to begin rejuvenating the country's arrested economy.

Accordingly, an orderly national election was held in July 1963. Unexpectedly, it resulted in a victory for the presidential candidate of the People's Radicals, Arturo Illia, a 63-year-old physician and party worker from the province of Córdoba, who was inaugurated on Oct. 12. But, though Illia won the election, his vote was far short of a majority and he won in the electoral college only with support of several minor parties. His party likewise failed to gain control of congress. This situation, together with the sharp reverses suffered by the Peronistas and by Frondizi in this election, reinforced the party's tendency to moderation in domestic affairs. In foreign affairs, on the other hand, Illia took a strong nationalist line, and one of his first acts was to cancel Frondizi's petroleum contracts with foreign (mainly U.S.) companies. The applause with which most Argentines greeted this measure was one of several signs of an approach to the restoration of a national consensus for the first time in many years. On the other hand, radicals of both the right and the left continued to agitate, and in the mid-1960s the country still faced a formidable array of problems, such as large-scale unemployment, budget and trade deficits, and inflation. (A. P. WH.)

Local elections held during the early part of 1966 demonstrated that Peronism was still a strong force in the nation's politics. Alarmed at the prospect of a Peronist triumph in the elections for half the chamber of deputies scheduled for 1967, the military staged a bloodless coup in June 1966 and deposed Illía. Lieut. Gen. Juan Carlos Onganía became the leader of the new authoritarian regime, which dispensed with congress and all existing political parties and assumed all legislative and executive power for an indefinite period.

One of the first and most controversial measures of the new regime was its decision to deprive the universities of their autonomy and place them under the central control of the ministry of education. This decision led to violent clashes between the police and students. (X.)

V. POPULATION

1. Number and Distribution.—The census of 1947, the first since 1914, showed the population of Argentina to be 16,052,765, or the equivalent of 15.0 persons per square mile. By 1960 the total was 20,008,945 or 18.7 persons per square mile. In 1947 almost one-fifth of the population lived in the federal capital (in 1960, 15%), and 4,272,337 (26.6%) in Buenos Aires province. Almost one-half resided either in the capital or in the adjacent province of Buenos Aires in 1960. (*See* Table.)

Population in Argentina by Major Civil Divisions in 1960

Divisions	Area (sq. mi.)	Population	Persons per square mile
Total of the country	1,553,844	20,008,945	12.9
Total excluding antarctic sector and islands of the Atlantic	1,072,067	1,072,067	18.7
Provinces			
Federal Capital	77	2,959,746	38,438.1
Buenos Aires	118,753	6,707,498	56.5
Catamarca	38,540	168,231	4.4
Córdoba	65,161	1,762,803	27.1
Corrientes	34,054	537,284	15.8
Chaco	38,468	543,331	14.1
Chubut	86,751	142,412	1.6
Entre Ríos	29,427	808,465	27.5
Formosa	27,825	178,526	6.4
Jujuy	20,548	241,462	11.8
La Pampa	55,382	158,436	2.9
La Rioja	35,649	128,220	3.6
Mendoza	58,239	824,036	14.1
Misiones	11,506	379,378	33.0
Neuquén	36,324	109,890	3.0
Río Negro	78,383	193,292	2.5
Salta	59,759	412,854	6.9
San Juan	33,257	352,387	10.6
San Luis	29,632	174,316	5.9
Santa Cruz	94,186	52,908	0.6
Santa Fe	51,354	1,879,310	36.6
Santiago del Estero	52,222	476,503	9.1
Tucumán	8,697	773,972	89.9
Federal territory of Tierra del Fuego, islands of the Atlantic			
Continental sector	7,873	7,955	1.0
Antarctic sector and other islands	481,777	...	...

Argentina is distinguished by the extent to which its people live in cities and towns. In 1960, 72% of the population was classified as urban; that is, as living in centres of 2,000 or more inhabitants. More than 40% of all Argentines were residents of cities having 100,000 inhabitants or more; including metropolitan Buenos Aires, about 48% lived in the nation's 16 largest cities.

2. Composition.—Persons of the Caucasoid race constitute the overwhelming proportion of Argentina's population. Most of them are descendants of immigrants from European countries who arrived after 1850. Full-blooded Indians are few in number, probably not more than 60,000, but approximately 10% of the population consists of mestizos. The numbers in these categories were increased considerably by influxes of persons from Paraguay and Bolivia, those from the former to work largely as domestic servants in the city of Buenos Aires and those from the latter in jobs on sugar plantations. Negroes and mulattoes are practically absent, the total number in both categories probably not exceeding 15,000. Asians, mostly Japanese, likewise are few in number, probably totaling less than 7,000.

The various censuses show that the foreign-born have consistently made up very high proportions of Argentina's population, the exact percentages being as follows: 1895, 25.4; 1914, 29.9; and 1947, 15.3. Of the 2,435,927 persons of foreign birth enumerated in 1947, the largest numbers had originated in Italy, Spain, Poland, the U.S.S.R., Paraguay, Uruguay, Germany, Chile, Bolivia, Brazil, France, Austria, Syria, Yugoslavia and Portugal, in that order. After the 1947 census was taken, immigration frequently exceeded 100,000 per year, and a large share of those admitted came from European countries, especially Italy and Spain.

Argentina's population has been heavily concentrated in the productive ages of life. In 1960, 52.4% of its people were aged 14–49; 28.8% under 14; and only 18.3% were 50 or over. Immigration also has been responsible for the high proportions of males in the population. Specifically, the number of males per 100 females was 111.9 in 1895, 115.5 in 1914, 105.1 in 1947, and 100.6 in 1960.

According to the 1947 census of population 14,880,246 (93.6%) of Argentina's people professed the Roman Catholic religion. The other faiths were represented by the following numbers: Protestants of all denominations, 310,633; Jews, 249,330; Eastern Orthodox, 66,217; other Christians, 2,125; Muslims, 18,764; other religions, 11,974; without professed religion, 239,949; and undeclared 114,589.

(*See* also *The People*, above.)

3. Growth of Population.—During the period 1914 to 1960 the population of Argentina increased at the rate of 1.8% per annum, one of the highest rates registered among the populous nations for the period. In earlier decades, however, the rate was even higher, averaging 3.7% per year during the intercensal period 1895–1914. After 1960 the increase probably did not exceed 2% per year. Immigration has figured to a considerable extent in the growth of population, but even so the excess of births over deaths is the principal reason for the rapid increase that has taken place. In 1960 the birth rate was about 25 and the death rate approximately 10 per 1,000 inhabitants, and it is unlikely that either of these changed substantially after that time.

Growth of population has been much more rapid in Argentina's cities and towns than in the rural districts. This is reflected in the fact that as the nation's population increased from 7,885,237 in 1914 to 16,052,765 in 1947, the proportion of the inhabitants who resided in urban districts rose from 52.7% to 62.5%. During the same intercensal period, the urban population increased 139% and the rural population by only 60%. Between 1947 and

1960 the difference between urban and rural growth rates was 48.5% to 15.2%. (T. L. Sh.)

VI. ADMINISTRATION AND SOCIAL CONDITIONS

1. Constitution and Government.—A federal union of 22 provinces, 1 territory, and a federal capital (coterminous with the city of Buenos Aires), Argentina has a form of government similar to that of the United States. The Argentine constitution of 1853 was modeled after that of the United States, and the similarities between the two are so marked that, in a famous decision, the Argentine supreme court once said:

> The system of government that rules us is not our creation. We found it in action elsewhere, tested by long years of experience, and we have appropriated it. And it has been said with reason that one of the great advantages of this adoption has been the existence of a vast body of doctrine, a practice and a jurisprudence that illustrate and fulfill the fundamental rules, and that we can and must utilize with regard to everything that we do not wish to alter because of our peculiar circumstances (*in re* Lindo de la Torre 19 CSN 236, 1887).

Nevertheless, there are some major differences between the two constitutional systems. One of the most important is that in Argentina power is somewhat more centralized in the national government, which under certain conditions can intervene in the administration of the provinces. The constitution of 1853 was modified in 1860, 1866 and 1898. It was superseded in 1949 by a new constitution, but was restored by a decree of the provisional government on May 1, 1956.

Under the constitution of 1853 legislative power is vested in a congress of two chambers: the senate, composed of two members for each province and two from the federal capital; and the chamber of deputies, with the number of inhabitants per deputy fixed by law, with periodic reapportionment provided for. Senators must have been Argentine citizens for at least six years before their election, and deputies for four years. Senators are elected by the legislatures of the provinces (and in the federal capital by a special body of electors) for terms of nine years, one-third renewed every three years. Deputies are elected by direct popular vote for four years, one-half renewed every two years.

The president and the vice-president of the republic are elected by electors voted for by the people. Their terms are six years and they may not immediately succeed themselves. They must be native-born citizens of the Roman Catholic faith. The president is commander in chief of the armed forces and appoints all civil, military, naval and judicial officers. The vice-president is the presiding officer of the senate. The president in his executive capacity is assisted by a cabinet of ministers appointed by him. There is a complex system of universal suffrage in national elections. Compulsory voting, enforced by fines, is required of all Argentine citizens over 18 years of age who are not deprived of the vote by law. Woman suffrage has been in effect since 1947. Clergymen and members of the regular army are prohibited from voting.

The judicial system is comprised of federal and provincial courts. The judges of the federal supreme court, the five courts of appeal and the district courts, one at least in each province, are appointed for life by the president, with the approval of the senate.

Each province has its own constitution and its governor, legislators and provincial functionaries, and each has its own judicial system. The governor of the territory is appointed by the national executive. The executive of the city of Buenos Aires, the federal capital, is appointed by the president. The city is separate from the province of Buenos Aires.

2. Living Conditions.—Working conditions, including the length of the working day, wage rates and the question of the rights and obligations of workers to become members of organized unions, have been major political questions in Argentina since the 1890s. On two chief occasions during the 20th century—during the administrations of Pres. Hipólito Irigoyen and again during the Perón period—the country had governments that, in seeking the political support of workers, translated into law measures providing for shorter working hours, higher wages and a strengthened organized labour movement. The bulk of these measures, although political conditions changed, remained in force. The Confederación General del Trabajo (C.G.T.) has been a major interest group in the country since the 1930s and, during the Perón period, developed a strongly political orientation. Approximately two-thirds of all employed workers were members of organizations affiliated with the C.G.T. Housing conditions in general reach a higher standard in Argentina than in other Latin-American countries. Nevertheless, adequate housing for workers and for the lower-income groups has long been a problem in the country. Widespread construction of low-rental housing was stimulated by Perón in an attempt to improve the living conditions of these groups.

3. Welfare Services.—Until the Perón period, organized and

(ABOVE) WERNER SCHUMACHER, (RIGHT) EWING GALLOWAY

VIEWS OF BUENOS AIRES

(Above) Plaza de Mayo, an important centre of government in the city. The architecture of many buildings surrounding it reflects Argentina's Spanish heritage. (Right) National Monument, at left, and capitol dome viewed from the Plaza del Congreso

systematically planned social welfare was virtually unknown in Argentina. Many of the relevant problems had been handled largely as a matter of charity. A good deal of this had been dispensed by the aristocratic Society of Philanthropy, whose membership was a species of who's-who of the upper classes. In 1948, however, under the leadership of Eva Perón, the María Eva Duarte de Perón Social Aid foundation was established as a quasi-governmental agency. The foundation gave financial aid and assistance in finding employment for the needy, and also constructed housing units, schools and hospitals. Although the bulk of the foundation's work was conducted within Argentina, the agency also made emergency and disaster relief available in other countries. The foundation itself was abolished in the mid-1950s, after establishing the precedent of social welfare as a rational public program, replacing the earlier tradition of relief of the needy through the philanthropy of the wealthy. Argentina has one of the most extensive social security programs in Latin America. Provision is made for health and maternity benefits, compensation for workmen injured during the course of their employment, severance pay for those who lose their jobs, family allowances for the unemployed and financial assistance to the aged and indigent. In health and sanitation, Argentina has historically been one of the best-situated countries in Latin America.

4. Education.—Argentina's possession of one of the finest educational systems in the western hemisphere dates from the administration of the "schoolmaster president" Domingo Faustino Sarmiento. Under Perón, the schools suffered in quality primarily because of the suppression of academic freedom, but the number of persons receiving this poorer education increased as many new schools were built and most Argentine educational institutions became tuition-free. There are about 2,900,000 pupils in the country's primary schools and about 775,000 in its secondary and technical schools. The oldest university, the University of Córdoba, was founded in 1613. The other major centres of higher education are the universities of Buenos Aires, La Plata, Santa Fe and Tucumán. Literacy is estimated at 91.4%, one of the highest rates in Latin America.

5. Defense.—The armed services, especially since 1930, have been highly important in Argentine national life. Of the 11 presidents of the country between 1930 and 1960, 8 were army officers. During the Perón period, all men and women between the ages of 12 and 50 were subject to military service. As of the early 1960s, men between 20 and 45 were required to serve at least one year of active duty in the armed forces, and at least three years in the reserve. At that time, the armed services had more than 500,000 men.

The Argentine navy had its origins in the wars of independence, during the second decade of the 19th century. Although its record in that, as well as in later wars, was a commendable one, it was not until the closing years of the century that boundary disputes and the threat of war with Chile induced the government to develop an appreciable navy. In the 20th century a keen naval rivalry with Chile and, later, Brazil, was maintained. (G. I. B.)

VII. THE ECONOMY

The cities in the eastern foothills of the Andes—Santiago del Estero, Salta, etc.—were founded by Spaniards who crossed the mountains into Argentina from Peru and Chile. During the colonial period they prospered on their trade with the silver-mining regions in the Andes and the Spanish possessions on the Pacific side of the Cordillera—for example, mules were fattened on the pastures around Salta, to be sold in the arid altitudes of Bolivia, where they were the only means of transport. Meanwhile, the faraway Plata estuary, being remote from any mineral resources, was neglected. Buenos Aires remained a dreary little town, prohibited from engaging in direct commerce with the outside world; all its trade had to be conducted across the continent by way of Lima, which was the political and economic centre of Spain's empire in southern South America. Transport by mule and ox cart on the long overland route was slow and costly.

It was not until the end of the 18th century, when the authorities in Madrid relaxed these restrictions, that the Plata was freed from the economic domination of Lima. From that time, Argentine hides, skins, tallow, horns and wool could be exported directly from Buenos Aires by sea, and manufactured goods could be imported directly from Europe, at about one-third of their previous cost. One hundred years were to pass before the invention of the refrigerator ship, which made it possible to send meat through the tropics for delivery in edible condition to the industrial populations of the old world.

Argentina's economic centre thus was transferred from the Andes to the Atlantic region. As a result, the cities in the Andean foothills declined into poverty. But the opening of the pampas' natural outlet was an essential step toward the future prosperity of the nation. The Plata estuary was also the natural entry for the European immigrants and the equipment which, after the fall of Rosas, transformed the pampas into one of the world's greatest sources of meat and grain. The provinces resented the growing wealth of Buenos Aires, which arose from its virtual monopoly of the handling of exports and imports. Nevertheless, when the provincial coalition of 1880 had defeated the Buenos Aires army, the victorious landowners themselves quickly saw that the captured city was the inevitable focal point of the republic. This landowning aristocracy therefore set about making Buenos Aires even more powerful than it had been before by providing it with a new port and by extending the railways, which carried everything to its docks, to distant regions. From Buenos Aires they bound Argentina to Great Britain and Europe by commerce and by the loans they contracted to finance their projects.

Economic development was accompanied by extravagance and speculation. The bubble burst in 1890, bringing disaster to the overoptimistic firm of Baring (*q.v.*) Brothers of London. But confidence soon revived, and after 1895 foreign funds were again arriving. By 1912 about 20,000 mi. of railways had been built; vast areas had been plowed and sown with alfalfa (*i.e.*, lucerne, for fodder) and cereals; huge pastures had been fenced in with barbed wire; all over the pampas metal windmills had been erected to pump water to the surface for the livestock; pedigree bulls and rams had been imported to improve the local breeds.

Argentina was rich indeed, but it was dependent on Great Britain and Europe for the disposal of its primary products and for obtaining the manufactures and essential commodities, such as coal, which it lacked. The weakness of this so-called "colonial" type of economy was felt during World Wars I and II, when the flow of imports was interrupted, and during world-wide economic crises, such as that of 1930, when a slump in foreign demand for meat and grain caused distress and bankruptcy. It became apparent that industry must be developed so that some degree of economic independence might be attained. Wartime shortages encouraged industrial expansion, and after 1945 President Perón used foreign exchange profits to hasten the process.

The growth in imports of machinery, raw materials and fuels that inevitably accompanied industrialization was not matched by increased exports of pastoral and agricultural products. Indeed, the growing urban population of Argentina itself made ever greater demands on the nation's production of meat and grain. President Frondizi's austerity program in 1959 succeeded in eliminating the country's foreign trade deficit. Another surge of industrial development followed in 1960 and 1961. Foreign investment was considerable, but the volume of short-term foreign borrowing in that period led to another balance of payments crisis in 1962, followed by a prolonged and serious economic recession from which the country began to recover only in mid-1963. As a founder-member of the Latin American Free Trade Association (L.A.F.T.A.) which was set up in 1960, Argentina has sought to increase its trade with its neighbours, particularly in the export of manufactured goods. A five-year national development program was announced at the end of 1964.

A. Production

Argentina lacks so many of the basic resources necessary to a modern industrial economy that it is difficult to conceive of a time when the fertility of its soil will have ceased to be its greatest asset. Recognizing that industrialization depends on a high level

of rural exports, 20th-century governments have endeavoured to stimulate rural production by guaranteeing minimum prices to cattle raisers and farmers, granting credit facilities and loans, and other devices. Rural output still comes mainly from large-scale ranches and farms, whether owned privately or by joint stock companies, although by the middle of the 20th century an increase had occurred in the number of small holdings.

1. Livestock.—Conditions in the pampas are extraordinarily favourable to natural pasture and the cultivation of alfalfa. Moreover, cattle can be grazed there throughout the year without need for shelter. But the number of animals has not corresponded to the growth in the human population. In 1895 Argentina had about 5.4 head of cattle per inhabitant, while by the 1960s it had about 2. The total number of cattle varies according to world conditions and government incentives and is sometimes affected by drought, which may cause serious losses. During the mid-1960s the estimated stock of cattle averaged 41,000,000–43,000,000 head. The chief breeds are Shorthorn, Aberdeen Angus and Hereford. The highest grade of beef cattle is produced, but the methods generally are not up-to-date and the number of animals per acre could be increased if the pastures were improved. Foot-and-mouth disease in a mild form is endemic. In addition to meat in its various forms, cattle hides and calfskins are important items for export.

Sheep are bred in many parts of the republic, especially in Patagonia (where the land, however, has been overgrazed) and on the pampas. The number of sheep varies according to fluctuations in the price of wool, but the total tends to rise year by year. By the mid-1960s there were about 48,000,000 head. The favourite breeds are Corriedale (in Patagonia), Lincoln (on the pampas), Merino and Romney Marsh. More than one-half the flocks are crossbred. About one-third of the wool is used by local textile manufacturers. After the Uruguayans, the Argentines are the world's biggest meat eaters (as much as 240 lb. annually per inhabitant), but they prefer beef to mutton.

2. Agriculture.—The length of the republic from north to south is so great (2,294 mi.) that almost every type of climate exists somewhere within its borders and almost all crops can be grown. The whole of the most fertile part of the country, the humid pampa, is already in use for pasture and the cultivation of grain; so throughout that region livestock and cereals are in competition for the land. When world prices, government incentives, labour shortages or rising costs of wages and agricultural machinery lead to the expansion of cattle raising (which is less dependent on labour and machinery), the area planted with cereals is reduced. When prices or incentives encourage the sowing of crops, pastures are encroached upon and plowed up. In the future, therefore, if cattle raising is to be increased, the only possible means of simultaneously raising the production of cereals will be by intensive technological improvement, including the use of better seeds, fertilizers and more mechanization.

The grain belt extends through the provinces of Buenos Aires, Córdoba, Entre Ríos, La Pampa and Sante Fe. The chief crops are wheat and corn. Wheat is sown from April to August, according to latitude, and is harvested from November to January. Corn is sown from August to October and harvested from March to June. As corn harvesting is done by hand, the cultivation of this grain in particular has suffered from the departure of rural workers, who have gone to the factories in the towns to earn higher wages. Other cereals are barley, oats and rye. Oilseeds include linseed and sunflower. Argentina also is self-supporting in cotton (grown mainly in the hot regions of the Chaco and Formosa), sugar cane (mostly in Tucumán), rice (Corrientes, Entre Ríos and Santa Fe), tobacco (Corrientes and Salta), tung (Misiones) and yerba maté (Misiones).

Citrus fruits are grown in the central and northern provinces; apples and pears in Río Negro and Mendoza; plums in Mendoza; peaches in Buenos Aires and Mendoza; and grapes in Mendoza, San Juan and Río Negro. In these last three regions the orchards and vineyards are irrigated. Deciduous fruits are exported to Brazil and the United Kingdom.

3. Forestry, Mining and Fisheries.—The most valuable tree is the quebracho, which grows in the Chaco and provides tannin extract. It is also used for railway ties (sleepers) and fencing. But the forests easily accessible from the rivers have been denuded, and every year the quebracho cutters have to travel farther inland in search of trees. As the quebracho takes a century to reach maturity, no reafforestation has been attempted. Softwood is imported. Forests in the southern Andes as yet are almost unexploited.

Small deposits of lead, zinc, iron ore and some other minerals are mined, mainly in distant Andean regions.

In spite of the country's extensive coast line, its many rivers and its southern lakes, fishing is of little importance in the national economy. The government has tried to encourage this activity (hoping thereby to reduce the local consumption of meat), but fish is not a popular food.

4. Fuel and Power.—In the necessary endeavour to industrialize, Argentina's chief problem is the inadequacy and geographical remoteness of its resources of fuel and power. Although consumption of fuel and power is still low by United States and European standards, it more than doubled in the three decades after 1930, and expenditure on importing petroleum in particular became an increasing drain on foreign exchange.

Petroleum is obtained in the Andean regions of Salta, Mendoza

OPENING OF "LA RURAL," YEARLY AGRICULTURAL SHOW HELD EACH WINTER IN BUENOS AIRES. THE SHOW BEGINS WITH THE PARADE OF PRIZE-WINNING ANIMALS AND ENDS WITH THE SALE OF THE ANIMALS AT AUCTION

ILSE MAYER—PIX FROM PUBLIX

and Neuquén, and at Comodoro Rivadavia in Patagonia. Production by the state-controlled organization Yacimientos Petrolíferos Fiscales (Y.P.F.) continued to rise year by year but did not keep pace with the growing demand. Foreign participation on an adequate scale was long delayed because nationalist sentiment prevented the granting of sufficiently attractive concessions. In 1958 President Frondizi decided to negotiate a number of contracts with foreign companies whereby they would explore and exploit local oil resources as agents of Y.P.F., which would continue to safeguard national sovereignty over the oil. Domestic output increased rapidly, with a corresponding reduction in fuel imports and saving of foreign exchange. New refineries were planned, to supplement those already existing at La Plata and San Lorenzo (on the Río Paraná). However, soon after taking office in 1963 President Illia's administration annulled the petroleum contracts, alleging that they were illegal and contrary to the national interest. Several long pipelines convey natural gas and oil to centres of population and industry. The most ambitious of these undertakings is the pipeline that brings natural gas from Comodoro Rivadavia to Buenos Aires, a distance of 1,000 mi.

Almost all coal is imported. A little is mined at Río Turbio in Patagonia and smaller quantities in Mendoza and San Juan.

Production of electricity is insufficient, the unexploited sources of hydroelectric power, notably the Iguaçu (Iguazú) falls, being very remote from the industrial region. Hydroelectric plants have been built in the provinces of Mendoza, Río Negro and Córdoba. One of the largest of several thermoelectric projects is the station at San Nicolás, well-placed on the Paraná river and designed to supply Buenos Aires, Rosario and lesser towns.

5. Industry.—Argentina's basic industries have always been those devoted to processing the produce of the land. Manufacturing is largely concentrated in or near Buenos Aires but, as a result of an official decentralization policy enunciated in the 1950s, factories began to be built in greater numbers in several other riverside cities and in the interior, notably at Córdoba.

The important meat packing industry is mainly foreign owned, with about 50% United States and 20% British capital, but it is subject to government controls of many kinds. Meat is chilled, frozen and canned in the *frigoríficos* (packing plants) for export. Leather working is one of the oldest industries in the country. The largest of the manufacturing industries are those turning out woolen and cotton textiles. Argentina is self-supporting, too, in almost all other consumer goods (except in the luxury qualities).

By the second half of the 20th century the establishment of heavier industries had begun, often with state participation. A modern steel mill at San Nicolás produces billets, rails, structural steel, plates, rolled sheets, tin plate, etc. This plant, however, is almost entirely dependent on imported iron ore and coal. Encouraged by a special promotion scheme, the production of motor vehicles developed rapidly after 1959 into one of the country's leading industries, centred in Buenos Aires and Córdoba.

B. Trade and Finance

1. Exports and Imports.—Argentina's principal exports (in order of value, though this order varies slightly from year to year) are cereals and linseed; meat; wool; hides; dairy produce; wheat meal and flour; quebracho extract and other forest products; and animal by-products. The chief destinations of exports (the order of importance may vary slightly) are the United Kingdom, the Netherlands, the U.S., Italy, the Federal Republic of Germany and Brazil. Principal imports are machinery and vehicles; fuels (which are declining in volume) and lubricants; iron and steel; chemicals; wood; and nonferrous metals. The chief suppliers are the U.S., the Federal Republic of Germany, Venezuela, the United Kingdom, Brazil, Italy, Belgium and France.

2. Banking and Finance.—Argentina's banking system dates from the economic crisis of the 1930s. The powerful Banco Central was created in 1934 as a national institution to carry out the government's monetary and economic policies. Among its many functions, it regulates the volume of credit and money supply; it is the bank of issue and rediscount; and it serves as agent for international payments. The state issues investment credit through three state-owned banks, the Banco Industrial, the Banco Hipotecario Nacional and the Banco de la Nación Argentina, which is the largest of the commercial banks.

Foreign investment, which performed such a vital role in the development of Argentina's "colonial" economy, was greatly reduced in the years immediately following World War II, when President Perón's policy of nationalization was in force. Besides the petroleum industry, the state now controls such enterprises as the railways, merchant marine, air services, telephones, port facilities, grain elevators and military factories.

At the time of Perón's overthrow, Argentina was suffering from severe inflation, an adverse balance of payments and a depreciated currency. In Oct. 1955 the peso was officially devalued to a rate of 18 to the U.S. dollar (50.03 pesos to the pound sterling); but this proved to be an overvaluation, and the peso continued to decline during the following years.

President Frondizi's austerity program, inaugurated in Jan. 1959, provided for abolition of the official rate of exchange and import permits (the latter were replaced by surcharges to discourage nonessential imports); the restriction of bank credit; and the removal of price controls in the domestic market and subsidies. To support the program, credits were granted to Argentina by the International Monetary fund, the Export-Import bank and other official and private U.S. agencies. The peso, freed to find its own level, fell abruptly, finally settling at a fairly stable rate of about 82.5 to the U.S. dollar (232 to the pound sterling). The cost of living rose by about 102% in 1959, but thereafter it rose much less steeply.

A further depreciation of the peso in the exchange market began in 1962 when the Central Bank withdrew its support. By the late 1960s the peso was valued at about 350 to U.S. $1. The annual national budgets in the 1960s showed considerable deficits, one of the principal causes being the heavy operating loss of the state railways.

C. Transport and Communications

A 19th-century Argentine statesman declared that the most formidable obstacle to the country's progress was distances. As far as immediate needs were concerned, this obstacle was then overcome by the construction of the railways (financed, equipped and directed mostly by British companies). The railway system was planned, however, with the single purpose of carrying the pastoral and agricultural produce of the pampas to the eastern river ports and Bahía Blanca. There are now about 27,000 mi. of railways, but about 70% of the track is still concentrated in the pampas (which amounts to only one-fifth of the total area of the republic). The railways provide no communication with the southern oil fields and many other regions that urgently require development. Re-equipment of the railways was interrupted during World War II and they were in a somewhat dilapidated condition when they were bought by the government in 1948 for £150,000,000. Thereafter Argentina lacked sufficient foreign currency for their rapid rehabilitation.

The highway system is inadequate for modern needs. Paved roads connect the principal cities, but most of the lesser roads are unpaved and often unusable in wet weather.

The state-owned merchant fleet was greatly enlarged during the Perón regime. Almost all Argentina's foreign trade is carried by sea. The Paraná river is an important inland waterway connecting upstream districts with Buenos Aires. The state-owned airlines provide internal services and regular flights to other Latin-American countries, the U.S. and Europe. There is a large, up-to-date airport at Ezeiza, on the outskirts of Buenos Aires.

Argentina has more telephones per 100 inhabitants than any other Latin American country. However, with more than 1,000,000 lines in operation in the mid-1960s the state service was by no means adequate and there was a considerable backlog of requests for telephones. Private cable companies and a telex service provide external communications.

A government television channel has operated in Buenos Aires since 1951; other channels in the capital and the provinces began operating after 1960.

See SOUTH AMERICA; *see* also references under "Argentina" in the Index. (GE. P.; I. C. C.)

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ARGENTINA, LA (ANTONIA MERCÉ) (*c.* 1888–1936), greatest Spanish dance artist of her generation, was born in Buenos Aires about 1888. Both her parents were Spanish and professional dancers. La Argentina began studying ballet at the age of four under her father's instruction. At 14 she turned to Spanish dancing and shortly thereafter began to appear in the *cafés* of Spain and Latin America. At the end of World War I, Paris enthusiastically acclaimed her creative artistry. Concert engagements throughout Europe followed, and for 15 years she toured almost constantly. She made six concert tours of North America, three of South America, and was the first Western dancer, after Pavlova, to tour the Orient. She traveled without a company, her entire program being made up of her creative solos performed to piano accompaniment. She died at her home in Bayonne, France, on July 18, 1936.

La Argentina is universally recognized as the greatest of creative Spanish dance artists. Her treatment of this art established the Neoclassic style. She revived the essential nobility of the Spanish dance and, with unerring musical talent, interpreted the music of Iberian classical composers. Her control and musical understanding of castanets remain unsurpassed.

LA ARGENTINITA (*c.* 1900–1945), Spanish dancer whose fame rivaled La Argentina's, was also born in Buenos Aires and similarly used the name of her native country (in the diminutive form) as her stage name. Her childhood and early years as a dancer were spent in Spain. In 1932 she collaborated with the poet F. García Lorca in forming the Madrid Ballet. She toured Europe and North and South America with her own small company from 1935 until her death in New York City on Sept. 24, 1945.

(R. M. HS.)

ARGENTITE, a mineral consisting of silver sulfide. It occurs in mineral veins, and when found in masses, as in Mexico and in the Comstock lode in Nevada, it is an important ore of silver. It is occasionally found as uneven cubes and octahedra, but more often as compact masses, with a blackish lead-gray colour and metallic lustre. Silver sulfide is cubic in crystallization only at temperatures above 91° C; the cubic crystals found in nature are really paramorphs, consisting of an intricate lamellar aggregate of orthorhombic crystals. The orthorhombic modification of silver sulfide stable below 91° C is the mineral acanthite. Argentite is perfectly sectile, or can be cut with a knife, and has a shining streak. The formula is Ag_2S, the hardness 2.5 on Mohs' scale, and the specific gravity 7.3. (CL. F.)

ARGILLITE is a fine-grained, well-indurated, fairly hard, clayey rock. It differs from clay and shale in being harder and in disintegrating or slaking less readily in water. Argillite has undergone some recrystallization as a result of compaction and metamorphic processes. In this way it also differs from clay and shale, which have undergone substantially no metamorphism, and from slates and schists, which have suffered greater metamorphic changes. The hardness of the rock, the mineral composition and the texture are to a considerable degree the result of metamorphic changes.

There are two slightly varying uses of the term. One limits the term to rocks which do not have a laminated structure; in the other the term applies only to rocks which do have a laminated structure and are intermediate in hardness between shale and slate. The first usage is probably the most general in both the United States and Europe. Except for some use in making portland cement, argillite has slight commercial value. (R. E. GM.)

ARGINUSAE, the ancient name of a group of islands off the coast of Asia Minor, opposite the southern end of Lesbos, and the scene of the last Athenian victory in the Peloponnesian War (August 406 B.C.). The Athenian admiral Conon having been blockaded by superior Spartan forces in Mitylene, the Athenians, by ruthless conscription of their last resources of men and wealth, raised a fresh fleet which engaged the Spartans and defeated them heavily. A storm rose and the eight generals in charge of the Athenian fleet retired to shelter without attempting to rescue the Athenian sailors on the 12 triremes that were sinking. Six of the generals, Aristocrates, Diomedon, Erasinides, Lysias, Pericles (son of the statesman), and Thrasyllus were in the same year tried before the assembly for negligence and executed.

ARGON, a chemical element, is a colourless, odourless, and tasteless gas. It is the most abundant of the family of noble gases, accounting for almost 1% of the earth's atmosphere, and is commercially the most important. Argon is obtained from liquid air by a fractionation process and has a variety of applications, usually based on its inertness. Its chemical symbol is Ar; the atomic number is 18; and the atomic weight is 39.942.

Argon is not known to form stable compounds with other elements. The discovery in 1962 that xenon (*q.v.*) will combine with platinum hexafluoride and with fluorine itself toppled the theory that no member of the noble-gas group (formerly called the inert gases) would form a stable compound, but subsequent attempts to effect an argon-fluorine bond failed.

History.—Definite evidence for the existence of some inert constituent in the earth's atmosphere was obtained by Henry Cavendish (*q.v.*) as early as 1785 while trying to determine whether atmospheric nitrogen ("phlogisticated air") was homogeneous or a mixture of different substances. In these experiments a mixture of air and oxygen was sparked over potash, which absorbed the oxides of nitrogen formed. After the removal of excess oxygen there remained a small bubble of gas which could not be diminished by further sparking with oxygen. It is now known that the residue must have consisted mainly of argon, but Cavendish did not pursue the experiments further. He concluded that "if there is any part of the phlogisticated air of our atmosphere which differs from the rest, and cannot be reduced to nitrous acid, we may safely conclude, that it is not more than $\frac{1}{120}$ part of the whole."

This evidence was overlooked for more than a century, until Lord Rayleigh, in the course of accurately redetermining the densities of the principal gases, found that the density of atmospheric nitrogen was always about 0.5% greater than that of nitrogen derived from chemical sources; *e.g.*, from ammonia or nitrous oxide. This pointed to the presence of an unknown gas and brought to light the earlier work of Cavendish. The gas, called argon (from the Greek *argos*, "idle") because of its chemical inertness, was finally isolated in 1894 by Lord Rayleigh and Sir William Ramsay (*q.v.*), who employed a method similar to that of Cavendish.

They also obtained the gas by passing air over heated copper, to remove the oxygen, and then over heated magnesium, which removes the nitrogen as nitride. They also showed, by measurement of the ratio of the specific heats at constant pressure and constant volume, that the energy absorbed on heating is wholly translatory and that the gas must therefore be monatomic. Argon was the first of the noble gases to be isolated from a terrestrial source. (Helium had been detected in the sun in 1868.)

Scientific Importance.—The discovery of argon was of profound scientific importance, because it provided the starting point for many great developments in chemistry and atomic physics. It led directly to the terrestrial discovery of the other noble gases and so completed, in form at least, the periodic classification of the elements. (*See* PERIODIC LAW.) At the time of the discovery of argon there were a number of gaps in the periodic table (later gradually filled). Most of these gaps represented isolated missing elements whose properties could be predicted with some certainty. But the presence of an entire new group of elements, apparently of zero valence, was totally unsuspected. In a search for other sources of argon Ramsay examined the mineral cleveite, which is mainly uranium oxide, and isolated not argon but helium (*q.v.*), a much lighter gas. This element proved to be the first member of the new family. Three other members, krypton, xenon, and neon (*qq.v.*), were isolated soon afterward. The general chemical inactivity of these gases and the correlation of this fact with their outer complete octet of electrons constituted a fundamental feature of the theory of valence (*q.v.*), which postulates that all atoms strive to attain the stability of this simple octet and that the sharing and exchanging of electrons which goes on in the process is the source of all chemical change.

In another direction, the discovery of argon led to the immediate understanding of the true nature of two important products of radioactivity: helium, which is produced spontaneously as alpha-particles; and the intensely radioactive gas known as radium emanation, or radon (*q.v.*), which proved to be the last member of the noble gas family, after xenon. Interpretation of the phenomenon of radioactivity and all the knowledge of the structure of atoms which followed would thus have been indefinitely delayed and complicated but for the far-reaching discovery of Ramsay and Rayleigh.

Uses.—The most important industrial use of argon is in so-called gas-filled electric lamps. (*See* LIGHTING: *Electric Discharge Lamps.*) It makes an ideal inert atmosphere. To prevent arc formation, however, a little nitrogen is generally added. Argon has also been used in vapour-pressure thermometers for use at very low temperatures; as a carrier gas in chromatography (*q.v.*); and for filling ionization chambers and proportional counters (*see* NUCLEAR INSTRUMENTS) for the measurement of X-ray intensities.

Production.—The methods already described (*see* above, *History*), although laborious, produce small quantities of argon. A mixture of pure dry lime and magnesium powder may also be used. When heated to redness the mixture yields metallic calcium, which reacts with atmospheric nitrogen to give the nitride, Ca_3N_2, leaving argon.

For large-scale production the removal of both nitrogen and oxygen in one operation by passing air slowly over heated calcium carbide is a more suitable process. In this reaction carbon dioxide (which is easily removed) and calcium cyanamide, $CaCN_2$, a solid, are formed. This process was used for the first commercial production of argon in quantity in the U.S. in 1914.

None of the above methods is capable of separating argon from the other noble gases which are present in very small amounts in the atmosphere (*q.v.*). Separation can be effected by the fractionation of liquid air, the process now exclusively used in the large-scale industrial production of argon. (*See* DISTILLATION: *Fractional Distillation and Rectification.*) The boiling point of liquid argon, −185.7° C, is intermediate between that of nitrogen (−196°) and oxygen (−182°). Helium and neon have much lower boiling points and can therefore be isolated from the more volatile fraction, while the higher boiling points of krypton and xenon ensure that they are retained in the less volatile fractions. But the argon is closely associated with the oxygen and nitrogen fractions, and these three gases together comprise more than 99.99% of the total. A rectification column consisting of a number of plates, with taps at different levels, is employed. The argon accumulates on the lower plates of the column, and at a certain point gas containing about 10% argon, mixed mainly with oxygen, can be withdrawn. This gas must then be redistilled, or rectified, in a separate column, and finally the remaining oxygen can be easily removed by combustion. The gas obtained in this way is reasonably pure, although traces of the other noble gases still remain. These do not interfere with its main use, in the electric lamp industry; but if chemically pure argon is required, further processes of fractional condensation and evaporation and also fractional adsorption (*q.v.*) over charcoal may be employed.

Physical and Chemical Properties.—Argon is monatomic. The 18 electrons are arranged in shells, 2, 8, 8, the outermost shell being a complete octet, which gives the atom zero valence and apparent chemical inertness. It is known to exist in three naturally occurring isotopic forms, of mass numbers 40, 38, and 36, the relative abundances being respectively about 99.60%, 0.06%, and 0.34%. The atomic weight is therefore just a little below 40. The production of Ar^{40} from K^{40} decay is important as a means of determining geologic age (potassium-argon dating; *see* GEOCHRONOLOGY).

Argon condenses to a colourless liquid at −185.8° C and to a crystalline solid at −189.3° C. The crystal structure indicates a face-centred cubic lattice with *a* (cube edge) = 5.42 Å (angstrom units), the contact distance between the argon atoms being 3.83 Å. The density of the liquid at −183° C is 1.374. The critical temperature is −122.4° C, the critical pressure 48 atm., and the critical density 0.509. The solubility of the gas in water is considerable, 3.94 vol. dissolving in 100 vol. of water at 12° C—this being more than double the solubility of nitrogen. The spectrum of argon is not outstanding and consists of many lines spread over the whole visual range. At low pressure the discharge is pale red in colour, changing to a steely blue when a condensed discharge is used.

Although no compounds involving normal bonds between argon and the atoms of other elements have been prepared, several complexes, of varying degrees of stability, have been recorded. At a pressure of 150 atm. and in the presence of ice, a hydrate of composition $Ar{,}5.5H_2O$ is obtained; it is extremely unstable, with a dissociation pressure of nearly 100 atm. Freezing-point data for the system boron trifluoride-argon indicate the formation of a series of unstable complexes of composition $Ar{,}BF_3$; $Ar{,}2BF_3$; $Ar{,}3BF_2$; $Ar{,}6BF_3$; $Ar{,}8BF_3$; and $Ar{,}16BF_3$. The most interesting and the best established "compound" containing argon is a quinol clathrate of composition $3C_6H_4(OH)_2 0.8Ar$, prepared by H. M. Powell (1950). The structure of this type of complex, fully established by X-ray analysis, consists of a cagelike arrangement of quinol molecules held together by hydrogen bonds. A cavity about 4 Å in diameter is formed between every three quinol molecules, and in these cavities various small molecules or large atoms can be trapped when the substance crystallizes. The argon clathrate is prepared by exposing a solution of quinol to argon at a pressure of about 40 atm. When the clathrate crystallizes out it is quite stable and contains almost the theoretical quantity of one argon atom to every three quinol molecules. In solution, however, the argon escapes with vigorous effervescence: it is clearly not bonded to any of the other atoms. A similar explanation probably applies in the case of some other complexes that have been described.

See also references under "Argon" in the Index.

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ARGONAUTS, in Greek legend, a band of heroes who went

with Jason (*q.v.*) to fetch the golden fleece in the ship "Argo." This task had been imposed on Jason by his uncle Pelias, who had usurped the throne of Iolcus in Thessaly, which rightfully belonged to Jason's father Aeson. The story of the fleece follows:

Jason's uncle Athamas had two children, Phrixus and Helle, by his wife Nephele, the cloud goddess. But after a time he became enamoured of Ino, the daughter of Cadmus, and neglected Nephele, who disappeared in anger. Ino, who hated the children of Nephele, persuaded Athamas, by means of a false oracle, to offer Phrixus as a sacrifice, as the only means of alleviating a famine which she herself had caused by ordering the grain to be secretly roasted before it was sown. But before the sacrifice, the shade of Nephele appeared to Phrixus, bringing a ram with a golden fleece on which he and his sister Helle endeavoured to escape over the sea. Helle fell off and was drowned in the strait, which after her was called the Hellespont. Phrixus reached the other side in safety, and, proceeding by land to Aea in Colchis on the farther shore of the Euxine (Black) sea, sacrificed the ram and hung up its fleece in the grove of Ares, where it was guarded by a sleepless dragon.

Jason, having undertaken the quest of the fleece, called upon the noblest heroes of Greece to take part in the expedition. According to the original story, the crew consisted of the chief members of Jason's own race, the Minyae. But when the legend became common property, other and better-known heroes were added to their number. The crew was supposed to consist of 50, agreeing in number with the 50 oars of the "Argo," so called from its builder, Argus, or from Gr. *argos* ("swift"). It was the first ship, or the first war galley, ever built. Athena herself superintended its construction, and inserted in the prow a piece of oak from Dodona, which was endowed with the power of speaking and delivering oracles.

The Argonauts arrived at Lemnos, which was occupied only by women, who had put to death their fathers, husbands and brothers, and there they remained several months. It is known from Herodotus that the Minyae had formed settlements at Lemnos at a very early date. Proceeding up the Hellespont, they sailed to the country of the Doliones, by whose king, Cyzicus, they were hospitably received. After their departure, being driven back to the same place by storm, they were attacked by the Doliones, who did not recognize them, and in a battle that took place Cyzicus was killed by Jason. After Cyzicus had been duly mourned and buried, the Argonauts proceeded along the coast of Mysia, where occurred the incident of Hercules and Hylas (*q.v.*). On reaching the country of the Bebryces, they again landed to get water, and were challenged by the king, Amycus, who forced all passing travelers to box with him in the hope of killing them. Polydeuces accepted the challenge and slew him. At the entrance to the Euxine, at Salmydessus, on the coast of Thrace, they met Phineus, the blind and aged king whose food was being constantly polluted by the Harpies. He knew the course to Colchis, and offered to tell it, if the Argonauts would free him from the Harpies. He was freed by the winged sons of Boreas, and Phineus now told them their course, and how to pass through the Symplegades or Cyanean rocks—two cliffs that moved on their bases and crushed whatever sought to pass. His advice was successfully followed: Jason sent ahead a dove, which was damaged between the rocks, but the "Argo" slipped through almost unscathed while the rocks were rebounding. From that time the rocks became fixed and never closed again.

After sundry minor adventures, the Argonauts reached Colchis. But the king, Aeetes, would not give up the fleece until Jason yoked his bulls (given him by Hephaestus), which snorted fire and had hooves of bronze, to a plow, and with them plowed the field of Ares. That done, the field was to be sown with the dragon's teeth, from which armed men were to spring. Aeetes' daughter, the sorceress Medea, who had fallen in love with Jason, gave him a salve that protected him from fire, and advised him to cast a stone at the newborn warriors to cause them to fight to the death among themselves. These tasks accomplished, Aeetes refused to give over the fleece, but Medea put to sleep the dragon that guarded it; Jason then carried off the fleece, with Medea. When Aeetes pursued them, to delay him and thus obtain escape, Medea dismembered her young brother Absyrtus, whom she had taken with her, and cast his limbs in the sea for his father to pick up. In another account Absyrtus had grown to manhood then, and met his death in an encounter with Jason, in pursuit of whom he had been sent.

Of the homeward course various accounts are given. In the oldest (Pindar), the "Argo" sailed along the river Phasis into the eastern Oceanus, round Asia to the south coast of Libya, thence to the mythical lake Tritonis, after being carried 12 days overland through Libya and thence again to Iolcus. Hecataeus of Miletus suggested that from the Oceanus it may have sailed into the Nile, and so to the Mediterranean. Others, like Sophocles, described the return voyage as differing from the outward course only in taking the northern instead of the southern shore of the Euxine. Some (pseudo-Orpheus) supposed that the Argonauts had sailed up the river Tanais, passed into another river, and by it reached the North sea, returning to the Mediterranean by the Pillars of Hercules. Again, others (Apollonius Rhodius) laid down the course as up the Danube (Ister), from it into the Adriatic by a supposed mouth of that river, and on to Corcyra. Then follow wanderings, partly based on those of Odysseus (*q.v.*), partly on the older Argonautic routes. Finally, they reached Iolcus, and the "Argo" was placed in a grove sacred to Poseidon in the isthmus of Corinth.

The story of the expedition of the Argonauts is very old. Homer was acquainted with it and speaks of the "Argo" as well known to all men; the wanderings of Odysseus may have been partly founded on its voyage. Pindar, in the fourth Pythian ode, gives the oldest detailed account of it. Apollonius Rhodius in the 3rd–2nd centuries B.C. artificially rendered the story as an epic, "The Argonautica," which still survives. In ancient times, the expedition was regarded as a historical fact, an incident in the opening up of the Euxine to Greek commerce and colonization, and so it probably is, but with a great accretion of fabulous details of many kinds.

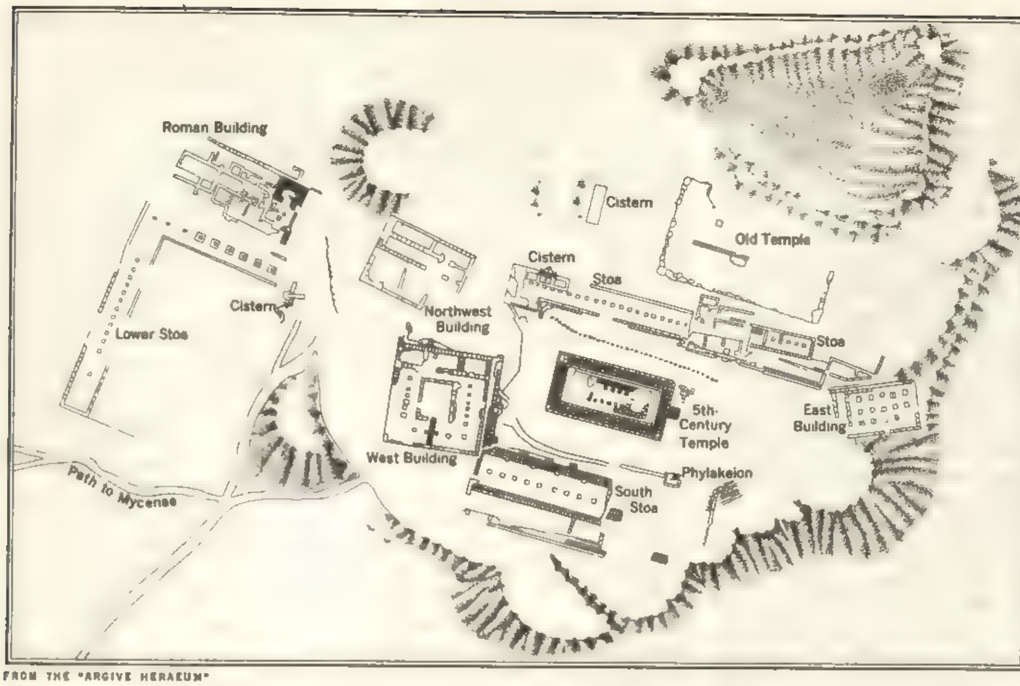
See J. R. Bacon, *The Voyage of the Argonauts* (1925), for further discussion and bibliography. (T. V. B.)

ARGONNE, a wooded, hilly area of eastern France, forms a natural barrier between Champagne and Lorraine. In the Lower Cretaceous rocks there is a local development of highly resistant sandstone that is responsible for this hilly massif, aligned south-southeast to north-northwest for more than 40 mi., with an average breadth of about 10 mi. The Aire and Aisne and their numerous tributaries dissect it with deep valleys, and the area has little, save strategic importance. The Prussians were repulsed by the French at Valmy in 1792. The Meuse-Argonne operation (Sept.–Nov. 1918) was a major victory engagement of U.S. forces in World War I. (Ar. E. S.)

ARGOS, a name apparently signifying an agricultural plain, which was applied to several districts in ancient Greece of which the most celebrated was the capital of the Argolis, or Argolid, a dry but fertile plain which still lives up to its Homeric epithets of "thirsty" but "fertile" and "horse-rearing." The plain is encircled by mountains, but easy passes connect it with the modern *nomos* of Korinthia on the north, with the Arcadian highlands on the west and with the district of Epidaurus on the southeast. The chief harbour must always have been at Nauplia (*q.v.*), and the city-state of Argos was always a land, not a naval power.

History.—Traditionally the city was said to have been founded by the mythological Phoroneus the son of the river-god Inachus about 1750 B.C. Derivations of a royal family from a god frequently imply that the human founder arrived as an invader, and this date is compatible with that assigned by many philologists and archaeologists to the arrival of the first Greek-speaking people (the beginning of the 2nd millennium B.C.), who probably introduced the gray wheelmade pottery termed gray Minyan. A settlement of these people was revealed on the hill called the Aspis (from *aspis*, "shield," whose form it resembled) by Dutch excavations conducted by W. Vollgraff.

In the Mycenaean or Late Bronze Age (*c.* 1650–*c.* 1125 B.C.) the city of Argos was eclipsed by Mycenae, Tiryns (*qq.v.*) and Midea, but with the collapse of the Mycenaean power and the infiltration of the Dorians in the late 12th century Argos became the dominant city-state of the Argolis and, during the tyranny of Pheidon (675?–655? B.C.), even of the whole Peloponnese. Later



FROM THE "ARGIVE HERAEUM"

PLAN OF THE ARGIVE HERAEUM

the Argives were frequently at war with the Spartans, who severely defeated them at Sepeia in 494 B.C. and who endeavoured to protect the older settlements such as Mycenae and Tiryns, both of which had sent detachments in 480 to fight the Persians when Argos itself had remained neutral. In revenge the Argives destroyed these cities in 462 B.C.

In 461 Argos made an alliance with the Athenians, who were shortly to capture Memphis in Egypt (where they had gone to assist Inaros, the Libyan king, against Persia), and Athens' old rival Aegina. In 451 Sparta signed a five-year truce with Athens and a 30-year one with Argos, which therefore remained neutral during the earlier part of the Peloponnesian War (*q.v.*). After the peace of Nicias in 421 B.C. the alliance between Athens and Argos, Mantinea and Elis was renewed, but the defeat of the Argives, Athenians and their other allies by the Spartan king Agis II at Mantinea in 418 B.C. was followed by an oligarchic revolution at Argos, which returned to its neutrality (repudiating the treaty with Athens and making a 50-year alliance with Sparta) and maintained it even after a democratic counterrevolution. Peace with Sparta, however, seemed unnatural to the Argives, and in 395 (when the Corinthian War began; *see* GREECE: *History*) they signed a federal union with Corinth. This union, however, was partly severed by the military operations of Agesilaus II, and the break was confirmed by the peace of Antalcidas (the King's peace) of 387 when Artaxerxes II of Persia dictated his terms to the Greeks. The rise of Thebes under Epaminondas was at first hailed joyfully by the Argive democrats, who took part in his two victories at Leuctra (371) and Mantinea (362) and violently repressed an attempted counterrevolution by the oligarchs. On the retirement of the Theban forces the Argives again suffered from the aggressions of Sparta and appealed to Philip II of Macedonia, who restored to them their old province of Cynouria on the western side of the gulf of Argos. Later the Argives came to recognize the danger from Macedonia, and in the Lamian War (323–322 B.C.) they joined the confederate forces against Antipater; Argos, however, was captured by Cassander in 317 and by Demetrius I Poliorcetes in 303 B.C. In 272 Sparta and Argos united to resist Pyrrhus, king of Epirus, who was killed during a night attack on the latter city. For several years Argos was subject to Antigonus II Gonatas, but in 229 it joined the Achaean league (*q.v.*) and remained an active member except for brief occupation of the city by the Spartan kings Cleomenes III (225) and Nabis (196).

The Roman conquest and the destruction of Corinth in 146 B.C. increased the relative importance of Argos, which became the centre of the Achaean league. The city was temporarily captured by the Goths in A.D. 267 and in 395, but it continued to be important in Byzantine times. After the establishment of the Frankish principality of Achaea after the fourth crusade (1202–04), Argos declined and Nauplia became the capital of the Argolis; it is now the capital of the modern *nomos* of Argolis. In 1397 Argos was captured by the Turks, who took it again in 1500, when they massacred the inhabitants and replaced them with Albanians. Argos figured in the Greek War of Independence (*see* GREEK INDEPENDENCE, WAR OF); there Demetrios Ypsilantes summoned the first free Greek parliament in 1821, and in 1825 the plain of Argos was ravaged by Ibrahim Pasha.

Archaeology.—The French School at Athens conducted various excavations at Argos before and after World War II, uncovering part of the prehistoric city of the Aspis and the remains of a temple of Apollo of the Saddle on the neck dividing that hill from the summit of Larissa. On the lower ground their researches uncovered another temple site, as well as the site of what was in all probability the *bouleuterion* (council house) of the Greek city, city baths and a *heroon* (hero-cult shrine) of Roman date, and a cemetery with graves extending from the Middle Helladic period (*c.* 2000–*c.* 1600 B.C.) to late Roman times.

The Argive Heraeum, the centre of the worship of the mother goddess Hera, the national sanctuary of the Argolis long before the coming of the Dorians, was traditionally reported to have been founded by Phoroneus. The prehistoric settlement on the upper terrace, excavated by an American expedition under C. W. Blegen, has been tentatively identified with the legendary Prosymna; it lasted from the Neolithic period to about 1100 B.C. A *tholos* (domed or beehive) tomb in the vicinity dates from the second half of the 15th century B.C. The town site was abandoned but the worship of the Mycenaean goddess continued on the upper terrace, which was bounded on the west by a Cyclopean terrace wall. Some idea of the earliest post-Mycenaean temple may be gained from a terra-cotta model of late geometric date (*c.* 8th century) found on the site (even if this is regarded as the model of a house), showing a single-roomed building with high gable roof and a porch of two wide-set wooden columns. A more monumental temple was erected later, probably in the 7th century B.C. Nothing survives of this except the limestone platform and a portion of the stylobate, but the weathering on the latter fragment and the measurements suggest that the temple may have had 6 by 14 wooden columns 31.496 in. in diameter with an intercolumniation of approximately 97 in. The ruins of this temple were still visible when it was visited by Pausanias, who records that it was burned down in 423 B.C. owing to the negligence of its priestess, Chryseis, who fled to Tegea but whose statue still stood in front of the ruins. A base of irregular stones 70.88 in. square marks the site of the cult statue.

Construction of a new and more splendid temple was begun immediately by the local architect Eupolemos, who designed an ideal structure in limestone with 6 by 12 Doric columns, column spacings of exactly 10, diameters of 4, triglyphs of 2 and metopes of 3 Doric feet and so on (the Doric foot was 12⅞ in.). It was in this temple that Pheidon of Argos dedicated offerings of the ingot currency of spits which were current before the first issue of Aeginetan silver money.

A famous school of sculptors and bronze workers existed in

Argos, presided over by Ageladas, who was said to have taught both Phidias and the Argive Polyclitus the elder. The latter was chosen to execute the cult statue at the Heraeum, a colossal figure of Hera in gold and ivory, enthroned and bearing in her left hand a sceptre surmounted by a cuckoo (for Zeus had wooed her in the form of that bird). Polyclitus also wrote a treatise on the art of modeling and illustrated his theories on the ideal statue by the representation of a boy carrying a lance (the so-called Doryphoros or "lance-bearer") of which many Roman copies survive. No certain copy exists of Argive Hera, but an idea of the head may be gained from certain Argive coins of the same period as the statue. The marble head found by the American school may represent Hera but was certainly no copy of the gold and ivory statue.

See also references under "Argos" in the Index.

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(R. W. Hu.)

ARGOSTOLION, the capital of the *nomos* (department) of Cephalonia (Kephallēnia or Kefallinia), one of the Ionian islands, Greece, is the seat of a bishop of the Greek church. Pop. (1961) 7,322. It was founded by the Venetians in 1757 to replace the medieval capital of St. George; but there is a Mycenaean necropolis at Mazaracata and there are ancient fortifications at Cranii nearby. Argostolion has a good harbour, with a quay a mile in length. Shipbuilding and silk-spinning are carried on. West of the harbour a curious stream, flowing *from* the sea, is employed to drive mills before losing itself in caverns inland. The town was devastated by an earthquake in 1953. *See* also Cephalonia; Ionian Islands.

(D. M. N.)

ARGOSY, the term originally for a carrack or merchant ship from Ragusa and other Adriatic ports, later used poetically of any vessel carrying rich merchandise. In English writings of the 16th century the seaport named is variously spelled Ragusa, Aragouse or Aragosa, and ships coming thence were named ragusyes, arguzes and argosies, the last form surviving and passing into literature. The incorrect derivation from Jason's ship, the "Argo," is of modern origin.

ARGUIN, an island (identified by some writers with the Cerne of the Carthaginian navigator, Hanno), off the west coast of Africa, about 50 mi. S.E. of Cap Blanc, in 20° 35′ N., 16° 25′ W. It is about 4 mi. long by 2½ mi. broad, produces gum arabic and is the seat of a turtle fishery. Off the island, which was discovered by the Portuguese in the 15th century, are extensive and dangerous reefs. Arguin was occupied in turn by the Portuguese, Dutch, English and French. It became part of Islamic Republic of Mauritania in 1960. Aridity and bad anchorage prevent permanent settlement.

(J. D.)

ARGUS, the name of three figures in Greek mythology.

1. Argus, the son of Inachus, Agenor or Arestor, or, according to others, an earthborn hero (*autochthon*). Because of the number of eyes in his head or all over his body, he was called Panoptes (all-seeing). He was appointed by Hera to watch the cow into which Io (*q.v.*) had been transformed but was slain by Hermes who stoned him to death, or put him to sleep by playing on the flute and then cut off his head. His eyes were transferred by Hera to the tail of the peacock. This Argus was often confused with the son of Niobe who gave his name to the city Argos (Aeschylus, *Prometheus Vinctus*; Ovid, *Metamorphoses*).

2. Argus, the old dog of Odysseus who recognized his master returning to Ithaca in disguise after 19 years, and promptly expired (Homer, *Odyssey*).

3. Argus, the architect of the ship "Argo" (*see* Argonauts).

(T. V. B.)

ARGYLL, EARLS AND DUKES OF. For the rise of this family of Scottish peers, originally the Campbells of Lochow, and first ennobled under the title of Lord Campbell, *see* Argyll. The 1st earl of Argyll, Colin, Lord Campbell (d. 1493), received his title in 1457. His son, Archibald, the 2nd earl, was killed at the battle of Flodden in 1513; the 3rd and 4th earls were Archibald's son Colin (d. 1529) and grandson Archibald (d. 1558).

Archibald Campbell (*c.* 1532–73), 5th earl of Argyll, succeeded his father in 1558. He was an adherent of John Knox and assisted Lord James Stewart (afterward the regent Moray) in the warfare of the lords of the congregation against the regent Mary of Lorraine, the mother of Mary Stewart. Argyll's support of Mary Stewart after her return to Scotland (1561) gradually separated him from John Knox's party. When Mary escaped from Lochleven castle in 1568, he commanded her forces during the few days which preceded her flight to England. He then made his peace with Moray, although he may have connived at his murder in 1570. He became lord high chancellor of Scotland in 1572 and died on Sept. 12, 1573. His first wife was an illegitimate daughter of James V, and he was thus half brother-in-law to Mary and Moray.

Archibald Campbell (1607–61), 1st marquess and 8th earl of Argyll, eldest son of Archibald (1575–1638), 7th earl, took over the management of the family estates in 1619 after his father had renounced Protestantism. As Lord Lorne (the title borne by the eldest son of an earl of Argyll) he was made a privy councilor in 1628, but his refusal to support the attempt by Charles I to enforce the use of a new liturgy in Scotland brought him into disfavour, and by a secret commission the earl of Antrim was permitted to invade Argyllshire. The expedition was unsuccessful, but it strengthened the determination of Argyll (who inherited the title by the death of his father in 1638) to join the Covenanters in defense of Presbyterianism. He wrote to Archbishop Laud in 1639, defending the abolition of episcopacy by the general assembly, which had continued to sit after its dissolution by Hamilton, the king's commissioner. His increasing opposition to the royal policy brought him gradually into conflict with the earl of Montrose and his associates, but their plot to discredit Argyll on the occasion of Charles's visit to Scotland in 1641 miscarried, and they were themselves imprisoned. Charles was obliged to make concessions to the Covenanters; he acquiesced in the transfer of judicial and political appointments to the parliament, and he created Argyll a marquess (1641) with a pension of £1,000 a year. During the next two years Argyll was mainly responsible for maintaining unity among the Scottish Presbyterians and for effecting the alliance with the English parliament (1643). He was made a member of the committee of both kingdoms and his active participation in the English Civil War began in Jan. 1644: he commanded a troop of horse when the Scottish army invaded England. But he was soon compelled to return in order to oppose royalist movements in the north and to defend his own territories against attack by the marquess of Huntly. During the summer of 1644 he fought inconclusively against Irish troops commanded by Montrose, but soon abandoned his commission, retiring to Inveraray castle. Montrose unexpectedly followed him there in December, forcing him to flee to Roseneath (Dumbartonshire) and devastating his territories. Argyll was surprised and defeated by Montrose at Inverlochy on Feb. 2, 1645, and again at Kilsyth on Aug. 15; but he was present when Montrose himself was finally beaten at Philiphaugh on Sept. 13.

Up to this point Argyll's statesmanship had been highly successful. Charles I became a prisoner and the national liberties and religion of Scotland had been defended and seemed to be further secured by the alliance with the triumphant parliament and army of England. But Argyll's whole policy depended on the maintenance of this alliance and he opposed vigorously but vainly the secret treaty concluded between the king and the Scots against the English parliament (the Engagement) in July 1648. The duke of Hamilton, marching to oppose Cromwell's advance in accordance with the new treaty, was defeated by him at Preston; but Argyll joined the extreme Covenanters in Edinburgh and established a new government which welcomed Cromwell on Oct. 4, 1648. This alignment was destroyed, however, by Scottish disapproval of the execution of Charles I (Jan. 1649) and Argyll supported the in-

vitation from the Covenanters which resulted in the arrival in Scotland (1650) of Prince Charles whom he himself crowned king of Scotland, as Charles II, at Scone on Jan. 1, 1651. He strongly opposed but was unable to prevent the expedition to England which resulted in Charles's defeat at Worcester (Sept. 3, 1651). In the subsequent reduction of Scotland, after holding out in Inveraray castle for nearly a year, he was at last surprised in Aug. 1652 and submitted to the Commonwealth. In Richard Cromwell's parliament of 1659 Argyll sat as member for Aberdeenshire. At the Restoration he presented himself at court, but was at once arrested by order of Charles II, and in Dec. 1660 was sent to Edinburgh to stand his trial for high treason. He was acquitted of complicity in the death of Charles I and his escape from the whole charge seemed imminent. But the arrival of a packet of letters written by Argyll to George Monck (commander in chief in Scotland from 1654 to 1660) showed conclusively his collaboration with Cromwell's government, particularly in the suppression of the earl of Glencairn's royalist rising of 1653–54. He was immediately sentenced to death and was beheaded at Edinburgh on May 27, 1661.

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Archibald Campbell (1629–85), 9th earl of Argyll, eldest son of the 8th earl, was born on Feb. 26, 1629 at Dalkeith. He studied abroad, but returned to Scotland in 1649. He fought at Dunbar (Sept. 3, 1650) and, after the battle of Worcester, joined the royalist leader Glencairn in the Highlands. Ultimately he fell foul of both the royalists and their opponents; he was imprisoned in 1657 for refusing to renounce allegiance to the Stewarts and again in 1661 for incautious criticisms of the government of Charles II. He was released in 1663 and his father's earldom and lands were restored to him. However, his staunch Protestantism and great territorial influence made him suspect to James, duke of York, who became high commissioner in Scotland in 1680. He was sentenced to death on a dubious charge of high treason in 1681, but escaped to Holland and there joined the conspiracy to procure the succession of the duke of Monmouth. He led an unsuccessful invasion of Scotland in 1685, was captured at Inchinnan on the river Clyde on June 18 and was beheaded at Edinburgh on June 30.

See J. Maidment (ed.), *The Argyle Papers* (1834); J. Willcock, *A Scots Earl in Covenanting Times* (1907).

Archibald Campbell (1651?–1703), 10th earl and 1st duke of Argyll, was the eldest son of the 9th earl. Failing to obtain a reversal of his father's attainder, he went to The Hague and joined William of Orange. Despite the attainder he was admitted in 1689 to the convention of the Scottish estates and in June of that year an act was passed restoring his title and lands. He raised the earl of Argyll's regiment of foot, which served in the British army from 1692 to 1697, and was created duke of Argyll in 1701. He died on Sept. 25, 1703, at Cherton house near Newcastle.

John Campbell (1680–1743), 2nd duke of Argyll, son of the 1st duke of Argyll, was born at Petersham, Surrey, on Oct. 10, 1680. In return for his services in furthering the union of England and Scotland he was created a peer of England (1705), with the titles earl of Greenwich and baron of Chatham. He served under the duke of Marlborough from 1706 in the war of the Spanish Succession, gaining particular distinction at the battle of Malplaquet in 1709. He acted as commander in chief in Spain and as ambassador to the archduke Charles in 1711. Argyll's intervention at Queen Anne's last council meeting helped to ensure the Hanoverian succession (Aug. 1714) and during the early years of George I's reign he stood in high favour at court. As commander in chief of the forces in north Britain during the Jacobite rebellion of 1715, he managed with very little bloodshed to suppress the rising in Scotland. After a temporary eclipse, caused by disagreement with the ministry rather than the disfavour of the king, he regained his influence and was created duke of Greenwich (1719). He held various offices and in 1736 was made a field marshal. He strenuously opposed in 1737 the bill to penalize the city of Edinburgh over the Porteous riots, and a violent speech against the government in April 1740 led again to his dismissal from office. Apart from one further short period of power, he spent the remainder of his life in retirement, dying at Petersham on Oct. 4, 1743.

Archibald Campbell (1682–1761), 3rd duke of Argyll, brother of the 2nd duke, was born at Ham house, Surrey, in June 1682. He served for a short time under the duke of Marlborough, but was appointed treasurer of Scotland in 1705 and the following year was one of the commissioners for negotiating the union of the two kingdoms. Raised to the peerage of Scotland as earl of Islay he was among the 16 Scottish peers chosen to sit in the first parliament of Great Britain. He became a privy councilor in 1711, keeper of the privy seal of Scotland in 1721 and keeper of the great seal of Scotland in 1733. He played an important part in the movement led by Duncan Forbes of Culloden to promote Scottish loyalty to the Hanoverians by raising Highland regiments from among the Whig clans. Succeeding his brother as duke of Argyll in 1743, he rebuilt Inveraray castle and collected one of the most valuable private libraries in Great Britain. He died in London on April 15, 1761, without legitimate issue.

The succession thus passed to the descendants of the younger son of the 9th earl, the Campbells of Mamore. The 4th duke, John (*c.* 1693–1770), was succeeded by his son John (1723–1806), the 5th duke, who had represented Glasgow in the house of commons from 1744 to 1761, and Dover from 1765 to 1766, when he was created a peer of Great Britain as Baron Sundridge, the title by which until 1892 the dukes of Argyll sat in the house of lords. His sons George (1768–1839) and John (1777–1847) became in turn the 6th and 7th dukes.

George Douglas Campbell (1823–1900), 8th duke of Argyll, the second son of the 7th duke, was born at Ardencaple castle, Dumbartonshire, on April 30, 1823. He became a prominent Liberal member of the house of lords, and was lord privy seal (1852) and postmaster general (1855) in the cabinets of Lord Aberdeen and Lord Palmerston. As secretary of state for India in Gladstone's first ministry (1868–74), he was responsible, against the advice of the Indian administration, for the refusal of help to the amir of Afghanistan, which caused the amir to approach Russia and led later to the second Afghan War. His disapproval of Gladstone's second Irish Land act (1881) caused him to resign the office of lord privy seal to which he had been appointed in 1880; later he opposed the Home Rule bills with equal vigour. Detached from party politics, Argyll wrote many letters to *The Times* on questions which included the rights of landowners; he himself was a keen and enlightened landlord, and much interest still attaches to his *Scotland as It Was and as It Is* (1887). One of the duke's chief preoccupations was the reconciliation of the dogma of Christianity with the progress of scientific discovery. His *The Reign of Law* (1866), *Primeval Man* (1869), *The Unity of Nature* (1884), *The Unseen Foundations of Society* (1893) and other essays found a wide public. He also wrote on the eastern question with particular reference to India, on the history and antiquities of Iona, and on patronage in the Church of Scotland. Argyll, to whose Scottish title a dukedom of the United Kingdom was added in 1892, died at Inveraray on April 24, 1900; his *Autobiography and Memoirs* was published posthumously by his widow (1906).

John Douglas Sutherland Campbell (1845–1914), 9th duke of Argyll, eldest son of the 8th duke, was born at Stafford house, Westminster, on Aug. 6, 1845. His marriage in 1871 to Princess Louise, daughter of Queen Victoria, gave him a special prominence in British public life. He was governor general of Canada from 1878 to 1883, and Unionist member of parliament for South Manchester from 1895 to 1900. His reminiscences, *Pages from the Past*, were published in 1907. He died in the Isle of Wight on May 2, 1914, and was succeeded by his nephew Niall Diarmid Campbell (1872–1949), 10th duke; he in turn was succeeded by his cousin, Ian Douglas Campbell (1903–), 11th duke.

(G. S. P.)

ARGYLL, a county on the west coast of Scotland, is second in size only to Inverness-shire, which adjoins it to the north. It is bounded on the east by Perthshire and Dumbartonshire, on the west by the Atlantic and on the south by the Firth of Clyde with

its tributaries, while the Mull of Kintyre is separated from Ireland by the North channel, only 13 mi. wide. One-quarter of the county consists of islands, including the large islands of Mull, Jura and Islay, smaller ones such as Tiree, Colonsay, Iona, Staffa (*qq.v.*), Coll and Scarba (the latter separated from Jura by the notorious whirlpool of Corrievreckan), together with many tiny islets that are little more than rocks. The total land area is 3,110 sq.mi.

The boundaries of Argyll have varied at different times, and it has been (1) a small independent kingdom known as Dalriada; (2) a spacious province made up of north and south Argyll, stretching from Loch Broom to the Mull of Kintyre; and (3) an extensive county composed of the old shires of Argyll and Tarbert formally united in 1633. Argyll (Gaelic *Earraghaidheal* meaning "coastland of the Gael") has finally superseded the old alternative form of Argyle.

Physical Features.—Argyll comprises about one-third of the wet, deeply dissected western Highlands, whose rivers flow to the Atlantic. There is a repeated pattern of plateau blocks, sometimes roughly rhomboidal and bounded by valleys which have some correspondence to major fault lines. Thus the great Glen fault corresponds with the southwest-northeast line of the Firth of Lorne and Loch Linnhe, at the head of which Loch Eil runs due west at an acute angle. The Caledonian trend southwest-northeast is of particular importance in the grain of the country. The plateau blocks, at various dominant heights from 1,000 ft. to 3,000 ft., were dissected by water and ice to yield very spectacular scenery, particularly in the higher parts of the north and east, where residual heights such as Bidean nam Beann (3,766 ft.) and Ben Cruachan (3,689 ft.) rise above the general summit plane. Glacial action has gouged the corries and rock basins of freshwater lochs such as Awe (*q.v.*) and Avich, and of sea lochs like Fyne and Long, and deposited many hummocks of coarse moraine or boulder clay on lower ground. Postglacial drowning, in an area of local depression of the crust through the weight of the ice cap, has given the long, complex coastline of peninsulas and sea lochs, while later partial recovery of the land has left raised beaches in sheltered coastal reaches at about 25 ft. and about 100 ft. above mean sea level.

The solid rocks of Argyll include: the Dalradian and Moine schists (mainly mica-schists, slates and phyllites), with contemporary granites like those at Strontian, limestones as in Lismore Island and quartzites giving conical hills such as the Paps of Jura; the granites (Glen Etive), the andesite and rhyolite lavas (Glen Coe and Oban areas) and associated dikes of the Old Red Sandstone era; the downfaulted Carboniferous area between Campbeltown and Machrihanish, including some coal; the small patches of Mesozoic, Lias shales and Greensand (including the white sandstones of Lochaline) in the north; and the Tertiary cauldron-subsidence and associated basalt lavas and dolerite dikes of Mull and adjacent mainland areas.

Coastal Argyll has a cool, damp summer, a mild, wet winter with little snow and a drier, rather sunny late spring and early summer (July mean approximately 58° F.; January mean about 40° F.; mean annual rainfall in windward sites less than 40 in.). Inland conditions are much wetter (mean rainfall commonly exceeding 80 in.) and a little less equable, with from 10 to 30 days of snow on the hills and severe frosts in sheltered hollows.

Residuals of natural vegetation include: the valley oak woods, near their limit and tending to be on the sunny side; birch or pine on shady or higher sites (birch, for instance, regenerating naturally to 1,000 ft. or more if protected from grazing); hazel scrub in the lava country of Mull; a moorland flora varying with grazing and rather tolerant of wet conditions, with much reed and purple moor grass, though heather and mat grass and wild flowers such as harebells are also found; and small areas of Alpine flora including purple saxifrage.

Animals of inland Argyll include red deer, red squirrels, pine martens, wildcats, mountain hares, golden eagles, capercaillies and ptarmigan, with many badgers in the oak woods. Foxes, largely deprived of their natural diet of rabbits through myxomatosis, were frequently reported raiding poultry. Despite an overlap, the coastal tracts and islands may rather be associated with such fauna as gray seals, fulmar, petrels and (particularly on Tiree) migrating ducks and waders.

The fine Glen Coe motor road traverses the wild sad country associated with the massacre of 1692, while Sunart and Morar have fine mountain and coast scenery. In the southeast is the Argyll National forest park, including the mountain range popularly known as Argyll's bowling green between Loch Goil and Loch Long.

(A. T. A. L.)

History.—The secular and the religious history of Argyll are closely connected. The recorded secular history begins in the 2nd century A.D. when Argyll was invaded by Scots (Celts) who came from Ireland, then known as Scotia. The earliest Celtic settlement is assigned to the 3rd century when a victorious chief, Cairbre Riada, occupied lands in the area later known as mid Argyll. These lands, called Dalriada (*q.v.*), were reinforced from time to time by fresh bands of immigrants from Celtic Ireland. Dalriada developed gradually as an independent kingdom under ambitious rulers and maintained a separate existence until 844 when one of them, Kenneth Macalpine, united the men of Dalriada with the Picts of central Scotland and founded a new hybrid kingdom from which Scotland ultimately emerged. After Kenneth's departure from Argyll the Norsemen obtained control and held sway until 1266 when Argyll was added to the Scottish kingdom. Prior to this, however, semi-independent chiefs of mixed Celtic and Norse ancestry acquired power in Argyll and the Isles. One of them, Somerled, really the first lord of the Isles, was killed near Renfrew in 1164 on an expedition against the Scottish king, but the lordship of the Isles was held by his descendants until 1493 when John, the last MacDonald lord of the Isles, was deprived of his vast estates by James IV. The Campbells of Lochow (now Lochawe) rose on the ruin of the MacDonalds and had a run of success unparalleled in Scottish history. The Campbell chiefs were men of much natural ability and the prominence of the 9 Campbell earls of Argyll in Scottish history and of the subsequent 11 dukes of Argyll in the history of Great Britain is unsurpassed by any other single noble British family.

The failure of the second Jacobite rising, in which the men of Argyll with few exceptions served under the Hanoverian banner, was followed by important political and economic changes. The abolition of the heritable jurisdictions in 1747, prior to which Highland lairds and chiefs had been petty kings over their tenants and followers, led to the development of new relationships. The rents of tenants became of greater importance to their masters than the former friendly loyalties. Sentimental ties were broken and the small farms and holdings which had supported large numbers of occupants on a meagre scale of subsistence had to give way to larger farms stocked with flocks of sheep, immediately but only temporarily more profitable to their owners. Throughout the Highlands, including Argyll, thousands of small tenants were displaced by methods that were later universally condemned.

The ecclesiastical history of Argyll shows a people deeply concerned with matters of religion. The earliest phase was the old Celtic period when missionaries from Celtic Ireland spread the Christian faith. St. Columba (*q.v.*) with his associates from Iona (*q.v.*) and successors did more for the spreading of the Gospel than any other contemporary group of religious pioneers in Britain. The Celtic phase lasted for several centuries until it was displaced by the Roman Catholic period which continued until the first Scottish Reformation (1560) in which the 5th and 6th Campbell earls played a decisive part as the most influential Protestant laymen in Scotland. The Protestantism of Scotland and of Argyll was never seriously challenged at any subsequent period although there were conflicts between Episcopacy and Presbyterianism. In the end the latter prevailed and is still the commonest form of church government in Argyll.

Population and Administration.—The population of Argyll in 1961 was 59,345. The peak figure for the county was 100,973 in 1831, after which every decennial census, except 1881, 1921 and 1951, recorded a decrease. The decline in population tended to be greater in rural areas than elsewhere but, even so, the rural population still represents more than half the total. There are six

small burghs of which those with the biggest population in 1961 were Dunoon (9,215), Campbeltown (6,523) (*qq.v.*) and Oban (6,869). The oldest burgh, Inveraray (*q.v.*), chartered in 1474, had only 501 inhabitants compared with 1,208 for Lochgilphead (*q.v.*) and 668 for Tobermory. In 1961, 9,510 people (16.0% of the population) spoke Gaelic as well as English.

The headquarters of the various branches of the county council are in different burghs. Those of the county clerk, the chief constable and the county engineer are at Lochgilphead; the director of education, the county architect and the county librarian are stationed in Dunoon; the county medical officer and the chief sanitary inspector have their offices in Oban; and the county treasurer and the county assessor have their headquarters at Campbeltown.

The coat-of-arms of the county council shows its historical associations with the clans of the MacDougalls, MacDonalds and Campbells, while its motto is in Gaelic: *Seas ar coir* ("Maintain our right").

Industries and Communications.—Industries include farming, afforestation, quarrying, the tourist trade and numerous occupations requiring only small numbers of workers. Farming, including sheep and cattle raising, is the staple industry, giving employment to more than 6,000 persons in the early 1960s. The forestry commissioners, with their extensive estates well-planted with trees, gave employment to more than 1,000 workers and their activities were still expanding. Only about 5% of the total land area is agriculturally improved land, of which just over half is arable land mainly for oats, hay and other fodder crops, the rest being permanent grass. The agriculture of Argyll is somewhat transitional in character. There are individual farms like those of the lowlands in the southeast, in much of Kintyre and on Islay, but there is more crofting agriculture, including common grazings, in the north of the county, though the crofts may be fairly substantial as on Tiree. Both farms and crofts depend on rough grazings on the hills for sheep and cattle, and on winter pasture on the lower slopes, with the fodder from the improved pastures and arable to provide additional winter feed.

The only colliery in active production is at Machrihanish, where several hundred workers have a weekly output of about 3,000 tons. Small veins of silver were exploited at Silvercraigs near Lochgilphead in the 19th century and copper used to be worked in various localities. Lead was also produced in many areas, especially near Strontian, where the mineral strontianite containing the element strontium was found. The abundance of slate in different parts of Lorn supported many quarrymen at such places as Easdale, Luing and Ballachulish, but there are signs that the slate industry has passed its peak. A fine quality sand for making optical glass is produced at Lochaline.

At one time herring fishing was a major occupation but it languished and although many fishermen turned their attention to whitefish their number fell from 1,222 in 1921 to 807 in 1951. The tourist trade provides valuable additions to local incomes, but the county's chief hope lies in the introduction of a multiplicity of small industries such as the manufacture of chipwood and paper pulp, pit props and fence posts from the abundance of local timber. In the 1950s a clothing factory was established at Campbeltown and pottery factories for high-class articles were set up in Strachur and Dunoon.

The fresh-water lochs are used to supply both domestic water and electric power.

The county was slow in introducing railways and it was not until 1880 that Oban was linked with Glasgow by the extension of the existing line from Callander. Later came the construction of the branch line from Connel ferry to Ballachulish but this line was never continued to Kinlochleven, the chief industrial village in Argyll. Much transport still goes on by sea between Argyll ports and outside communities. The roads extend to 1,450 mi. and vary in quality from excellent to poor but the main roads in general are good. Much was hoped for in the early 1960s from the development of existing and projected air services to Tiree, Mull, Islay and other islands as well as to mainland airports; and it was thought that helicopters might be used to link isolated communities with airports of national importance. (C. M. M.)

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ARGYRODITE, the silver sulfide mineral in which the element germanium was discovered (*see* Germanium). First discovered in the form of crystalline crusts in a silver mine at Freiberg, Saxony, it was later found in the form of large distinct crystals in Bolivia.

A relatively scarce mineral, it occurs associated with the tin ore cassiterite, the iron ore siderite and with silver sulfosalts in sulfide veins. It is opaque, with a metallic lustre; the colour is black with a purplish tinge. The hardness is 2.5, specific gravity 6.3. Argyrodite is isometric in crystallization. Named after its silver content, its formula is Ag_8GeS_6. The corresponding tin compound, Ag_8SnS_6, is known by the name canfieldite, and a complete solid solution series extends between this species and argyrodite. (Cl. F.)

ARGYROPULUS (Argyropoulos), **JOHN** (1415–1487), Byzantine humanist, an active promoter of the revival of learning in the west, was born in Constantinople and became a teacher there. Among his pupils was the scholar Constantine Lascaris (*q.v.*). He divided his time between Italy and Constantinople. He was in Italy for the council of Florence (1439) and also spent some time teaching in Padua. When Constantinople fell in 1453 he left it for the Peloponnesus and then in 1456 took refuge in Italy. He was professor of Greek in Florence, and in 1471 moved to Rome where he continued to teach Greek until his death on June 26, 1487. His pupils in Italy included Politian and Johann Reuchlin (*qq.v.*). He left Latin translations of a number of Aristotle's works, some letters in Greek and Latin and some Greek orations. His real importance lies in his work as a teacher in Italy rather than in his writings.

See S. P. Lampros, *Argyropouleia* (1910) for his minor works. See also G. Cammelli, *I dotti bisantini e le origini dell' umanesimo*, vol. 2, *Giovanni Argiropulo* (1941). (J. M. Hy.)

ARIA, a solo song, either simple or elaborate, with instrumental accompaniment, that is not only one of the most important ingredients of opera, especially up to the later 19th century, but is also found extensively outside opera in the 17th and 18th centuries, notably in cantatas and oratorios (*qq.v.*).

The term originated in Italy in the 16th century and first gained currency with the publication in 1602 of *Le Nuove Musiche*, a collection of solo songs with *continuo*, by Giulio Caccini, who called the strophic songs in his collection *arie*. The word can be seen as a counterpart to the contemporary English "ayre" and French *air* (*see* Air); it was later adopted in Germany, where the songs of composers such as Heinrich Albert and Adam and Johann P. Krieger are called *Arien*. All the more serious strophic songs composed thereafter in Italy—and there were a great many of them—were called arias; the form soon made its way into opera (*e.g.*, Orpheus' "Vi ricord', o boschi ombrosi" in Monteverdi's *Orfeo*, 1607). Instead of using the same music for every verse some composers varied a basic vocal line over a constant, steadily moving bass. Terms such as *canzonetta* and, later, *arietta* were used for arias of more popular or frivolous cast.

After about 1620 arias, still usually found as separate songs in published collections, were nearly always in triple time and became longer, notably at the hands of the Venetian organist Giovanni Pietro Berti; and new structural schemes, often suggested by the texts, were devised to lend unity to what might otherwise have become a somewhat sprawling form. It was Berti who composed a song, "Dove sei gita," published in 1634, that is probably the earliest aria in *da capo* form; this involved the organization of an aria as a whole and not merely that of a single verse whose music was then used for subsequent verses. (Berti achieved the new ABA form in the space of a single verse by placing a triple-time refrain at the beginning as well as at the end, the main body of the text being set in a contrasting duple time between them.)

For over a century the *da capo* aria, now mainly found in Italian operas and cantatas, was one of the most popular musical forms of all time. Texts became much shorter, since, instead of having several verses sung to the same music, all that was required was, first, a few lines, heard twice complete in the outer A sections to the same music, which treated the words expansively with plenty of repetition, and, secondly, a few more lines for the central B section, which was usually much terser and in a related key and frequently contrasted in mood and tempo. Instrumental ritornellos (sometimes sharing the vocal material) framed the arias, and snatches of them often punctuated the vocal sections. While the story of an opera was advanced through recitative, the arias were dramatically static, affording opportunities for single characters to reflect on the immediately preceding action, after which they left the stage. Arias might assume various moods and were codified as *Aria cantabile, Aria di bravura, Aria parlante* and so on; these were supposed to be carefully distributed throughout an opera or single act, though in fact their finest composers—among whom Alessandro Scarlatti and, especially, Handel stand pre-eminent—did not rigidly observe these conventions. The finest singers of these arias, particularly sopranos, both female and male (*castrati*), were the most popular international public entertainers of the age and decorated the reprise of the A section of an aria with brilliant improvised embellishments (sometimes in competition with an equally brilliant and agile obbligato instrument, such as flute or trumpet), culminating in an unaccompanied cadenza at the final cadence. The *da capo* aria was also a staple constituent of chamber cantatas and to a lesser extent of sacred cantatas (many of Bach's, for example) and oratorios (the finest examples being by Handel). Composers occasionally dispensed with the *da capo* form for dramatic effect.

By about the third quarter of the 18th century influential voices—those of Jean Jacques Rousseau, Francesco Algarotti and C. W. Gluck, for instance—began to protest against the *da capo* aria, and it suffered a sharp decline. These writers protested against abuses such as excessive coloratura; the dramatic impropriety of a return to the mood of section A after this mood had been dispelled by the sense of section B; and the "absurdity" of a character who had sworn, say, "immediate vengeance" in a recitative, having to wait before elaborating his point in the ensuing aria while the orchestra played a ritornello. It is tempting to attend to these admittedly reasonable complaints and to forget that in its long heyday the *da capo* aria gave immense pleasure. A reaction against it was bound to come. When baroque opera began to return to the operatic stage about the middle of the 20th century, it was seen that in the hands of an imaginative producer and musical director, unshackled by virtuoso singers, long successions of recitative and aria need not lead to dramatic absurdity or stagnation.

There is less to say about the aria after about 1770. It continued to play a prominent part in opera in many different, less stereotyped forms, ranging from simple strophic songs to long and elaborate *scenas*. Since Gluck was impatient of the *da capo* aria and he was the greatest operatic composer between Handel and Mozart it is not surprising that his operas are the first important ones to show this new variety. In the late 18th century the aria enjoyed a vogue as a concert piece (Mozart). At this time, too, many arias were in two distinct parts, one dramatic, one lyrical (e.g., Leporello's "Catalogue Aria" in Mozart's *Don Giovanni*). In Italian operas—those, for instance, of Donizetti and Verdi (up to *Aida*, produced in 1871)—the aria was cultivated over a longer period than in German operas. This was due not merely to the Italian love of singing but also to the operatic reforms of Wagner, which led to a "continuous" texture founded on orchestral motives in place of the discontinuous texture of separate numbers (aria, chorus, etc.), which, however, survive in special instances like the "Prize Song" in *Die Meistersinger von Nürnberg*, produced in 1868. In the 20th century arias occur mainly in operas by composers uninfluenced by, or hostile to, Wagner (*e.g.*, Stravinsky's *The Rake's Progress*, and the operas of Benjamin Britten). (*See* also OPERA and articles on individual composers.)

The term "aria" has also occasionally been used to denote instrumental pieces of a songlike nature (*e.g.*, the two middle movements of Stravinsky's Violin Concerto). (N. Fo.)

ARIADNE, a heroine of Greek mythology, daughter of Pasiphae and the Cretan king Minos. She fell in love with the Athenian hero Theseus, and with a thread or glittering jewels she helped him escape the Labyrinth after he slew the Minotaur (*q.v.*). Here the legends diverge: she was abandoned and hanged herself; she was carried to Naxos and left there to die or to marry Dionysus; she died in childbirth on Cyprus. Poetry and art preferred the picture of her asleep on the shore of Naxos while Dionysus gazes in admiration and love; and the Naxians, to oblige the view that she died, spoke of another and younger Ariadne. The jewels that guided Theseus through the Labyrinth became the stars in the constellation Corona, according to some.

Ariadne was once a vegetation-goddess of pre-Greek Minoan Crete, Cyprus, Naxos and perhaps elsewhere. The Naxians, who alone preserved her divinity, honoured the elder Ariadne, wife of Dionysus, with a joyous festival and the younger with gloomy sacrificial rites. Originally there must have been but one Ariadne, and these rituals reflected the death and revival of the vegetation she personified. Later Dionysus partly absorbed her cult, in one version (Odyssey, xi, *322*) even instigating her death. The myths say that Theseus "carried her off," as Paris did Helen, which may express the feeling that to pick the harvest fruit was to violate the plant's vital spirit. The goddess of the Minoan tree cult was apparently hanged in effigy on a tree, and Ariadne's hanging may go back to this (*see* also ARTEMIS; HELEN). She was honoured with dances, a common Minoan religious feature, whose motions and rhythms suggested the twistings of the Labyrinth. The myth that she died in childbirth on Cyprus arose from her role in the cult of Aphrodite, a role hard to assess because her name here may have been originally merely an epithet of Aphrodite, meaning "very holy" (Gr. *ari-*, *hagne*). Elsewhere, however, she was an individual, and indeed an original product of Minoan religious thought, since in comparable religions the dying vegetation is ordinarily thought of as male (*e.g.*, Attis and Adonis).

See Martin P. Nilsson, *Minoan-Mycenaean Religion*, 2nd ed. (1950), with references. (W. M. SE.)

ARIANISM is the belief, first propounded early in the 4th century by Arius (*q.v.*), that Christ is not truly divine, but a creature *ex nihilo*, who at one time did not exist. The controversy initiated by this teaching persisted until the 7th century.

The fundamental premiss of Arius was the uniqueness of God, who is alone self-existent and immutable. Because the Godhead is unique, it cannot be shared or communicated, so that the Son cannot be God. Because the Godhead is self-existent, the Son, who is not self-existent, cannot be God. Because the Godhead is immutable, the Son, who is mutable, being represented in the gospels as subject to growth and change, cannot be God. "He too is called God in name only"; *i.e.*, as a courtesy title. The Son must therefore be deemed a creature who has been called into existence out of nothing and has had a beginning—"there was when he was not." Consequently the Son can have no direct knowledge of the Father, being finite and of a different order of existence.

Arianism was the full flowering of the subordinatism that had been introduced into Christian theology in the 2nd century through the acceptance of the Logos or Word Christology, which tended to make the Son an impersonal function of and therefore inferior to the Father. Deriving his ideas possibly in part from Lucian (*q.v.*) of Antioch, Arius regarded himself as doing no more than carrying on the tradition exemplified by Dionysius of Alexandria and Origen (*qq.v.*). The latter was responsible for some very emphatic statements regarding the subordination of the Son, but whereas he balanced such ideas with his doctrine of the eternal generation, Arius seized upon the subordinationist elements alone and carried them to their logical conclusion.

Such teaching, as its opponents were not slow to point out, reduced the Son to a demigod, reintroduced polytheism (for the worship of the Son was not abandoned) and undermined the Christian concept of redemption, since only he who was truly God could be deemed to have reconciled man to the Godhead.

The controversy seemed to have been brought to an end by the

Council of Nicaea (A.D. 325; *see* COUNCIL), which condemned Arius and his teaching and issued a creed to safeguard orthodox belief. This creed states that the Son is *homoousion to patri* ("of one substance [or stuff] with the Father"), thus declaring him to be all that the Father is: he is completely divine. In fact, however, this was only the beginning of a long-protracted dispute, the intensity and duration of which were due to conservatism on the part of many who failed to appreciate what was at stake; to the readiness of many half-converted pagans to accept this rationalized brand of Christian belief; and to political intrigue and the entrance of the emperors into church affairs.

Arianism in the Empire After Nicaea.—The first stage, which centred in persons, lasted from 325 to 337 when Constantine I died. During this period the Arian leaders, exiled after Nicaea, sought by intrigue to engineer their own recall and then the banishment of their enemies. So in 328 Eusebius of Nicomedia was reinstated, although Arius himself had to wait a further seven years. Also in 328 Eustathius of Antioch, a prominent Nicene, was ousted, followed shortly by Marcellus of Ancyra; and in 336 after numerous *démarches* culminating in the synod of Tyre (335), Athanasius (*q.v.*) was exiled to Trier.

The second stage embraced the period of the joint rule (to 350) of Constans in the west and Constantius in the east, the latter being sympathetic toward the Arians and the former to the Nicenes. The Arian policy was now to have the Nicene statement replaced by another formulary, omitting the *homoousion* and so deposing it from its position as an ecumenical test; in this the Arians were at one with the general body of eastern opinion, which was essentially conservative and, while accepting the Nicene repudiation of Arianism, disliked the term because it was unscriptural. So at the synod held at Antioch in 341 an affirmation of faith, omitting the *homoousion*, was issued. In 342 a further council met at Sardica (mod. Sofia) to consider the case of Athanasius and to regulate the legal position of the many bishops who had suffered deposition. The easterns soon withdrew to Philippopolis (mod. Plovdiv) and held a separate meeting. Little was immediately achieved by either council, and the position became one of uneasy equilibrium until 350 when Constantius became sole ruler.

The third stage may be divided into two parts, the first, 350–356, witnessing the re-establishment of Arianism, the second, 357–361, its apparent triumph but inner disintegration. Under Constantius' leadership the Nicene party was largely crushed. In 353 at Arles the Gallican bishops were brought to heel; in 355 Liberius of Rome was exiled, to be followed by Ossius of Córdova; in 356 Hilary of Poitiers was sent to Phrygia and in the same year Athanasius had to withdraw from Alexandria to seek refuge among the desert monks. All sees were now either vacant or occupied by Arians or their sympathizers. The real Arians, who differed from their predecessors in being frank rather than evasive, now came out into the open with the declaration that the Son was "unlike" (*anomoios*) the Father. These Anomoeans, led by the bishops Aetius and Eunomius, succeeded in having their views endorsed at Sirmium in 357, but their extremism stimulated the moderates who, under Basil of Ancyra, asserted that the Son was "of similar substance" (*homoiousios*) to the Father. Constantius was initially favourable toward the Homoeousians, but soon transferred his support to the Homoeans, led by Acacius, who affirmed that the Son was "like" (*homoios*) the Father, and their views were approved in 360 at Constantinople, where all previous creeds were rejected, the term *ousia* ("substance" or "stuff") was repudiated and a statement of faith was issued stating the Son to be "*like* the Father who begot him."

The final stage of the controversy began with Constantius' death in 361. The rule of Julian the Apostate (361–363) impressed upon all parties the need for unity. Then the policy of neutrality in the west of Valentinian (364–375) enabled the orthodox majority to consolidate its position. The Arian persecution conducted by Valens (364–378) in the east and the success of the teaching of the Cappadocian trio, Basil of Caesarea, Gregory of Nyssa and Gregory of Nazianzus (*qq.v.*), led the Homoeousian majority to realize its fundamental agreement with the Nicene party. Hence the way was prepared for united action when Gratian (375–383) and Theodosius I (379–395) took up the defense of orthodoxy. Deprived of official protection and at last faced with a united opposition, Arianism could not escape the collapse that had for long threatened it. In 381 the second ecumenical council met at Constantinople; Arianism was proscribed and a statement of faith, the Nicene creed, was approved (*see* CREED). Both Gratian and Theodosius implemented these decisions with decrees that ousted all Arian office holders, and the heresy was speedily and finally extirpated.

Arianism Among the Germanic Tribes.—Although Arianism within the empire had become a spent force, beyond its borders among the Germanic tribes the situation was different. One of those present at the Homoean council of Constantinople in 360 was Ulfilas (*q.v.*), who had been consecrated bishop by Eusebius of Nicomedia. Ulfilas accepted the council's Homoean statement, and taught the similarity of the Son to the Father and the complete subordination of the Holy Spirit. He carried this teaching to the Visigoths, north of the Danube, and when they entered Italy under Alaric (who was to capture Rome itself in 410) the heresy once more found a foothold within the western empire. Yet, although it is customary to describe the beliefs of these invaders as Arian this is really a misnomer, for none of the articles of the old heresy made explicit by the Anomoeans, was professed by them. They were rather Semi-Arians, who refused to call the Son a creature, were prepared to acknowledge a Trinity, and would even accept a certain "unity" of substance, although they understood this to mean "similarity" of substance and affirmed a gradation of beings within the Trinity. The Catholic response, typified by the Athanasian creed (*see* CREED), was to emphasize the consequences of this unity of substance in the co-equality of the three persons, so that there is no subordination but a unity in Trinity.

While the Visigoths were preying upon Italy, the Vandals from Germany were pressing down into Gaul, having adopted Arianism in the sense defined immediately above as they traversed the middle Danube. In 409 they crossed the Pyrenees, thus bringing Arianism into Spain. Hard on their heels came the Visigoths, who had withdrawn from Italy, and, driving the Vandals before them across the sea into Africa in 429, they set up yet another Arian state in Spain; the Vandals, under Gaiseric and his successor Huneric, carried on a bitter persecution of the Catholics in north Africa. In the meanwhile the Franks, themselves pagan, were on the move from Belgium, and the baptism of Clovis (496 or 506?) brought an end to Arianism in Gaul. In Spain, the labours of Martin, bishop of Braga, and Leander, bishop of Seville, who converted the Arian Reccared, eventually culminated in the condemnation of Arianism at Toledo in 589. But in 603 Witteric headed a rebellion against Reccared's son, Liuva, and Arianism was temporarily restored. After Witteric's assassination in 610 it soon became a lost cause, but a following persisted until the extinction of the Visigothic kingdom by the conquering Muslims. In north Africa the successful campaign of Justinian, in part motivated by a concern for orthodoxy and the suffering of its adherents, ended the Arian domination. Justinian's defeat of the Arian Ostrogoths and reconquest of Italy, which began shortly after the death of their great leader Theodoric, only gave a short check to Arianism which was brought in again with the invading Lombards in 568. The continued loyalty and solidarity of the Catholic population and the lack of unity among the Arian churches, each limited to its particular tribe or kingdom, led to its final disappearance by the end of the 7th century, after a period of wavering. Liutprand (712–744), probably the greatest of the Lombard leaders, rejected Arianism and from then onward the movement failed to win any serious support.

Modern Holders of Arianism.—Arianism could maintain itself in force only against a background of polytheism, and once monotheism had become the generally accepted belief it showed no signs of a recrudescence. Throughout the centuries that followed its eclipse with the conversion of the Lombards, little or no hint of it is to be found, except in 18th-century England.

The questioning of fundamental beliefs that resulted from the Enlightenment, and issued in deism (*q.v.*), also led to a temporary reappearance of 4th-century Arianism in the person of Samuel

Clarke (*q.v.*), who in 1712 published *The Scripture Doctrine of the Holy Trinity* in which he maintained that Jesus was divine only by the communicating of divinity to him, being the Son of God rather than God the Son, and that the Holy Spirit was inferior to both Father and Son. Clarke, whose views were also held by his biographer, William Whiston (*q.v.*), was answered by Daniel Waterland, who in a series of works argued so convincingly that thereafter it became difficult to adopt any halfway position between orthodox Trinitarianism and complete Unitarianism, although it is to be acknowledged that some modern Unitarians are virtually Arians in that they are unwilling either to reduce Christ to a mere human being or to attribute to him a divine nature identical with that of the Father. The Christology of Jehovah's Witnesses too is a form of Arianism, Arius himself being regarded as a forerunner of C. T. Russell (*q.v.*), the founder of the movement.

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ARIAS DE ÁVILA, PEDRO, commonly known as Pedrarias Dávila (1440?–1530), Spanish soldier and colonial governor, founder of the city of Panamá, was born probably at Segovia about 1440. He served in the wars against the Moors in Granada and Africa, and with ecclesiastical backing won the governorship of Castilla de Oro, later the republic of Panamá. He left Spain for that post in 1514, accompanied by 1,500 troops, his wife, two daughters and the first bishop of Darién. Upon his arrival in July he was kindly received by Vasco Núñez de Balboa (*q.v.*), who was later executed by Pedrarias.

Under Pedrarias' orders, Hernán Ponce and Bartolomé Hurtado explored in 1516 the territories comprising the modern states of Nicaragua and Costa Rica. Pedrarias himself led an unsuccessful expedition against the cacique, Urraca. His policy of eliminating all who might excel him gave him the reputation of being the most cruel and inhuman of all the Spanish captains. Replaced as governor of Panamá in 1526, Pedrarias became governor of Nicaragua and executed Francisco Hernández de Córdoba, whom earlier he had employed in the conquest of Nicaragua. Pedrarias died at León, Nicaragua, at about the age of 90. (R. G. Rr.)

ARIAS MONTANO, BENITO (1527–1598), Spanish orientalist, who directed the translation of the Antwerp polyglot Bible, was born at Frejenal de la Sierra, in Estremadura. In 1562 he was appointed consulting theologian to the Council of Trent. He retired to Peña de Aracena in 1564, wrote his commentary on the minor prophets (1571), and was sent in 1568 to Antwerp by Philip II to edit the *Biblia polyglotta* projected by Christophe Plantin (*q.v.*). The last years of his life were spent in seclusion in Seville, where he died.

He is the subject of an *Elogio histórico* by Tomás González Carvajal in the *Memorias de la Real Academia de la Historia*, vol. vii (1832).

ARIBAU, BUENAVENTURA CARLOS (1798–1862), full Catalan name, Bonaventura (Francesc Gervasi Protasi) Carles Aribau i Farriols, Spanish economist and man of letters, one of whose poems was of great importance in the revival of Catalan literature in the 19th century, was born in Barcelona, Nov. 4, 1798. He worked in Catalonia and later in Madrid, where he joined Gaspar Remisa's banking concern (1830–41) and became director of the treasury and financial secretary to the royal household. His writings voice the ideals of liberalism and the historical trend of early romanticism—as in his contributions to the Barcelona periodical *El Europeo* (1823–24), which he helped to found, and later in his *El Vapor* (1833–35). His collected Spanish essays were published as *Ensayos Literarios* (1827). Aribau edited the first four volumes of the well-known *Biblioteca de Autores Españoles* (1846–80), which he founded with Manuel de Rivadeneyra, but his fame rests chiefly on his Catalan poem *Oda a la Pàtria* (1832), marking the Catalan *renaixensa*—the re-establishment of Catalan as a literary language after an almost total eclipse of over a century. His poem, later translated into the main European languages, is a highly representative work uniting native traditions with contemporary literary ideas. It is written in Alexandrine double quatrains and contains echoes of Manzoni, Schiller and Scott. He died in Barcelona, Sept. 17, 1862.

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ARICA (San Marcos de Arica), Chilean town and port near the Peruvian border, a free port for Bolivia and Peru. Pop. (1960) 43,344. Since May 1, 1930, it has been part of Tarapacá province (*q.v.*). Arica's main economic function is the handling of transit trade. The irrigated Lluta and Azapa valleys, which partially supply trade products for Arica, have a long agricultural history. Inca occupation may date from 1250. The Spanish, who used Arica's roadstead in the 1550s, gave the community city status in 1570.

Disasters that have befallen the city include sacking by pirates and the Chilean army, numerous earthquakes and a pair of tidal waves, one of which carried an American sailing vessel .3 of a mile inland. During the War of the Pacific, El Morro, the precipitous headland overlooking the city, was the scene of a battle memorable for the fanatic but fruitless resistance of the entrenched Peruvians. Chile controlled the city thereafter (June 1880). The treaty of Ancón (1883) outlined a procedure for determining ultimate sovereignty of the area, but the question of Chilean possession was not definitely resolved until 1929. The city is the terminus for a 39-mi.-long railway (completed 1854) to Tacna, Peru, and for a 285-mi.-long railway to La Paz, Bolivia (completed 1913). (J. T.)

ARICIA, an ancient city in Latium, the modern Ariccia in the Italian *regione* of Lazio, 16 mi. S.E. of Rome on the Via Appia. The nucleus of the old town originally lay 1,352 ft. above sea level above a volcanic depression known as Valle Ariccia; remains of its walls are traceable. After the construction of the Via Appia in 312 B.C. the inhabitants of Aricia moved southwest to form the lower town close to the road; about 250 yd. of fine substructions of polygonal masonry survive. There are remains of the walls of the lower town, of the *cella* of a temple of the 2nd century B.C. and also of later buildings connected with the post station and baths. Aricia was one of the oldest cities of Latium, and the name of the inhabitants, Aricini, with its ending *-cini*, suggests that an earlier stratum of population in Latium with names ending in *-ci* (*cf.* Volsci, Osci) may have been absorbed by a later stratum with names ending in *-ni* (*cf.* Latini, Sabini, etc.). Aricia was an early opponent of Rome. In the 6th century it opposed Tarquinius Superbus and was helped by Aristodemus of Cumae against the Etruscans at the battle of Aricia. It was a meetingplace of the Latin league, and the Aricini took part in the battle of Lake Regillus (early 5th century) and in the Latin War (340–338 B.C.), after which they received Roman citizenship. Aricia remained a prosperous *municipium* until the barbarian invasions. It was celebrated for the cult of Diana Nemorensis, whose temple was in the forest near Aricia, beside Lake Nemi. The priest, called *rex nemorensis*, acquired office by killing his predecessor and held it only so long as he could defend himself from any stronger rival.

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'ARID, AL ('Aridh) is the central district of Najd, the premier province of Saudi Arabia, containing the capital, Riyadh (*q.v.*). It occupies the width of the Tuwayq plateau between Al Mahmal (north) and Al Kharj (south) districts, extending east and west to the sand belts of Ad Dahna' and Qunayfidhah. In it are numerous oasis settlements, of which the most important are Ad Dir'iyah and Al 'Uyaynah in Wadi Hanifah; Durma, Al Ghatghat and Muzahimiya in Al Batin plain (west); Sudus and Ar Rimah. Their yeoman farmers, always renowned for their sturdy independence and martial qualities, at first resisted the Wahhabi (*q.v.*) movement in the mid-18th century but later became its stoutest champions until Wahhabism itself merged with

the latitudinarianism of the oil economy of modern times. (H. St. J. B. P.)

ARIÈGE, a frontier *département* of southern France, is bounded on the south by Spain and Andorra, on the west and north by Haute-Garonne, and on the east by Pyrénées-Orientales and Aude. Area 1,888 sq.mi. Pop. (1962) 137,192. The *département* extends to the crest of the central Pyrenees, where the mountain system attains its maximum development in breadth and height, with peaks above 9,000 ft. culminating in Montcalm (10,105 ft.), and passes above 6,000 ft., so near the snow line as to be impassable for a long winter period. No railway line crosses Ariège but the Col de Puymorens has long provided an important road route into Spain. North of the crystalline core of the Pyrenees the flanking belts of folded sedimentary rocks form parallel ridges and valleys. The outermost ridge, the Plantaurel, intersected by the Ariège river, drops steeply to the lowlands of Aquitaine. Controlling the Ariège gateway into the mountains and the approach to the Col de Puymorens, Foix (*q.v.*) was the centre of a county that retained its distinctness until the French Revolution. This ancient county now forms the nucleus of the *département,* which also includes parts of Languedoc and Gascony (*qq.v.*). Although it largely comprises the upper basin of the river Ariège, the *département* extends westward into that of the Salat headstream of the Garonne.

A pastoral economy prevails in the high mountains, and as use of the summer pastures from the French side has decreased, more use has been made of them by Spanish shepherds. There are some forests, but within the forest zone farming has made extensive encroachments. Maize, haricot beans, potatoes and deciduous fruits are grown in the lower valleys, and the mixed farming that is so typical of the lowlands of Aquitaine is practised in the lower country in the north of the *département.* Pockets of highgrade iron ore have been extensively worked in the mountains and there is still some exploitation of it at Puymorens and Montels. Iron-working industries also survive, especially at Pamiers. There are also deposits of lead and zinc ore, but more important than the ore bodies today are the deposits of gypsum and anhydrite at Tarascon (*q.v.*) and the talc of Luzenac. Several hydroelectric power stations are in operation and others are under construction, while the tourist industry is bringing new life to spa towns such as Aix-les-Thermes and other resorts along the roads that are being improved for motor traffic. The outer limestone ranges have picturesque gorges, river tunnels, and caves that are famous for the archaeological remains they have yielded. The grottoes of Le Mas d'Azil and Niaux, among Paleolithic sites, are especially worthy of mention. Foix, the departmental capital, Pamiers and St. Girons give their names to the three *arrondissements.* Pamiers is the seat of the bishopric that is co-extensive with the *département.* The court of appeal and educational headquarters (*académie*) are at Toulouse. (Ar. E. S.)

ARIEL, a biblical word used in several ways. In the Revised Standard Version it is given as an untranslated common noun in II Sam. xxiii, 20 and I Chron. xi, 22 ("he smote two ariels of Moab"), translated in the King James Version as "lionlike men" and in the Douai Version as "lions." Isa. (ch. xxix) uses Ariel as a synonym for Jerusalem, and in Ezra viii, 16 it is the name of one of Ezra's companions.

In Shakespeare's comedy *The Tempest* the spirit of the air delivered from captivity by Prospero, and thereafter his devoted familiar, is called Ariel. Milton used the name for one of the fallen angels in *Paradise Lost.*

ARIES (the "Ram"), in astronomy, a small constellation with three easily visible stars, the first sign of the zodiac. Aries is denoted by the sign ♈, in imitation of a ram's head. The "first point of Aries," which is now far away from the constellation and is situated in Pisces, is the zero from which the right ascensions and longitudes of the stars are measured. It is at the crossing point of the equator and ecliptic on the celestial sphere.

According to a Greek myth, Nephele, mother of Phrixus and Helle, gave her son a ram with a golden fleece. To avoid the evil designs of Ino, their stepmother, Phrixus and Helle fled on the back of the ram, and reaching the sea, attempted to cross. Helle fell from the ram and was drowned (hence the Hellespont); Phrixus, having arrived in Colchis, sacrificed the ram to Zeus, who placed it in the heavens as the constellation.

ARIKARA (Ricara or Ree), northernmost Caddoan-speaking Plains Indians, related linguistically and culturally to the Pawnee, Wichita and Caddo (*q.v.*). First reported in the early 1700s as consisting of several thousand persons living in many villages along the Missouri river in South Dakota, they continually moved upstream and lost population during the 19th century. In the 1860s they joined the Hidatsa-Mandan tribes at Ft. Berthold, N.D. where they have remained. By 1885 their village was dispersed into individual families on scattered farmsteads. Construction of the Garrison reservoir dam and discovery of oil in the Williston basin forced another removal to new homes in the 1950s. In the 1960s they constituted a population of about 700 on the Fort Berthold reservation (*see* Hidatsa).

Originally marginal horticulturalists surrounded by nomadic tribes of hunters, they lived in large permanent villages of earth lodges. Corn, beans, squash and sunflower crops were maintained by the women. Communal bison hunts under the direction of the men interspersed the horticultural cycle. Village activities were controlled by reference to a sacred bundle in the hands of a priest. This office and chiefly posts tended to be the hereditary prerogative of a few leading families. Lower posts associated with organized military, dancing and curing societies fell to the men of commoner families. Different personality ideals were demanded of the two groups. Matrilineal emphasis is indicated by high status for women, the avunculate, sororal polygyny and important maternal fertility roles in the religion. Their occupation of the banks of the Missouri for some 500 years is suggested by archaeological evidence. Comparative ethnology indicates the cultural roots of Caddoan-speaking peoples lay in the prehistoric mound-building cultures of the lower Mississippi valley with some important similarities to customs of the high cultures of Middle America. (*See* Plains Indians.)

See B. Neal, *Last of the Thundering Herd* (1960); J. J. F. Deetz, *The Dynamics of Stylistic Change in Arikara Ceramics* (1965). (P. Ho.)

ARIMASPI, an ancient people in the extreme northeast of Scythia, probably the eastern Altai. All accounts of them go back to a poem by Aristeas of Proconnesus, from whom Herodotus drew his information. They were supposed to be one eyed and to steal gold from the griffins that guarded it (the district contains gold-bearing ores). In art they are usually represented as richly dressed Asiatics, picturesquely grouped with their griffin foes; the subject is often described by poets from Aeschylus to Milton. They are so nearly mythical that it is impossible to insist on their identification with any historical people. *See* Scythians.

ARIMINUM: *see* Rimini.

ARIOBARZANES, the name of a Persian satrap of Hellespontine Phrygia, a king of Pontus, and three successive kings of Cappadocia. Ariobarzanes (4th century b.c.), son of a Persian nobleman, Mithradates, was satrap of Hellespontine Phrygia about 387 b.c. He cultivated the friendship of Athens and Sparta and led the revolt of the western satraps against Artaxerxes II (*c.* 366). When the revolt collapsed he was killed (*c.* 360).

Ariobarzanes (3rd century b.c.) was king of Pontus *c.* 265–255 b.c. in succession to his father Mithradates II.

Ariobarzanes I Philoromaios (1st century b.c.) became king of Cappadocia *c.* 95 b.c. Driven out by Mithradates VI of Pontus in 93 and 88 he was restored by the Romans in 92 and 85 b.c. In 63 he abdicated in favour of his son Ariobarzanes II Philopator. His who was king of Cappadocia till his assassination in 52 b.c. His son Ariobarzanes III Eusebes Philoromaios then succeeded him. Ariobarzanes III's rule was menaced by internal disaffection, and he owed large sums of money to Pompey, Marcus Junius Brutus and other prominent Romans. Cicero befriended him, as did Pompey and Caesar. He was put to death by Gaius Cassius Longinus in 42 b.c. on a charge of conspiracy. (R. H. St.)

ARION, the name of two figures in Greek legend.

1. Arion of Methymna in Lesbos, a semilegendary poet and musician, friend of Periander, tyrant of Corinth. He flourished about 625 b.c. He is said to have invented the dithyramb; *i.e.,* he gave it literary form. The name Cycleus given to his father indicates

the connection of the son with the cyclic or circular chorus of the dithyramb. No genuine work of his survives. Of his life, only the following story, popular in antiquity, is known.

After a successful "tour" in Sicily and Magna Graecia, Arion embarked at Taras (Tarentum) in a Corinthian vessel. The sight of his treasure roused the cupidity of the sailors, who resolved to possess themselves of it by putting him to death. Arion, as a last favour, begged permission to sing a parting song. The sailors, desirous of hearing so famous a musician, consented, and the poet, standing on the deck of the ship, in full minstrel's attire, sang a dirge accompanied by his lyre. He then threw himself overboard; but instead of perishing, he was miraculously borne up in safety by a dolphin, supposed to have been charmed by the music. Thus he was conveyed to Taenarum, whence he proceeded to Corinth, arriving before the ship. Periander, tyrant of Corinth, at first incredulous, eventually learned the truth by a stratagem. Summoning the sailors, he demanded what had become of the poet. They affirmed that he had remained behind at Tarentum; upon which they were suddenly confronted by Arion himself, arrayed in the same garments in which he had leapt overboard. The sailors confessed their guilt and were punished. Arion's lyre and the dolphin were translated to the stars.

Herodotus and Pausanias both refer to a bronze figure at Taenarum that was supposed to represent Arion seated on the dolphin's back. But this is quite as likely to be Phalanthus, the founder of Tarentum, who was commonly represented on the coins of that city riding on a dolphin.

2. Arion or Areion, a wonderful horse, offspring of Poseidon and Demeter Erinys (*see* DEMETER), which belonged to Adrastus, and by its speed saved its master, the only leader to escape from the disaster of the Seven against Thebes. (T. V. B.)

ARIOSTO, LUDOVICO (1474–1533), Italian poet and author of the *Orlando Furioso*, the most perfect expression of Renaissance classicism, was born on Sept. 8, 1474, at Reggio Emilia, where his father, Count Niccolo, of a Ferrarese family, was commander of the citadel; his mother was Daria Malaguzzi Valeri. At the age of ten he moved with his family to Ferrara, and always considered himself a Ferrarese. Although he early showed an inclination for poetry, his father intended him for a legal career, and he studied law unwillingly at Ferrara from 1489 to 1494. He then devoted himself to literary studies under Gregorio Elladio di Spoleto, who, however, left Ferrara in 1499 without having taught his pupil Greek.

When Niccolo died in 1500, Ludovico, being the eldest son, had to provide for his five sisters and four brothers: one of these, Gabriele, a cripple, remained with him all his life, helping in the administration of their shaky estates and sharing his interest in learning and poetry. Ludovico had to give up his dream of a peaceful life devoted to humanistic studies and seek public employment in order to provide for his family. In 1502 he became commander of the citadel of Canossa and in the following year entered the service of Cardinal Ippolito d'Este, the son of Duke Ercole I. His duties as a courtier were in sharp contrast with his simple tastes and, beside accompanying his master on dangerous expeditions and traveling for him on diplomatic missions, he had to be in constant attendance on him. In 1509 he followed the cardinal in the campaign against Venice and, in 1512, he went to Rome with Alfonso, the cardinal's brother, who has succeeded Ercole as duke in 1505, in an attempt to placate the pope, Julius II. Having been unsuccessful, they both had to flee over the Apennines to escape the pope's wrath.

In the hope of finding a situation at the Roman court which would allow him to follow his literary inclination, Ariosto went to Rome in 1513, after the election of Leo X. His hope proved vain and he returned to the cardinal, but when Ippolito was created bishop of Buda in 1517, Ludovico refused to follow him to Hungary and was dismissed. In the following year he entered into the personal service of Duke Alfonso. He was thus able to remain in Ferrara, near Alessandra Benucci, whom he had met in 1513 and who became his faithful companion, although he did not marry her until 1527 (secretly, in order not to lose certain ecclesiastical benefices). In 1522, however, financial necessity compelled him to accept the post of governor of the Garfagnana, in the wildest part of the Apennines. The province was torn by rival factions and brigands and Ariosto showed great skill and wisdom in keeping order.

In 1525 he was at last able to return to Ferrara and, with the money saved during his term of office he bought a little house with a garden. Thus his dreams of a peaceful life devoted to study and poetry came true, and he spent his last years with Alessandra and his own son Virginio, cultivating his garden and revising the *Orlando Furioso* which had been first published in 1516 and was published for the third time in 1532, a few months before his death on July 6, 1533.

Minor Works.—Ariosto's minor works are not on the same level as his masterpiece, although they reveal the same reflective and ironical attitude. His Latin verses, inspired by Tibullus and Horace, were mainly composed in his early years. Although they do not compare in technical skill with those by Marco Antonio Flaminio, Andrea Navagero, Giovanni Cotta and Pietro Bembo, they are much more sincere in feeling. Love is the main subject of his vernacular poems (sonnets, *canzoni* and elegies in *terza rima*) which are his least original work. More important is his *Satire* (1517–25), seven satires which derive from Horace's *Sermones* (*Satires*): the first, written in 1517 when he had refused to follow the cardinal abroad, is a noble assertion of the dignity and independence of writers; the second criticizes ecclesiastical corruption; the third moralizes on the need to refrain from ambition; the fourth deals with marriage; the fifth and sixth describe the personal feelings of the author when kept away from his family by his masters' selfishness; the seventh, addressed to Bembo, points out the vices of humanists and reveals the poet's sorrow at not having been allowed to finish his literary education. Ariosto's five comedies, *Cassaria* (1508), *I Suppositi* (1509), *Il Negromante* (1520), *Lena* (1529) and *I Studenti* (completed by his brother Gabriele and published posthumously under the title *La Scolastica*) mark the beginning of the Renaissance theatre and introduce the imitation of Latin comedy. Although based on the classics, they are all inspired by contemporary life.

The "Orlando Furioso."—Many of the elements scattered in Ariosto's minor works find their poetical development in the *Orlando Furioso*, the poem on which Ariosto worked for nearly 30 years, from *c.* 1502 or 1503 to the end of his life. In its first edition, published in Venice in 1516 at the cardinal's expense, it consisted of 40 cantos, as did the second edition (Ferrara, 1521), in which, however, some revisions of language and style show the influence of Bembo. Such revision is still more evident in the third edition (Ferrara, 1532), in which the poem was extended to 46 cantos. In this final version Ariosto's style achieved its perfection.

The *Furioso* is a continuation of Boiardo's *Orlando Innamorato* which places Orlando in imaginary circumstances. Ariosto's work consists of a number of episodes derived from the epics, romances and heroic poetry of the middle ages and early Renaissance. The poem, however, achieves homogeneity by the author's skill and economy in handling the various episodes. Despite complete disregard of unity of action (which was to become compulsory in the second half of the century) it is possible to identify three principal nuclei round which the various stories are grouped: Orlando's passion for Angelica, the war between Christians and pagans near Paris and the love between Ruggero and Bradamante. The first is the most important, particularly in the first part of the poem; the second represents the epic background to the whole narrative; the third is merely introduced as a literary courtesy, since the Este family was supposed to owe its origin to the union of the two lovers. The main unifying element, however, is the personality of Ariosto himself, who confers his own refined spirituality on all his characters. Sensual love is the prevailing sentiment; but it is tempered by the author's ironical attitude and artistic detachment. The metrical form of the poem is the *ottava*, according to a tradition which continued from Boccaccio to Politian and Boiardo.

In substance and form, the *Orlando Furioso* can be regarded as the most perfect expression of the artistic tendencies and spiritual

attitudes of the Italian Renaissance. It enjoyed immediate popularity all over Europe and greatly influenced the literature of the Renaissance. It was translated into French by Jean de Gouttes in 1543 and by Jean Formier in 1555, into Spanish by Jeronimo de Urrea in 1549, and into English by Sir John Harington in 1591.

Modern editions of Ariosto's works are: *Orlando Furioso*, ed. by L. Caretti (1954); *Opere minori*, ed. by C. Segre (1954), with a bibliography. For a portrait of Ariosto *see* ITALIAN LITERATURE.

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ARIOVISTUS (1st century B.C.), king of the Suebi, a Germanic people, who led a mixed force of German tribes into Gaul at the invitation of the Sequani, perhaps as early as 71 B.C. Having defeated the Aedui at a place called Magetobriga in 61 B.C., he made them give hostages to the Sequani and settled Germans in territory of the Sequani on the left bank of the Rhine. The Romans, apparently not appreciating the danger at first, formally recognized Ariovistus as "friend of the Roman people" in 59; but in the spring of 58, after Julius Caesar's defeat of the Helvetii, a convention of the tribes of central Gaul, headed by the Aedui, at Bibracte asked the Romans for help. Caesar sent a courteous message to Ariovistus asking him to return the hostages of the Aedui and bring no more Germans into Gaul: Ariovistus refused and hostilities began. Caesar occupied Vesontio (Besançon) in the territory of the Aedui, and in the preliminary maneuvering Ariovistus managed to split Caesar's army and attack one division of it (somewhere north of the modern Mulhouse) in mid-September 58 B.C. A general engagement followed, doubtful at first, which was decided by the Roman reserve under P. Licinius Crassus. Ariovistus then fled over the Rhine. Although Caesar crossed the Rhine in 55 B.C. to affirm Roman control of the Rhine frontier, he seems to have left Ariovistus' settlements undisturbed.

See T. R. Holmes, *Caesar's Conquest of Gaul* (1911) and *The Roman Republic*, vol. ii (1923).

ARISTAENETUS (fl. 5th or 6th century A.D.), Greek letter writer, is credited with having written two extant books of love stories, in the form of letters. The subjects are borrowed from the erotic elegies of Alexandrian writers and the language is a patchwork of phrases from Plato, Lucian, Alciphron and others. The author was formerly identified with Aristaenetus of Nicaea, who perished in an earthquake at Nicomedia, A.D. 358, but internal evidence points to a much later date.

See R. Hercher, *Epistolographoi Hellenikoi* (1873); *The Love Epistles of Aristaenetus*, trans. by N. B. Halhed and R. B. Sheridan (1771, etc.).

ARISTAEUS, a divinity whose worship was widely spread throughout ancient Greece, but concerning whom the myths are somewhat obscure. The name is derived from the Greek *aristos*, "best." According to the generally received account, Apollo carried off the nymph Cyrene from Mt. Pelion in Thessaly and conveyed her to Libya, where she gave birth to Aristaeus. Having been brought up by the Horae or by the centaur Chiron, Aristaeus left Libya and went to Thebes. There he received instruction from the Muses in the arts of healing and prophecy and became the son-in-law of Cadmus and the father of Actaeon (*q.v.*). He is said to have visited Ceos, where, by erecting a temple to Zeus Ikmaios (the giver of moisture), he freed the inhabitants from a terrible drought; for this service he was himself honoured as Zeus Aristaios. After traveling extensively, Aristaeus reached Thrace, where he finally disappeared near Mt. Haemus. While in Thrace he is said to have caused the death of Eurydice, who was bitten by a snake while fleeing from him.

Aristaeus was essentially a benevolent deity. He introduced the cultivation of bees (Virgil, Georgics) and the vine and olive; he was the protector of herdsmen and hunters; he warded off the evil effects of the dog star, and possessed the arts of healing and prophecy. He was often identified with Zeus, Apollo and Dionysus. In ancient sculptures and on coins he is represented as a young man, dressed like a shepherd, and sometimes carrying a sheep on his shoulders. (T. V. B.)

ARISTAGORAS (d. 497 B.C.), Milesian statesman prominent in the Ionian revolt that led to the first of the Greco-Persian Wars, was son-in-law and cousin of Histiaeus, tyrant of Miletus. He acted as regent while Histiaeus was detained at the court of Darius. In 499 B.C. he persuaded the Persians to join him in an attack upon Naxos, but he quarreled with the Persian commander, who, according to Herodotus, warned the Naxians, so that the expedition failed. Finding himself out of favour with Persia, Aristagoras, prompted by a message from Histiaeus, raised Ionia in revolt. He then went to Greece (winter 499–498) to secure help and induced the Athenians to send the force which attacked Sardis. After the failure of the revolt, Aristagoras emigrated to Myrcinus in Thrace, where he was killed in an attack on a Thracian stronghold.

ARISTARCHUS OF SAMOS, Greek astronomer, flourished about 270 B.C. and is famous for having been the first to maintain that the earth revolves around the sun. On this ground Cleanthes the Stoic declared that he ought to be indicted for impiety.

Aristarchus' only extant work is a short treatise *On the Sizes and Distances of the Sun and Moon;* here he obtains, by geometry, certain results as regards sizes and distances which are inaccurate because of the incorrectness of the assumptions, due to the imperfect state of knowledge at the time. The heliocentric hypothesis does not appear in the treatise, but a quotation in the *Arenarius* of Archimedes from another work of Aristarchus proves that he anticipated the great discovery of Copernicus. Moreover, Copernicus himself was clearly aware of the achievement of Aristarchus, for he mentioned it in a passage which he afterward suppressed.

Aristarchus is also said to have invented a hemispherical sundial.

The Greek text of the extant treatise was first edited by Wallis (1688); for a new Greek text with English translation and notes *see* T. L. Heath, *Aristarchus of Samos* (1913).

ARISTARCHUS OF SAMOTHRACE (*c.* 220–*c.* 143 B.C.), Greek critic and grammarian, noted for his contribution to Homeric studies. He settled in Alexandria, where he was a pupil of Aristophanes of Byzantium, and, *c.* 153 B.C., became chief librarian there. Later he withdrew to Cyprus, where he died. Aristarchus founded a school of philologists, called after him "Aristarcheans," which long flourished in Alexandria and afterward at Rome. Cicero and Horace regarded him as the supreme critic. His works fall into three categories: (1) two editions of the text of Homer and editions of Hesiod, Pindar, Archilochus, Alcaeus, Anacreon; (2) commentaries stated in the *Suda* lexicon to number 800 on these poets, as on Aeschylus, Sophocles, Aristophanes and Herodotus; (3) critical brochures on particular problems, especially Homeric. In the time of Augustus two Aristarcheans, Didymus and Aristonicus, undertook the revision of his work on Homer, and the extracts from these two writers in the Venetian scholia to the *Iliad* give an idea of his achievements. Although there is some difference of opinion on the point, it would seem that the vulgate text of Homer has been little affected by the Alexandrian editions, except perhaps for the exclusion of surplus lines.

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ARISTEAS, LETTER OF, a pseudonymous Jewish letter variously dated between 200 B.C. and A.D. 33, in which is described in legendary form, the origin of the Greek translation of the Old Testament known as the Septuagint (*q.v.*). The author represents himself as a Gentile Greek, but was really an Alexandrian Jew who lived under one of the later Ptolemies.

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ARISTIDES (ARISTEIDES) THE JUST (b. late 6th century B.C.), son of Lysimachus, Athenian statesman and general and founder of the Delian league (*q.v.*). Nothing is known of his early life except that he is said to have been a follower of the reformer

Cleisthenes (*q.v.*), but later he must have been prominent among the party that favoured resistance to Persia, since he commanded the regiment of his own tribe Antiochis at Marathon (490 B.C.), and in the spring of 489, before Miltiades' fall from power, he was elected archon for the coming year. He is not heard of again till 482, when he was ostracized, probably because he opposed Themistocles' plan, put through at this time, to use the silver from a new vein of the mines at Laurium to build a large fleet; Aristides may have preferred to build up Athens' land forces. Recalled with other exiles before Salamis (480), he loyally supported Themistocles, and led the Athenian infantry that landed on the island of Psyttaleia late in the battle and annihilated the Persian force stationed there.

He commanded the Athenian force at Plataea (479) as general with special powers. Herodotus makes much of the Athenian contribution to the Greek victory; Plutarch adds the suppression of an oligarchic conspiracy in the Athenian army. Next year (478) Aristides commanded the Athenian contingent of 30 ships in the fleet that Pausanias led to Cyprus and Byzantium. There, toward the end of the year, the eastern Greek allies revolted from Spartan control and offered their allegiance, through Aristides, to Athens. This was the origin of the Delian league, which was to become the Athenian empire. In the winter Aristides was entrusted with the assessment of the members' contributions, a task he carried out to general satisfaction, using as his basis the Persian assessment made by the satrap Artaphernes in 493, after the Ionian revolt. The military command of the league's forces passed to Cimon (*q.v.*), and there is no reliable information about Aristides' later career or the date of his death.

The foundation of the Delian league was his great achievement, based on Athens' naval power and the trust he himself inspired. His assessment was the conspicuous instance of his "justice" though not the origin of his reputation. Inevitably, his poverty became a legend, though he must have been a man of substance to qualify for the archonship; but a state pension was paid to some of his descendants. The view that he was a democratic reformer seems traceable to Aristotle and his school, who thought he planned from the start the development the empire underwent later; in fact his main associations are with Miltiades and Cimon, the enemies of the democratic leaders Xanthippus and Ephialtes. He is said to have collaborated with Themistocles in the winter of 479/478 over the refortification of Athens, but thereafter Themistocles' influence diminished while that of Aristides and Cimon increased.

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ARISTIDES (ARISTEIDES) OF MILETUS (*c.* 150–100 B.C.), author of short narratives who wrote in Greek the very popular work, lost except for fragments, the *Milesiaca* (Milesian tales), a collection of erotic stories, often obscene. They were translated into Latin by the Roman historian Cornelius Sisenna in 1st century B.C. The Latin form of the title *Milesiae* (*fabulae*) became the name given to similar collections of erotic stories such as the *Satyricon* of Petronius (d. A.D. 66) and the *Metamorphoses* of Apuleius (b. *c.* A.D. 125). *Italica, Persica* and *Sicelica* are wrongly credited to this Aristides.

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ARISTIDES (ARISTEIDES), **PUBLIUS AELIUS** (surnamed THEODORUS) (2nd century A.D.), Greek rhetorician and sophist, wrote a number of treatises and speeches which because of their correctness of style and eloquence, were destined to become school books and the subject of commentaries. After studying at Pergamum and Athens he lived at Smyrna and when it was destroyed by an earthquake in 178, he wrote an account of the disaster to the emperor Marcus Aurelius and induced him to rebuild the city. Aristides' extant works consist of two small rhetorical treatises on political and simple speech, with Demosthenes and Xenophon as models, and 55 declamations of which only the *Panathenascus* and the *Encomium of Rome* were actually delivered. Of the others, *The Sacred Discourses* deal with his illness and with miraculous cures and the rest are panegyrics or treat subjects from Greek history.

See W. Schmid (ed.), *Aristidis qui feruntur Libri Rhetorici II;* J. E. Sandys, *A History of Classical Scholarship*, vol. i (1921, etc.).

ARISTIDES, QUINTILIANUS (2nd or 3rd century A.D.), Greek Neoplatonist, author of a treatise on music (*Peri musikes*), which was regarded by Byzantine and Arab theorists as an important source for the study of Greek music, a judgment generally accepted by modern scholars. The treatise was first published in Marcus Meibohm's collection of writings by Greek musical theorists in 1652. A critical edition by A. Jahn appeared in 1882; and R. Schäfke published a German translation and commentary in 1937. (E. J. Wz.)

ARISTIDES, APOLOGY OF, one of the earliest (2nd century) Christian apologetic works. *See* APOLOGISTS, EARLY CHRISTIAN.

ARISTIPPUS (*c.* 435–356 B.C.), of Cyrene, was regarded in antiquity as the founder of the Cyrenaic school of philosophy (*see* CYRENAICS). He belonged to the circle of Socrates but taught for pay and led the wandering life typical of the Sophists, among whom Aristotle reckons him. Visits to the court of the elder and perhaps of the younger Dionysius of Syracuse are attested. No genuine writings survive, but numerous anecdotes, such as gather round a striking personality, make a consistent picture of a hedonist, proud of the practical good sense which makes him kindly, witty, adaptable, always ready to turn circumstances to the best account, the master and not the slave of his pleasures. The tenets of the Cyrenaics are recorded only in a form which, because of its vocabulary and its attention to the views of Epicurus, cannot be attributed to Aristippus but may perhaps be ascribed to his grandson, who had the same name. Nevertheless, the elder Aristippus was clearly the source of the school's principal doctrines. (F. H. SH.)

ARISTO (ARISTON) OF CHIOS (*c.* 250 B.C.), a Stoic philosopher and pupil of Zeno, though he approximated more closely to the Cynic school. He considered only ethics worthy of study, and in that only general and theoretical questions. He rejected Zeno's doctrine of desirable things, intermediate between virtue and vice. There is only one virtue—an intelligent, healthy state of mind (*hygieia*). Aristo is often confounded with Aristo(n) of Ceos, head of the Peripatetics about 230 B.C. *See* STOICS.

ARISTOBULUS OF PANEAS (fl. *c.* 160 B.C.), Jewish philosopher, a forerunner of Philo (*q.v.*) in the attempt to reconcile Greek philosophy with Judaism, lived at Alexandria in Egypt under the Ptolemies. According to some Church Fathers he was a Peripatetic, but he also used Platonic and Pythagorean concepts. Following the Stoic method of allegorizing Greek mythology, he interpreted the anthropomorphic references to God in Scripture as allegorical expressions. Mosaic laws such as that governing the Sabbath he explained symbolically. He tried to prove that the principal Greek philosophers and poets had borrowed from Judaism, but his quotations from Greek literature are often inaccurate or plainly false. Fragments of his work on the Mosaic laws are preserved in the *Praeparatio Evangelica* of Eusebius of Caesarea and in the *Miscellanies* of Clement of Alexandria.

See E. Schürer, *A History of the Jewish People in the Time of Jesus Christ*, vol. ii (1886); M. Joel, *Blicke in die Religionsgeschichte*, vol. i (1880). (A. AN.)

ARISTOCRACY today is a term referring to the nobility, and the qualities believed to be aristocratic are those associated with a hereditary nobility. These qualities cannot be simply enumerated, as was often done in the past, by reciting the traits, such as those characteristic of the "gentleman," that have been prevalent in western culture; for in each culture the nobility will exhibit those traits that are most highly prized in the particular culture's value and belief system. Thus *noblesse oblige* may mean participation in war and government in England, while it may mean the shunning of these very activities to a Brahmin. In contemporary usage, both aristocracy and nobility have acquired a somewhat antiquated flavour, and the term preferred by social

scientists, at least, is "elite." It is noteworthy how many of the generalizations at present discussed under that heading are found in older writers, such as Montesquieu, under the heading of aristocracy.

Aristocracy did not always have such a broad and rather indefinite connotation. Indeed, at its birth it did not refer to a class at all. In the Greek context aristocracy referred to those cities or *poleis* in which a small group governed who considered themselves (and usually were so considered by their fellow citizens) "the best." In all those cities that at the height of the struggle between Athens and Sparta were associated with Sparta, the aristocracy ruled. Thucydides describes the quick alteration between aristocratic and democratic factions which the shifting fortunes of that great and dramatic fight for supremacy in the Greek world brought with them.

This dichotomy between the rule of the many and the rule of the few is the true core of the arguments about government in both Plato and Aristotle, as well as the many writers who followed them. But the philosophers were unwilling to accept the popular connotations. Instead of the hereditary and plutocratic aristocracies, they pleaded for an aristocracy of merit, and they would see that merit in the possession of virtue, or *arete*. But whereas Plato stressed wisdom, in the transcendent sense of his idealistic philosophy, as the prime basis of virtue, Aristotle took a more traditional Greek view of virtue, though he incorporated the capacity to reason profoundly and thus achieve wisdom along with other kinds of superior performance.

What in the perspective of the Peloponnesian War had been the antithesis between Athens and Sparta became in the world of Roman thought the fight between nobles and plebeians. Polybius suggested that the blending of the aristocratic and the democratic principles (with a dash of monarchy) had given Rome its powerful government. He built upon Aristotle's earlier suggestion that a combination of aristocratic and democratic principles would result in the best form of government—ideal state, as it is often put. This notion continued to appeal to political thinkers not only among the Romans but also in the middle ages and down to modern times. Thomas Aquinas and Marsilius of Padua, no less than James Harrington and Machiavelli, were attached to it. But in the course of the 17th century the idea became transformed into that of the separation of powers.

Aristocracy had a considerable appeal to some of the U.S. founding fathers. There can be little doubt that the republicanism of men like George Washington, Alexander Hamilton and John Adams was aristocratic rather than democratic. On the other hand, Thomas Jefferson, although perhaps the most aristocratic of them all as far as personality was concerned, decried the aristocratic tendencies of many of his friends, especially the great plantation owners of the south, and raised the banner of democracy against them. Thus it may be said that the antithesis between aristocracy and democracy was one of the central themes of early U.S. party politics, with the Federalists standing for aristocracy, the Jeffersonian Republicans for democracy. It might be added, though, that the issue was a confused one, further complicated by the slavery problem. In the defense of slavery, some of the most extreme statements of an aristocratic and elitist nature in America were penned.

Aristocracy as the rule of the few has thus been recurrently associated with both monarchy and democracy. Evidently, a prince must seek to secure as helpers some group of people who will not only assist in governing but who will also provide a broader base for legitimacy and authority. Similarly, a democracy will strive to find "the best" to wield temporary power and rule in accordance with the people's wishes. This observation has led to the proposition that at bottom all governments are aristocracies, and the concept of the ruling class has served to emphasize this insight. Ruling class and elite are becoming synonymous terms to describe as actual what Plato and Aristotle argued for as ideal. But the "virtue" of the few who rule is once more seen as the capacity to succeed, rather than as a transcendent quality of goodness. Those who expound such notions often forget that to say "those few who succeed (the elite) always rule" is little more than a tautology that obscures the dialectic challenge inherent in the idea of aristocracy as "truly best."

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(C. J. FR.)

ARISTODEMUS, the name of four personages in the ancient world, not all of them historical.

1. The legendary father of the twins Eurysthenes and Procles who were traditionally regarded by the Greeks in general as the founders of Dorian Sparta; the Spartans themselves, according to Herodotus, ascribed the foundation to Aristodemus.

2. King of Messenia in the 8th century B.C., the time of the Spartan conquest of Messenia. Although he was an historical figure, much that is related of him by Pausanias (writing in the 2nd century A.D.) is legend.

3. A Spartan, often included among the Seven Wise Men of Greece.

4. A tyrant of Cumae who defeated the Etruscans in the late 6th century B.C.

ARISTOLOCHIA, a genus of about 300 species of woody vines or herbs of the family Aristolochiaceae (birthworts), chiefly tropical. The flower forms a tube swollen at the base. The name (Gr. *aristos*, "best"; locheia, "childbirth") alludes to its reputed aid in parturition. The birthwort (*A. clematitus*) is a European species, found sometimes in England, apparently wild, on ruins and similar places, but not native. In the United States it occasionally escapes from cultivation from New York to Maryland. The Dutchman's-pipe or pipe vine (*A. durior*), native to rich woods in the eastern U.S. from Pennsylvania to Georgia and Alabama, is a vigorous climber, and it is widely planted in Europe and the U.S. as a porch vine. The flower is of an odd shape and bent like a pipe. About 12 other species are native to the U.S. Among the best known of these are the Virginia snakeroot (*A. serpentaria*), called also sangreeroot and serpentary, found in dry woods in the eastern U.S. and valued medicinally for its aromatic-stimulant root; the woolly pipe vine (*A. tomentosa*), native to woods from Indiana and Missouri southward; and the western Dutchman's-pipe (*A. californica*), native to California.

F. E. WESTLAKE

DUTCHMAN'S-PIPE (ARISTOLOCHIA DURIOR)

Among the various species grown in greenhouses are the remarkable pelican flower (*A. grandiflora*), a native of Jamaica, some varieties of which bear immense carrion-scented flowers 20 in. across with a taillike appendage 3 ft. long; and the showy calico flower (*A. elegans*), of Brazil, a graceful, free-blooming climber with solitary flowers having a yellow-green tube $1\frac{1}{2}$ in. long and a purple and white blotched limb 3 in. across. The tropical kinds are often called gooseflowers.

(N. TR.)

ARISTOMENES (according to one tradition 7th century B.C.) the hero of Messenian resistance to Sparta, may be a historical figure but has been heavily overlaid with legend. The standard version makes him leader of the rebellion of the 7th century B.C., the second Messenian War in which the poet Tyrtaeus took part on the Spartan side. After initial victories Aristomenes was betrayed by the Arcadian king Aristocrates at the battle of the Great Trench, and was besieged for many years in Eira in Messenia. This tradition probably goes back to the historian Callisthenes (4th century B.C.). The Cretan poet Rhianus (3rd century

B.C.) wrote an epic in six books, which apparently placed Aristomenes in a revolt of 490 B.C. and stressed his connection with Rhodes. The historian Myron of Priene (2nd century B.C.) connected him with the original Spartan conquest of Messenia in the 8th century. From these and other materials Pausanias compiled the longest surviving account, a story of the 7th-century rebellion with romantic embellishments drawn largely from Rhianus.

Pausanias records a tradition that Aristomenes' shield was dedicated in a temple at Lebadea, and used by Epaminondas at the battle of Leuctra. This may have been a popular story before the liberation of Messenia in 370, but that event gave a great impetus to the legend. Aristomenes' bones were brought from Rhodes to Messene, and heroic honours were paid to him for many centuries.

See, Pausanias iv; F. Jacoby, commentary to Rhianus in *Fragmente der griechischen Historiker* iii a. (1943). (A. As.)

ARISTOPHANES (*c.* 450–*c.* 388 B.C.), the most famous of all Greek writers of comedy. The little that is known of his life is derived mainly from Aristophanes' own words in the plays themselves, though a little outside information is to be had from the various hypotheses or arguments appended to these plays and stemming probably from a commentary or edition by the grammarian Symmachus (fl. *c.* A.D. 100). Aristophanes, son of Philippus, was an Athenian citizen belonging to the tribe named Pandionis, though he, or his father, seems to have owned some property on the island of Aegina. This fact is clear from his own words in the *Acharnes* (*The Acharnians;* lines 652–654); and it may be this which gave rise to certain unlikely, not to say absurd, accusations of foreign birth which seem to have been brought against him. He was born *c.* 450 B.C. (perhaps later) and must have died shortly after 388, the year in which his last play, *Ploutos* (or *Plutus;* "Wealth") was staged. Two posthumous comedies, *Aeolosicon* (probably a skit on Euripides' *Aeolus*) and *Kokalos* (or *Cocalus;* also, presumably, a mythological burlesque), were produced in or about the year 387 by his son, Araros. Aristophanes' dramatic activity covered the end of the period of Old and the start of that of the so-called Middle Comedy; and though the line of demarcation between these two is shadowy, it is not unreasonable to say that the first 10 of Aristophanes' 11 surviving plays belong to the Old and the last to the Middle. One of the indications of the change from Old to Middle Comedy being the dwindling importance of the chorus, it is worthy of note that whereas in the *Batrachoi* (*The Frogs;* 405 B.C.) the choric part still forms a fifth of the total number of lines, in the *Ecclesiazousai* (or *Ecclesiazusae; Ladies in Parliament;* 391 B.C.) it has shrunk to a mere twelfth, and in *Plutus* (388) has entirely disappeared, its place being taken by the performance of musical interludes.

Aristophanes' dramatic life covered about 40 years, and tradition ascribes to him a like number of comedies. (Some authorities, accepting a variant reading in the text of the *Suda Lexicon*, credit him with 44. In either case four of the total are generally attributed to Archippus, not Aristophanes.) The subject matter of these plays seems to have been highly diverse, and it is not easy to arrange even the extant plays, let alone those of which little is known except the titles, into anything approaching a satisfactory classification. (Little of any value has, in the case of Aristophanes, survived among papyrus finds, and most of the extant fragments are citations from lexicographers such as Photius and Hesychius, florilegists such as Stobaeus, grammarians such as Chaeroboscus, and literary antiquarians such as Athenaeus and Pollux. Of the 969 fragments that have been collected only four run to over ten lines; and many are no more than single words.) Roughly, however, the comedies may be divided into mythological burlesques and parodies; comedies of fancy; plays on social themes; war plays; and political plays.

Mythological Burlesques and Parodies.—These included the *Daedalos* (*Daedalus*) and the *Danaïdes* (*Danaïds*). There is no whole surviving play of this type, though many of the extant comedies contain much incidental parody, as did also many of those since lost.

Comedies of Fancy.—The only extant play of this type is the *Ornithes* (*The Birds;* 414 B.C.) with its Cloudcuckooborough or Land of Cockaigne setting—and even this seemingly fanciful play has by some scholars been accorded a political significance, being regarded as a satire on the imperialistic dreams of the city which had dispatched the ill-starred Sicilian expedition. The *Geras* (*Old Age* or *The Snakeskin*), with its chorus of rejuvenated old men, is lost.

Plays on Social Themes.—This is a numerous class and includes the *Nephelai* (*The Clouds*), the *Sphekes* (*The Wasps*), *The Frogs* and the *Ecclesiazusae*, all of which have survived complete.

The Clouds (423 B.C.) is an attack on "modern" education and morals, as imparted and taught by the sophists. In this play Socrates and his pupils are ridiculed, and at the end of it their school, the *Phrontisterion* or "Thinking Shop" is burned to the ground. Aristophanes' selection of Socrates as the typical sophist, Socrates being one of the sophists' most hostile and bitter critics, has long worried scholars. The most probable explanation is that the poet, who was in fact, as is known from Plato's *Symposium*, a personal friend of Socrates and not at all likely merely to have made a mistake, deliberately chose a man who, thanks to his odd looks and strange habits, was a figure much better known to the average Athenian than any of the genuine sophists.

The Wasps (422 B.C.) satirized the litigiousness of the Athenians in the person of the old juryman, Philocleon (*i.e.*, Love-Cleon), whose son, Bdelycleon (*i.e.*, Loathe-Cleon), arranges for his father to hold a "court" at home, where the first "case" to be heard is that of the house dog accused of the theft of a cheese, and so finally cures the father of his passion for the dicasteries (law courts).

The Frogs is a literary rather than a strictly "social" comedy. Dionysus, the god of drama, discontented with the poor quality of present-day tragedy, now that Euripides is dead, disguises himself as Hercules and goes down to Hades to bring back his favourite playwright to the land of the living. However, as the result of a competition which is arranged between Euripides and the elder poet, Aeschylus, Dionysus is won over from his old allegiance and returns to earth with the latter instead.

In the *Ecclesiazusae* the women of Athens are in power instead of the men. The plot introduces a communism of wealth, property and sex, which strongly recalls that discussed in the fifth book of Plato's *Republic*—so strongly, indeed, that one cannot help believing that in this play Aristophanes is parodying the philosopher's theories.

Of plays in this category only fragments of which have survived there may be mentioned (1) Aristophanes' earliest comedy *Daitales* (*The Banqueters*), which seems, like *The Clouds*, to have satirized modern educational and moral theories. It contained a "debate" between a good and a bad brother like that between the Just and Unjust Reason in the later play. (2) The *Heroes*, which apparently criticized adversely a modern tendency to neglect the old hero worship of Athens. (3) *Horai* (*The Seasons*), which dealt with the complementary theme of the growth and spread of new, mostly eastern, cults, among them that of the Thraco-Phrygian Sabazios, which is expelled from the city. (4) *Lemniai* (*The Women of Lemnos*), which satirized the immorality of the Athenian women. (5) *Gerytades* (*The Sweet Singer*), which was probably built on the same lines as *The Frogs* and depicted a similar attempt to recall older and better poets from the underworld.

War Plays.—About two-thirds of Aristophanes' dramatically active life was spent under the dark shadow of the Peloponnesian War, waged in the main between Athens and Sparta; and throughout this period the poet never ceased to use the theatre as a pulpit from which to preach his political doctrine of the criminal folly of war. *The Acharnians* (425 B.C.), his first extant play, deals with this subject. Its farmer-hero, Dicaeopolis, secures a private peace treaty for himself from the Spartans in spite of the violent opposition of the chorus of embittered and bellicose old charcoal burners of Acharnae. The play contains two harsh comic scenes set in Dicaepolis' private market: one in which a needy Megarian sells his own two daughters disguised as pigs rather than let them starve at home; and another in which a prosperous Boeotian, seeking a truly Athenian item, buys an informer. The *Eirene* (*Peace;* 421 B.C.), the title of which explains its theme, differs

from the earlier play in that it was staged seven months or so after the death in battle of Cleon and Brasidas, the two main champions of the war policy on the Athenian and Spartan sides respectively; indeed, only a few weeks, at most, could have elapsed after its production before the ratification of the peace of Nicias (? March 421 B.C.). Its main theme is the extraction of Peace from the cavern in which Zeus has allowed War to immure her.

The *Lysistrata* (411 B.C.), which was written not long after the Athenian disasters in Sicily and not long before the revolt of the Four Hundred, shows the seizure of the Acropolis and the treasury of Athens by the women who, at Lysistrata's instigation, have, together with all the women of Greece, declared a sex strike until such time as the men will make peace. The play is a strange mixture of humour, indecency, gravity and farce.

Of the plays in this category which have survived only in fragments may be mentioned (1) *Georgoi* (*The Farmers;* ? 424 B.C.), a comedy seemingly not unlike *Peace*, which also had a chorus of Attic farmers. There is indeed considerable confusion between the two plays, and it seems likely that one or two fragments sometimes attributed to a so-called second edition of *Peace* in fact come from *The Farmers.* (2) *Holkades* (*The Merchantmen*), described as a "peace play" in one of the arguments to *Peace*.

Political Plays.—These, as will be easily understood, are not easy to keep separate from the war plays, as, inevitably, during the last quarter of the 5th century B.C., politics meant foreign politics, and foreign politics meant but one thing: the question of continuing or stopping the Peloponnesian War. Aristophanes being a pacifist, in the sense that he was a convinced opponent of war, it was only to be expected that he should be "agin the government," so long as a series of bellicose politicians were in power. In all his earlier comedies, accordingly, there are assaults on the successive *Prostatai tou demou* (roughly, "prime ministers") from Pericles (whom he attacked posthumously) to Cleophon. As early as 426 B.C. the poet violently attacked in his *Babulonioi* (*Babylonians*) the regnant demagogue Cleon, and did not hesitate to criticize by implication the character of the Athenian empire by staging a chorus of Athenian "allies" shown as slaves of their master, the Athenian Demus. As this play was produced at the festival of the Great Dionysia, when deputies from those very "allied" cities were admitted among the audience, this piece of courage, or foolhardiness, involved its author in an impeachment at the hands of its chief victim. For the fact of this impeachment there is the word of the poet himself in the following year's play, *The Acharnians* (lines 377–382); though it is not known what form the case took. Aristophanes may have been tried for treason, or possibly "framed" by a *graphe xenias; i.e.*, an indictment on the score of foreign birth. But whatever the upshot, it may be supposed that the poet's punishment, if any, was light, for the production of the *Hippes* (*The Knights*) two years later shows that he had by no means learned his lesson. This play contains, or rather, is, a violent attack on the same demagogue, Cleon, who is depicted as the favourite slave of the stupid and irascible old man Demus, until he is at last ousted from his position of influence and authority by one Agoracritus, a sausage seller with even greater claims than himself to scoundrelism and impudence.

The Thesmophoriazusae and Plutus.—These two surviving comedies have been left out of this attempted classification. The *Thesmophoriazousai* (or *Thesmophoriazusae; Women Celebrating the Feast of Demeter;* 411 B.C.) is perhaps the funniest play that Aristophanes ever wrote. Its plot is as follows: Euripides has discovered that the women of Athens, angered by his constant attacks upon them in his tragedies, mean to discuss during their coming festival the question of compassing his death. Euripides calls on the effeminate Agathon, the tragic poet, to try and persuade him to plead his cause. Agathon refusing, Euripides gets his brother-in-law Mnesilochus to undertake the assignment. Mnesilochus is in consequence disguised (with great thoroughness) as a woman and sent on his mission. Unfortunately for him his true sex is discovered, and he is at once seized by the women. There follow three scenes in which he tries to escape; all three involve parodies of Euripides' tragedies, *Telephus*, *Palamedes* and (the extant) *Helen*, and all three attempts fail. Finally Euripides himself arrives and succeeds in rescuing his advocate by promising never again to revile women.

Plutus (*The God of Wealth*), a Middle Comedy (*see* above), will naturally not fit into the scheme. It is a somewhat drab play and does not enhance its author's reputation. The poor but honest Chremylus, on the advice of an oracle, pursues and possesses himself of a blind old man, who turns out to be none other than Plutus, god of wealth. Chremylus brings about the cure of his blindness, whereupon the god, his sight now restored, gives up his old and bad associates and begins to consort with worthy people who he can now see deserve his company and patronage. Three elucidatory, and not very interesting, scenes bring the play to an end.

Conclusion.—Aristophanes' reputation has stood the test of time, as witness the many modern translations of various of his plays and the frequent scenic and radio reproductions of them. When, however, we start to ask why the appeal of his comedies is still potent after the best part of two and a half millenniums—for comedy is as a rule a short-lived plant—it is not easy to give an answer. In the matter of plot construction Aristophanes' comedies leave much to be desired; they are often loosely put together and full of strange inconsequences, and, though in this matter the playwright was to a great extent at the mercy of tradition, the ends of most of his comedies degenerate into a series of disconnected and often somewhat boisterous and boring episodes. Nor can it be said that he is a good delineator of character; we look in vain in his plays for the equivalent of Falstaff or even of Dogberry or Sir Toby Belch. His personages are, when not, like George Bernard Shaw's, mere mouthpieces of their creator, little more than types. Where Aristophanes is great is in the wittiness of his dialogue, the keenness of his satire (good-humoured as a rule, though hardly so in the case of Euripides and certainly not in that of Cleon), the brilliance of his parody (particularly that of Euripides and especially in the *Thesmophoriazusae*), and perhaps above all in the ingenuity and invention of his comic scenes: Socrates suspended in his basket, Poseidon hiding from Zeus' observation under the umbrella, Trygaeus' ride to Heaven on his dung beetle, the trial of the dog Labes, Dionysus' bargaining with the corpse, and many more. And not the least claim on our admiration is that exacted by the beauty of some of his choral lyrics which, fresh and simple as they are, will be found by many readers as charming in their way as the more elaborate songs of the three great tragedians.

Where all is so excellent it is not easy to choose an example; but the *parodos* or entrance song of the chorus of *Clouds* in the play of that name (in B. B. Rogers' translation, pub. with the play by G. Bell & Sons, Ltd., London, 1916) is a typical specimen of the lyrics of Aristophanes at their best:

Clouds of all hue,
Rise we aloft with our garments of dew.
Come from old Ocean's unchangeable bed,
Come till the mountain's green summits we tread,
Come to the peaks with their landscapes untold,
Gaze on the Earth with her harvests of gold,
Gaze on the rivers in majesty streaming,
Gaze on the lordly, invincible Sea,
Come, for the Eye of the Ether is beaming,
Come, for all Nature is flashing and free.
Let us shake off this close-clinging dew
From our members eternally new,
And sail upwards the wide world to view.
Come away! Come away!

Come then with me,
Daughters of Mist, to the land of the free.
Come to the people whom Pallas hath blest,
Come to the soil where the Mysteries rest;
Come, where the glorified Temple invites
The pure to partake of its mystical rites:
Holy the gifts that are brought to the Gods,
Shrines with festoons and with garlands are crowned,
Pilgrims resort to the sacred abodes,
Gorgeous the festivals all the year round.
And the Bromian rejoicings in Spring,
When the flutes with their deep music ring,
And the sweetly-toned Choruses sing
Come away! Come away!

See also Index references under "Aristophanes" in the Index volume.

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ARISTOPHANES OF BYZANTIUM (*c.* 257–180 B.C.), was a distinguished Greek literary critic and grammarian. He early removed to Alexandria, where he studied under leading scholars. He was appointed chief librarian there *c.* 195 B.C., and died *c.* 180 B.C. Aristophanes produced a text of Homer and also edited Hesiod's *Theogony,* Alcaeus, Pindar, Euripides, Aristophanes and perhaps Anacreon. Many of the *Arguments* prefixed in the manuscripts to Greek tragedies and comedies are ascribed to Aristophanes, and his study of Greek comedy led to separate works on Athenian courtesans and on character types. He revised and continued the *Pinakes* of Callimachus, a biographical history of Greek literature. As a lexicographer Aristophanes compiled collections of archaic and unusual words, of technical terms and of proverbs. As a grammarian Aristophanes founded a school and in his treatise *About Analogy* he laid down rules for declension, etc. In editing the lyric and dramatic poets he introduced innovations in metrical analysis and textual criticism which were widely adopted by later scholars. He was responsible for arranging Plato's dialogues in trilogies and is generally credited with the foundation of the so-called "Alexandrian Canon" (a selection in each genre of literary works which were considered models of excellence).

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ARISTOTLE (384–322 B.C.), philosopher, psychologist, logician, moralist, political thinker, biologist, the founder of literary criticism, was born at Stagira, a Greek colonial town on the northwestern shores of the Aegean, in 384 B.C. He was the son of Nicomachus, a doctor belonging to the guild of the "sons of Aesculapius," who had acted as court physician to Amyntas II, the father of Philip of Macedon. We may perhaps attribute to this fact the interest which Aristotle afterward showed in physiological and zoological studies—though it must be admitted that these studies belong to his later years and were perhaps due less to early influence than to that general passion for detailed inquiry in every direction which marks the later stages of his development. Stagira had been largely colonized from the Ionic district of Chalcis in Euboea; Aristotle's mother was a native of that district; and to it he retired near the end of his life. His Ionic origin has been called in evidence to explain his interest in the facts of nature. It was the Ionian philosophers of Asia Minor who had first investigated "nature"; and Aristotle, it has been said, "was from first to last an Ionian, an observer of the facts of nature, a man for whom no problem was too detailed to whet his curiosity." But the development of Aristotle's thought probably would have led him to detailed scientific inquiry if he had been born an Athenian or a Theban.

ALINARI

ARISTOTLE. ROMAN SCULPTURE AFTER A GREEK ORIGINAL; IN THE SPADA GALLERY, ROME

Life of Aristotle.—The life of Aristotle falls into three clearly marked periods. First, there is the period of work in the philosophic school of Plato, the Academy at Athens, which covers the 20 years from the age of 17 to that of 37 (367–347 B.C.) and only comes to an end with the death of Plato. Next, there is the period of his *Wanderjahre*—at Assus, in the south of the Troad; on the island of Lesbos opposite; and at the Macedonian court in Pella, about 80 mi. to the west of Stagira—which covers the dozen years from the age of 37 to that of 49 (347–335 B.C.) and ends with the majority and accession of his pupil Alexander. Finally, there is a second period of work in Athens—a period of work on his own account as the head of the Peripatetic school in the Lyceum—which covers, roughly, another dozen years of his life, from the age of 49 to that of 62 (335–322 B.C.), and ends with his retirement to Chalcis and his death. These periods are not only stages in the external course of a life; they are also—it has been contended by W. Jaeger in his work on Aristotle—stages in the internal development of a body of thought.

The Aristotle of the first period differs from the Aristotle of the last; and it is thus of the first importance to follow the stages of his life in order to understand the stages, and the progress, of the development of his thought.

1. It must have been the greatest and the profoundest of factors in the life of Aristotle that he worked for 20 years by the side of Plato. He came as a disciple—a young disciple of 17—to sit at the feet of a master who had attained the age of 60; but in the course of time he must have become a fellow worker in the studies of the Academy. The Plato of those years—the gray-haired Plato in the evening of a life which reached 81—was no longer the Plato of the *Republic;* but he was more than ever the beloved master of a body of "friends" engaged in the pursuit of truth and goodness. His school was now in the stage which is marked by the *Theaetetus,* the *Politicus* and the other dialogues of this period: it had left the Socratic stage and was occupied with the problem of "ideas" and with the division of "ideas," down and down, until the indivisible (or final unit of division, by which Plato meant the *infima species*) was eventually reached. Here was the germ from which grew Aristotle's logic and from which, again, his metaphysics took its beginning. But the Academy was also engaged in some measure of concrete and scientific study. Mathematics and astronomy were especially cultivated: the *Laws* of Plato, the work of his old age, presupposes a body of research in legal and constitutional questions; and the study of medicine seems also to have been in some measure pursued. We may guess that Aristotle took his part in these various studies. His sketch of an ideal state in the last two books of the *Politics* shows a study of, and is partly based on, Plato's *Laws.* He hardly shared, indeed, in Plato's passion for mathematics; and he was perhaps always more interested than Plato in biological study. Some scholars have drawn a distinction between Plato the mathematician and Aristotle the biologist. There is some truth in the distinction. Plato's interest in "ideas" found a natural basis in geometrical forms and the abstract rules of numbers; Aristotle's interest in the classification of genera and species led him naturally toward the world of organic nature, and the emphasis which he came to place on development (*genesis*) accentuated that tendency. Yet it may be contended that the mathematical knowledge of Plato went little

deeper than that of Aristotle; and on the other hand it is easy to exaggerate the importance of the biological element in Aristotle's general system of thought. What seems certain is that there is no proof of any serious division of opinion between Aristotle and Plato during the 20 years of their intercourse.

Aristotle remained one of the circle of "friends" in the Academy throughout that period; he joined in its researches and possibly its teaching[1]; and the dialogues which he wrote during those years —dialogues now lost, but celebrated in antiquity alike for their style and their content—were modeled largely on the style of the later series of Platonic dialogues which begins with the *Theaetetus*. We may admit, indeed, that in his later dialogues, and particularly in that entitled *De philosophia*, he diverged from the Platonic doctrine of "ideas" as "separable" from and existing "beyond" individual things; but there is no reason for thinking that this divergence ever approached the nature of a sharp contention or was anything more than a friendly difference of opinion.

The master and the pupil were undivided when Plato died in 347; and the noble words which Aristotle wrote for an altar of friendship in memory of Plato attest the depth of the pupil's feeling even after the master's death.

2. On Plato's death his nephew Speusippus became the head of the Academy. Aristotle and another of Plato's pupils, Xenocrates, thereupon left Athens, perhaps believing, as Jaeger suggests, that Speusippus was the heir not of the spirit, but only of the office of the master, and perhaps desiring to find a new place for the habitation of the spirit. They chose Assus for interesting reasons. Two old pupils of Plato, Erastus and Coriscus, had taken his teaching back to their native town of Scepsis, on the slopes of Mt. Ida. There they had come in contact with Hermias, a eunuch, who had perhaps been a banker's clerk and had thrived sufficiently to buy mining property near Mt. Ida and eventually to acquire the title of prince from the Persians and establish himself as "tyrant" in Atarneus, a town to the southeast of Assus. The two Platonists and Hermias had studied together. Plato had written to them the sixth of his *Epistles* for their guidance; and Hermias, some time before the death of Plato, had given the town of Assus in gratitude to his two companions in study. To Assus, in this conjuncture of affairs, Aristotle and his fellow pupil came in order to join the Platonic circle; and there Aristotle set up a school in which he taught for the next three years. Hermias was among his pupils; and Theophrastus came from the neighbouring island of Lesbos to join the company. Two consequences followed. In the first place, Hermias gave his adopted daughter (who was also his niece) in marriage to Aristotle. In the second place, perhaps on the suggestion of Theophrastus, Aristotle moved, about 344 B.C., to the island of Lesbos, and there he spent two years (344–342 B.C.) largely in the study of natural history, especially marine biology. But politics, as they had been present in his thought and probably in his teaching from his first coming to Assus and joining the company of Hermias (we may attribute the germ of the *Politics* to this date), continued to be present and pressing while he was at work in Lesbos. Hermias seems to have been negotiating about this time with Philip of Macedon, who was already thinking of the expedition against Persia and might naturally desire a foothold on the south of the Dardanelles in the territory of the "tyrant" of Atarneus. It may have been in this way and in consequence of these negotiations that Aristotle, the son-in-law of Hermias, was invited by Philip to come to Pella and continue his teaching there for the benefit of the young Alexander. In 342 he accepted the invitation; and the next seven years of his life (342–335 B.C.) were spent in Macedonia. He had scarcely settled in Pella when he heard the news that Hermias had been seized by the Persians, taken to Susa, tortured and crucified, with the final words on his lips, "Tell my friends and companions that I have done nothing unworthy of philosophy." The news may have helped to inspire Aristotle (who wrote an ode celebrating Hermias, along with Achilles, as a follower of true valour) with anti-Persian feeling; and it may conceivably have led him to inspire his pupil to follow the way of Achilles[2] and, as the champion and leader of a united Greece, to lay low the great king of the east. Unfortunately, there is little evidence which bears on Aristotle's work and teaching in Macedonia. Possibly he had a little circle of "friends" (including Theophrastus) with whom he continued his general studies and teaching. It is known that he formed a friendship with Antipater, and this friendship was one of the chief factors in the last phase of his life.

3. Even before the death of Philip in 336 Alexander was more and more concerned in affairs, and Aristotle must have seen less of his pupil. After the accession of Alexander there was nothing to keep him in Macedonia, and he naturally returned to Athens, the intellectual centre of Greece, consecrated for him by the memory of Plato, where he could hope to work quietly under the protection of Antipater, now acting as regent in Macedonia and Greece after the departure of Alexander on his eastern campaign. His relations with Alexander now were practically at an end. True, his nephew Callisthenes accompanied Alexander to the east; true, he received scientific material from the scientific staff which accompanied the eastern expedition; true, again, he wrote a treatise *Alexander, or On Colonies*, which seems to belong to the period of Alexander's foundation of colonial cities in Egypt and Asia. But Callisthenes was done to death by Alexander in 327; and even before that time Alexander had already departed widely from Aristotle's teaching and had deserted anti-Persian feeling and notions of Greek supremacy for the plan of an empire resting on the equal and harmonious co-operation of Persians and Greeks. In any case the Aristotle of the last 13 years (335–322 B.C.) is an Aristotle immersed in pure science and investigation. Side by side with the Academy (now under Xenocrates, the fellow pupil of Plato who had once followed him to Assus) he set up his own school in the Lyceum—a school which came to be known as the Peripatetic, from the *peripatos* or "walk" in its garden in which he walked and talked with his pupils. The school was a definite organization (*thiasos*), somewhat like a college, which formed a society devoted to the cult of the Muses; and like a college it had its regular dinners and even its plate. It was furnished with maps and a library, it had something of a staff, and Theophrastus was among its lecturers. The great body of the extant Aristotelian treatises represents the lectures which Aristotle delivered in his school at Athens in the evening of his life—not that they were then all composed for the first time (on the contrary, they may have grown during the years of wandering, and the extant forms may perhaps contain traces of earlier versions and views); rather they were now reduced by Aristotle to the form in which we know them. The range of studies was catholic and indeed universal. It is now that Aristotle departs from his master Plato—not so much in altering his theory of "ideas" as in shifting the whole balance of his interest and in turning from "the heavenly things that are the objects of the higher philosophy" to the detailed facts of historical and biological process. He leaves "philosophy," it may be said, for "history," in that wide sense of the word in which it means the sober registering of recorded fact; and here he shows himself more Baconian than the Bacon of the *Novum Organum*. The work of his last years is an encyclopaedia—an encyclopaedia of unique value, in that it proceeds from a single mind informed by a single set of controlling ideas. In the field of human history he produced, on the one side, lists of the victors in the Pythian and Olympic games and a chronology of the Athenian drama (which supplemented the *Poetics*); on the other, a record of 158 constitutions (which equally supplemented the *Politics*), an account of "the customs of barbarians" and a treatise on "cases of constitutional law." In the field of natural history the volume of his production was greater still. It included the *Historia Animalium*, a record of biological facts, in which the material furnished by Alexander's expedition seems to have been used (as it also seems to have been used in a treatise "on the rising of the Nile"); it included biological treatises based on these facts; it included a body of treatises which inaugurated the study of psychology; and it has been suggested that it also included both a scheme for the

[1]Rhetoric was possibly the subject of his lectures; and we may perhaps date the beginning of the *Rhetoric* in this period.

[2]One of the first acts of Alexander, after crossing the Dardanelles, was to place a garland on the tomb of Achilles.

history of the sciences (physics—including metaphysics—mathematics and medicine) and researches in medical subjects such as anatomy and physiology.

In 323, in the midst of all these activities, Aristotle received the news of the death of Alexander. Antipater had been summoned to the presence of Alexander and was absent from Greece; a nationalist party raised its head in Athens; and Aristotle fled to his mother's home in Chalcis, on the island of Euboea, where he died in 322 at the age of 62.[1] By his marriage with the adopted daughter of Hermias he had a daughter, called Pythias; by a later union he had a son, called according to Greek custom by the name of his grandfather Nicomachus.

Aristotle's personality is hidden behind his works. Tradition makes him speak with a lisp and pay attention to dress. The busts, which seem to be authentic, show firm lips and intent eyes. He was a man of affairs, versed in the ways of courts; and he had at its height the invincible and insatiable curiosity of the Greek mind. But there was something more in him than the light of a pure intellect. The study of his life leaves the impression of generous humanity. His will shows him concerned for every relative and dependent, not least for the emancipation of his slaves. And there is a phrase in an Aristotelian fragment, which may come from a letter of his later years, which cannot be forgotten: "The more I find myself by myself and alone, the more I have become a lover of myth." "Myth" may have meant to Aristotle a little of what revelation has meant to millions in later centuries; and for all his scientific labours he may yet have felt at the last—what indeed he suggests in passages of his own treatises—that there was a supreme consolation in the life of contemplation which might lead, at its highest moments, to visions of the divine.

The Writings of Aristotle.—The writings of Aristotle fall into three main kinds. There are literary essays intended for publication, such as the early dialogues (now lost except for fragments); there are the set works of his later years, such as the *Constitution of Athens* (*q.v.*; from his record of 158 constitutions); and above all there are what may be called treatises, intended for use in lectures or for the reading of the students of the Lyceum, of which there are a large variety.

1. The dialogues, written with a conscious art and a definite pursuit of style, were modeled on those of Plato; but they are said by ancient writers to have differed from Plato's dialogues in representing different persons as stating at length their different views on the subject treated. They were famed for their lucidity and the easy flow of their style; they belong to the period of Aristotle's discipleship in the Academy (367–347 B.C.); almost to the very last they followed the doctrine of Plato; and their clear and stirring account of Platonic doctrine exercised a large influence in antiquity down to the days of St. Augustine. The two most famous and considerable of these dialogues were (*a*) the *Protrepticus*, an exhortation to the philosophic life, which was a model for Cicero's *Hortensius* and was partly incorporated by Iamblichus (as Ingram Bywater first recognized in 1869) in a philosophic textbook for beginners, also called the *Protrepticus;* and (*b*) the *De philosophia*, perhaps the latest of all the dialogues, in which, as we have already seen, Aristotle first showed signs of a movement away from Plato's theory of "ideas." Generally, however, the dialogues of Aristotle were purely Platonic in the range and in the substance of their thought; and several of them, such as the *Politicus* and the *Sophistes*, bore the same name and perhaps handled the same theme as Platonic dialogues. If only we could recover the lost dialogue "On Justice," which appears from its title to correspond to Plato's *Republic* (for the *Republic*, too, treats of justice, and indeed its alternative title is "On Justice"), it would be interesting to compare Aristotle's views in this dialogue both with those of his master and with his own later views on the doctrines of the *Republic* as they are expressed in the second book of the *Politics*.

2. Midway between the dialogues and the treatises of Aristotle come a number of works which, like the dialogues, were set compositions in literary form intended for publication, but which, like the treatises, were mainly of the nature of scientific compilations. Apart from an essay *On Monarchy*, which may belong to the time of his residence at Pella, these works belong to the third and last period of his life, during which he was occupied in investigation and teaching in the Lyceum. They include the *Alexander, or On Colonies;* the accounts of 158 constitutions; the compilations of *The Customs of Barbarians* and of *Cases of Constitutional Law;* the chronological tables of victors in the Pythian and Olympic games; and a list of the successful dramas produced at the festivals of Dionysus at Athens.

3. The treatises, as we have seen, may possibly have been begun during the *Wanderjahre* from 347 to 335, but in the form in which they have come down to us they belong to the final period between 335 and 322. They were all written by Aristotle in connection with his courses of lectures—not so much, probably, in the way of "notes" to be followed in the delivery of lectures (the actual lectures may have been more discursive and more of the nature of discussions or conversations with a class) as in the way of "memoranda," which may have been written afterward, to preserve a record of the main results attained in lectures and discussions.

The treatises may be grouped under some eight main heads, though we cannot for a moment say that each of these heads corresponds to a separate "course" of lectures, or that the classification is the same as Aristotle himself would have made. The first head is what Aristotle calls "analytics," or, as we should say, logic. Under this head there are half a dozen treatises (the *Categories*, the *De interpretatione*, the *Topics*, the *Sophistici Elenchi* and the *Prior* and *Posterior Analytics*) which came to be known, centuries afterward, as the *Organon*, or "instrument" of science and scientific reasoning. The second head we may call by the name of "physics," using that term in a wider sense than that in which we use it today and taking it to mean the general study of inorganic "nature" (*physis*). Here we have to reckon the treatise on *Physics*, the *De caelo*, the *De generatione et corruptione* and the *Meteorologica*. The third head may be termed psychology—of which (as also of logic) Aristotle was the inventor. Under it fall the *De anima* and the *Parva naturalia*—the latter a collection of essays on subjects such as sensation, memory, sleep and dreams. The fourth head may be called by the name of biology. We have seen that Aristotle was interested in the study of this subject as early as 344–342 B.C., and that he continued his interest and extended his studies in the final period of his life. His biological treatises are the *Historia animalium* (a record of data corresponding, in the sphere of natural history, to the record of 158 constitutions in the sphere of politics) and a number of theoretical works, based on the data of the *Historia*, which include studies of the "parts," the "progression," the "motion" and the "reproduction" of animals. It was indeed, in the sphere of biology that Aristotle made one of his greatest contributions to the advancement of learning.

The remaining heads under which his treatises may be grouped are the metaphysical, the ethical, the political and the literary. Under the head of metaphysics, or "first philosophy," which is an inquiry into the nature of existence (*ousia*) and involves a discussion of the question whether universals exist as substances "separable" from their particulars, we have a composite treatise, containing different strata put together by later editors, which is called the *Metaphysics*. Under the head of ethics there are two treatises—the *Eudemian Ethics* (so called from Eudemus, one of Aristotle's pupils) and the *Nicomachean Ethics* (which derives its name from his son Nicomachus). It is now held that the former is a genuine work of Aristotle, belonging to the middle period of his life and was subsequently edited by Eudemus; and that the latter is a statement, edited by his son, of his final views on ethics

[1] An archaeological discovery, which may bear on Aristotle, was made about 1890. Near Eretria, in Euboea, in an ancient cemetery in which nonresidents as well as residents had been buried, there was exhumed from a rich tomb with marble foundations a number of objects—seven gold diadems, two styluses, a pen, a signet ring and a terra-cotta statuette of a man in an attitude like that which Christodorus (*Anthologia Palatina*, ii) ascribes to a statue of Aristotle. On a sepulchral stone in the grave was found the inscription, in lettering of the early 3rd century B.C., [B]ιοτη [A]ριστοτελου ("Life of Aristotle"). The grave may have been connected with the family of Aristotle (though Chalcis is over a dozen miles away from Eretria); the styluses, pen and statuette may, in that case, be connected with Aristotle himself; and a skull which was also discovered may have been his. (See *Corpus Inscriptionum Graecarum*, vol. xii, fasc. ix, under "Eretria," where references are given to the literature on the subject.)

in the last period of his life. (However, even the *Nicomachean Ethics* is somewhat simple, not to say elementary, in its psychological foundations and shows little connection with the detailed study of the problems of psychology in the treatises which deal with that subject.) Under the head of politics there is the treatise called the *Politics,* which falls into three parts—a philosophical "theory of the state" in books i–iii; a detailed study (running into practical suggestions) of the "forms and methods of government" in books iv–vi; and a torso of a sketch of an ideal state in books vii–viii. Opinions differ in regard to the dates of the different parts; but it has been suggested that the last two books, which show a considerable dependence on Plato's *Laws,* are early and that the three middle books, which go naturally with the collection of 158 constitutions and suggest in their method the biological studies of Aristotle's last period, are of a later date. Finally, we have to count, under the head of literary criticism, the three books of the *Rhetoric* and the short treatise called the *Poetics.*

More important than the classification of Aristotle's treatises is the chronology of their composition, although as it is, it must also remain conjectural. We are justified, however, in saying that Aristotle seems to have moved from an earlier concern with logic and "the higher philosophy of heavenly things" (or, in other words, from the circle of Platonic interests) toward a later and more absorbing passion for the study and record of actual facts alike in the world of "nature" and in the world of political and literary "art." On this basis some would assign the first form of a number of treatises (which, it is true, must have been expanded later in connection with Aristotle's later lectures) to the period before 335. Among these may have been the *Organon,* the *Physics,* the third (and most general) book of the *De anima,* the *Eudemian Ethics,* a considerable part of the *Metaphysics* and some parts of the *Politics.* The rest of the treatises may be ascribed to the final period of Aristotle's life. But such speculations in the chronology of his writings are at best conjectural.

The Philosophy of Aristotle.—It is impossible, within the space of this brief article, to give any account of Aristotle's teaching on the many specific branches of knowledge with which he dealt. (*See* rather such articles as LOGIC, HISTORY OF; ETHICS, HISTORY OF; and KNOWLEDGE, THEORY OF.) Here we can only deal with the general development of Aristotle's thought, the general views which run through his treatises and the particular opinions which have influenced subsequent thought most profoundly. Starting with a veneration for Plato and an acceptance of the Platonic tradition which lasted almost to the death of Plato and his own middle age, he followed even more in the last 25 years of his life (347–322 B.C.) a peculiar and distinctive method of his own. Plato had studied reality as a whole; and the reality that he had studied had been the suprasensible reality of "ideas." Aristotle divided reality into the several spheres of physics, biology, ethics, politics and psychology; and the reality that he studied in these spheres was constituted by the observable facts of actual and concrete individual substances. The essence of his procedure in each field of inquiry was observation of the data (coupled, in biology at any rate, with experimental research in the way of dissection, with a view to determining the data more exactly); and the object of his study was to discover some general theory which, in the Greek phrase, "saved"—or, as we might say, explained without doing violence to them—the data which had been observed. ("The course of exposition," he says in the *De partibus animalium,* "must be, first, to state the attributes common to whole groups of animals, and then to attempt to give their explanation.") Aristotle possessed in a remarkable degree the scientific habit of mind. On the one hand he distinguished the various "sciences" (or, as he would have preferred to say, "inquiries"), drawing the lines of division between them and attaching to some of them the names that they have since continued to bear; on the other hand he followed a scientific procedure in each of the subjects treated and, within the limits of his technique (he had few instruments at his disposal and he had to discover for himself the rules of reasoning), observed the permanent canons of scientific inquiry. If the essence of his method and teaching had been followed, the fruit would have been a great period of scientific investigation and discovery. No nobler exordium to such a period could be furnished than the great passage in the *De partibus animalium* (642b, 22 ff.), in which he propounds the program and the justification of a study of nature. But the essence of his teaching and method was not followed. The reason may partly be that his treatises seem to have been submerged for more than 200 years following his death. According to a tradition of antiquity which may well be accepted, the library and the treatises of Aristotle passed at his death to Neleus, the son of that Coriscus of Scepsis whom he had left Athens to join in 347 B.C.; and they continued in the hands of the descendants of Neleus, apparently neglected and forgotten, until they were recovered for the learned world from the cellar of a house in Scepsis in the time of Sulla (80 B.C.). Destitute of the master's treatises and rapidly forgetting his spirit, the Peripatetic school hardened into a logical tradition of its own; and even when the treatises were recovered, they were treated not as incentives to inquiry and further discovery but as a rounded body of complete knowledge (perhaps the last thing that Aristotle would have claimed for his tentative conclusions), on which commentators might write and lecture as if it contained the final word of perfection. As a spirit and an incentive, Aristotle was dead; he only remained as "the master of those who know" and a *corpus scientiae.* In this way the great researcher was made the enemy of research; and this continued to be his fate for centuries. The middle ages, as we shall see, inherited the Peripatetic cult of "the master"; they "made his torch," as Dryden said, "their universal light"; and thus the beginning of modern science in the 16th century took the form of a revolt against Aristotle—one of the most scientific spirits that ever lived.

Aristotle had a profound respect for given facts and a deep passion for classifying these facts with a scrupulous respect for their exact character. He was no longer, when he reached the definitely scientific stage of his development, interested in "ideas" as they were conceived by Plato; but he was profoundly interested in "forms"—in the common attributes which can be observed in the same kind of things and enable us to classify such things in terms of genera and species. "The principal object of natural philosophy," he wrote, "is not the material elements, but their composition and the totality of the form." The aim of all science, we may say, is to form an intelligible universe by discovering the universal in the particulars—particulars which are the primary and only substances or existences, but which none the less have no existence independently of the universal which is their "form" and makes them the class or kind of existence which they are. Such universals are concepts formed by the intuitive reason on the basis of repeated "sensations," which rise to "memory" and then to "experience" of the same kind of thing. By making such concepts we make a world we can understand—the world of knowledge; and within that world we can reason and use the methods of valid argument.

It is one of the greatest services of Aristotle to knowledge that he laid down these methods, that he was the first to do so, and that he invented the science of logic. There was reasoning before Aristotle, and the dialogues of Plato abundantly imply its methods and rules. But Aristotle was the first to make them explicit; and the inventor of the syllogism, as he may justly be called, deserves to be celebrated in the annals of human thought.

One of the general views which runs through Aristotle's thought, if it is expressed more particularly in the *Physics,* is a view which we may call by the name of evolution or *genesis.* Whether this view was a result of study of biology, or his study of biology was a result and an application of a general view which he had formed on general grounds, we cannot pause to inquire. In any case, a pervading conception of growth is what chiefly distinguishes his thought from that of Plato. Plato had been more deeply interested in being than in becoming, which belonged in his view to the deceptive world of fallible sense; and he had tried to interpret true and permanent being in the light of the permanent truths of mathematics, making number the basis of the universe and identifying matter with space. His universe was thus a static universe.

The universe of Aristotle is dynamic; his world is engaged in becoming; the "nature" of each thing is a potentiality which

moves through a process of development (a process which is also "nature") to an actuality which is true and final and perfect "nature"—for "nature is the end," as he writes in the *Politics*, "and what each thing is when fully developed we call its nature." There is thus a teleological view behind Aristotle's conception of the nature of things. The movement which he sees incessantly at work is a movement toward an end immanent from the first in the subject of movement and determining all its growth; "for the process of evolution is for the sake of the thing finally evolved, and not this for the sake of the process." This general conception is applied by Aristotle not only to developments in the sphere of organic nature, but also to constructions in the sphere of human art. The activity of man, alike in the building of a house and in the making of a statue, in the putting together of a state and in the composition of a tragedy, is the activity of realizing a plan or "form" and of causing a material which has the proper potentiality—be it wood and stone, or marble, or the human trend to association, or the human passion for imitation—to move toward the "form" which is also its "end." There is thus no distinction between "nature" and "art" in Aristotle's view. They move on parallel lines; they may co-operate. As he says of the state in the *Politics*, "by nature there is an impulse in all men toward political association, but he who first put them together was the cause of the greatest of benefits."

Of all Aristotle's treatises it is perhaps those on ethics and on politics (along with that on logic) which have exercised the deepest and most continuous influence on subsequent thought. There have been many who, like Archbishop Laud (St. Thomas Aquinas and Dante might equally have made the confession), have acknowledged Aristotle as their "master *in humanis*." The *Nicomachean Ethics* is one of the great books of the world. Its application of the doctrine of the mean to the various virtues; its theory of the relation between external goods and the inward happiness of the spirit; its doctrine of habit and of the importance of the stage of habituation in moral development—all these are among the permanent possessions of human thought. We may reckon in the same class what Aristotle says of the life of contemplation (which is "a laying hold on immortality as far as is possible for men") and what he writes of the connection between "leisure" (an activity to be distinguished alike from "work" and from "amusement") and the contemplative life. The *Politics*, if it has not all the qualities of the *Ethics*, has furnished the generations with many of the great axioms of political truth. That "the state is by nature" (which does not prevent it from also being "by art"); that it exists for the good life, if it begins for the sake of life only; that law is the true sovereign of states, and governments are servants of law; that there is a fundamental difference between the lawful monarch and the tyrant who governs by his arbitrary will; that there is a right inherent in the people, in virtue of their capacity of collective judgment, to elect their rulers and call them to account—these are some of the axioms on which men have argued from century to century. Here, and in this example, we can see a service which Aristotle—schematized and glossed and ossified as he might be in the teaching of the schools—nonetheless continued to render for generations. He supplied the great "topics" of thought—the themes for discussion and the standard "commonplaces" on these themes; and he supplied, too, a terminology in the grooves of which thought could run. When thought had to be rebuilt after the collapse of classical civilization and while the middle ages were toiling at the work, it was no small thing that men should have the tools of a terminology and the rules of accepted axioms.

The History of Aristotle's Writings and Philosophy.—The tradition of Aristotle was continued—and forgotten, perhaps, even more than it was continued—in the Peripatetic school. But it never affected classical antiquity so deeply as the tradition of Plato, which—whether it was fused, as by Posidonius of Apamea, into an eclectic philosophy which also included Stoic theory, or was exaggerated, as it was by the Neoplatonists, into a sort of mysticism—continued to be a magnet to ancient thought. It is in the period between the collapse of ancient civilization in the 5th century A.D. and the beginning of the classical Renaissance in the 15th that the influence of Aristotle is strongest and most diffused. It was the logic of Aristotle which for more than half of this period (from 500 to 1200) was alone known in the west; and not only so, but down to the beginning of the 12th century it was only the earlier and more elementary parts of the *Organon* which were known and studied. Even this was only studied in a Latin translation and commentary made by Boethius; and indeed the study of Aristotle through the whole of the middle ages was the study of Aristotle in a Latin version, not in the original Greek. But the Latin version of the first half of the *Organon* was nonetheless a considerable instrument of education for many centuries. It was the staple of dialectic, one of the three subjects of the medieval trivium; and as dialectic was the subject of all others which set students effectively thinking, we may say that Aristotle was in this way the chief influence, outside theology, in the educational system of the early middle ages. His logical treatises were studied in the chapter schools attached to cathedrals and in the schools of the Benedictine monasteries; and along with grammar and rhetoric, the other two subjects of the trivium, they were the discipline of thousands of students.

A new epoch begins in the 12th century. In the first place, the methods of dialectic, no longer studied merely as a discipline in schools, begin to be applied to problems of theology; for already Berenger of Tours in the 11th century had brought Aristotelian logic to bear on the problem of transubstantiation. The application of logic to theology became still more evident when Roscelin, Guillaume de Champeaux and, above all, Abelard began to ventilate theories about the nature of universals and to draw their theories to theological consequences. The old difference between Platonic "ideas" and Aristotelian "forms" re-emerged in the field of theology; and conceptions of the nature of God were made to depend on the difference. In the second place, about 1130, the whole of the *Organon* became known to the west and began to be studied there, and before the middle of the 12th century Otto of Freising had come to Paris, as he tells, to study the subtleties of Aristotelian logic in the later and profounder *Analytics* as well as in the earlier treatises of the *Organon*. Finally, about 1170, the University of Paris came into existence as an organized body; and with the foundation of the medieval university the great cadre was provided in which the whole body of Aristotelian writings might find a place and in which, as soon as they had found their place, the great attempt might be made—the attempt which we call scholasticism—to reconcile their tenets and their secular wisdom with the revelation of the Bible and the divine wisdom of the fathers of the church.

Between 1200 and 1270, the general body of the Aristotelian writings other than the *Organon* (the *Physics*, the *Metaphysics* and the *De anima;* the *Politics* and the *Ethics*) began to be imported into the University of Paris, the University of Oxford, which had arisen at the same time, and the University of Cambridge, which had arisen a little later. It was from Córdoba and Constantinople that the new knowledge of the works of Aristotle was derived; and the process of the transmission of his various writings to the Latin west is one of the curiosities of the history of learning.

Córdoba in the 12th century was the great seat of Arabic learning. Arabic learning had included, after about A.D. 800, the study of the Aristotelian treatises and especially of those which dealt with physics, metaphysics and psychology. The tradition of Aristotle had survived among the Syrians, and the Arabs had acquired it when they conquered Syria in the 7th century. Great Aristotelian commentators had arisen among the Arabs—especially Avicenna (*q.v.*), who lived in the east and died at Hamadan in 1037, and Averroës (*q.v.*), who lived in Arabic Spain and died at Córdoba in 1198. The Arabic paraphrases and commentaries began to penetrate into the Latin west after 1200, partly across the Pyrenees and partly by way of Palermo, the half-Arabic capital of Sicily, in which the emperor Frederick II was a patron of science and literature. They came in a curious form—the form of Latin translations (which sometimes sank to the level of transliterations and sometimes were not even made directly, but only from an intervening Hebrew version) of Arabic exegesis, which itself was not based on the original Greek, but rested on Arabic versions of

Aristotle, which might rest in turn on Syriac versions of the original text. Not only did they come in a curious form, but they also brought curious views of Aristotle's doctrines, which had suffered a change in the course of their wanderings; and Aristotle would hardly have recognized as his own the idea, which the Arabs had extracted from the *De anima*, that the mortal soul of man was reabsorbed at death into the universal creative soul of the universe. With their curious form and their dubious views the Aristotelian treatises which the west received from the Arabs were at first suspect; their study was at one time prohibited by the church, which frowned on the *fisica et metafisica;* but they won their way and established their place in study. A school of "Averroists," which lasted until the 16th century, drew its inspiration from these writings. (*See* AVERROISM, LATIN.)

Constantinople supplied the west with a more sober and recognizable Aristotle. All through its history, from the time of Justinian onward, the scholars of the city had pursued the study of Aristotelian philosophy; and toward the reign of Alexius Comnenus, about A.D. 1100, we find Michael of Ephesus lecturing in the school of philosophy (which had been recently refounded by the empire and of which the great scholar Psellus had been the head) on the physics and metaphysics, and also the ethics and politics of Aristotle. When the city was captured by the Latins during the fourth crusade (1204) Latin clergy settled in the Byzantine empire. They learned Greek: they found Greek manuscripts; and two of them (both Dominicans), William of Moerbecke in Flanders and Henry of Brabant, translated, under the impulse of the great Dominican scholar St. Thomas and in collaboration with him, many of the writings of Aristotle (1260–70): It was mainly in this way that St. Thomas learned the Aristotle on whom he wrote commentaries and whose views he sought to co-ordinate with Christian revelation in the great edifice of his *Summa*.

In the writings of St. Thomas, Aristotle the encyclopaedist, 1,600 years after his death, was wrought upon by another great and massive encyclopaedist, who sought to inform the sum of ancient knowledge with the spirit of Christian faith; and the pagan scholar, who had built his own great monument, was incorporated by a Christian thinker into another of the great and enduring monuments of human knowledge.

By 1300 Aristotle was the acknowledged "master of those who know." For Dante, indeed, he was "the philosopher": his views run through the *De monarchia,* appear in the exegesis of the poems of the *Vita nuova* and are part of the texture and framework of the *Divina commedia*. The empire of Aristotle lasted for two centuries. It passed with the Italian Renaissance, which was Platonic rather than Aristotelian; it passed with the German Reformation, which, through Luther, denounced the "Aristotelianism" of the schoolmen; it passed with the beginnings of modern science, which, seeking to escape from the medieval tradition and dogma, in which Aristotle had been incorporated, left Aristotle, neglecting the deep and genuine science of his writings because it had been yoked with what they sought to escape. Only in the latter part of the 19th century, with the development of biological study, did Aristotle the scientist—the student of biology and the prophet of growth—come to be recognized once more, and only in the 20th century did the development of his mind and the growth of his philosophy of nature begin to be understood in terms of his own doctrine of "evolution."

See also references under "Aristotle" in the Index.

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ARISTOTLE'S LANTERN, the name applied to the complex masticatory apparatus of sea urchins. *See* SEA URCHIN.

ARISTOXENUS (fl. late in the 4th century B.C.), Greek philosopher, the first authority for musical theory in the classical world, was born at Tarentum (Taranto) in southern Italy but studied under Aristotle and Theophrastus in Athens and became one of the Peripatetics (*q.v.*). He was interested in ethics as well as in music and wrote much, but most of his work is lost. Apart from his musical treatises, fragments of his reconstruction of the old Pythagorean ethics as well as of his biographies of Pythagoras, of Archytas, of Socrates and of Plato are still extant. His theory that the soul is related to the body as harmony to the parts of a musical instrument seems to follow early Pythagorean doctrine.

In musical theory Aristoxenus held that the notes of the scale are to be judged not by mathematical ratio but by the ear. Parts of his *Elements of Harmony* and of his *Elements of Rhythm* are extant.

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ARITHMETIC. The word arithmetic is derived from the Greek word *arithmos*, meaning "number." The term is ordinarily applied to the more elementary aspects of the theory of numbers, in particular to the arts of mensuration and computation.

There is a tendency to consider arithmetic not as a logically defined branch of mathematics but rather as consisting of those topics which are taught before algebra. From this point of view arithmetic is not concerned with negative numbers or with literal notation. A few simple geometric concepts such as area and volume are frequently included.

The term arithmetic usually implies a limitation in rigour as

marked as the limitations in subject matter; for example, the incommensurable numbers are ordinarily assumed with very little attempt at justification. The point of view is generally utilitarian and dogmatic. A student who is interested in the logical foundations of arithmetic should consult a book on the theory of numbers. (See NUMBERS, THEORY OF.)

There have been, on the other hand, a few mathematicians who would consider arithmetic to be synonymous with the theory of numbers or at least with some parts of the theory of numbers. Thus Leonard Eugene Dickson speaks of the arithmetic of a linear associative algebra, meaning the number theory of the maximal integral ring of that algebra.

The Fundamental Laws for the Positive Integers.—Two sets of objects which can be paired so that each pair contains one object from each set are said to possess the same (cardinal) number. If a set of objects can be thus paired with the symbols of the sequence 1, 2, 3, . . . , n, then the set is said to contain the number n of objects. The determination of this number n is called counting. The numbers thus obtained are known as the natural numbers, the whole numbers or the positive integers.

If a set A contains a objects and a set B contains b objects, the two sets together constitute a set containing $a + b$ objects. The number $a + b$ is called the sum of the numbers a and b, the numbers a and b are called the summands, and the binary operation of forming the sum is called addition. The symbol $+$ of this operation is read plus.

From the process of counting it is evident that the following fundamental laws hold for the operation of addition:

1. The commutative law of addition: $a + b = b + a$
2. The associative law of addition: $a + (b + c) = (a + b) + c$

If there exists a positive integer k such that $a = b + k$, it is said that a is greater than b (written $a > b$), and that b is less than a (written $b < a$). If a and b are any two positive integers, either $a = b$ or $a > b$ or $a < b$.

From the above laws it is evident that a repeated sum such as $5 + 5 + 5$ is independent of the way in which the summands are grouped and is written 3×5. Thus a second binary operation called multiplication is defined. The number 5 is called the multiplicand, the number 3 which denotes the number of summands is called the multiplier and the result 3×5 is called the product. The symbol $\times$ of this operation is read times. If letters such as a and b are used to denote the numbers, the product $a \times b$ is often written $a.b$ or simply ab.

If 3 rows of 5 dots each are written,

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. . . . .
. . . . .
. . . . .
```

it is clear that the total number of dots in the array is 3×5 or 15. This same number of dots can evidently be written in 5 rows of 3 dots each, whence $5 \times 3 = 15$. The argument is general, leading to

3. The commutative law of multiplication: $ab = ba$

By the use of a three-dimensional array of dots, the following law becomes evident:

4. The associative law of multiplication: $a(bc) = (ab)c$

Separate the 15 dots written above into two sets:

```
. . .   . .
. . .   . .
. . .   . .
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The first set consists of 3 columns of 3 dots each, or 3×3 dots; the second set consists of 2 columns of 3 dots each, or 2×3 dots; the sum $3 \times 3 + 2 \times 3$ consists of $3 + 2 = 5$ columns of 3 dots each, or $(3 + 2) \times 3$ dots. In general one may prove

5. The distributive law: $(a + b)c = ac + bc$

Just as a repeated sum $a + a + \ldots + a$ of k summands is written ka, so a repeated product $a \times a \times \ldots \times a$ of k factors is written a^k. The number k is called the exponent and a the base of the power a^k.

The following fundamental laws of exponents follow easily from the definitions:

6. $a^m a^n = a^{m+n}$ 7. $(a^m)^n = a^{mn}$ 8. $a^m b^m = (ab)^m$

Other laws such as

$$a^m \div a^n = a^{m-n} \qquad m > n$$

are immediate consequences of these.

Theory of Divisors.—If three positive integers a, b and c are in the relation $ab = c$, it is said that a and b are divisors or factors of c, or that a divides c (written $a \mid c$) and b divides c. The number c is said to be a multiple of a and a multiple of b.

The number 1 is called the unit, and it is clear that 1 is a divisor of every positive integer. If c can be expressed as a product ab where a and b are positive integers each greater than 1, then c is called composite. A positive integer neither 1 nor composite is called prime. Thus 2, 3, 5, 7, 11, 13, 17, 19, . . . are prime numbers. Euclid proved that the number of prime numbers is infinite (*Elements*, book ix, proposition 20).

The fundamental theorem of arithmetic (Carl Friedrich Gauss, *Disquisitiones Arithmeticae*, 1801) states that every composite number can be expressed as a product of prime numbers and that, save for the order in which the factors are written, this representation is unique. This theorem follows rather directly from a theorem of Euclid (*Elements*, book vii, prop. 30) to the effect that if a prime divides a product, it divides one of its factors, and the fundamental theorem is therefore sometimes credited to Euclid.

For every finite set $a_1, a_2, \ldots, a_k$ of positive integers, there exists a largest integer d which divides each of these numbers, called their greatest common divisor (g.c.d.). If $d = 1$, the numbers are said to be relatively prime. There also exists a smallest positive integer m which is a multiple of each of the numbers. This is called their least common multiple (l.c.m.).

If $p_1, p_2, \ldots, p_h$ are the distinct primes which divide all of the numbers $a_1, a_2, \ldots, a_k$, and if e_i is the smallest exponent to which p_i occurs in any of them, then

$$d = p_1^{e_1} p_2^{e_2} \ldots p_h^{e_h}$$

is the g.c.d. of $a_1, a_2, \ldots, a_k$. If $p_1, p_2, \ldots, p_t$ are the distinct primes which divide any one or more of the numbers $a_1, a_2, \ldots, a_k$, and if n_i is the largest exponent to which p_i occurs in any of them, then

$$m = p_1^{n_1} p_2^{n_2} \ldots p_t^{n_t}$$

is the l.c.m. of $a_1, a_2, \ldots, a_k$. Thus if

$$a_1 = 2^3.3.5^3.7^4 \qquad a_2 = 2.3^5.7^3.11^3$$
$$d = 2.3.7^3 \qquad m = 2^3.3^5.5^3.7^4.11^3$$

Obviously if $k = 2$, $a_1 a_2 = dm$.

If a and b are two positive integers, $a > b$, by means of the division algorithm (*q.v.*) two integers q and r can be determined such that

$$a = bq + r \qquad 0 \leqq r < b$$

The number q is called the partial quotient (the quotient if $r = 0$) and r is called the remainder. The g.c.d. of a and b is equal to the g.c.d. of b and r. If the division algorithm is applied successively, a remainder 0 must ultimately appear. The last remainder > 0 is the g.c.d. of a and b. Thus if $a = 544$, $b = 119$,

$$544 = 4.119 + 68 \qquad 119 = 1.68 + 51$$
$$68 = 1.51 + 17 \qquad 51 = 3.17$$

The g.c.d. of 544 and 119 is 17.

This process is known as the Euclid algorithm (*Elements*, book vii, prop. 1). By means of it, the g.c.d. can be obtained without first factoring the numbers a and b into prime factors.

Common Fractions.—In certain problems it may happen that the unit of measure is inconveniently large. Thus in measuring the width of a room the number of feet in this width may not give a sufficiently accurate measurement. In such a case a smaller unit of measure called the inch may be adopted, 12 of which are equivalent to one foot. But without surrendering the foot as the fundamental unit, the inch may be denoted by the symbol $\frac{1}{12}$. (See FRACTION.)

In general the fractional unit $\frac{1}{d}$ is defined by the property $d \times \frac{1}{d} = 1$. The number $a \times \frac{1}{d}$ is written $\frac{a}{d}$ and is called a (common or vulgar) fraction. It may be considered as the quotient of a divided by d. The number d is called the denominator (since it determines the fractional unit or denomination) and a is called the numerator (since it enumerates the number of fractional units which are taken). The numerator and denominator together are called the terms of the fraction.

A positive fraction $\frac{a}{d}$ is said to be proper if $a < d$, otherwise improper.

The positive integers and fractions are sometimes called the positive rational numbers.

The numerator and denominator of a fraction are not unique, since for every positive integer k,

$$\frac{a}{d} = \frac{ka}{kd}$$

Clearly every fraction can be written as the quotient of two relatively prime integers. In this form it is said to be in lowest terms.

It is not difficult to show that the five fundamental laws, which in the first section were proved to hold for positive integers, hold more generally for all positive rational numbers.

It is obvious from the definition of fraction that the sum (or difference) of two fractions having the same denominator is a fraction with this denominator whose numerator is the sum (or difference) of the numerators of the given fractions. Two fractions having different denominators may be added by first reducing them to fractions with the same denominator. Thus to add $\frac{a}{d}$ and $\frac{b}{e}$ we first determine the l.c.m. m of d and e, often called the least common denominator of the fractions. Then there exist numbers k and l such that $m = kd = le$,

$$\frac{a}{d} = \frac{ka}{kd} = \frac{ka}{m}, \quad \frac{b}{e} = \frac{lb}{le} = \frac{lb}{m}$$

so that

$$\frac{a}{d} \pm \frac{b}{e} = \frac{ka}{m} \pm \frac{lb}{m} = \frac{ka \pm lb}{m}$$

The product of two fractions is a fraction whose numerator is the product of the numerators of the factors, and whose denominator is the product of the denominators of the factors. Thus

$$\frac{a}{d} \times \frac{b}{e} = \frac{ab}{de}$$

The quotient of two fractions is equal to the product of the dividend by the divisor inverted, *i.e.*, the divisor with its terms interchanged. That is,

$$\frac{a}{d} \div \frac{b}{e} = \frac{a}{d} \times \frac{e}{b} = \frac{ae}{db}$$

A method of introducing the positive rational numbers which is free from intuition was given by Ernst Steinitz in 1910. Consider the set of all number pairs (a,d), (b,e), . . . where a, b, d, e, . . . are positive integers. Define the equals relation $(a,d) = (b,e)$ to mean that $ae = bd$. Define the two operations $+$ and $\times$ as follows:

$$(a,d) + (b,e) = (ae + bd,\ de)$$
$$(a,d) \times (b,e) = (ab,\ de)$$

It can now be proved that the fundamental laws of section one hold for these pairs, and that the pairs of the type $(a,1)$ are abstractly identical with the positive integers a. Moreover, $d \times (a,d) = a$, so that the pair (a,d) is abstractly identical with the fraction $\frac{a}{d}$.

Irrational Numbers.—It was known to the Pythagoreans that, given a straight line segment a and a unit segment u, it is not always possible to find a fractional unit such that both a and u are multiples of it. Thus the hypotenuse of an isosceles right triangle whose sides are taken as the unit u must by the Pythagorean theorem have a length whose square is 2, *i.e.*, a length of $\sqrt{2u}$. But there exists no rational fraction whose square is 2.

It is customary to assume as an axiom that, corresponding to every line segment and every unit length, there exists a number (called a positive real number) which represents the length of the line segment. Not all such numbers are rational, but every one can be approximated arbitrarily closely by a rational number. That is, if α is real and ϵ is any positive rational number no matter how small, it is possible to find two positive rational numbers a and b such that

$$a < \alpha < b \qquad a - b < \epsilon$$

In problems in mensuration, real numbers are usually replaced by rational approximations.

A rigorous development of the irrational numbers is beyond the scope of arithmetic. They are most satisfactorily introduced by means of Dedekind cuts or Cauchy (or regular or fundamental) sequences or the infinite decimals of Georg Cantor. These methods are discussed in books on the theory of functions of a real variable.

The employment of irrational numbers greatly increases the scope and usefulness of arithmetic. For instance, if n is any whole number and a is any positive real number, there exists a unique positive real number $\sqrt[n]{a}$, called the nth root of a, whose nth power is a. The root symbol $\surd$ is a conventionalized r for radix or root.

The term evolution is sometimes applied to the process of finding a rational approximation to an nth root.

A number such as

$$\sqrt[3]{\frac{\sqrt{2} + \sqrt[6]{3}}{\sqrt{5}}}$$

which is obtainable from rational numbers by a finite number of additions, multiplications, divisions and root extractions is called a surd. An irrational number of the form $\sqrt{a}$ where a is rational is called a pure surd of index n. For $n = 2$, it is called a quadratic surd or square root and is written simply $\sqrt{a}$. A surd which is not pure is called mixed.

A pure surd of index n may be reduced to a rational multiple of the nth root of a positive integer no prime factor of which occurs to an exponent as high as n. Such a surd is in lowest terms. Thus consider $\sqrt[3]{125/18}$. Since $18 = 2.3^2$, it becomes a perfect cube upon multiplication by $2^2.3 = 12$. Then

$$\sqrt[8]{\frac{125}{18}} = \sqrt[3]{\frac{125 \cdot 12}{18 \cdot 12}} = \sqrt[3]{\frac{5^3 \cdot 12}{6^3}} = \frac{5}{6}\sqrt[3]{12}$$

Two surds which can be written as rational multiples of the same surd are called similar. Their sum is similar to each of them, its rational coefficient being the sum of the rational coefficients of the summands.

The following elementary properties of surds are readily provable:

9. $\sqrt[n]{a} \cdot \sqrt[n]{b} = \sqrt[n]{ab}$

10. $\sqrt[n]{\sqrt[m]{a}} = \sqrt[mn]{a}$

11. $(\sqrt[m]{a})^k = \sqrt[m]{a^k}$

12. $\sqrt[mn]{a^{kn}} = \sqrt[m]{a^k}$

13. $\sqrt[n]{\frac{a}{b}} = \frac{\sqrt[n]{a}}{\sqrt[n]{b}}$

The theory of surds can be much simplified by the introduction of negative and fractional exponents. By definition

$$a^0 = 1 \qquad a^{-n} = 1/a^n \qquad a^{p/q} = \sqrt[q]{a^p} \qquad a \neq 0$$

It can be shown that the fundamental laws of exponents (6), (7) and (8) together with the properties of the rational fractions, are equivalent to the above elementary properties (9), (10), (11) and (12). For instance,

$$\sqrt[n]{a} \cdot \sqrt[n]{b} = a^{1/n}b^{1/n} = (ab)^{1/n} = \sqrt[n]{ab}$$

$$\sqrt[m]{a^k} = a^{k/m} = a^{kn/mn} = \sqrt[mn]{a^{kn}}$$

The Decimal System.—It was only after the adoption of the Hindu-Arabic, or decimal, notation that the easy methods in use for adding, subtracting, multiplying and dividing were possible. In this notation every number is written as a linear combination of powers of 10.

Thus

$$32{,}158 = 3.10^4 + 2.10^3 + 1.10^2 + 5.10 + 8$$

where each coefficient is $\geqq 0$ and $\leqq 9$.

Large numbers are usually separated into periods of three digits each, starting at the right, or at the decimal point in the case of a fraction.

This makes it easier to tell at a glance the approximate size of the number.

The notations

32 158   32,158   32'158

are all in use.

The use of 10 as a base is doubtless due to the fact that early man used his 10 digits or fingers as counters. There are vestiges of systems using the base 12 (the dozen and gross), the base 20 (the score) and the Babylonian system with base 60 which still survives in our system of dividing the angular degree into minutes.

From time to time there has been some agitation to supplant the decimal system with the duodecimal system having 12 as its base, but the advantages of this system over the decimal system are scarcely material.

With the introduction of decimal fractions, the decimal system has been extended so that all positive numbers, integral, fractional and irrational, can be approximated to any desired degree of accuracy by a decimal number.

Thus

$$241\frac{37}{100} = 2.10^2 + 4.10 + 1.10^0 + 3.10^{-1} + 7.10^{-2} = 241.37$$

The decimal point precedes the digits which are coefficients of negative powers of 10. This is written as a period in the United States but is slightly raised (241·37) in Britain, while the French use a comma (241,37). (*See* NUMBER; NUMERALS AND NUMERAL SYSTEMS: FRACTION.)

Addition and Subtraction.—Numbers in decimal notation can easily be added by adding the coefficients of corresponding powers of 10, and then adjusting the coefficients which exceed 9 by the process known as carrying.

For example:

$$\begin{array}{lrrrrrr}
47.65 = & & 4.10 + & 7 + & 6.10^{-1} + & 5.10^{-2} & \\
5.473 = & & & 5 + & 4.10^{-1} + & 7.10^{-2} + & 3.10^{-3} \\
\underline{649.8} = & \underline{6.10^2 +} & \underline{4.10 +} & \underline{9 +} & \underline{8.10^{-1}} & & \\
\text{Sum} = & 6.10^2 + & 8.10 + & 21 + & 18.10^{-1} + & 12.10^{-2} + & 3.10^{-3}
\end{array}$$

After adjustment of the coefficients, this is

$$7.10^2 + 0.10 + 2 + 9.10^{-1} + 2.10^{-2} + 3.10^{-3} = 702.923$$

The process of addition is commonly carried out as follows.

$$\begin{array}{r} \underline{2\,1\,1} \\ 47.65 \\ 5.473 \\ \underline{649.8} \\ 702.923 \end{array}$$

Begin at the right. The sum of the coefficients of 10^{-3} is 3, which is written below the answer line. The sum of the coefficients of 10^{-2} is 12; the digit 2 is placed to the left of the 3 in the sum, but the 10 becomes a 1 in the preceding position and may be placed at the top of the column of coefficients of 10^{-1}, etc. In practice the "carrying" is usually performed mentally.

Subtraction is performed by reversing the above procedure. In order to subtract 170.8 from 563.142, place the smaller number

$$\begin{array}{r} 563.142 \\ \underline{170.8} \\ 392.342 \end{array}$$

under the larger with the decimal points under each other. Begin at the right. Since .8 = .800, 0 subtracted from 2 is 2 (which is written below the line) and 0 from 4 is 4. Since 8 exceeds 1, a unit is borrowed from unit's place (which changes the 3 to 2) and the 1 in tenth's place becomes 11. Then 8 from 11 is 3, 0 from 2 is 2, etc.

Multiplication.—Multiplication of decimal numbers is based upon the distributive law. Thus

$$\begin{aligned} 25.78 \times 7 &= 20 \times 7 + 5 \times 7 + .7 \times 7 + .08 \times 7 \\ &= 140 + 35 + 4.9 + .56 = 180.46 \end{aligned}$$

This process may be carried out as follows by a process known

$$\begin{array}{r} \underline{45\;5} \\ 25.78 \\ \underline{7} \\ 180.46 \end{array}$$

as short multiplication. Start at the right. Since $7 \times 8 = 56$, write 6 below the answer line, and place the 5 above the 7 in the multiplicand. Then $7 \times 7 = 49$, to which is added the 5 which was carried, making 54. The 4 is written in the answer, the 5 is carried as before. The numbers written above the top line are usually carried mentally.

If the multiplier has more than one digit, long multiplication is used. This process also is based upon the distributive law. The

$$\begin{array}{r} 25.78 \\ \underline{45.7} \\ 18046 \\ 12890 \\ \underline{10312} \\ 1178.146 \end{array}$$

first partial product is 18.046, which was obtained by multiplying 25.78 by .7 by short multiplication. The second partial product is $25.78 \times 5 = 128.90$; the third is $25.78 \times 40 = 1031.2$. The product is the sum of these partial products. It is customary to ignore the decimal point in these partial products but to indent each partial product one more place than the partial product above it. In the product, point off from the right as many digits as the sum of the number of digits to the right of the decimal point in the multiplicand and the number of digits to the right of the decimal point in the multiplier.

When only approximate accuracy is demanded, a shorter form of multiplication may be used. If measurements can be made

$$\begin{array}{r} 2.578 \\ \underline{.457} \\ 18 \\ 129 \\ \underline{1031} \\ 1.178 \end{array}$$

only to three decimal places, the accuracy of the product beyond three places is fictitious. The number 2.578 is rounded off to 2.6; then $6 \times 7 = 42$, which is rounded to 40, and the 4 is carried. Then $2 \times 7 + 4 = 18$, which is the first partial product. Next 2.578 is rounded off to 2.58, $8 \times 5 = 40$, again giving 4 to be carried; $25 \times 5 + 4 = 129$, which is the second partial product. In the last step 2.578 is not rounded off, $8 \times 4 = 32$, which gives 3 to carry and $257 \times 4 + 3 = 1.031$. The approximate product is the sum, 1.178. As many decimal places are pointed off from the right as there are in each of the given numbers, namely three.

Another short method which is useful in the hands of experts is as follows. Start at the right. Since $8 \times 7 = 56$, write 6 in the

$$\begin{array}{r} 25.78 \\ \underline{45.7} \\ 1178.146 \end{array}$$

answer and carry 5. Then $7 \times 7 + 8 \times 5 + 5 = 94$; write 4 and carry 9. Then $5 \times 7 + 7 \times 5 + 8 \times 4 + 9 = 111$; write 1 and carry 11. Then $2 \times 7 + 5 \times 5 + 7 \times 4 + 11 = 78$; write 8 and carry 7. Then $2 \times 5 + 5 \times 4 + 7 = 37$; write 7 and carry 3. Finally, $2 \times 4 + 3 = 11$, which is written down. The product is 1,178.146.

Division.—The division algorithm was mentioned earlier. If a and b are two whole numbers, $a > b$, there exist two whole numbers q and r such that

$$a = bq + r \qquad 0 \leqq r < b$$

The process of finding these numbers can be carried out by the processes called long and short division.

If $b < 10$, say $b = 7$, use short division. Let $a = 53{,}149$. Start at the left. Since $5 < 7$, consider the first two digits, 53. The

$$\begin{array}{r} 4\;6\,1\,5 \\ 7\,\overline{)\,53\;1\,4\,9} \\ 7\;5\,9\,2 \end{array}$$

largest multiple of 7 which is less than or equal to 53 is $49 = 7 \times 7$. Write 7 below the 3, and the remainder, $53 - 49 = 4$, above the 3. This remainder with the next digit in the dividend is 41; the largest multiple of $7 \leqq 41$ is $35 = 7 \times 5$. Write 5 below the 1 and the remainder $41 - 35 = 6$ above the 1. The last remainder is 5. Usually the remainders which have been written above the dividend are carried mentally and not written down.

It should be noted that this process involves guessing the largest multiple of the divisor which is less than a certain number. But only a few guesses are ever required and no practical difficulty is encountered.

Since $53{,}149 = 7{,}592 \times 7 + 5$, one may write

$$\frac{53{,}149}{7} = 7{,}592\tfrac{5}{7}$$

where 7,592 is the partial quotient and 5 is the remainder.

If the divisor exceeds 10, long division is preferable. Let it be required to divide 83,742 by 621. Since the largest multiple of $621 \leqq 837$ is 621×1, write 1 as the first digit of the quotient and subtract 621×1 from 837. Actually what is done is to subtract 621×100 from 83,742 leaving a remainder of 21,642. Since only the 2,164 will be used in the next step, the final 2 of the dividend need not be brought down yet. The largest multiple of $621 \leqq 2{,}164$ is $621 \times 3 = 1{,}863$, and the remainder is 301.

```
621) 83742 (134
     621
     2164
     1863
      3012
      2484
       528
```

Now the final 2 must be brought down to make 3,012. The largest multiple of $621 < 3{,}012$ is $621 \times 4 = 2{,}484$, and the remainder is 528.

Thus

$$83{,}742 = 621 \times 134 + 528$$

This method of long division can be condensed as follows by subtracting the partial product as it is formed:

```
621) 83 742  (134
     21 64
      3 012
        528
```

By this process it is possible to express an improper fraction as the sum of an integer and a proper fraction,

$$\frac{83\,742}{621} = 134\frac{528}{621}$$

If it is preferable to express the result as a decimal fraction carried out to any desired number of decimal places, the process is merely continued:

```
621) 83742 (134.8502
      2164
       3012
        5280
         3120
           1500
            258
```

$$\frac{83742}{621} = 134.8502$$

Any two numbers written decimally may be so divided. The number of digits to the right of the decimal point in the quotient is equal to the number of such digits in the dividend diminished by the number of such digits in the divisor, care being necessary to add to the dividend all 0s which are brought down. Thus in the above example

$$\frac{83742.0000}{621} = 134.8502$$

An alternative method for determining the position of the decimal point in the quotient is to write

$$\frac{83742}{621} = \frac{837.42}{6.21} = 134.8502$$

making the divisor lie between 0 and 10, whence it is obvious that the quotient lies between 100 and 1,000.

Square and Cube Root.—An algorithm for the determination of the square root of a decimal number is carried out as follows.

```
      15 78.42 (39.72
       9
  69 | 678
     | 621
 787 | 5742
     | 5509
7942 | 23300
     | 15884
        7416
```

Starting at the decimal point, the number is separated into periods of two digits each. The leftmost period is 15, and the largest square $\leqq 15$ is $9 = 3^2$. The 3 is written at the right and the remainder $15 - 9 = 6$ is brought down. The next period 78 is brought down beside the 6, giving 678. The 3 is doubled and written at the left. By trial it is found that 9 is the largest digit such that $69 \times 9 = 621 \leqq 678$. The 9 is written after the 3 in the answer, and the difference 57 is brought down, followed by the next period 42. The partial answer 39 is doubled and written at the left under the 69. By trial it is found that $787 \times 7 = 5{,}509 \leqq 5{,}742$ while $788 \times 8 > 5{,}742$. The next digit in the answer is therefore 7. The process is continued until the desired degree of accuracy is attained. In the present example the last remainder 7,416 exceeds half of the last trial divisor 7,942 so that 3 is a better approximation than 2 for the last digit. In fact $39.73^2 = 1{,}578.4729$.

The above process is based upon the relation $(a + b)^2 = a^2 + (2a + b)b$. In each step the part of the square root already obtained is a; the part remaining to be found is b. In the example, $(a + b)^2 = 1{,}578.42$, $a = 30$. Then $2ab + b^2 = 678.42$. In order to determine the largest integer n in b, one must find the largest integer n (namely 9) such that $(2a + n)n \leqq 678.42$. The trial divisor is $2a + n = 69$. In the next step $a = 39$, $2ab + b^2 = 57.42$ etc.

Cube and Higher Roots.—The cube root of a number may be calculated by a similar algorithm based upon the relation

$$(a + b)^3 - a^3 = (3a^2 + 3ab + b^2)b$$

Thus to find the approximate cube root of 279,463, proceed as in the example.

```
          279 463.000 (65.38−
          216
    10800 | 63 463
      900 |
       25 |
    11725 | 58 625
  1267500 | 4 838 000
     5850 |
        9 |
  1273359 | 3 820 077
127922700 | 1 017 923 000
   156720 |
       64 |
128079484 | 1 024 635 872
```

This last remainder is too large, but much closer than the remainder resulting from using 7 as the last digit.

A fourth root is easily obtained as the square root of the square root. Fifth and higher roots can be obtained by an algorithm similar to those just given, based upon the expansion of $(a + b)^n$ by the binomial theorem. The method is cumbersome and is seldom used, for the method of logarithms is easy and rapid.

In fact, if tables of logarithms are not available, the fifth root of a (for instance) can be quite quickly found by solving the equation $x^5 - a = 0$ by Newton's or Horner's method. (*See* EQUATIONS, THEORY OF.)

Checking.—An easy and fairly reliable check applicable to any arithmetic calculation is based upon the method of "casting out nines." This method, presumably of Hindu origin, has been known for a thousand years. The proof of its validity may be found in any book on the theory of numbers.

Let a and m be any positive integers. By the division algorithm there is a unique least positive remainder a' such that

$$a = qm + a' \qquad 0 \leqq a' < m$$

Similarly let b determine the least positive remainder b', and let c similarly determine c'. If $a + b = c$, then $a' + b'$ has the same least positive remainder c' as does c; if $ab = c$, then $a'b'$ likewise determines c'; and if $a^n = c$, then a'^n determines c'.

If $m = 9$ is chosen, the check is particularly simple to apply for then 10, 100, 1,000, . . . each have the least positive remainder 1 so that every number determines the same least positive remainder as does the sum of its digits.

Consider the multiplication problem of the section on multiplication, $25.78 \times 45.7 = 1{,}178.146$. Let $a = 2{,}578$, $b = 457$, $c =$ 1,178,146. Then $a' = 4$, $b' = 7$, $c' = 1$. To find c', for instance, add the digits of c, getting 28; the sum of the digits of 28 is 10; the sum of the digits of 10 is 1, so that $c' = 1$. Now $a' \times b' = 28$ also determines 1, which checks the multiplication. It does not, of course, check the placing of the decimal point.

Consider the square root problem of the section on square root. We found that the approximate square root of 1,578.42 was 39.72 with a remainder of 7,416. Let $a = 157{,}842$, $b = 3{,}972$, $r =$ 7,416. Then $a' = 0$, $b' = 3$, $r' = 0$. To check, $b'^2 + r'$ must have the same least positive remainder as a, namely 0, which it does.

It should be remembered that this check is not infallible. The problem may be incorrect and still check, but this situation will occur only if the error is divisible by 9. But if the problem does not check, either the problem or the check necessarily contains a numerical error.

Logarithms.—If $10^x = n$, then x is called the (common) logarithm of n, written $x = \log n$. Except for a very few numbers n the logarithm of n is irrational and is usually represented by its decimal approximation. Since logarithms are fully treated elsewhere (*see* LOGARITHMS) their applications to arithmetic will be only briefly sketched.

Since $\log xy = \log x + \log y$, the product of two numbers is quickly obtainable by logarithms. Using four-place tables, it is

found that

$$\begin{aligned} \log\ 2.578 &= .4113 \\ \log\ .457 &= 9.6599 - 10 \\ \hline &.0712 = \log\ 1.178 \end{aligned}$$

Hence the product $2.578 \times .457$ is equal to 1.178 to four significant figures.

Similarly division may be performed by subtracting logarithms. If accuracy to five significant figures is desired, five-place logarithms must be used. Thus

$$\begin{aligned} \log\ 837.42 &= 2.92294 \\ \log\ 6.21 &= .79309 \\ \hline &2.12985 = \log\ 134.85 \end{aligned}$$

so that $837.42 \div 6.21 = 134.85$.

Perhaps the most spectacular common use of logarithms is in finding powers and roots. This application is based upon the relation

$$\log x^k = k \log x$$

For $k = 1/3$, $\log \sqrt[3]{x} = \frac{1}{3} \log x$. Using six-place tables,

$$\begin{aligned} \log\ 279{,}463 &= 5.446324 \\ 1/3\ \log\ 279{,}463 &= 1.815441 = \log\ 65.3795 \end{aligned}$$

Thus $\sqrt[3]{279{,}463} = 65.3795$ to six significant figures.

In addition to the various related articles cited above, *see* MATHEMATICS, HISTORY OF. For mechanical and electronic computing devices, *see* ABACUS; SLIDE RULE; COMPUTER; MATHEMATICAL INSTRUMENTS; and OFFICE MACHINES AND APPLIANCES. *See* also references under "Arithmetic" in the Index.

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ARIUS (d. *c.* A.D. 335), Christian priest at Alexandria who was the originator of Arianism (*q.v.*), the theory that Christ, the Son of God, is not divine but a created being. Born in Libya, and possibly a pupil of Lucian of Antioch, Arius was made a deacon at Alexandria under the bishop Peter (300–311), but was excommunicated for his association with the Meletians (*see* MELETIUS), being restored under Achillas (311–312) and advanced to the priesthood in charge of the church of Baucalis.

Arius came into conflict with Bishop Alexander (312–328), according to some scholars in 318, according to others in 323. The sequence of events is uncertain, but if 323 is accepted, a reasonable chronology can be presented. In Aug. 323 Alexander investigated Arius' teaching. Arius then wrote to Eusebius of Caesarea (*q.v.*) seeking his support and also to Eusebius of Nicomedia (*q.v.*), a statesman-bishop who had the ear of Constantia, sister of the emperor Constantine I and wife of Licinius. In September a synod of Alexandrian clergy condemned his teaching. Meanwhile another synod in Palestine obtained an undertaking from the Arians that they would refrain from public disputation, together with a doctrinal statement upon which a truce could be negotiated. Alexander accepted this. In October another synod met in Bithynia under Eusebius of Nicomedia and declared that the dissidents should be admitted to communion. Alexander replied in March 324 with a provincial synod, which did not repudiate the truce but anathematized the Arians as a "hands off" sign to overseas bishops.

Arius published his *Thalia* (extant only in so far as it is quoted by Athanasius), partly in verse, to further his views, and in September himself repudiated the truce. In November the emperor decided to intervene, sending Ossius of Cordova, who satisfied himself of the rightness of Alexander's position. In Feb. 325 Arius was condemned by a synod at Antioch, and in March he followed Alexander to Nicomedia. The emperor then summoned an ecumenical council, which met on May 20 at Nicaea and condemned Arius and his teaching (*see* COUNCIL). Arius forthwith was banished to Illyricum, and although he continued to teach there, converting to his ideas such men as Valens of Mursa and Ursacius of Singidunum, he no longer had a principal part to play in the controversy he had originated.

It was not until 332 or 333, after much intrigue, that Constantine wrote to Arius expressing a wish to see him. Arius was mistrustful, but in 335, on receipt of a second letter, he went to Nicomedia and presented a confession of faith which the emperor considered sufficiently orthodox to warrant the reopening of his case. At the synod of Jerusalem, which followed the dedication of the Church of the Resurrection, Arius was declared restored to communion but is said to have died in Constantinople on the eve of the day when he was to be readmitted.

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ARIZONA, the "Grand Canyon state," is situated in the southwestern part of the United States between approximately 31° 20′ and 37° N and 109° 2′ and 114° 45′ W. It is bounded north by Utah, east by New Mexico, south by Mexico, and west by California and Nevada, the Colorado River separating it from California and in part from Nevada. Of its total area of 113,909 sq.mi. (water surface, 334 sq.mi.), approximately 39,000 are less than 3,000 ft. above sea level, 27,000 are from 3,000 to 5,000 ft., and 47,000 are above 5,000 ft. The popular name "Apache state" was also given it as the home of the Apache Indians. Arizona is the 6th state of the Union in size. The state capital is Phoenix.

Arizona entered the Union in 1912, as the 48th state. The state flower is the flower of the saguaro cactus; the state tree, the paloverde; and the state bird, the cactus wren. The name Arizona comes from the Indian *arizonac* meaning "little spring."

PHYSICAL GEOGRAPHY

General Features.—Three characteristic physiographic regions are distinctly marked: first, the great Colorado plateau, about 45,000 sq.mi. in area, in the northern part of the state; next, a broad zone of compacted mountain ranges with a southern limit of similar trend; and, lastly, a region of desert plains, occupying the southwestern quarter of the state. The plateau is not a plain. It is dominated by high mountains, gashed by superb river canyons, scarred with dry gullies and washes, the beds of intermittent streams, varied with great shallow basins, sunken deserts, dreary levels, bold buttes, picturesque mesas, forests, and rare verdant bits of valley. The surface in general is rolling, and drains through the Little Colorado (or Colorado Chiquito), Rio Puerco, and other streams into the Grand Canyon (*q.v.*). Along the Colorado is the Painted Desert (*q.v.*), remarkable for the bright colours—red, brown, blue, purple, yellow, and white—of its sandstones, shales, and clays. Within the desert is a petrified forest of Mesozoic time, the most remarkable in the U.S. The marks of volcanic action, particularly lava flows, are abundant and widely scattered.

Separating the plateau from the mountain region is an abrupt transition slope, often deeply eroded, crossing the entire state in a northwest-southeast direction. In localities the slope is a true escarpment falling 150 and even 250 ft. per mile. The mountain region has a width of 70 to 150 mi. and is filled with short ranges parallel to the plateau escarpment. Many of the mountains are extinct volcanoes. The southeastern corner of Arizona is a region of greatly eroded ranges and gently sloping valleys. This mountain zone has an average elevation of not less than 4,000 ft., while in places its crests are 5,000 ft. above the plains. These plains, the third or desert region of the state, have their mountains also, but they are lower and not compacted. The plains near the mountain region slope toward the Gulf of California across wide valleys separated by isolated ranges, then across broad desert stretches traversed by rocky ridges, and finally there is no obstruction to the slope at all.

Climate.—Arizona's climate is marked by extreme variety, re-

MARKOW

STATE CAPITOL AT PHOENIX. THE BUILDING AT CENTRE DATES FROM 1900; THE TWO WINGS, OCCUPIED BY THE SENATE AND THE HOUSE OF REPRESENTATIVES, WERE COMPLETED IN 1960

sulting from the wide range of elevations (from 12,670 ft. at the top of Humphrey's Peak in the San Francisco Mountains to 138 ft. at Yuma) and the approximately 400-mi. difference in latitude from the northern to the southern boundaries of the state. The general classification, however, is arid or semiarid.

Maximum annual precipitation is represented by Crown King's 32.42 in., while the true desert regions are represented by Yuma's 3.10 in. Temperatures in the desert often are higher than those at the Equator, while minimums in Arizona's mountains not infrequently are the lowest recorded in the United States on a given day. Phoenix, typical of the less extreme desert regions, is 1,117 ft. above sea level, and has an annual average temperature of 69° F. Its annual 7.20 in. of precipitation comes principally in July, August, and September, and December, January, and February. Annual relative humidity is fairly constant through the year at 38%, while Phoenix enjoys an annual average of 86% of possible hours of sunshine. Flagstaff, at an altitude of 6,907 ft., is typical of northern Arizona with an annual mean temperature of 45.7° F. Annual precipitation at Flagstaff is 18.31 in. Flagstaff averages 79% of possible hours of sunshine, and its annual average of snowfall totals 74.3 in.

Rainfall comes from the Gulf of Mexico in summer and from the Pacific Ocean or the Gulf of California in winter. Heavy thunderstorms and accompanying cloudbursts are not uncommon in season, and frequently convert the arroyos (dry stream beds) throughout the state into swirling, muddy torrents, occasionally causing flood damage. Sudden spring thaws of mountain snows sometimes flood such streams as the Little Colorado River, the Bill Williams, Oak Creek, the Rio Puerco, and the Hassayampa.

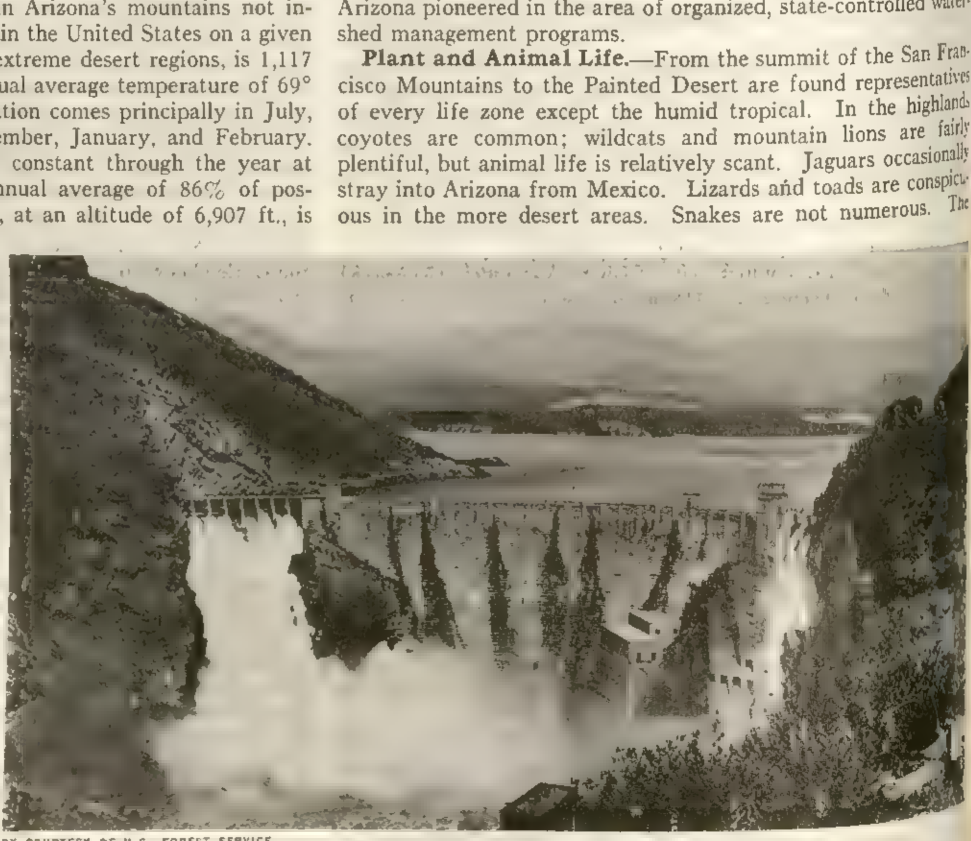
Arizona's diurnal temperature variation is typical of arid and semiarid regions where radiation is rapid. Frequently it is as much as 50° to 60° F. The dry, clear air is one of Arizona's major attractions as a year-round health and vacation resort.

Soil and Irrigation.—The great bulk of Arizona's acreage is composed of mountainous forest and woodland in the northern plateaus, and of desert and grassland in the south and west. The bottomland and lower valleys are very fertile. Since most of the agricultural land is in the semiarid region, water has been the vital problem. Because of the arid climate, the soil is alkaline and contains from 2% to 10% calcium carbonate.

The early melting of the mountain snow makes reservoirs necessary. Several dams were built in early territorial days and frequently destroyed by floods. The Roosevelt Dam, the key structure of the Salt River project, was completed in 1911. It was the first sound construction and was followed by others on the same river. Hoover (Boulder) Dam was completed in 1936. The Upper Colorado Basin compact was completed in 1948 and approved by Arizona in 1949.

Because of the rapidly lowering groundwater level, the Arizona legislature enacted early in the 1950s laws governing the drilling of wells in an attempt to stabilize the declining underground water table. The number of acres irrigated in the state was estimated at more than 1,000,000 in the second half of the 20th century. Arizona pioneered in the area of organized, state-controlled watershed management programs.

Plant and Animal Life.—From the summit of the San Francisco Mountains to the Painted Desert are found representatives of every life zone except the humid tropical. In the highlands coyotes are common; wildcats and mountain lions are fairly plentiful, but animal life is relatively scant. Jaguars occasionally stray into Arizona from Mexico. Lizards and toads are conspicuous in the more desert areas. Snakes are not numerous. The



BY COURTESY OF U.S. FOREST SERVICE

THE ROOSEVELT DAM ON THE SALT RIVER; COMPLETED IN 1911

Gila monster, tarantula, and scorpion occur in some localities in the rainy season.

A narrow belt along the lower Colorado River, with a short arm extending into the valley of the Gila, supports desert birds and mammals and other desert life. The largest native predator, the grizzly bear, and the most dangerous predator, the lobo wolf, have been hunted to virtual extinction. The native elk met a similar fate, but Arizona now supports a large population of transplanted Wyoming elk. Other large animals found in Arizona include the prong-horned antelope, several varieties of deer, the black and brown bears, and the javelina (a wild boar).

The general conditions of distribution of plant and animal life are shown even more distinctly by the vegetation. There are firs and spruces on the mountains, pines farther down, and piñon juniper, greasewood, and sagebrush in the north, extending as far south as Flagstaff. In southern and western Arizona the giant saguaro cactus grows in groves, attaining a height of 40 and even 50 ft. In many localities the mesquite is the only important native tree. But it is easy to exaggerate the barrenness of an arid country. There are fine indigenous grasses that spring up over the mesas after the summer rains, furnishing range for livestock; some of these grasses are extraordinarily independent of the rainfall. The cliff-dweller country supports a scant vegetation—a few cottonwoods in the washes, some cedars on the mesas.

Continuous forest areas are few. A fair variety of trees—cottonwood, sycamore, ash willow, walnut, and cherry—grow in thickets in the canyons, and each mountain range is a forest area. The lower timberline is about 7,000 ft. and the upper timberline about 11,500 ft. Of Arizona's total area, about 42% supports typical desert vegetation; about 23% is grassland; about 19% is piñon and juniper forest, 9% other forest, and 7% chaparral. From 1898 almost all of the wooded lands were made reservations, and work was done also to preserve the forest areas in the mountains in the southeast, from which there are few streams of permanent flow to the enclosing arid valleys.

Parks and Monuments.—There are a number of national monuments, and Grand Canyon and Petrified Forest National parks, administered by the National Park Service. Prehistoric cliff dwellings are preserved at Canyon de Chelly, Montezuma Castle, Navajo, and Tonto National monuments; cliff dwellings built between A.D. 900 and 1100 are preserved in Walnut Canyon National Monument. A prehistoric pueblo city may be seen at Casa Grande National Monument, and pueblos of more recent occupation (*c.* A.D. 1200) may be seen at Tuzigoot and Wupatki National monuments. Among the natural wonders protected by the national government are the natural rock pinnacles of Chiricahua National Monument; the extinct volcano, ice caves, and lava flows of Sunset Crater National Monument; the petrified trees, Painted Desert, and Indian ruins of Petrified Forest National Park; more than 80 sq.mi. of giant cacti in Saguaro National Monument; and a 330,870-ac. desert supporting the unique cacti of Organ Pipe Cactus National Monument. Tumacacori National Monument houses the ruins of one of the earliest Spanish missions in the territory; and a 40-ac. tract dedicated to American pioneers in Arizona has been preserved as Pipe Spring National Monument. One of the last states to do so, Arizona established in 1957 a state park board to set aside and administer state park areas.

HISTORY

Prehistory.—The history of the southwest is full of interest to the archaeologist. The dryness has preserved invaluable evidences of early cultures which, in other climates, would have disintegrated rapidly. Seeds, cloth, baskets, and even human mummies have been discovered in most sections of the state, giving proof that several well-advanced ancient cultures flourished. Many of the more notable sites of these cultures are preserved as national monuments and parks.

Earliest prehistoric culture proved to have existed in the southwest was the Sandia, which centred in New Mexico *c.* 25,000 B.C. and which quite possibly spread into Arizona and other present states. From about 25,000 to about 10,000 B.C. the Folsom people were in the area, while Yuman people thrived in Colorado.

AUTHENTICATED NEWS INTERNATIONAL

MONTEZUMA CASTLE NATIONAL MONUMENT, NEAR CAMP VERDE, A FIVE-STORY, 20-ROOM SERIES OF CLIFF DWELLINGS DATING FROM ABOUT A.D. 1100

Both probably came into what is now Arizona. They were followed by the increasingly complex Cochise, Hohokam, and Anasazi cultures which have received remarkably detailed study.

The cooperative aspects of the Hohokam culture are demonstrated in the great public works these people built in the Gila and Salt River valleys. They constructed dwellings and extensive systems of dams and ditches for irrigation purposes. In many cases the courses of their canals, laid out with only the crudest of instruments, are followed exactly by modern irrigation waterways.

The Apaches and the Navahos, both primarily nomadic and predatory, appeared in Arizona probably between A.D. 1000 and 1300. The Hohokam culture, which had absorbed such other peoples as the Sinaguans and the Salados from the north disappeared about 1450, probably as a result of a combination of drought, Apache raids, and possibly sickness. Evidence supports the belief that some of the modern Indian tribes of central Arizona are their direct descendants (*see* also INDIAN, NORTH AMERICAN).

Arizona north of the Gila, except for a very limited and intermittent missionary effort and for scant exploring expeditions, was practically unknown to the white man until well after the beginning of rule by the United States. The Santa Cruz Valley, however, has much older annals of a past that charms by its picturesque contrasts with the present.

Spanish Settlement.—Arizona history begins with the arrival in Sonora in 1536 of Alvar Núñez Cabeza de Vaca, whose stories of Arizona and New Mexico incited the Spaniards to explore the unknown north in hope of finding the wealth of the fabled Seven Cities of Cibola. Marcos de Niza, a Franciscan friar to whom the first reconnaissance was entrusted, was, in 1539, the first Spaniard to enter the limits of Arizona. Members of Francisco Vázquez de Coronado's expedition (1540–42) explored the Moqui country and reached the Grand Canyon, and after this a succession of remarkable and heroic explorations followed through the century. All this has left traces in still-living myths about the early history of the southwest. Early in the 17th century considerable progress had been made in Christianizing the Pimas, Papagoes, and Moquis. Following 1680 came a great Indian revolt in New Mexico and Arizona, and thereafter the Moquis remained independent of Spanish and Christian domination, although visited occasionally by rival Jesuits and Franciscans. During this period Jesuit missions

BY COURTESY OF (ABOVE) SUNSHINE CLIMATE CLUB, (BELOW) SANTA FE RAILWAY; PHOTOGRAPH, (RIGHT) JOSEF MUENCH

PARKS AND MONUMENTS

(Above) Cacti in Saguaro National Monument near Tucson. (Right) Kaibab Bridge over the Colorado River at the mouth of Bright Angel Creek in Grand Canyon National Park; Zoroaster Temple is in the centre background. (Below) El Capitan at the south entrance to Monument Valley on the Navajo National Monument

were founded at San Xavier del Bac and Guevavi, but in 1767 the Jesuits were banned from Spanish dominions and superseded by the Franciscans. The region south of the Gila had already been repeatedly explored. In the second half of the 18th century there were a presidio at Tubac and about six *pueblos de visita,* including the Indian settlement of Tucson.

Persistent traditions have greatly exaggerated the former prosperity of the old southwest. The Spaniards probably provoked some intertribal dealings among the Indians, and encouraged agriculture in several tribes. Their own farms and settlements, confined to the Santa Cruz Valley, were often plundered and abandoned, except in the immediate vicinity of the presidio. From about 1790 to 1822 there was a period of peace with the Apaches and of comparative prosperity for church and state. The fine Indian mission church at San Xavier del Bac, long abandoned and neglected, was rebuilt in 1783–97.

In 1752 the first post of Spanish authority on Arizona soil was established as a presidio at the ancient Indian village of Tubac, just north of the Mexican border, on the Santa Cruz River. The establishment of a presidio at Tucson in 1776 marks its beginning as a Spanish settlement, which it remained until 1821 when Mexican independence was granted. The decay of the military power of the presidios during the Mexican War of Independence, the expulsion of loyal Spaniards—notably friars—and the renewal of Apache wars led to the temporary abandonment of all settlements except Tubac and Tucson. The church practically forsook the field about 1828.

United States Entry.—American traders and explorers including Sylvester and James O. Pattie, Bill Williams, Kit Carson, Ewing Young, Pauline Weaver, and Al Sieber first penetrated Arizona in the first quarter of the 19th century. As a result of the Mexican War, New Mexico, which then included all Arizona north of the Gila, was ceded to the U.S. (1848). California gold discoveries drew particular attention to the country south of the Gila, which was wanted also for a transcontinental railway route. This strip was bought in 1853 by the U.S., which took possession in 1856. (*See* GADSDEN PURCHASE.) This portion also was added to New Mexico. The Mexicans, pressed by the Apaches, had in 1848 abandoned Tubac and Tumacacori, first a *visita* of Guevavi, and after 1784 a mission. The progress of U.S. settlement was interrupted by the Civil War, which caused the withdrawal of the troops and the outbreak of prolonged Indian wars.

Meanwhile, a convention at Tucson in 1856 sent a delegate to Congress and petitioned for independent territorial government. The movements that followed were ignored by Congress because of the general slavery question, and especially the belief of northern members that the control of Arizona was an objective of the proslavery party. In 1862 Arizona was established as a separate territory by the Confederate Congress, but Union forces reoccupied Tucson later that year. Congress organized Arizona territory on Feb. 24, 1863, as the country west of 109° W longitude which remained the state's eastern boundary. In December an itinerant government headed by Gov. John N. Goodwin, sent out from Washington, D.C., entered Arizona and effected a formal organization. The territorial capital was first at Prescott and after 1889 at Phoenix.

There were boundary difficulties with every contiguous state or territory. The early period of U.S. rule was extremely unsettled. The California gold discoveries (1849) and overland travel directed many prospecting adventurers to Arizona. For several years there was considerable sentiment in favour of filibustering in Sonora, Mex. The Indian wars, breeding a habit of dependence on force, and the heterogeneous elements of cattle thieves, Sonora cowboys, mine labourers, and adventurers led to one of the worst periods of U.S. border history.

Admission to the Union.—Agitation for statehood, which began as early as 1872, seemed on the point of success in 1891, when a constitution was drafted, submitted to the people of the state, and ratified. The U.S. Senate objected to this constitution because

BY COURTESY OF TUCSON CHAMBER OF COMMERCE; PHOTOGRAPH, RAY MANLEY

INDIAN MISSION CHURCH AT SAN XAVIER DEL BAC, FOUNDED IN 1700 BY PADRE EUSEBIO KINO; REBUILT, 1783–97

it seemed to repudiate certain contracts and set up a double monetary standard. The Senate continued to reject bills providing for statehood until the state sent up a new constitution in 1910. The constitution raised a question of national importance in the form of a provision for the recall of judges by popular vote. After much argument Pres. William Howard Taft and Congress finally agreed on a resolution granting statehood on condition that the provision for recall be struck out. This was done, and on Feb. 14, 1912, the president signed the proclamation admitting Arizona as a state. After admission the people of the state promptly inserted by amendment the original provision for the recall of judges.

George W. P. Hunt, chairman of the Constitutional Convention and a Democrat, was elected as first governor of Arizona in December 1911. His securing for labour certain contested clauses in the constitution won for him the support of that faction. He was reelected in 1914 and in 1916 was a candidate for the third time, but was declared defeated by Thomas E. Campbell, a Republican. After a bitter struggle the state supreme court decided in December 1917 that Hunt had been elected. In 1918 Campbell was elected the first Republican governor.

The political struggle reflected a tense industrial situation. In 1915 a serious strike occurred at Clifton-Morenci in the copper-mining district, and several other camps were struck in the next two years. In 1917 the Industrial Workers of the World (IWW) gained considerable strength in the state and struck a number of mines. A major strike at Bisbee was climaxed by the Bisbee deportation (July 12, 1917) in which more than 1,250 men suspected of being members of the IWW were loaded on railroad cattle cars and boxcars and escorted to Columbus, N.M. The incident became a *cause célèbre*, and repercussions were felt as late as World War II. Arizona mines were not effectively unionized until the mid-1930s. Meanwhile, the railroad brotherhoods and numerous other unions were growing. After 1945 unionization was accelerated by the arrival of many union members during Arizona's postwar population boom, and by the concurrent tremendous increase of industrialization and building in the state.

Colorado River Controversy.—A major problem confronting the state after 1920 was the disposal of the Colorado River water for irrigation and power. The problem was more critical because of the state's location on the Lower Colorado and its inability to develop hydroelectric plants. Governor Hunt, who was elected to the position of chief executive for seven terms, opposed the Colorado River compact and the construction of Hoover Dam on the grounds that Arizona might lose much-needed water that could by agreement go to Mexico. The Parker Dam was also opposed, since it would send Arizona water to Los Angeles, Calif. Arizona in 1931 brought suit to prevent construction on the grounds that the Colorado was a navigable river, but the U.S. Supreme Court subsequently dismissed the case. In 1948 an appropriation was made to aid the Arizona Interstate Stream Commission to stop California's effort "to use all the water in the river." An agreement of the states of the upper basin was reached in 1949, but disputes over the use of the Colorado River continued into the second half of the 20th century. (See *Soil and Irrigation*, above.)

From its admission to the Union, Arizona voted primarily Democratic, especially in local and state elections. From 1930 until 1950 Democrats won every gubernatorial election in the state. After mid-20th century, Republicans gained, winning the governorship in 1950, 1952, and in 1958, 1960, 1962, and 1966.

GOVERNMENT

Arizona was acquired from Mexico in 1848 and became a separate territory in 1863. From that time until attainment of statehood its organic law consisted of sections of the revised statutes of the U.S. While the territory was Democratic, its administrative officials were Republican; so the territorial governor worked with a legislature of the opposite party. One important control was the Arizona rangers, organized in 1901 to protect the cattle interests against thieves. Licensed public gambling was prohibited by law in 1907, but later became a vital issue until an attempted constitutional amendment legalizing gambling was defeated at the election of 1950. The Constitution specifically protected child labour.

Constitutional amendments of 1912 provided for recall of judges and for woman suffrage; an amendment (1914, 1916) provided for prohibition but was repealed by referendum in 1932; an attempt to secure local option was defeated in 1950 by popular election. The death penalty, abolished in 1916 as a liberal political issue, was restored in 1918, and in 1933 there was ratified a constitutional amendment making lethal gas the state's mode of capital

BY COURTESY OF ARIZONA STATE MUSEUM

NETWORK OF IRRIGATION CANALS IN THE GILA RIVER VALLEY, NEAR SNAKETOWN, BUILT BY THE HOHOKAM IN THE EARLY CENTURIES OF THE CHRISTIAN ERA

After extensive study and photographing by the University of Arizona, the entire Snaketown excavation site was recovered with earth in 1965 to protect it from weather and vandalism

punishment. In 1947 provision was made for the election of the state's two congressmen (three after the 1960 census) by districts instead of at large. Both houses of the Legislature were reapportioned on the basis of population by federal court action in 1966.

Finance and Taxation.—After mid-20th century the state's receipts from all sources amounted to over $450,000,000 annually. Property taxes and sales taxes were the main sources of the state's revenue. General expenditures totaled about $400,000,000 annually, of which about $157,000,000 was spent on education. At the same time the state's gross debt was reduced to less than $50,000. The state's income in the 1960s was about ten times as great as it had been just prior to World War II. In the same period per capita income increased from less than $500 (just over 80% of the national average) to about $2,300, approaching the average for the nation as a whole. Sources of income were manufacturing, mining, crops, tourism, and livestock, in that order. Annual income from the tourist industry had reached $250,000,000 by 1960.

POPULATION

General.—The population of Arizona in 1870 (the first census after the state was incorporated as a territory, 1863) was less than 10,000. By the beginning of the 20th century it was more than 122,931. By 1920 (the first census after the state entered the Union) it had almost tripled and totaled 334,167; the population ranked 45th among the states and was two-thirds rural. During the succeeding 20 years Arizona's population increased gradually; by 1940 it was 499,261, still ranked 45th in the Union and was still two-thirds rural. The state's rate of growth increased markedly after World War II, primarily because of increased industrialization. By 1950 the population totaled 749,587, ranked 37th in the Union and was 55.5% urban. Continuing its rapid growth, the state's population exceeded 1,000,000 after mid-20th century. By 1960 it totaled 1,302,161, ranked 35th in the union and was 74.5% urban. Always one of the most sparsely settled of the United States, there were only 11.4 residents per square mile in 1960. Only New Mexico, Montana, Wyoming, Nevada, and Alaska were less densely populated. In 1960 the population of the state was distributed by colour and nativity as follows: 72.2% native white; 17.6% foreign-born white; and 10.2% nonwhite (Indians 6.9%; Negroes 3.3%). Phoenix and Tucson (*qq.v.*) are the only standard metropolitan statistical areas.

*Arizona: Places of 5,000 or More Population (1960 Census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	1,302,161	749,587	499,261	334,167	122,931
Ajo	7,049	5,817	—	—	—
Avondale	6,151	2,505	—	—	—
Bisbee	9,914	3,801	5,853	9,205	—
Casa Grande	8,311	4,181	1,545	948	—
Chandler	9,531	3,799	1,239	—	—
Douglas	11,925	9,442	8,623	9,916	—
Flagstaff	18,214	7,663	5,080	3,186	1,271
Glendale	15,696	8,179	4,855	2,737	—
Globe	6,217	6,419	6,141	7,044	1,495
Mesa	33,772	16,790	7,224	3,036	722
Nogales	7,286	6,153	5,135	5,199	1,761
Phoenix	439,170	106,818	65,414	29,053	5,544
Prescott	12,861	6,764	6,018	5,010	3,559
Scottsdale	10,026	2,032	—	—	—
South Tucson	7,004	2,364	1,066	—	—
Tempe	24,897	7,684	2,906	1,963	885
Tucson	212,892	45,454	35,752	20,292	7,531
Winslow	8,862	6,518	4,577	3,730	1,305
Yuma	23,974	9,145	5,325	4,237	1,519

*Populations are reported as constituted at date of each census.
Note: Dash indicates place did not exist during reported census, or data not available.

Indians.—The Indian population has increased steadily since 1900, but its proportion relative to that of the state as a whole has decreased from more than 20% in 1900 to less than 10% by mid-20th century. Nevertheless Arizona's Indian population was larger than that of any state in the union.

The Indians are organized in 15 tribes, divided into three language groups: Athabascan (Navaho and Apache); Yuman (Mohave, Yuma, Cocopa, Maricopa, Walapai, Yavapai, and Havasupai); Uto-Aztecan (Pima, Papago, Hopi, Paiute, Chemehuevi, and Yaqui). The Pimas and Papagoes figured much in early Arizona history; the Hopis or Moquis are of unusual interest for their prehistoric culture (Tusayan); the Navahos and kindred Apaches were perhaps the most relentless and savage of Indian warriors.

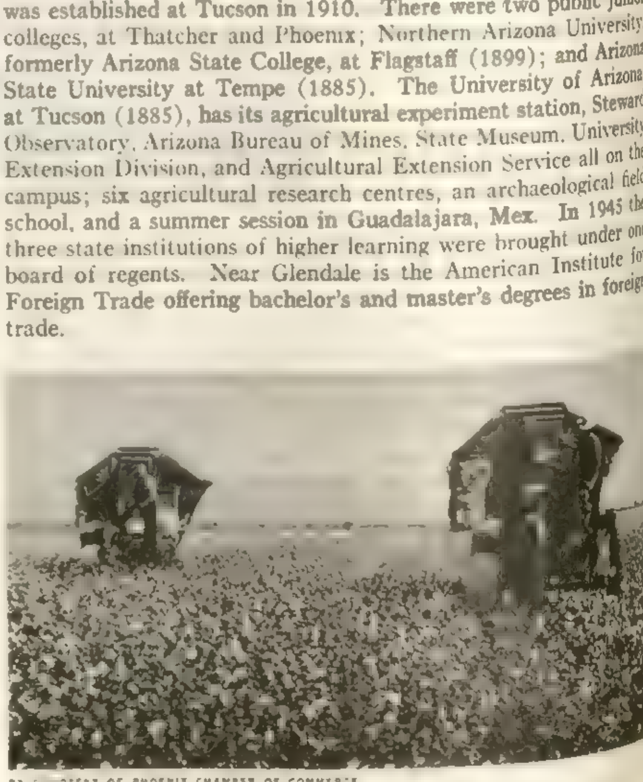
After 1900 a few hundred Yaquis, because of difficulties with the Mexican government, settled in southern Arizona.

The 19 Indian reservations in the state occupy a total of 30,845 sq.mi., slightly more than 25% of Arizona land. The largest is the Navaho reservation in northeastern Arizona. It is a huge, barren area in which the nomadic Navahos raise a few goats and sheep. During the uranium rush of the late 1940s and the 1950s, rich deposits were found on their land. There has also been considerable prospecting for oil in the area. The Hopi reservation lies in the middle of the Navaho tract and is surrounded by it. The Apaches occupy two reservations in the east-central portion of the state, their lands varying from warm valleys to high mountains. The several reservations along the Colorado River provide potentially rich agricultural lands, as do those in the irrigated central valleys. Most of these lands are leased to large farm operators. By far the most picturesque reservation is that in Havasu Canyon, a deep and colourful adjunct to the Grand Canyon of the Colorado. It is reached only by a narrow trail.

EDUCATION

A few school districts of Arizona were established as early as 1864, and a definite public-school system was adopted in 1871. At the time of statehood (1912) land grants of more than one-ninth of the state's area were made for education. Public-school education was made available to pupils between 6 and 21 years of age, and from 1921 compulsory attendance was required of pupils between 8 and 16 years of age. In 1936 requirements for elementary teaching certificates were designated as four years beyond high school, and for high-school teachers, five years. Because of its climate, many private schools have been located in Arizona. In the 1960s there were 58 federal schools for Indians (34 day schools, 17 boarding schools, and 7 boarding-day schools) with an enrollment of about 7,500. In addition there were Indians in attendance at public schools and mission schools.

The Arizona State Industrial School for boys was located at Ft. Grant in 1913, more than half the inmates being of Mexican-American descent. The Arizona State School for Deaf and Blind was established at Tucson in 1910. There were two public junior colleges, at Thatcher and Phoenix; Northern Arizona University, formerly Arizona State College, at Flagstaff (1899); and Arizona State University at Tempe (1885). The University of Arizona at Tucson (1885), has its agricultural experiment station, Steward Observatory, Arizona Bureau of Mines, State Museum, University Extension Division, and Agricultural Extension Service all on the campus; six agricultural research centres, an archaeological field school, and a summer session in Guadalajara, Mex. In 1945 the three state institutions of higher learning were brought under one board of regents. Near Glendale is the American Institute for Foreign Trade offering bachelor's and master's degrees in foreign trade.



BY COURTESY OF PHOENIX CHAMBER OF COMMERCE

HARVESTING COTTON NEAR MESA, SOUTH CENTRAL ARIZONA

BY COURTESY OF TUCSON CHAMBER OF COMMERCE. PHOTOGRAPH, RAY MANLEY

THE LAVENDER PIT, ONE OF SEVERAL OPEN-PIT COPPER MINES NEAR BISBEE, SOUTHEASTERN ARIZONA

THE ECONOMY

Agriculture.—Because of the long seasons, semitropical climate, and irrigation, farming in Arizona has been varied and intensive. Arizona derives most of its agricultural income from crops, which were followed in value by truck farming and livestock raising. Crops include dates, cotton lint and cottonseed, alfalfa (which yields four to seven cuttings a year), hay, barley, flaxseed, grain sorghums, potatoes, wheat, grapefruit, and oranges. Cotton was first grown commercially in the state just before World War I, but by mid-20th century it was Arizona's most important cash crop. In the 1960s only about 14% (approximately 10,000,000 ac.) of Arizona land was privately owned. The federal government owned about 45%, and held in trust for Indians about 26%. The remaining 14% was state owned.

Eight national forests, which occupied a total of about one-sixth of Arizona's area, yielded an annual crop of about 175,000,000 bd.ft. of timber. State and private land yielded an additional annual crop of about 100,000,000 bd.ft.

Industry.—Because of high cost of power, manufacturing in Arizona has not been a leading industry, smelting and sawmills being the most important. Other establishments were brick kilns, concrete block producers, cottonseed oil and cottonseed meal factories, flour mills, lime kilns, canning and dried fruit factories, and mattress factories. Manufacturing products included electronic devices and components, aircraft and parts, and machine tools.

Minerals.—Mining is the leading industry of Arizona. Contrary to tradition, there is no evidence that mining was practised except to a very limited extent by aborigines, Spanish conquistadors, or Jesuits. In 1738 an extraordinary deposit of silver nuggets, quickly exhausted (1741), was discovered at Arizona. At the end of the 18th century the Mexicans considerably developed the mines in the southeast. The second half of the 19th century witnessed several great finds: first, of gold placers on the lower Gila and Colorado (1858–69); later, of lodes at Tombstone, which flourished from 1879 to 1886 then decayed, but in 1905 had again become the centre of important mining interests; and still later, of copper at Jerome and around Bisbee. Several of the Arizona copper mines are among the greatest in the world. The Copper Queen at Bisbee from 1880 to 1902 produced 378,047,210 lb. of crude copper, which was then practically the total output of the territory. Other valuable mines were developed later; the Ajo, Morenci, and Jerome districts are secondary to Bisbee.

Important mines of gold and silver, considerable deposits of wolframite (chief ore of tungsten), valuable ores of molybdenum and vanadium, and quarries of onyx marble are also worked. Low-grade coal deposits occur in the east central part of the state and near the junction of the Gila and San Pedro rivers. Fine gems of peridot (gem olivine), garnet, and turquoise have also been found there.

In the 1960s Arizona was the nation's leader in the value of production of nonferrous metals. The principal mining products are copper, sand and gravel, molybdenum, silver, and zinc.

Transportation.—Until railroads reached the territory in the 1880s, Arizona was accessible from the east only by the sea voyage around Cape Horn and then across southern California or, from east or west, by a difficult and perilous overland trek by horse or wagon. For more than 40 years after their arrival, the railroads remained the principal means of transportation throughout the state. The state was served by two transcontinental railways, the Atchison, Topeka and Santa Fe in the north and the Southern Pacific in the south; in the 1960s there were about 2,000 mi. of railroad trackage.

Arizona lagged behind most of the United States in its use of automobiles. The expense of highway construction in the deserts and mountains was so great, and the state so sparsely settled, that by the early 1920s only about 250 mi. of improved roads carried motor traffic. By the late 1960s, however, there were about 40,000 mi. in the federal, state, and county road systems and the ratio of automobiles to people was high. Four east-west transcontinental highways and one north-south transcontinental highway crossed Arizona. The state was served by commercial airlines, and several transcontinental and interurban bus lines.

See also references under "Arizona" in the Index.

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(H. A. H.; E. H. P.)

ARK, derived from Lat. *arca* ("container," "box"), is used exclusively in biblical contexts, where it represents two different

Hebrew words: *tebah* and *aron*.

Tebah.—This word, borrowed from Egyptian, means either a box or a palace (as a rectangular building with a flat roof). *Tebah* in Ex. ii, 3 means "box"; the infant Moses was put into a box of calked papyrus. The story of the flood uses the word in the second sense of "palace" for Noah's ark (Gen. vi–ix). Here *tebah* is a house made of wood that can float. While the older Yahwist tradition (*see* PENTATEUCH) does not describe Noah's ark in detail, the later Priestly version gives detailed information, perhaps based on a regained knowledge of the Babylonian prototype. The ark was built from wood timbers or planks, calked with pitch on the outside. It had three stories and a door at the side. The model for the story of the ark is found in the 11th tablet of the Gilgamesh (*q.v.*) epic. Here too the ark is a box, synonymous with both a ship and a palace; it is even larger than in the biblical story, with six stories.

Aron.—This Hebrew word is common to other Semitic languages and also exists in Akkadian as *'aranu*. It occurs in three usages. There is a single example of it describing the coffin in which Joseph's body is said to have been brought from Egypt to Shechem (Gen. l, 26). The narrator evidently knew Egyptian wooden coffins, which were chestlike. Further, in a historically reliable account in II Kings xii, 9, 10 (in Hebrew text verses 10, 11; *cf.* II Chron. xxiv, 8–11), *aron* is applied to a wooden chest with a hole in the lid for the collecting of money.

Ark as a Holy Vessel.—In contrast to these two rare mentions of the chest there are nearly 200 references in the Old Testament to a holy vessel closely connected with the presence of the God of Israel. Where the context is clear (*e.g.*, Num. x, 35 ff.; Josh. iv, 10) it is simply called "the ark." Usually, however, it is distinguished from secular chests by a descriptive word. Even these epithets show that various conceptions were associated with the ark. There are five such titles: the ark of God (*e.g.*, I Sam. iv, 13), the ark of the God of Israel (*e.g.*, I Sam. v, 7), the ark of the Lord (Yahweh; *e.g.*, I Sam. iv, 6), the ark of the covenant of the Lord (*e.g.*, Deut. x, 8; xxxi, 9; *cf.* Jer. iii, 16) and the ark of the testimony (especially Ex. xxv, 21 ff.). The significance of these various titles will be discussed in the course of considering the history of the ark.

The first question is the ark's appearance. It is described only once, in the Priestly narrative (Ex. xxv), which dates from a period when the ark was no longer in existence, since it was lost during the destruction of Jerusalem by Nebuchadrezzar (587 B.C.). The legend, dating from the 2nd century B.C. and related in II Macc. ii, 4–8, that Jeremiah hid the tabernacle, the altar of incense and the ark in a cave where they would remain until the return of Israel from exile, stresses the continuity of the cult. Rabbinical sources suggest a subterranean chamber under the holy of holies in the Temple or a particular place in the forecourt. In Jer. iii, 16 it is stated that the ark should not be remade after its destruction. Although the description of the ark in the Priestly account in Ex. xxv is not based on personal observation, it is at least founded on a good and early tradition, as is shown particularly by the mention of the *kapporeth* ("mercy seat"). According to Ex. xxv the ark was a chest of acacia wood 2½ cubits long, 1½ cubits wide and 1½ cubits high. The poles supported by rings on the long sides made it possible for the ark to be carried (Ex. xxv, 12–15; *cf.* I Kings viii, 7–8). Although the earlier accounts do not mention the number of the bearers, Josh. iii and II Sam. vi, 13 show that the ark was normally carried; it was the exception for it to be driven (I Sam. vi, 8 ff.; II Sam. vi, 3). The gilding of the ark commanded in Ex. xxv, 11, 13 is unknown to the older tradition (*e.g.*, Deut. x, 3); it is a parallel to the gold of the mercy seat.

The wooden ark doubtless had a lid that could be opened and shut. This is the only explanation for the belief (known at least as early as the pre-exilic period) that the ark was a container in which the tablets containing the ten commandments were kept (*cf.* Deut. x, 1–5). Hence came the title "the ark of the covenant." The Priestly tradition also recognizes the presence of something inside the ark; it is the testimony (of the covenant?), Hebrew *eduth*, which Moses received from God and which he was to put into the ark. Hence in the Priestly traditions the ark is called "the ark of testimony." It would be the two tablets of the decalogue that were in question, not the Pentateuch, for otherwise the name would have been "the ark of the Law" (the Torah).

The Priestly account also is interested in another holy object, the *kapporeth*, a golden slab of the same measurements as the top of the ark, with two golden-winged cherubim at the sides (Ex. xxv, 17–22). The Priestly account shows that the *kapporeth* is not identical with the lid of the ark but is a separate object (*e.g.*, Ex. xxxi, 7; Ex. xxxv, 12; according to Ex. xl, 20 Moses set the *kapporeth* on the ark outside the tabernacle; according to Ex. xxvi, 34 it is only set upon the ark within the holy of holies of the tabernacle). Hence the ark with the *kapporeth* has been very variously reconstructed. An attempt has been made to see behind the text different traditions with perhaps two different conceptions of the position of the cherubim on the ark, but this has met with no success. The presupposition must rather be that behind the Priestly account in I Kings vi, 23–28 lies the description of the great cherubim in the holy of holies of the temple whose task was, according to I Kings viii, 6–7, to cover the ark. Just as the Priestly account of the tabernacle which belonged to the period of the wandering in the wilderness is coloured by detail from the temple of Solomon, so here it places the two cherubim of the temple (which were independent of the ark) in the period of the wandering in the wilderness and by means of the *kapporeth* associates them with the wooden ark. In the same way the cherubim carved on the doors of the temple in I Kings vi, 32, are found again on the curtain in the tabernacle (Ex. xxvi, 31).

History of the Ark.—The early history of the ark before the time of Saul (*cf.* I Sam. iii–vi) is obscure in many respects. Its place of origin is also an open question. It is not clear whether the ark was the holy thing that guaranteed the helping presence of God to the Israelite groups on Sinai and in Kadesh, or whether it was the tabernacle that had this function. The earlier narrators do not know the story of Moses making the ark on Sinai (which appears first in Deut. x, 1–8; *cf.* Ex. xxxvii, 1 ff.); a stone as testimony is mentioned at the assembly at Shechem (Josh. xxiv, 26–27) but not the ark. In Num. x, 35–36 the invocation of God that originally was made before and after a holy war is now associated with the daily setting forth and coming to rest of the ark as God's escort of the people's wanderings.

Although it is not in principle impossible that the wandering tribes of Israel had a wooden ark, it is disconcerting that the earliest title for the ark, in I Sam. iii, 3 is not "the ark of the Lord" but "the ark of God." The origin of the ark outside Israel is stressed by a statement in II Sam. vi, 2: that David fetched the ark of God over which was proclaimed the name of Yahweh Sabaoth, who sits enthroned among the cherubim (*i.e.*, he who—in the holy of holies—reigned over the cherubim). The proclamation of the name was in Israel a legal act that marked the transfer of a person, thing or piece of land into the possession of another. Thus the ark of God is claimed for the great God of Jerusalem, and is thereby taken over by the people of the covenant. The place of the transfer could have been the pre-Israelite holy place of Shiloh (in the area of the tribe of Joseph). The connection with Gilgal near Jericho (Josh. iii–iv) and with Bethel (Judges xx, 26–27), both Benjamite places, could date from before or, more probably, from after the Shiloh period. Later the ark was lost to the Philistines in battle and then given back. After the first stage of its recovery (I Sam. vi), David brought it to Jerusalem (II Sam. vi); there in the city of David the object of reverence which had protective religious power was intended to bind all Israel to the house of David. Thus the ark came too into the holy of holies of the temple of Solomon (I Kings viii, 6).

The conclusion has been drawn, probably correctly, from Ps. xxiv, 7–10, that on certain feast days there were solemn processions in which the ark was carried out of the temple and in again through the gate of the temple forecourt, though the ark is not actually mentioned in this psalm. The kings of Judah no longer took the ark into battle (especially as some of the wars were against the northern kingdom!) as they apparently still did in the time of Saul (I Sam. xiv, 18) and David (II Sam. xi, 11). The theory propounded by W. R. Arnold and H. Gressmann (who

points to I Sam. xiv, 18) that there was an ark in every large holy place in Israel cannot be correct; otherwise it would certainly have been mentioned in I Kings xii, 28 ff. in connection with the rival temples in Bethel and Dan, and King Josiah of Judah would have mentioned the local arks when the local holy places were put down (II Kings xxiii, 4 ff.).

Contents of the Ark.—Those who like J. Morgenstern date the ark from the period of the wanderings in the wilderness postulate primarily an empty chest, which has been compared with the tabernacle that Bedouin tribes set upon a camel. R. H. Kennett supposed that the brazen serpent made by Moses was once kept in the ark (Num. xxi, 4–9). This serpent when placed on a pole would have been of sufficient proportions to fill the ark. It would then have to be assumed that the brazen serpent was removed from the ark when the latter was put in the holy of holies. The ark would then apparently be interpreted as the footstool of Yahweh as he reigned above the cherubim in the temple (*cf.* Ps. xcix, 5; Ps. cxxxii, 7; and I Chron. xxviii, 2. In the latter text the word "and" has to be interpreted as "that is" in order to fit in with this view).

Those who believe with Gressmann that the ark had a Canaanite origin think in terms of two idols, whether representational or not (*cf.* the two tables of the Law). E. Nielsen concludes from *eduth* (ark of testimony) that from the time of David the royal protocol of the kings of Judah was deposited in the ark. In that case, however—and this is a fatal objection—the ark would have lost its protective character. If the ark was not empty in the Canaanite period (but why should it then be a chest with a lid?) then the idol or idols would have been removed in Shiloh or Jerusalem because Yahweh had forbidden idols in the second of the ten commandments (Ex. xx, 4). It could have been said in the 7th century that the two tables of the decalogue were kept in the ark only if it was known that the ark was empty up to that time. As tablets containing laws are not normally concealed but are publicly displayed, it is only possible at the most that the tables were at some time copied (though there is in fact no record of this) and that the old ones were deposited in the ark.

In Jer. iii, 16–17 Jerusalem, as the throne of Yahweh, is placed in antithesis to the ark, which might lead to the conclusion that the empty ark was conceived as being the throne of Yahweh; there were not a few examples in neighbouring lands of empty divine thrones. Empty divine thrones (always with high backs), with cherubim on the sides, seem to provide a good parallel, but the prototype for these divine thrones is always a king's throne. The chief objection to this widely held view derives from the description and form of the ark. If it was a throne, why is it called a chest? If it was a throne, why is it twice as long as it is broad, especially as it was placed in the holy of holies (as I Kings viii, 8 shows) with the narrow side to the front? The ark, that is to say a chest, was rather given over to Yahweh, who reigned among the cherubim (II Sam. vi, 2); that is to say, Yahweh had this title before there was an ark for him. He was given the title because of the great cherubim that stood in the holy of holies, above whom he was seen by Isaiah in his vision, reigning as a king (Isa. vi). And the prophet Ezekiel (Ezek. i ff.) sees the glory of Yahweh above a vehicle with four cherubim (called *merkava* in Jewish tradition), and not above the ark, just as the *kapporeth* (*see* above) was also not a part of the ark.

Ark in Later Judaism.—Both the Hebrew words for ark, in association with the word for holiness, are used as descriptions of the holy shrine in the synagogue where the encased rolls of the Law were kept. In this sense the Torah shrine is the successor of the "ark of the covenant," the contents of which were believed to be the two tables of the Law. The ark of Noah is interpreted allegorically by Philo.

Ark of Noah in Christian Tradition.—As Noah was saved by the ark from the waters of death, so, in the catacomb paintings, the dead person whose soul is to be saved is represented as praying in the ark. In addition to this symbolism of salvation there is also baptismal symbolism, going back to I Pet. iii, 20, whereby the ark is the type of the saving church, as for instance in Cyprian, Jerome and Augustine. On a 4th-century sarcophagus in Trier the ark embodies the eternal church, crowned with victory. *See* FLOOD (IN RELIGION AND MYTH).

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(KU. G.)

ARKANSAS, once called the "Bear state" and later the "Wonder state" and renamed the "Land of Opportunity" by the 1953 general assembly, is one of the south central states of the United States. Situated between 33° and 36° 30′ N. lat. and 89° 40′ and 94° 42′ W., it is bounded by Missouri on the north, Tennessee and Mississippi on the east, Louisiana on the south, Texas on the southwest and Oklahoma on the west. In size, it ranks 27th among the states with an area of 53,104 sq.mi., including 605 sq.mi. of water surface. The capital city is Little Rock. Arkansas entered the Union, as the 25th state, on June 15, 1836. The state flower is the apple blossom, the official tree is the short-leaf pine and the mockingbird is the state bird. The official state flag is a blue-bordered white diamond on a rectangular field of red; the border contains 25 stars, the diamond has 4 stars.

PHYSICAL GEOGRAPHY

Topography.—Arkansas is in the drainage basin of the lower Mississippi valley; the Mississippi river forms the eastern boundary of the state and the Arkansas, the largest river, bisects the state from northwest to southeast. Other major tributaries include the Red, the White, the Ouachita and the St. Francis rivers. The state falls within two major physiographic divisions of the southern United States, the line of demarcation extending diagonally from the northeast corner to the southwest; on the east and south is the low gulf coastal plain; to the west and north are the interior highlands. The gulf coastal plain is composed of two parts: the rich Mississippi alluvial plain along the eastern boundary of the state, with elevations of 100–300 ft.; and the west gulf coastal plain in the southwest, a more hilly and generally less fertile section with an elevation of 200–700 ft. An unusual feature of the Mississippi alluvial plain is the loessial Crowley's ridge, which describes an arc from Phillips county north into Missouri. The Ozark plateau and the Ouachita province comprise the northern and western parts of the state. The Ozark plateau is made up of the Boston mountains, the highest large land area in the state, with an average elevation of 2,000 ft. and with peaks above 2,800 ft.; the Springfield plateau, a gently rolling plateau north of the irregular north-facing escarpment of the Boston mountains which ranges from 1,250 to 1,700 ft. above sea level; and the Salem plateau, a rough to rolling country averaging 1,250 ft. in elevation on the northern boundary of the state. The Ouachita province in the west-central section of the state is lower, but the formations were raised by similar compressive forces. The rocks of the highlands are chiefly sandstone, shale, limestone and dolomite; in the lowlands, clay, sand, marl and chalk. The soils are extremely variable in composition, ranging from the heavy alluvial soils of the Mississippi alluvial plain to the light sandy soils of the Ouachita and Ozark uplands.

Climate.—The climate is temperate, the monthly average maximum and minimum temperatures ranging from 72°–50° F. in west Arkansas to 70°–53° F. in the east. Temperatures exceed 100° F. at times in July and August, and readings of 0° F. occur occasionally in the north in January and February. Normal precipitation is 48.63 in.; annual snowfall averages 2.8 to 10.4 in., and humidity ranges from 60% in December and January to 45% in July and August. An average of nine tornadoes occur each year, most of

them limited by short, extremely narrow paths.

Plants and Animals.—The state possesses rich and varied plant and animal life, with one-fourth of its area actually covered by standing timber and more than 2,000,000 ac. in the Ozark and Ouachita national forests. There are at least 210 species of trees, the oak group being the largest with 43 forms, the hickory with 21 and maple with 11. Of great decorative value are the redbud, holly, dogwood, buckeye, wild crab apple and other woody plants. Approximately 250 kinds of grasses, 200 different sedges and 24 different rushes are found in the state. The more important animals are deer, turkey, squirrel, rabbit, the fur-bearing skunk, opossum, mink, muskrat and red and gray foxes. Among the kinds of fish found are the large mouth bass, the small mouth bass, bream, crappie, buffalo, drum, catfish and the predatory gar. Bird life is prolific: among the 312 species and subspecies there are migrants, such as the canvasback and mallard ducks along the Mississippi flyway in the eastern counties; predators, such as hawks, owls and eagles; pests, such as crows, starlings and English sparrows; and quail, snipe, blackbirds, thrushes and warblers.

State and National Parks.—Hot Springs National park, in west central Arkansas, contains about 1,000 ac.; its 47 mineral hot springs are said to have therapeutic value. The state park system has achieved a delightful mixture of the rustic and the modern and provides facilities for camping, boating, swimming, fishing and hiking in some of the state's most beautiful sections. Most of the state parks have cottages equipped for light housekeeping. The 12 state parks and 4 state memorials attract more than 1,000,000 visitors annually. The state parks are named Petit Jean, Buffalo River, Devil's Den, Queen Wilhelmina, Lake Chicot, Lake Catherine, Mount Nebo, Crowley's Ridge, Bull Shoals, Arkansas Post, Lake Ouachita and Daisy. The state memorials, each commemorating a historical event or person, are Hampson, Herman Davis, Davidsonville and Carrollton. In 1960 the Pea Ridge battlefield in northwest Arkansas was designated a national military park by the national park service. In Little Rock may be seen the three capitol buildings that have served Arkansas as seats of government since 1821. The Territorial Restoration includes governmental offices from 1821 to 1836 and the homes of some of the state's earliest men of prominence. The Old State house, which was the state capitol from 1836 until the present capitol was occupied in 1909, is a beautiful example of civic architecture of that period; it contains displays depicting Arkansas' early days. At Fort Smith, the courtroom and gallows of U.S. district judge, Isaac Parker, known as the "hanging judge" because of his strict enforcement of the law, has been restored. Ouachita National forest and Ozark National forest provide scenic beauty and are popular recreation places. Near Murfreesboro, a portion of the only known diamond field in North America is open to the public and any diamonds found there may be kept. Fishing, boating and other aquatic sports are practised on the state's many lakes, the most notable of which are Lake Norfork, Bull Shoals lake, Lake Ouachita, Lake Nimrod, Lake Greeson, Lake Hamilton, Lake Catherine, Lake Conway and Lake Chicot.

HISTORY

Earliest Inhabitants.—Arkansas' earliest inhabitants, the pre-Columbian bluff dwellers, flourished about A.D. 500. Burial remains in Washington county, in the northwestern part of the state, indicate that the bluff dwellers planted corn, beans, pumpkins, sunflowers and other plants, and that they were adept at fishing, weaving, pottery making and chipping stones into awls and other tools. They used bows and arrows, darts and a throwing stick similar to the Aztec *atlatl* in hunting deer, buffalo and other game. Later, mound builders appeared along the Mississippi river and constructed sepulchral mounds containing effigy vessels, pipes, shells, implements and skeletons.

Exploration and Settlement.—Hernando de Soto, the first European explorer to enter Arkansas, crossed the Mississippi near Sunflower landing June 29, 1541. Search for food and gold took the Spaniards through central Arkansas, across the Arkansas river, to Hot Springs and down the Ouachita river to a site near Camden where they wintered. De Soto died the following spring. The French Jesuit missionary, Jacques Marquette, along with Louis Jolliet and five companions in 1673 descended the Mississippi to the mouth of the Arkansas river and spent a month among the Arkansea Indians. The explorers discovered that the Mississippi flowed into the Gulf of Mexico instead of into the Pacific ocean. Warned of hostile Indians downstream, Marquette and Jolliet returned to Canada.

The explorations of René Robert Cavelier, sieur de la Salle, who took formal possession of the territory for Louis XIV of France, April 9, 1682, led to the first permanent white settlement in Arkansas. La Salle's lieutenant, Henri de Tonti, left six men to build a fort near the mouth of the Arkansas in 1686, while he led a search party for La Salle who had, however, been killed in Texas. The fort became Arkansas Post, and served as a link between the French settlements of the upper Mississippi and those in Louisiana until John Law's Company of the West received a monopoly in the territory in 1717. Law's duchy of Arkansas, as it was called, attracted slaveholding colonists from the Palatinate in northern Germany, but the bursting of the "Mississippi Bubble" (for details of "Mississippi Bubble," *see* LAW, JOHN), caused them to withdraw to Louisiana. Arkansas Post remained a trading centre and a Jesuit mission under Bernard de la Harpe who ascended the Arkansas river beyond the present site of Little Rock in 1722.

The territory was ceded to Spain by France in 1763. Subsequently, the Spanish governors made land grants along the west bank of the Mississippi to U.S. settlers in order to populate the country, yet the 1785 census showed only 196 persons and that of 1799 only 368 living there. Spain was forced to return the territory to France in 1800; the United States acquired it as part of the Louisiana Purchase in 1803. Arkansas was an administrative subdivision of Louisiana until 1812, when congress attached the district to the territory of Missouri. The territory of Arkansas was created by congress in 1819 with the capital at Arkansas Post; two years later, Little Rock became the capital city.

Statehood.—Arkansas was admitted to the union in 1836 as a slave state, but the lawless spirit of the frontier continued, especially along the western border. When the Mexican War was declared in 1846, Arkansas oversubscribed its quota of volunteers and former Gov. Archibald Yell led an Arkansas regiment until his death at Buena Vista, Mex. Politically, the Masons under Albert Pike and the Roman Catholics under Bishop Andrew Byrne joined to squelch the Know-Nothing party (*q.v.*). The Butterfield stage line was extended from St. Louis, Mo., through western Arkansas in 1858 and a telegraph line connected Fayetteville, Ark., and St. Louis, in 1860.

The Civil War.—With many of its settlers natives of southern states and with nearly one-fourth of its inhabitants slaves, Arkansas was inevitably drawn into the secession crisis. Arkansans were alarmed by the reinforcement of the federal garrison at Little Rock in Nov. 1860, and state troops took over the post Feb. 8, 1861. In the convention that met March 4, 1861 to consider secession, David Walker, an antisecessionist, was elected president and Elias C. Boudinot, a half-Cherokee slaveholder, was named secretary. Immediate secession was rejected, but a referendum was asked to determine whether or not Arkansas should be represented at an impending conference of the border states. The Arkansas convention adjourned March 21 and before it reconvened the bombardment and surrender of Fort Sumter on April 12–14 had opened hostilities. When the convention met again on May 6 it voted for secession 69 to 1 and Arkansas joined the Confederacy on May 16, 1861.

About 58,000 Arkansas men joined the Confederate army and perhaps 6,000 served in the Union forces. Arkansas was the scene of several battles during the course of the war. Gen. Samuel R. Curtis' Union army defeated Gen. Earl Van Dorn's Confederate troops in a bloody battle at Pea Ridge (Elkhorn tavern) on March 7–8, 1862. At Prairie Grove on Dec. 7, 1862, Confederate Gen. Thomas C. Hindman tried to block the juncture of the Union forces of Gen. James G. Blunt with those of Gen. Francis J. Herron, but Hindman was forced to withdraw causing northwest Arkansas to remain in federal hands. Confederate Gen. T. H.

Holmes was repulsed at Helena July 4, 1863, by Curtis. When Little Rock fell to Gen. Frederick Steele Sept. 10, 1863, a Union governor was installed although Confederate Gov. Harris Flanagin also held office at the provisional capital at Washington in south Arkansas. After occupation by Union forces, Union sympathizers elected a Republican governor, repudiated the secession ordinance and Confederate war debts, ratified the 13th amendment and set up an orderly government in 1864. The 1866–67 legislature, made up largely of former secessionists, nullified much of this work, however.

Reconstruction.—Following the Confederate surrender, the state was controlled by the Federal army as part of the 4th military district. In Dec. 1867 the Republicans elected a constitutional convention and the Reconstruction government took office in 1868. It drew up a new constitution and provided for the registration of voters, the creation of public schools, the adoption of the 14th amendment and the establishment of a school for the deaf and an industrial university that later became the University of Arkansas. Arkansas was readmitted to the union June 22, 1868, over Pres. Andrew Johnson's veto.

Republicans remained in control until 1874. They suppressed the Ku Klux Klan, supported free schools and protected the rights of former slaves, but plunged the state into debt with exorbitant railway and levee grants. However, the state supreme court in 1877 ruled that the state was not responsible for railroad bonds not approved by popular vote, and in 1884 a constitutional amendment canceling bonded debts of the Reconstruction legislatures of 1868, 1869 and 1871 was approved.

The struggle between Joseph Brooks and Elisha Baxter, rivals for governor, climaxed the Reconstruction era. Brooks, at one time a supporter of Gov. Powell Clayton, began his campaign to depose Clayton in 1871 by forming a coalition of radical Republicans and Democrats. Clayton, however, who had decided to run for the U.S. senate, had chosen Baxter to be his successor as governor. Though Brooks probably received the larger vote, the legislature declared Baxter elected in 1873. Baxter gained the support of the Democrats, but lost that of the Republicans when he refused to countenance further exploitation of the state. In April 1874, Brooks got a circuit court writ of ouster and took possession of the capitol, proclaiming himself governor. Baxter retaliated by organizing an army and appealing to Pres. U. S. Grant for recognition. Brooks also organized a militia with the support of Arkansas's two senators. President Grant, who favoured Brooks, ordered troops to maintain the peace and called on the state legislature to settle the dispute. After a month, during which 20 men were killed in skirmishes, the Democratic legislature recognized Baxter as governor. The legislature then called a constitutional convention that limited the patronage powers of the governor, set his term of office at two years and reserved to itself the suspension of the writ of habeas corpus.

Return to One-Party Control.—Beginning with the administration of Gov. Augustus H. Garland in 1874, the Democratic party and the state government remained in the hands of former secessionists for a generation thereafter. Democratic party control has seldom been threatened since that time. In the 1880s farm and labour groups formed the Agricultural Wheel, a new political party, and came within 15,000 votes of electing a governor in 1888. Shortly after the return of the dissidents to the Democratic party, state politics came to be dominated by Jeff Davis (1862–1913), a namesake of the Confederate president. Though flamboyant in manner and accused of demagoguery by his opponents, he achieved educational and penal reforms and all but retired the bonded debt of the state during his terms as governor (1901–07).

There was general excitement at the discovery of diamonds in Pike county in 1906 (the only known deposits in North America), and the oil boom at El Dorado and Smackover in 1921–22 gave rise to a new industry. Bauxite, which had been discovered in 1887 only began to be exploited commercially in the 1940s, making Arkansas an important centre of the aluminum industry. A disastrous flood in 1927, which inundated one-fifth of the state's area, emphasized the need for control of the Mississippi river. Congress initiated such a program the following year.

Two Arkansas political figures became nationally prominent in the late 1920s and early 1930s. Sen. Joseph T. Robinson, who had taken Jeff Davis' seat in the U.S. senate, was the Democratic candidate for vice-president in 1928. In 1932 Hattie Caraway, the widow of Sen. Thaddeus H. Caraway (1871–1931), became the first woman ever to be elected to the U.S. senate.

A severe drought in 1930 aggravated the impact of the depression. State action to alleviate conditions was reinforced by federal programs including aid for the construction of new schoolhouses, courthouses and other public buildings. Through the 1930s and 1940s state politics were concerned largely with the creation of administrative and welfare agencies, the refunding of highway bonds and, after the repeal of national prohibition, the adoption of local option liquor laws. Liquor taxes and a new sales tax brought added revenue for expanding services. During World War II thousands of men received their basic training at Camp Robinson; Camp Chaffee was established near Fort Smith and a number of airfields and proving grounds were placed in operation. Politically, Democrats remained in control of the state government and Arkansas voters continued to support the Democratic presidential candidates.

After the war personalities dominated state politics more than issues. Then, in 1948, Sidney McMath was elected to succeed the conservative Gov. Ben T. Laney. He was re-elected in 1950 but lost a third term when Francis A. Cherry was swept into office as a reform candidate. Cherry's administration was notable for a lack of partisan politics, which was largely responsible for his being the second Arkansas governor to be defeated for a second term.

Cherry was succeeded in 1954 by Orval E. Faubus, a publisher, who later became the first Arkansas governor to win a sixth term. Faubus' administration was marked by industrial progress and the passage of tax increases to improve the schools and other services until, in 1957, the school integration issue became a chief concern in the state.

Integration Crisis.—After the 1954 U.S. supreme court ruling that racial segregation in public schools was unconstitutional, that state became the focus of international attention. Schools in six Arkansas towns with small Negro populations desegregated with little or no incident, but in Sept. 1957, on the eve of the opening of Little Rock Central high school on an integrated basis, Governor Faubus ordered the national guard to prevent integration and to preserve order. The troops, on Faubus' orders, barred from the school the nine Negro pupils who had enrolled. On Sept. 22, a U.S. judge ordered the removal of the troops. The Negroes' attempt to enter their classes was opposed by a segregationist mob and police were called to escort the students to safety. The next day, Pres. Dwight D. Eisenhower ordered into federal service the entire Arkansas national guard and sent 1,000 federal troops to Little Rock to enforce U.S. court orders, and to enable the Negroes to complete the school term.

In the summer of 1958, Governor Faubus won Democratic renomination for a third term by an unprecedented majority. The Little Rock school board asked a 30-month delay in desegregation, but was refused by the U.S. supreme court causing Governor Faubus to call a special session of the legislature. It passed, at the governor's urging, a package of segregation bills, including one used to close all the public high schools in Little Rock. Thus, all students were compelled to transfer to schools elsewhere, to attend private schools or simply to remain out of school. In 1959 the Little Rock high schools were reopened with token integration. An opening day mob was quickly dispersed by police and an uneasy truce between segregationists and integrationists was effected.

Governor Faubus was reelected to his unprecedented sixth term in 1964. He retired in 1966, the Democratic nomination going to an archsegregationist, James Johnson, and the voters, for the first time since Reconstruction, elected a Republican, Winthrop Rockefeller, as governor.

GOVERNMENT

The government of Arkansas is based upon the provisions of the constitution of 1874 and its amendments. The governor, who must

be at least 30 years old and a resident for 7 years, has the power to commute sentences or pardon in all cases except those involving treason and impeachment. His veto powers include the veto of specific items in appropriation bills.

The bicameral legislature is composed of 35 senators elected for 4 years and 100 representatives who serve 2 years. The regular biennial session of 60 days may be extended by a two-thirds vote of each house, but the governor may call special sessions at any time. Constitutional amendments may be proposed by a simple majority of both houses or by initiative petition. The seven members of the supreme court are elected for eight years. All elected state officials may succeed themselves. The franchise is extended to citizens 21 years or older who have lived in the state 12 months.

Denial of employment because of membership in or resignation from a labour union is prohibited.

Finance and Taxation.—In the second half of the 20th century, the state's receipts from general and special sources amounted to approximately $150,000,000 annually. In addition, the state received about $60,000,000 annually in federal grants. The major portion of the state's revenues was derived from the sales tax, the gasoline tax, the state income tax, the alcoholic beverage tax and automobile licence fees. The state's expenditures totaled nearly $250,000,000 annually and the state's net debt stood at $80,000,000. The state's income was about twice as great as it had been prior to World War II, but its per capita income remained among the lowest in the union, only one or two states having a lower statistic. Arkansas was spending 35.5% of its revenues on education, about 23% on highways, 13% on public welfare and 7% on health and hospitals.

POPULATION

The population of Arkansas in 1840, the first federal census in which it figured as a state, was 97,574. Its population ranked 26th among the 30 states and territories that then composed the union and was classified as 100% rural. The next decade was the period of most rapid growth after acquiring statehood—the population increased 115% between 1840 and 1850. In 1860, immediately before the Civil War, the state had a population of 435,450, of whom about one-fourth were Negro slaves. It was then the 25th most populous state, and was still practically 100% rural. At the beginning of the 20th century, the state remained 25th in rank of population with a total of 1,311,564 persons according to the census of 1900. It was still largely rural in character: 91.5% of the people were classified as nonurban dwellers. From 1910, the nonwhite population began a slow, but steady decline which continued through the 1960 census. In 1910 the nonwhite population was 28.1% of the total, but by 1950 had declined to 22.3%. The 1950 population showed a total of 1,909,511 persons living within the state making Arkansas the 30th in size of population among the states. The 1950 figure showed a decline of 2.1% from that for 1940 (1,949,387). The previous decade, from 1930 to 1940, had the slowest population growth in the state's history. By 1950 the rural population had declined to 67% of the total. The Little Rock-North Little Rock area was the state's only standard metropolitan statistical area in 1950; it contained 10.3% of the total population. By 1960 there were 3 standard metropolitan statistical areas and they housed 18.9% of the total population. In 1960 Arkansas had a population of 1,786,272, a decrease of 123,239 or 6.5% from 1950. Among the reasons cited for the state's decline in population since 1940 are the mechanization of agriculture which resulted in bigger farms and, until the mid-1950s, a lag in the state's industrial development. Many of the persons who left the state were Negroes; others were marginal farmers and young people, especially college graduates, who were looking for a higher income.

The population per square mile in 1960 was 33.6, as compared with 49.7 for the U.S. as a whole. The 1960 urban population was 765,303 or 42.8% of the total, continuing the trend toward increasing urban residence. Distribution by colour and nativity according to the 1960 census was as follows: 77.8% native white; 0.4% foreign-born white; and 21.8% nonwhite, practically all Negro. In line with the rest of the U.S. the percentage of persons 65 years old or over was increasing, being 10.6% in 1960. The percentage of the population 14 years old and over that was in the labour force (48.8% in 1960) was steadily decreasing, the result of prolonged schooling for that age group.

*Arkansas: Places of 5,000 or More Population (1960 Census)**

Place	Census of Population				
	1960	1950	1940	1920	1900
Total state	1,786,272	1,909,511	1,949,387	1,752,204	1,311,564
Arkadelphia	8,069	6,819	5,078	3,311	2,739
Batesville	6,207	6,414	5,267	4,299	2,327
Benton	10,399	6,277	3,502	2,933	1,025
Blytheville	20,797	16,234	10,652	6,447	302
Camden	15,823	11,372	8,975	3,238	2,840
Conway	9,791	8,610	5,782	4,564	2,003
Crossett	5,370	4,619	4,891	2,707	—
El Dorado	25,292	23,076	15,858	3,887	1,069
Fayetteville	20,274	17,071	8,212	5,362	4,061
Forrest City	10,544	7,607	5,699	3,377	1,361
Fort Smith	52,991	47,942	36,584	28,870	11,587
Harrison	6,580	5,542	4,238	3,477	1,551
Helena	11,500	11,236	8,546	9,112	5,550
Hope	8,399	8,605	7,475	4,790	1,644
Hot Springs	28,337	29,307	21,370	11,695	9,973
Jacksonville	14,488	2,474	—	—	—
Jonesboro	21,418	16,310	11,729	9,384	4,508
Little Rock	107,813	102,213	88,039	65,142	38,307
Magnolia	10,651	6,918	4,326	2,158	1,614
Malvern	9,566	8,072	5,290	3,864	1,582
Marianna	5,134	4,530	4,449	5,074	1,707
Morrilton	5,997	5,483	4,608	3,010	1,707
Newport	7,007	6,254	4,321	3,771	2,866
North Little Rock	58,032	44,097	21,137	14,048	—
Osceola	6,189	5,006	3,226	1,755	953
Paragould	9,947	9,668	7,079	6,306	3,324
Pine Bluff	44,037	37,162	21,290	19,280	11,496
Rogers	5,700	4,962	3,550	3,318	2,158
Russellville	8,921	8,166	5,927	4,505	1,832
Searcy	7,272	6,024	3,670	2,836	1,995
Springdale	10,076	5,835	3,319	2,263	1,251
Stuttgart	9,661	7,276	5,628	4,522	1,258
Texarkana	19,788	15,875	11,821	8,257	4,914
Van Buren	6,787	6,413	5,422	5,224	2,573
Warren	6,752	2,615	2,516	2,145	954
West Helena	8,385	6,107	4,717	6,226	—
West Memphis	19,374	9,112	3,369	—	—

*Populations are reported as constituted at date of each census.
Note: Dash indicates place did not exist during reported census, or data not available.

EDUCATION

Historical.—When Arkansas was admitted to the union, congress reserved the customary 16th section of each township of the public lands for school property and donated 72 sections (46,080 ac.) for a state university. However, early legislatures sold both the school and university lands to pay current expenses leaving public education to private academies. After the Civil War, the Reconstruction government established free public schools and a state university. Free textbooks were first provided in 1936 and a teacher retirement plan was initiated in 1937. In the 1950s public school enrollment was 98.3% of the school population; the average term was 173 days; and teachers received salaries averaging $2,469, and the expenditure per pupil in average daily attendance was $169, compared with a national average of nearly $300. Nevertheless, the percentage of state revenues spent for education was more than twice the pre-World War II percentage.

Schools.—The University of Arkansas, a land-grant university founded in 1871, has its principal campus at Fayetteville, where there are colleges of arts and sciences, education, engineering, agriculture, home economics and business administration, the school of law, the graduate school and the general extension service. The university's medical units, its graduate extension centre and graduate institute of technology are at Little Rock. Arkansas Agricultural, Mechanical and Normal college at Pine Bluff, founded in 1873, is the state's college for Negroes. Arkansas State Teachers college at Conway was founded in 1907. In 1925 the state's four agricultural high schools became Arkansas Polytechnic college (Russellville), Arkansas State college (Jonesboro), Arkansas State Agricultural and Mechanical college (name changed to Southern State college in 1951; Magnolia) and Arkansas Agricultural and Mechanical college (Monticello), respectively. In 1929, when Henderson-Brown college merged into Hendrix college (1884), a Methodist school at Conway, Henderson State Teachers college was established on the former Henderson-Brown campus at Arkadelphia.

Typical Ozark mountain scene near Winslow, northwestern Arkansas

The Old Statehouse, Little Rock, was constructed in the 1830s and served as the state capitol until 1909. In 1921 it became the War Memorial building

Cattle pens and silos at Winrock, a model farm near Morrilton. Purebred Santa Gertrudis cattle are raised on the farm, owned by Winthrop Rockefeller

Gardens of the Territorial Restoration, a group of early homes and public buildings preserved as an exhibit in Little Rock

Waterfall at Blanchard Springs, near Mountain View, north central Arkansas

SCENES IN ARKANSAS

ARKANSAS

Lumber, paper and chemical plants make up an industrial complex at Crossett

Cedar Falls, a 75 ft. drop in Petit Jean state park, in the central part of the state

Rice processing mill at Stuttgart. The state is one of the leading rice producers in the U.S., with California, Louisiana and Texas

Hot Springs National park. Buildings are some of the hotels which have been built to accommodate visitors seeking the curative powers of the mineral waters which come from nearby Hot Springs mountain

Breaking up a chunk of bauxite ore with an air hammer before it is sent to alumina plant in background. Arkansas produces virtually all of the bauxite mined in the U.S.

ARKANSAS SCENERY AND INDUSTRY

BY COURTESY OF (TOP) THE CROSSETT COMPANY (CENTRE RIGHT) ARKANSAS PUBLICITY AND PARKS COMMISSION, PHOTO BY PHELPS. (BOTTOM RIGHT) REYNOLDS METALS CO.; PHOTOGRAPHS, (CENTRE LEFT, BOTTOM LEFT) AUTHENTICATED NEWS

Private denominational colleges, in addition to Hendrix, include Ouachita Baptist college (1886) at Arkadelphia; the College of the Ozarks, Presbyterian (U.S.A.; 1891) at Clarksville; John Brown university, interdenominational (1919), at Siloam Springs; Harding college, Church of Christ (1924), at Searcy; Arkansas college, Presbyterian (U.S.; 1871), at Batesville; Conway Baptist college (1952), at Conway and Southern Baptist college (1941), at Walnut Ridge. Little Rock university (1927) is privately endowed. Negro denominational colleges include Philander Smith college (1868), Methodist, at Little Rock; Arkansas Baptist college (1884) at Little Rock; and Shorter college, African Methodist Episcopal (1886), at North Little Rock. The state maintains schools for the deaf and the blind at Little Rock, and in 1957 started a school for retarded children at Conway.

HEALTH AND WELFARE

The state maintains a tuberculosis sanatorium for white patients at Booneville and one for Negroes at Alexander; state mental hospitals are located at Little Rock and Benton. The state's welfare expenditures included aid to the aged, the blind, the disabled and dependent children. The state's penal system includes Tucker and Cummins prison farms for male criminals, industrial schools for delinquent boys at Pine Bluff (white) and at Wrightsville (Negro) and delinquent girls at Alexander (white) and at Fargo (Negro). There are facilities for women offenders at the Cummins prison farm. There are approximately 1,000 health and welfare agencies about one-half of which are public.

THE ECONOMY

In the second half of the 20th century, Arkansas remained primarily an agricultural state, but there was a definite trend toward industrialization. After 1940 the mechanization of agriculture resulted in larger farms and a smaller farm population. Also, the steady migration from farms to the urban centres resulted in population losses of as much as 30% in some counties and caused the state's population to decline during the 1950s (see *Population* above). To combat this decline the legislature established the Arkansas Industrial Development commission in 1955 to co-ordinate the work of about 100 local groups in attracting industry. The commission gathered information on desirable sites for new industrial plants and offered help to areas seeking industries. As a result, by 1960 there were almost 100,000 workers in more than 3,000 industrial plants in the state, and new jobs were being created at the rate of about 10,000 a year. Furthermore, laws were adopted permitting municipalities and counties to vote bond issues to provide buildings for industrial plants.

Agriculture.—The estimated 150,000 farms in the state were valued at about $1,225,000,000 in the 1960s. Farm owners cultivated more than 50% of the total acreage compared with 37% in 1930. Cotton, historically the state's principal crop, began to decrease in importance in the 1950s and by the 1960s, although still the state's largest money crop, had been surpassed by soybeans in acreage cultivated. Arkansas produced 60,000 bu. of soybeans in 1928, but 5,000,000 bu. in 1954 and more than 50,000,000 bu. by the 1960s. Mississippi county, formerly a major centre of cotton production, had become the nation's biggest producer of soybeans. Rice was first introduced in the 1920s. When the western two-thirds of the state ceased growing crops, the eastern third of the state accounted for 94% of the income from cotton and soybeans and 99% of state's income from rice. The major crops were soybeans, cotton, hay, corn and rice. The state also grew great quantities of peaches, strawberries, tomatoes, watermelons, spinach, pecans, sorghum, wheat and grapes. Arkansas was second in the nation in production of broilers in the late 1950s, the western section of the state being the poultry raising area. Livestock and poultry accounted for about 34% of the total agricultural economy.

Forest Products.—Arkansas is usually among the first ten states in the production of forest products. Approximately 19,350,000 ac. of forest land produce annually about 1,000,000,000 bd.ft. of pine, white oak, gum, red oak, nonpulping hardwoods, ash and hickory. Wood products are valued at more than $300,000,000 annually.

Water Power.—Bull Shoals, Norfork, Narrows and Blakely Mountain dams, all federal projects, produce an average of 600,000,000 kw.hr. a year. In addition they provide flood control and vast recreational areas. The lakes created by these dams attract fishermen and water sport enthusiasts from a wide area and are visited annually by tourists from throughout the nation.

Minerals.—The state has a rich assortment of minerals. Among them are petroleum, natural gas, coal, bauxite, limestone and manganese. By the 1960s, fuels accounted for approximately 69% of the total mineral production; two-thirds of the state's mineral income was derived from the production of petroleum, natural gas and coal. Coal, first mined in 1840, became important economically by the 1870s. Following World War II production declined. Natural gas was first discovered in 1887, but was not drilled commercially until 1901. Production amounted to more than 32,000,000,000 cu.ft. annually in the 1960s. After the discovery of petroleum at Smackover in 1921, oil production boomed reaching 77,000,000 bbl. annually in the peak year of 1925. More than 30 years later, production averaged about 30,000,000 bbl. per year. Probably the most important of the state's minerals is bauxite from which aluminum is made. Arkansas leads the U.S. in the production of this mineral, averaging about 1,500,000 tons annually. Pulaski and Saline counties contain more than 95% of the aluminum ore found in the United States. Manganese, first mined in 1950, barite and bromine are also important minerals economically.

Manufacturing.—Only 2% of the population was engaged in manufacturing in 1900. A half-century later, the figure was only slightly larger (less than 5% in 1950). But in 1958 nonfarm wages and salaries amounted to more than one-half of Arkansas' personal income for the first time in its history. Manufacturing consists mostly of processing raw materials for marketing. Besides lumbering and the production of wood products (see *Forest Products* above), shoe and garment manufacturing, vegetable and fruit canning, petroleum refining, oil extraction from cottonseed, rice milling and the making of clay and glassware products are among the important manufacturing enterprises.

Transportation.—The picturesque river boat was supplanted long ago on the Mississippi by the squat towboat with its tow of barges. Although the Mississippi is navigable along the entire eastern side of the state, and the U.S. corps of engineers maintains a 6.5-ft. channel in the Ouachita as far upstream as Camden, highways and railroads carry most of the traffic. The state highway system at mid-20th century included about 10,000 mi. of highways supplemented by approximately 58,000 mi. of county roads. In 1949 the state began a highway construction and repair program financed by four annual bond issues. Arkansas' share of federal funds, under the national highway program initiated in 1956, amounted to more than $29,500,000 for the fiscal year 1961. There were more than 75 private or municipal airports.

See also Index references under "Arkansas" in the Index volume.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Britannica Book of the Year*, American edition. (K. W. P.)

ARKANSAS RIVER. The Arkansas river rises in the Rocky mountains of the western United States near Leadville, Colo., on the Sawatch and Mosquito ranges, 10,000 to 14,000 ft. high. From its source the river flows through mountainous terrain, then over a vast expanse of flat land, emptying into the Mississippi river 40 mi. north of Arkansas City, Ark., 150 ft. above sea level. Its total length is 1,450 mi., and the drainage basin is 157,900 sq.mi. in area.

Great differences in climate, elevation and land forms within the drainage system result in highly variable characteristics of the river.

From Leadville, the river flows southeast through mountainous terrain for 150 mi. leaving the Rocky mountains at Canon City, Colo. In this distance the stream drops 6,700 ft. The river leaves the mountains through the Royal gorge, a narrow canyon cut into solid granite with vertical walls over 1,000 ft. high.

From Canon City to Great Bend, Kan., the river flows east over land that receives less than 20 in. of rainfall annually. The stream channel is wide and meandering with split channels and numerous sandbars. The river flood plain is wide and occasionally covered by floodwater from heavy rainfall upstream. On the stream terraces, land above the flood plain, are irrigated farms. Much of the river water is diverted during the growing season and the river bed contains a mere trickle of water or is dry during the irrigating season. Ten miles east of Las Animas, Colo., just below the confluence of the Purgatoire and Arkansas rivers, is the John Martin reservoir. It is one of the largest water-storage and flood-control units on the river. The reservoir, with a total capacity of 645,700 ac.ft., was completed in 1948.

From Great Bend to the Mississippi river the Arkansas flows over a humid landscape with 20 to 40 in. of annual rainfall. The river is larger than in the upper reaches, frequently over ½ mi. wide, with a deep channel. Because the river is contained in a definite channel by hills on either side, especially in eastern Oklahoma and in Arkansas, the river can do little changing of course. While the river gradient is slight the erosion of the land is intense and the stream is slow and muddy. Red and yellow clays and the fine black loams of the bottom lands provide the characteristic colours of the stream water.

At Little Rock, Ark., the hills that contain the stream dwindle. From here to the Mississippi land conditions are made to order for a vengeful and rambunctious river. Actually the Arkansas flows over a wide section of the Mississippi flood plain. Its stream gradient is shallow and the river becomes a maze of stream meanders, ever-changing patterns of stream channels, abandoned channels, loops and cutoffs. Because the river banks have been built up by heavy deposition of alluvium, the land slopes downward from the river banks and is subject to severe flooding. In these lowland areas swamp conditions prevail over large areas because of extremely poor drainage. During floods old abandoned stream channels become activated and are again used to discharge large volumes of excess water. When the river recedes some of the formerly abandoned stream channels become the main channel of the stream again. Thus the Arkansas presents an ever-changing spectrum of active and abandoned stream beds.

Discharge of the Arkansas river is extremely variable, its water rising and falling constantly at any particular point. The rhythm of the river consists of two periods of high water. One is in winter when rainfall is heavy in the lower part of the river system with but slight discharge in the upper portion where it is frozen.

The second high-water period occurs in late spring and early summer when rainfall is heaviest in Kansas, Oklahoma and Colorado and when the vast quantities of accumulated winter snow begin to melt in the Rocky mountains. Minimum flow periods occur in September and December. At Little Rock the water level varies about 27 ft. between the high- and low-water stages.

Principal tributaries of the Arkansas from source to mouth are the Purgatoire, Cimarron, Verdigris, Neosho and Canadian rivers. The principal cities on the river are Pueblo, Colo., Wichita, Kan., Tulsa, Okla., and Fort Smith and Little Rock, Ark.

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(M. J. L.)

ARKLOW (Inbhear Mór), an urban district of County Wicklow, Ire., 43 mi. S. of Dublin by road. Pop. (1961) 5,390. Land area 2.6 sq.mi. Arklow lies at the mouth of the Avoca river and is a seaside resort. There is some fishing, shipping and shipbuilding (the first motor fishing boat of the British Isles was built there), and there is a pottery industry. After the Anglo-Norman invasion, Henry II granted Arklow to the invaders. In 1649 the castle was seized by Oliver Cromwell, and in the rising of 1798 British forces defeated the insurgents after fierce fighting. A tower of the castle still stands.

ARKOSE is a type of coarse sandstone (*q.v.*) presumed to have formed by the disintegration, without appreciable decomposition, of a granite. Arkose consists, therefore, primarily of quartz and feldspar (mainly orthoclase or microcline) together with small amounts of mica (biotite). These minerals, moderately well sorted and generally but slightly worn, are loosely cemented with calcite or less commonly with iron oxide or silica. Arkoses are distinguished from the normal quartzose sandstones (orthoquartzites) by their high feldspar content and from the graywackes by their lighter colour (*see* Graywacke). In the absence of stratification, arkose may bear superficial resemblance to granite, and it has been aptly described as reconstituted granite or granite wash. Like the granites from which they came, arkoses are pink and, less commonly, light gray.

Well-known examples of arkose are the Pre-Cambrian Torridonian of Scotland and the related Sparagmites of Norway, the Portland and New Haven arkoses of the Newark series (Triassic) of the Connecticut valley region, and the Fountain arkose (Pennsylvanian) of Colorado and Wyoming.

The geological significance of arkose has been much debated. Under normal conditions, little feldspar escapes decomposition and conversion to clay, etc., during weathering of the source rocks. Under conditions of rigorous climate (extreme dryness or extremely low temperature) the decomposition of the feldspar is inhibited or greatly retarded. Arkoses were, therefore, presumed to be derived from the erosion of a granitic terrane characterized by an arid or a glacial climate. It is now known, however, that the feldspar may escape destruction, and therefore be transported and deposited with the quartz sands, if the relief of the source region is high enough. Under such conditions, irrespective of the climate, erosion is so rapid, especially in deeply incised canyons, that weathering or decomposition processes are incomplete and the sands derived from such regions are highly feldspathic. Arkoses, therefore, may be said to indicate either a climatic extreme or high relief. Most ancient arkose deposits seem to be the product of high relief.

(F. J. P.)

ARKWRIGHT, SIR RICHARD (1732–1792), English industrialist and inventor of spinning machinery, was born at Preston, Lancashire, on Dec. 23, 1732. He was the youngest of 7 children and was brought up to be a barber and wigmaker. He later traveled about the country buying hair for wigs which he prepared and dyed by a process of his own. He was a man of great enterprise and determination and, having received little education, continued to educate himself until late in life. In 1767 he began to construct his first spinning machine which he patented in 1769, and in partnership with John Smalley, later joined by Jedediah Strutt and Samuel Need, who supplied the necessary capital, started a small factory at Nottingham. He then built a factory at Cromford, Derbyshire, which was run by water power. He also designed and built carding engines and drawing frames which he made to function satisfactorily. Within a few years he had many factories in different parts of the country which were equipped with a sequence of machines for carrying out all the manufacturing operations from carding to spinning. Arkwright's spinning machine made use of L. Paul's drafting rollers and it is doubtful if any of the fundamental ideas in his inventions were his own; in fact, his comprehensive patent of 1775 was rescinded. His technical achievement was rather in embodying the ideas of others in machines that he made to work successfully. Even more important was his organization of large-scale production in factories employing power-driven machinery and division of labour. The thread made on the spinning jenny, invented about 1767 by James Hargreaves, could only be used for weft, since it lacked the strength required in the longitudinal threads or warp. Arkwright's machinery could make cotton yarn suitable for warps and there-

fore was able to fulfill a great potential demand. By 1782 he had a capital of £200,000 and employed 5,000 workers. In spite of losing his patent rights, Arkwright retained his dominant position in the textile industry and at his death at Cromford on Aug. 3, 1792, he left a large fortune. He had been knighted in 1786.

See R. S. Fitton and A. P. Wadsworth, *The Strutts and the Arkwrights 1758–1830* (1959). (K. R. G.)

ARLES, a city of southeastern France, lies in the *département* of Bouches-du-Rhône, 55 mi. N.W. of Marseilles by road. It is in the sandy and salty Camargue plain where the Rhône divides to form its delta. Pop. (1962) 29,251.

The main part of the town lies on the left bank of the Rhône. The old quarter, with its narrow winding streets, is surrounded by Roman and medieval ramparts. In the Place de la République, which has a Roman obelisk in the centre, is the town hall (17th century), containing the library; the art museum, formerly a Gothic church, which has a good collection of Roman remains; and the cathedral of St. Trophime. Founded in the 7th century, St. Trophime was rebuilt several times and has a splendid 12th-century portal and beautiful cloisters. There is also a museum of Provençal arts and crafts founded by the poet Frédéric Mistral. During his stay at Arles in 1888–89 the painter Vincent Van Gogh entered into his great productive period. Among the Roman remains are a large amphitheatre, now sometimes used for bullfights; a theatre, in which the famous Venus of Arles was discovered in 1651; the ruins of the palace of Constantine; the forum; the baths; and a cemetery, the Aliscamps or Alyscamps (*Elysii campi*), consisting of an avenue bordered by trees. The town has modern outskirts and across the Rhône is the suburb of Trinquetaille, badly damaged by bombing in World War II.

Arles is on the main railway line from Paris and Lyons to Marseilles, Nice and Genoa. It is linked with the sea by the Rhône, and by the Arles–Port-de-Bouc canal. Agriculture is the main occupation, especially the cultivation of corn, vines and olive trees and the breeding of sheep. The production of rice, early vegetables and fruit has also been developed. Industry includes the manufacture of metals and chemicals, shipbuilding and paper-making. The port, once little used, is a frequent calling place for oil tankers.

Already important in the days of the Ligurian tribes, Arles was made the Roman colony of Arelate by Julius Caesar in 46 B.C. and from its political, religious and commercial importance it soon became one of the leading cities of the Western Roman empire. Its bishopric was founded by St. Trophimus in the 1st century, and it became the seat of the prefecture of the Gauls (395) and the primatial see (417). A number of synods were held there. The city declined when it passed to the Visigoths and was plundered by the Saracens in 730. In the 10th century it became the capital of the kingdom of Arles and recovered much of its former importance. In the 12th century it became a free city, governed by a podesta and consuls like an Italian republic, which it also resembled in its commerce and navigation. In 1251 it submitted to Charles I of Anjou and from then onward its fortunes were linked with those of Provence. Its bishopric was suppressed in 1790. (J.-M. Ro.)

ARLES, KINGDOM OF (Lat. REGNUM ARELATENSE), the name given from the 13th century onward to the kingdom formed in A.D. 934 by the union of the kingdom of Provence with the kingdom of Burgundy and bequeathed in 1032 to the German king and emperor Conrad II by its last independent ruler, Rudolf III. The composite kingdom, which was known simply as the kingdom of Burgundy up to the end of the 12th century (the name Burgundy thereafter being increasingly reserved for the duchy and for the countship of Burgundy), extended from the upper Saône and from western Switzerland in the north to the Mediterranean in the south and from the Alps and the Valle d'Aosta in the east to the Rhône and across it into Vivarais, Forez and Lyonnais in the west. For the origins of the component kingdoms and their history down to 1032 *see* BURGUNDY; PROVENCE.

Rudolf III had never exercised more than nominal authority over the chief lords of the kingdom, the count of Burgundy (*see* FRANCHE-COMTÉ) and the count of Maurienne (founder of the house of Savoy). The German kings likewise enjoyed little real authority in their new possession. They could generally rely on support from the local bishops during the first 50 years after 1032, but they lost most of this in the course of their quarrel with the papacy. In the 1050s Rudolf of Rheinfelden (the future German king) was sent to Arles to strengthen royal control, probably with the title of "duke and rector of Burgundy," and toward the middle of the 12th century the rectorate was conferred on Conrad of Zähringen, whose family retained hereditary authority over the areas east of the Jura (Burgundia Minor or the Lesser Duchy) until the death of the last Zähringer duke in 1218. The emperor Frederick I's marriage with Beatrix, daughter of the count of Burgundy, in 1156, gave him more real power over the kingdom, but Henry VI was ready to invest Richard I of England with it in 1193. Frederick II, who had to take strong measures to assert his authority over that of his vassal Raymond Berengar V (IV) of Provence, tried to make his power more effective by delegating it first to a viceroy, then to a series of imperial vicars.

Imperial influence, however, gradually gave way to French. Louis VIII of France had intervened in Provence in the course of the crusade against the Albigenses, and Louis IX had married Raymond Berengar's eldest daughter Margaret. In 1246 Raymond Berengar's heiress Beatrix was married to Louis IX's brother Charles, count of Anjou (the future Charles I of Naples), so that the whole countship of Provence passed to the Angevin dynasty. By a treaty of 1295 the countship of Burgundy or Franche-Comté passed to the future Philip V of France. Vivarais and Lyonnais acknowledged French suzerainty early in the 14th century and Dauphiné was sold in 1349 to the future Charles V of France by Humbert II, dauphin of Viennois, who already in 1343 had agreed that on his death it should pass to a descendant of Philip VI.

Finally, in 1378, the emperor Charles IV, though he had taken some part in the affairs of the kingdom and in 1365 had been crowned at Arles, ceded the imperial vicariate to the dauphin Charles, later Charles VI of France. As the northeastern and eastern territories of the old kingdom were by this time in the hands of the counts of Savoy, the cession of 1378 marks the end of the kingdom of Arles.

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ARLES, SYNOD OF, the first representative meeting of Christian bishops in the Western Roman empire, was convened (Aug. 314) by the emperor Constantine in order to decide such questions as the date of Easter, the problem of Donatism and the validity of baptisms by heretics and of ordinations by traditores, those who had surrendered the sacred books during the persecution under Diocletian. This synod, attended by representatives of 43 bishoprics, was held because Donatists (*q.v.*) had denied the representative character of two earlier synods, at Rome and in Africa, at which their leader Donatus had been condemned. They continued to reject synodical decisions and appealed to the emperor against those made at Arles; they also instituted civil suits against various traditores, sometimes using forged documents. The church, however, regarded the decisions of Arles as binding. *See* AUGUSTINE, SAINT: *Donatist Schism.*

See W. H. C. Frend, *The Donatist Church* (1952); S. L. Greenslade, *Schism in the Early Church* (1953). (R. McQ. G.)

ARLINGTON, HENRY BENNET, EARL OF (1618–1685), English statesman, was a prominent member of Charles II's cabal (*q.v.*). He was born at Saxham, in Suffolk, in 1618 and was educated at Westminster school and Christ Church, Oxford. During the English Civil War he served briefly in the royalist forces, earning the honourable facial scar which is so distinctive a feature of his portraits. He went into exile and from 1657 was an agent in Spain for the future Charles II of England.

Returning to England in 1661 he became a member of parliament for Callington in Cornwall and keeper of the privy purse, but the career during which he was to dominate British domestic and

foreign policy properly began in Oct. 1662 with his appointment as principal secretary of state. In this office he was responsible for relations with France, Spain, the Netherlands, Portugal and Italy, as well as for the intelligence and postal services, and he was able to acquire an influence equal to that of the lord chancellor, the earl of Clarendon. He was created Baron Arlington in 1665. In 1667, by fostering Clarendon's dismissal and impeachment, he helped divert from himself parliamentary dissatisfaction with the management of the second Dutch War; but he now stood exposed to the jealousy of the ambitious cavaliers surrounding George Villiers, 2nd duke of Buckingham. The personal rivalry between Arlington and Buckingham bedeviled politics for the next ten years. Arlington, with greater resources than Buckingham, proved more successful as both a patron and a diplomat. Through him Sir Thomas Clifford, Sir John Trevor and Sir Thomas Littleton reached high office and he sponsored Sir William Temple's negotiation of the triple alliance of England, the Netherlands and Sweden in 1668. At this point Arlington's pro-Dutch policy was attributed to his marriage (1666) to Isabella van Beverwaert, daughter of Louis of Nassau. By 1669, however, he had been drawn into the secret policy of alliance with France culminating in the treaty of Dover (May 1670). He and Clifford were closer in Charles II's confidence than any other members of the cabal, and abetted the king in other aspects of his policy, including the "stop of the exchequer," the Declaration of Indulgence and the open league with France. Arlington was rewarded in 1672 with an earldom and the Garter.

His eclipse began the same year with the appointment of Clifford to the coveted lord treasurership; he was denounced to parliament by Buckingham and was impeached in Jan. 1674 for popery, corruption and betrayal of trust. He defended himself ably and the charges failed, but he shortly resigned his secretaryship for the less exposed role of lord chamberlain. In the years of the earl of Danby's ascendancy Arlington lost all influence. He attempted to regain power by associating with the earl of Shaftesbury's opposition "Country party," but instead Charles II withdrew his confidence. Arlington survived to hold office for a few months under James II, but died, after a deathbed confession of Roman Catholicism, on July 28, 1685.

Arlington's administrative abilities are open to question; he was fortunate in possessing a very able undersecretary in Joseph Williamson, who succeeded him; but he undoubtedly exhibited the full potentialities of the secretaryship of state as a source of power. His control of official correspondence, which he assiduously extended, greatly added to his personal security and his financial stake in the post office proved most profitable. But, as the failures of the second Dutch War showed, the secretary's intelligence service was inferior to Cromwell's, and Arlington was lucky to escape parliamentary censure in 1667. Subsequently he was active in creating the nucleus of a disciplined "Court party" in the house of commons, but the real basis of his influence was the uninterrupted possession of Charles II's confidence. He was prepared to pander to Charles, and at his great country house at Euston in Suffolk, Arlington procured for him the favours of Louise de Kéroualle. However, suppleness of this sort conflicted with a certain stiffness of manner which made him the butt of court wits; this was generally attributed to his admiration for things Spanish and jarred with the predominantly French tone of the English court. Arlington was also handicapped by a series of quarrels with James, duke of York, and it seems likely that his loss of favour was due to an early belief that the exile or even exclusion of James was desirable.

Arlington's only "expensive vice" was a passion for building, indulged at Euston and at Goring house, now the site of Buckingham palace. His religious beliefs were carefully dissimulated and rumours of his Catholicism fell into abeyance until his death.

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ARLINGTON, a city of Tarrant county, Tex., U.S., in the "Golden Triangle" (Arlington, Grand Prairie and Irving), characterized by rapid growth and careful modern planning, 18 mi. W. of Dallas and 12 mi. E. of Fort Worth. The first settlement, Bird's Fort (about 1845), was on an Indian council site; there Sam Houston counseled Comanches. Johnson's Station, the first Tarrant county plantation, preceded Arlington, named for Robert E. Lee's ancestral mansion and incorporated in 1920.

The city's population increased by almost sixfold from 1950 to 1960. For comparative population figures *see* table in Texas: *Population.*

A beautiful, tree-lined city, Arlington is the home of Arlington State college. A private academy was founded on the grounds in 1894; the school, which has undergone several changes of name became state-supported in 1917 and assumed senior college status in Sept. 1959.

Primarily an industrial and commercial centre, Arlington has as its most important industries automotive, aviation and missiles. (E. C. Be.)

ARLINGTON HEIGHTS, a city of Cook county, Ill., U.S., situated on high ground 22 mi. N.W. of downtown Chicago. On its west boundary is the Arlington park race track (opened in 1929). The first settlers came in 1833, even before the treaty was ratified with the Potawatomi Indians (1836). The town was originally called Dunton in honour of Asa Dunton, an early settler. After the Civil War as a patriotic gesture, the name was changed to Arlington Heights (1874).

The three largest factories, established in the early 1900s, make school furniture, felt erasers, bulletin boards, fabricated chalk boards and metal milk containers. Most of the employed residents commute to Chicago to work. The city was incorporated in 1887, and has been governed by a council-manager form of government since 1954.

For comparative population figures *see* table in Illinois: *Population.* (H. L. Sm.)

ARLINGTON NATIONAL CEMETERY occupies a beautiful site of more than 400 ac. in Virginia on the banks of the Potomac river, directly opposite Washington, D.C. The central feature of the cemetery is the mansion, built in 1802 of stuccoed brick on the estate of George Washington Parke Custis the adopted son of George Washington. The Custis-Lee mansion as it is now called, is said to have been modeled after the temple of Theseus in Athens. The portico, with its eight white columns is a striking landmark visible from the city across the river. Many famous Americans and foreigners, among them La Fayette have been entertained at the mansion. In the family parlour Mary Anna Randolph Custis in 1831 married Robert E. Lee, then a lieutenant in the United States army, afterward commander in chief of the Confederate army.

When, on April 22, 1861, Lee left Arlington to command the Virginia troops, federal soldiers took possession almost immediately, converting the mansion into a headquarters and the grounds into a camp. In 1864 Arlington became a military cemetery by order of the secretary of war. An area of 210 ac. was first set aside for this purpose and later the area was doubled. For years the title of the property was in dispute, but in 1883, after a supreme court decision favourable to George Washington Custis Lee, the United States government, by payment of $150,000 to him, obtained a clear title. The first soldier was buried in the cemetery on May 13, 1864; some of the dead from every war in which the United States has participated, including a few officers of the American Revolution, have since been buried there.

The cemetery, with its beautiful rolling terrain, its 20,000 trees and ten miles of winding paved roads, is a truly lovely spot. It is the resting place of many of the nation's great military leaders and outstanding individuals from various walks of life, including William Howard Taft, John F. Kennedy, Adm. Robert E. Peary, Gen. John J. Pershing, Adm. Richard E. Byrd, Gen. Jonathan M. Wainwright, Gen. George C. Marshall and Maj. Pierre Charles l'Enfant, the French engineer who designed the city of Washington. Any member of the armed forces of the United States who dies in active service and any former member whose last active service terminated honourably may be buried in Arlington.

The best-known memorial in the cemetery is the Tomb of the Unknowns, originally a memorial to the United States unidentified

dead of World War I. Formerly known as the Tomb of the Unknown Soldier, the shrine was renamed on Memorial day 1958, when unidentified servicemen of World War II and the Korean war were interred beside the solid block of marble; the inscription, "Here Rests in Honored Glory an American Soldier Known But to God," thereafter was considered to refer to all three crypts. A continuous guard is maintained at the tomb by selected soldiers of the 3rd "Old Guard" infantry regiment, United States army, Ft. Myer, Va. Sentinels relieve one another during a simple guard-changing ceremony every hour on the hour.

Near at hand stands the memorial amphitheatre erected through the efforts of the Grand Army of the Republic in memory of departed heroes, as a fitting place of assembly for the thousands who attend Memorial day services in their honour. It was dedicated on May 15, 1920. The roofless, white marble structure, with its eastern façade overlooking the Potomac river and Washington, encloses a natural amphitheatre. Copied after both the theatre of Dionysus at Athens and the Roman theatre at Orange, France, the proportions and distances convey the charm of an old Greek ruin. Crypts where especially distinguished servicemen may be buried are placed under the colonnade, while within the entrance are a reception hall, a chapel and a museum. The eyes of visitors—who may enter Arlington daily between sunrise and sunset—turn repeatedly to the Fields of Dead, with their seemingly endless lines of plain stones, of the pattern adopted in 1872 for use in all national cemeteries.

See "Arlington National Cemetery," Office of Arlington National Cemetery, U.S. Army (1961); *The Unknowns of World War II and Korea*, U.S. Government Printing Office, Washington, D.C. (1959).
(K. E. Bd.)

ARLISS, GEORGE (1868–1946), British film and stage actor, was born in London on April 10, 1868. He worked in his father's printing and publishing office until 1887, when he began his acting career. He met with his first substantial success appearing with Mrs. Patrick Campbell in London (1900–01). In 1902 he played in New York city in *The Second Mrs. Tanqueray.*

Arliss was already established as a leading actor when he turned to films in 1920. During his film career he usually portrayed famous historical characters, his pictures including *The Green Goddess* (1930), *Old English* (1930), *Alexander Hamilton* (1931), *The House of Rothschild* (1934) and *Cardinal Richelieu* (1935). The Academy of Motion Picture Arts and Sciences voted him the best actor of 1929–30 for his role in *Disraeli.* Arliss wrote two autobiographical works: *Up the Years From Bloomsbury* (1927) and *My Ten Years in the Studios* (1940). He died in London, Feb. 5, 1946.
(M. S. By.)

ARM, the human upper limb from the shoulder to the wrist, consisting of the upper arm and the forearm; the fore limb of an animal. *See* Drawing (Techniques of); Skeleton, Vertebrate: *Appendicular Skeleton;* Muscle and Muscular System: *Anatomy;* Anatomy, Gross.

ARMADA. The Spanish Armada (Sp. *Armada Invencible*) was the great fleet sent in 1588 by Philip II of Spain, leader of Catholic Europe, to assist in the attempted invasion of England. He had long been trying, by every means short of open war but if necessary by assassination, to overthrow Elizabeth I of England, the champion of Protestantism. She was aiding the Netherlanders in their rebellion against his regent, Alessandro Farnese (*q.v.*), duke of Parma, and her seamen were threatening his essential communications across the Atlantic. Elizabeth, although anxious to avoid war, knew that her life and England's national integrity and religious and economic future depended upon opposing him successfully. It was the devastating descent upon the Spanish colonies in America (1585–86) by Sir Francis Drake (*q.v.*) that finally convinced Philip that direct invasion was his only remedy. He thought first of launching it directly from Spain, but his trusted admiral, the marqués de Santa Cruz (*q.v.*), produced so staggering an estimate of the cost (suggesting 556 ships carrying 94,000 men) that Philip decided to use Parma's veteran army as the striking force and to send from Spain only sufficient strength to beat the English fleet and clear the straits of Dover for his army to cross.

Preparations were seriously delayed in 1587 by Drake's surprise attack on Cádiz. This did more than "singe his Catholic majesty's beard": it taught Philip that his oar-propelled galleys, still the backbone of Spain's fighting fleet, were no match for Elizabeth's new, swift-sailing navy. So he sent instead about 24 warships and the best merchantmen he could find, hastily converted for war. Thus the Armada was not Spain's conventional fighting fleet. Philip also learned from this raid the value of artillery in sea warfare. Drake's guns, mounted on the broadside, had played havoc with galleys whose guns could not be so mounted. Philip had no intention of forsaking the traditional Spanish tactics of "boarding and entering," but he saw that to get his ships alongside the far more mobile English vessels he must provide considerable batteries of the heavy guns then known as "cannons" and "periers" whose round shot, weighing up to 50 lb., could halt any ship. Elizabeth's fleet was radically different. Her seamen had evolved an entirely new form of warfare based upon the increased speed and maneuverability of their ships, combined with the use of broadside fire from many long-ranged, although light shotted, guns known as "culverins." Indeed, they had actually discarded their galleys altogether and almost all their heavy but short-ranged cannons. Thus equipped, they proposed always to attack their lumbering enemy from to windward, carefully keeping outside the effective range of his 50-pounders: so confident were they in their new technique that they had virtually discarded their soldiers. These basic differences of aim between the English and the Spanish were clearly reflected in the numbers of men and in the armament eventually employed.

Country	Ships		Men		Guns (4-pounders and over)			
	Total	Front line	Soldiers	Sailors	Total	% heavy short-range	% light long-range	Average weight of shot
Spain	130	68	19,000	8,000	1,124	44	56	17 lb.
England	197	61	1,500	14,500	1,972	5	95	7½ lb.

Santa Cruz died on Feb. 9, 1588, and the Armada was commanded by the duque de Medina Sidonia (*q.v.*); highborn, amiable and conscientious, the duque was ignorant of the sea, reluctant to serve and no leader of men. The English were more fortunate in their lord admiral, Charles Howard of Effingham (*see* Nottingham, Charles Howard, 1st Earl of); he was, like Medina

ROUTE OF THE SPANISH ARMADA, JULY 29 TO AUG. 9, 1588. BATTLES BETWEEN SPANISH AND ENGLISH FLEETS INDICATED BY X. (*See* TEXT)

BY COURTESY OF NATIONAL MARITIME MUSEUM, GREENWICH, ENG

PAINTING OF THE FIRESHIP ATTACK ON THE SPANISH ARMADA OFF THE COAST OF CALAIS, FRANCE, AUG. 7–8, 1588; ARTIST UNKNOWN. IN THE NATIONAL MARITIME MUSEUM, GREENWICH, ENG.

Sidonia, a nobleman and no seaman, but, unlike him, a born leader. The Armada cleared the Tagus estuary in the Iberian peninsula on May 28 (new style; May 18, old style) but because of storms, sickness and the necessity of replacing rotten stores, it did not leave until July 22, sighting the Lizard peninsula, Cornwall, Eng., on the 29th. The English meanwhile failed to profit from the delay. Drake wanted to make a bold sortie, attacking the enemy on his own coast, but Elizabeth, still loath to precipitate war, would not consent. Yet Drake did succeed in getting the main fleet moved to Plymouth whence it could hope to take advantage of the prevalent westerly winds. The fleet was then nearly caught in enclosed waters where it could not use its mobility but where Medina Sidonia could use his army. It was saved only by Philip's strict and unimaginative orders for the Armada to proceed upchannel in a tight defensive formation, refusing battle until junction was made with Parma, and by the brilliant seamanship of the English captains who, scenting danger, contrived to warp out of Plymouth harbour on a contrary wind and, crossing the bows of the Armada, worked westward to regain the all-important wind. Medina Sidonia's best chance was gone.

The English then attacked, but only at open range, according to plan. Three actions followed, off Plymouth (July 31), off Portland (Aug. 2) and off the Isle of Wight (Aug. 4). All were tactically indecisive although off the Isle of Wight the English scored a great strategic success by forcing Medina Sidonia past the last anchorage in which he could mark time if Parma were not ready. The English were able so completely to dictate conditions and to avoid close action that they suffered practically no damage; yet the results disappointed them for they failed to break Medina Sidonia's defensive formation. In fact a major flaw in the English tactical planning was gradually revealed: although their round shot could and did hit the enemy at a range where his could hardly reach them, it did not penetrate the hulls. The English could at this point annoy and delay the Armada, but not break and, still less, destroy it.

Medina Sidonia reached the straits of Dover on Aug. 6 and anchored off Calais, France, his stubborn formation still intact. The English also anchored, still to windward. Medina Sidonia found the French governor friendly—but Parma apparently was not ready. The regent's position was indeed impossible; he could not put to sea from his ports of Dunkerque and Nieuwpoort, having no fighting escort for his landing craft. Moreover he was doubly blockaded, by Lord Henry Seymour's English squadron in The Downs (English channel roadstead off Deal, Kent) and by the large if ragged flotilla of the Sea Beggars (Dutch privateers) at Flushing, Neth. In plain fact, Philip's whole conception of a junction off Flanders was a monstrous strategic blunder, based upon the fallacies that accurate co-ordination between the land and sea forces could be achieved and that England could be militarily invaded by a power that had not first obtained absolute mastery of the English channel.

Medina Sidonia too was in difficulties. Since wind and enemy prevented retreat westward, he could only sail northward—away from Parma altogether—or eastward to suicide on the Zealand banks. The English naturally exploited his embarrassment. At midnight on Aug. 7–8 they launched six fire ships straight downwind. All missed their targets yet entirely fulfilled their purpose, because the Spaniards in panic cut their cables and drifted eastward, their formation irretrievably lost. The English ships drove headlong into the Spanish fleet and the decisive battle off the coast of Gravelines, France (Aug. 8), ensued: and it differed profoundly from the earlier encounters. For soon the Spanish heavy guns fell silent, their round shot spent. The English, perceiving this, closed to a point-blank range at which their light weapons began to justify themselves. That day the Armada received its first and only real hammering. Three ships were certainly destroyed, perhaps several more, while the survivors and especially the flagships were battered into impotence, some dismasted and others leaking dangerously. All became prey to black despair, since throughout the engagement the fleet was drifting steadily to what seemed certain shipwreck.

But fate relented. First, the English also ran out of ammunition and were reduced to a game of bluff; second, when all seemed lost the wind suddenly shifted from northwest to southwest, allowing the Armada to claw off the lee shore and steer north into deep water. The fighting was over but not the tragedy. The Armada held on northward, committed now to navigating the long, dangerous route via Cape Wrath at the northwest extremity of Scotland and the open Atlantic. The English fleet followed until Aug. 12, and then returned home. The Spaniards lacked every necessity for their homeward journey—masts, sails, food, water and even, after their hasty departure from Calais, anchors. Typhus raged among the crews, shot-racked timbers crumbled, seams opened and many ships foundered or were wrecked on the Irish coasts. Some 51 ships did not reach home, and many thousands died of disease and sheer exhaustion even after disembarkation from those vessels that did reach Spain. The English naturally fared better. They lost no ships and, in battle, not 100 men. But before demobilization could begin, a virulent form of food poisoning killed perhaps 30 times as many as the Spaniards had slain.

On every count the Armada's defeat was epoch-making. It probably saved the Reformation and it certainly saved England; and it taught England that the sea would be the instrument of its future greatness. It was also of great significance in the history of war as the first gun duel between fleets propelled exclusively by sail, the prototype of all naval actions up to and including the battle of Trafalgar (1805).

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ARMADILLO, a mammal (order Edentata, family Dasypodidae) closely related to the sloths and anteaters and possessing a heavy coat of armour composed partly of solid bucklerlike plates and partly of movable transverse bands. Armadillos are omniv-

orous, feeding on termites, other insects, roots, worms, reptiles and carrion, and are mostly nocturnal. They are harmless, inoffensive creatures, their principal means of escape being the rapidity with which they burrow into the ground and the tenacity with which they retain their hold in their subterranean retreats and dwelling places. Armadillos also avoid danger by fleeing; they can run rapidly although their legs are short. Their flesh is sometimes used by natives as food. They are all inhabitants of the tropical and temperate parts of South America, although a few species range farther north, the peba or nine-banded armadillo (so called because of the bands around its middle) being found from Argentina to northern Texas. The adult male of this species is about 32 in. long and weighs about 13 lb.; the female is slightly smaller. The largest species is the giant armadillo (*Priodontes*), nearly five feet long including tail, found in Surinam and Brazil. For the distinctive characters of the genera *see* EDENTATA: *Armoured Edentates.*


LEONARD LEE RUE III FROM NATIONAL AUDUBON SOCIETY

NINE-BANDED ARMADILLO (DASYPUS NOVEMCINCTUS)

ARMAGEDDON, mentioned in the Bible only in Rev. xvi, 16, the place where at the end of world history the kings of the earth under demonic leadership battle the forces of God (Rev. xix, 11–21). The name, said to be Hebrew, probably represents two Hebrew words, *har megiddo*, "mountain (or hill) of Megiddo." The Palestinian city Megiddo was located where a strategic pass cut through the southeastern extension of the Mt. Carmel ridge from the coastal Plain of Sharon into the Plain of Esdraelon; Megiddo thus commanded the direct road from Egypt and the Palestinian coastal plain to Galilee, Syria and Mesopotamia. During its history, from the 4th millennium B.C. to the 4th century B.C., it was the scene of many important battles (as, indeed, it was also during World War I), and Rev. xvi, 16 seems to imply that the "hill" on which the city fortress stood, or the "mountain" heights behind it, had become a symbol of the final battlefield where God's heavenly armies will defeat the demon-led forces of evil. *See* also MEGIDDO. (F. V. F.)

ARMAGH, an inland county of Northern Ireland, is bounded on the north by Lough Neagh, northwest by Tyrone, east by County Down and south and west by the frontier of the Republic of Ireland. Its area is 512 sq mi.

Physical Features.—The low-lying northern area is made up of Tertiary basalts, Pliocene deposits and Triassic and Old Red Sandstone. It is very fertile and may formerly have been covered by the water of Lough Neagh. To the south there is a gradual rise to the mountains of Ordovician and Silurian rocks, which reproduce the trend and pattern of similar formations in the southern uplands of Scotland. Farther south the granite mountain core is revealed, while younger intrusive igneous rocks form Slieve Gullion (1,894 ft.). The Ice Age gave to the scenery of northern and central Armagh much of its distinctive character. There are vast numbers of drumlins, or small low hills, which give rise to picturesque scenery on a small scale, and the glaciers were also responsible for many lakes and ponds. Glacial debris formed the long spur running south from Slieve Gullion.

History.—In late prehistoric times and at the dawn of history Armagh was an important populated area in Ulster. About the beginning of the Christian era the fortress of Emain Macha, 2 mi. W. of the modern Armagh town at the site known as Navan fort, was the centre of a kingdom of Ulster which extended, at the greatest, as far west as the Shannon and as far south as the Boyne. Also associated with this period is an ancient earthwork, called either the "Black Pig's Dyke" or the "Dane's Cast," running north-east and southwest through several townlands.

A considerable mythology surrounds this early kingdom. The king was Conor MacNessa (Conchobar macNessa), whose many relatives and allies formed a sort of military order called the Red Branch. The greatest was the hero Cú Chulainn, whose father was said to be the sun-god Lugh (Lug). He took part in the fierce wars between the men of Ulster and the warriors of other parts of Ireland, particularly the invading hosts of Maev, queen of Connaught. To Armagh also belongs the tragic story of Deirdre (*q.v.*).

With the decline of this early kingdom of Ulster in the 4th century, Emain Macha lost its importance and Ard Macha, the modern Armagh town, became the political centre of that countryside. It gained added importance after St. Patrick made it his metropolitan see in the 5th century. The Protestant cathedral of Armagh, dating from the 13th century, was restored in the 18th and 19th centuries. Other ancient and ecclesiastical remains are in the vicinity, while at Tynan, west of Armagh, there is a fine Celtic standing cross. The area was ravaged by Scandinavian invaders but they made no permanent settlements. Armagh was a debatable land in many medieval conflicts and lay beyond the "gap in the north" through which representatives of the English crown tried to penetrate Ulster from Dundalk.

The county was made shire ground in 1586 and was included in the scheme for the plantation of Ulster in the early 17th century, being colonized mainly by landowners from England. The gateway of Charlemont fort survives from the vicissitudes of the 17th century. Armagh contains many ancient monuments and buildings of interest, often illustrating the prosperous times enjoyed by the clergy and gentry in the 18th century. This is particularly true of the town of Armagh. Among fine Georgian houses in the county is Derrymore house, 15 mi. S.E. of Armagh, a National trust property.

Population and Administration.—The population of County Armagh was 117,594 in 1961, the largest towns being the municipal boroughs of Portadown (*q.v.*; 18,609) and Lurgan (*q.v.*; 17,872) and the urban district and county town of Armagh (*q.v.*; 10,062). Of the total population, 46% were Roman Catholics, 30% Church of Ireland and 15% Presbyterians. The county returns four members to the parliament of Northern Ireland and one member to the United Kingdom parliament.

Industries and Communications.—The lowland parts of the county form rich agricultural land. West of Portadown, in the district surrounding the villages of Richhill, Kilmore and Loughgall, is Ulster's principal fruitgrowing area, a district that attracts many visitors at blossomtime. The county's many beauty spots draw tourist traffic. Coney Island, a picturesque islet in Lough Neagh, is the property of the National trust, as is the beautiful glen at Ballymoyer, 8 mi. W. of Newry. There is fishing in the rivers Bann, Callan and Cusher and elsewhere.

Although Armagh is mainly a rural county devoted to agriculture, many of the towns are industrialized. At Portadown linen manufacture is carried on; lace, pottery, metal cans and boxes, electrical equipment and synthetic fabrics are made; fruit is packed, fruit and vegetables canned, bacon cured and meat products processed. At Lurgan knitwear, handkerchiefs, optical goods, linen and rayon products, clothing, printed fabrics, chairs and light engineering products are made. At Armagh town clothing, knitwear, cotton and worsted yarn are produced, and the spinning and weaving of linen carried on, while milk products are manufactured in the neighbourhood. Carpets are made at Keady, air-conditioning machinery at Laurelvale, potato crisps at Tanderagee, milk products at Tullygoonigan and electrical goods at Bessbrook. Granite is quarried in the southern part of the county.

Armagh contains a considerable mileage of main railway line and has good road services. The town of Newry (*q.v.*) in adjacent County Down serves to some extent as the port of County Armagh. (HU. S.)

ARMAGH, an urban district and the county town of County Armagh, N.Ire., 36 mi. S.W of Belfast. Pop. (1961) 10,062. At Navan fort, 2 mi. W. of Armagh, is the site of the ancient Emain Macha, military centre of a kingdom of Ulster flourishing about the beginning of the Christian era. (*See* ARMAGH [county].) After the decay and downfall of Emain Macha in the 4th century some of its importance passed to the neighbouring fortified hill of Ard Macha around which the modern town of Armagh rose. In the 5th century St. Patrick made Armagh the ecclesiastical metropolis of Ireland. It is the seat of both the Protestant and Roman Catholic archbishops and has two cathedrals. After much

obscurity during the middle ages, Armagh was modernized and given a number of public institutions. A Royal school was founded in 1627; Archbishop Richard Robinson, who came to Armagh in 1765, founded a library and an observatory; there is now also a county museum. As well as being an important market town and a road and rail junction, Armagh has a number of industries, including the spinning and weaving of linen and the manufacture of clothing and cotton yarn. (Hu. S.)

ARMAGNAC, an ancient province of France, originally a fief of the duchy of Gascony, is now wholly comprised in the *département* of Gers (*q.v.*). It is a region of hills ranging to a height of 1,000 ft., watered by the Gers river and other rivers which descend fanwise from the plateau of Lannemezan. On the slope of its hills grow the grapes from which the famous Armagnac brandy is made.

Toward the middle of the 10th century the countship of Armagnac, around the small town of Nogaro, was one of the feudal units that originated in the decomposition of the diocese of Auch (the former *civitas Ausciorum*). This territory, enlarged during the 12th century by acquisition of the countship of Fezensac, became strategically important as the frontier zone between the kings of England and France, who controlled the duchy of Aquitaine and the countship of Toulouse respectively and whose growing differences enabled the counts to obtain favours from either side.

In 1304 the count of Armagnac's marriage to the heiress of the counts of Rodez established him as a leading power in southwestern France. The Valois kings sometimes appointed him their lieutenant in Languedoc; and two marriages with the Berry branch of the royal family strengthened the links of his dynasty to the monarchy. The treaty of Calais (1360) yielded the sovereignty over the countship of Armagnac to the king of England; but the appeal of the count, Jean I, to Charles V of France (1368) gave the latter his pretext for breaking the treaty and launching his victorious campaigns (*see* Hundred Years' War).

The lesser nobles of the region soon became dependent on the patronage of the counts of Armagnac, whose growing influence was counteracted only by that of the counts of Foix. A series of marriages, successions and purchases made the counts of Armagnac masters of two groups of estates by the beginning of the 15th century: (1) between the Garonne, the Adour and the Pyrenees, the counties of Armagnac, Fezensac and Pardiac, the viscounties of Fezensaguet and Lomagne and the seigniories of Rivière Basse and of the Quatre Vallées (Aure, Magnoac, Labarthe de Neste and Barousse); and (2) on the uplands of the Massif Central, the county of Rodez and the viscounties of Carlat and Murat—together with minor seigniories.

This strong regional position and the services of his rapacious Gascon mercenaries enabled Bernard VII of Armagnac to play an essential part in the great national crisis that opened when John the Fearless, duke of Burgundy, murdered Louis, duc d'Orléans, brother of the mad king Charles VI (1407). The son of the victim, Charles, married Bonne, daughter of Bernard VII, who became a leading member of the feudal coalition against the murderer; thus were formed the "parties" of the Armagnacs and of the Bourguignons. The Armagnac party controlled the king from 1413 and so assumed the direction of resistance against the English, who in 1415 reopened the war against the Valois. The battle of Agincourt (*q.v.*) was a great reverse for the Armagnac party, and many of its leaders were killed.

Bernard VII, however, became more and more powerful; he was made the "governor of all the finances" and chief of the army, with the title of constable and the right to appoint the captains of all the fortresses of the realm. But his government lacked money, and the excesses of his party incensed the population of the major towns; the Bourguignons mastered the situation in Toulouse on May 26, 1418, and in Paris two days later. Bernard VII and his principal adherents were killed.

After 1418 the power of the Armagnacs rapidly decreased. The treaty of Arras (1435) marked the reconciliation of Charles VII of France, who had at first appeared as the king of the Armagnacs, to the duke of Burgundy. Troops of "Armagnacs" (*i.e.,* Gascon mercenaries) were still used by the king and even sent to Alsace and Switzerland (1439–45). The counts gradually lost their regional position. In 1473 a royal army captured their capital of Lectoure, and Count Jean V was killed. On the death of his brother Charles in 1497, the countship was united to the crown of France by Charles VIII. Francis I of France, however, bestowed it upon another Charles (nephew of the last count) and at the same time gave him his sister Margaret in marriage. After the death of her husband, by whom she had no children, Margaret married Henry II of Navarre; and thus the countship of Armagnac came back to the French crown along with the other dominions of their grandson who became king of France as Henry IV. In 1645 Louis XIV erected a countship of Armagnac in favour of Henri de Lorraine, comte d'Harcourt, in whose family it continued until the Revolution.

In the last years of the *ancien régime* Armagnac was a province forming part of the *gouvernement-général* of Guienne and Gascony. It was divided into two parts: High or White Armagnac, with Auch for its capital; and Low or Black Armagnac.

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ARMATOLES (Gr. *armatoloi*), the name given to Greeks discharging certain military and police duties under the Turkish government in districts known as *armatoliks*. This police organization had its origins in Byzantine times, *armatolismos* being a form of feudalism, under which military and police duties were rendered in return for a title to land. When the Turks conquered Greece in the 15th century, they made treaties with the armatoles, allowing them to continue in their police functions. Other Greeks, taking to the mountains, became unofficial, self-appointed armatoles and were known as klephts (Gr. *kleptes*, "brigand"). These klephts might sometimes be recognized by the Turkish authorities as armatoles, while the armatoles who were out of favour continued as klephts. The two terms came to be used indiscriminately. The chief klepht, like the armatoles, was known as *kapetanos*, and the troops were called *palikaria* (palikars). Both armatoles and klephts played a most important part in the War of Greek Independence. (D. Dn.)

ARMATURE. In magnetism William Gilbert applied the term to the piece of soft iron with which he "armed" or capped the loadstone in order to increase its power. It is also used for the "keeper" or piece of iron placed across the poles of a horseshoe magnet to complete the magnetic circuit and preserve the magnetism of the steel; and hence, in dynamoelectric machinery, for the portion that is attracted by the electromagnet. The term is now applied to that member of an electric generator or motor in which currents are induced by the action of the field.

In sculpturing, the armature is the framework of the lead wire or pipe that supports the modeling.

See also Motor, Electric; Sculpture Techniques: *Modeling and Casting*.

ARMAVIR, a town in Krasnodar *krai* of the Russian Soviet Federated Socialist Republic, U.S.S.R., lies on the left bank of the Kuban about 100 mi. E. of Krasnodar. Pop. (1959) 110,994. Founded in 1848, Armavir became a town in 1915. It is on the railway from Rostov-on-Don to Baku, with a line to Tuapse on the Black sea. Good communications and the rich agricultural vicinity led to the development of food-processing industries, including a meat-packing combine (one of the largest in the U.S.S.R.), fruit and vegetable canning, milk processing and buttermaking. Spares for agricultural machinery, equipment for petroleum and transport undertakings, boots and shoes, cord and cotton wool are also produced. Natural gas is obtained nearby. (R. A. F.)

ARMED NEUTRALITY: *see* Neutrality.

ARMENIA (Armenian Hayastan, Turkish Ermenistan, Russian Armeniya), a region and ancient kingdom in southwest Asia. Its historical boundaries have varied considerably, but as a region Armenia is usually regarded as comprising the northeastern part of Turkey and the Armenian Soviet Socialist Republic (Armyanskaya Sovetskaya Sotsialisticheskaya Respublika). The latter is the smallest of the three soviet socialist republics to

Transcaucasia (Georgian, Azerbaijan, Armenian) in the extreme southern part of European U.S.S.R., lying beyond the Greater Caucasus mountain range (Bolshoi Kavkaz). The Armenian S.S.R. covers 11,506 sq.mi. and in Jan. 1959 had 1,763,048 inhabitants. The republic is somewhat cut off from the rest of Transcaucasia and from the European U.S.S.R., but occupies an area of great strategic importance on the Soviet-Turkish boundary.

Turkish Armenia, with an area of about 57,000 sq.mi., unlike Soviet Armenia, has no political designation. It is the location of Mt. Ararat (*q.v.*), the highest point in the region, and the historic Tigris, Euphrates and Aras (Araks, Araxes) rivers have their sources there.

HISTORY

The Armenians make their first appearance in history shortly after the collapse of the ancient kingdom of Urartu (*q.v.*), toward the end of the 7th century B.C. Driving some of the ancient population to take refuge in the lands to the east of Mt. Ararat—where, known to Herodotus as the Alarodioi, they continued for some time to lead a separate existence—the Indo-European invaders imposed their leadership upon those who remained. The occupied regions, although they had suffered much from the depredations of the Scythians and Cimmerians, must still have retained something of the high degree of civilization (fortified towns, irrigation works, fertile fields and vineyards) portrayed by the Assyrian Sargon II who marched through them in 714 B.C.

The newcomers were not able to achieve the power and independence that had in earlier centuries enabled their predecessors to resist the might of Assyria—an echo of this resistance is perhaps to be found in the legendary struggle between King Ara and Queen Semiramis related by Moses of Khoren (*q.v.*)—and they were rapidly incorporated first by Cyaxares in the Median empire and then annexed with Media by Cyrus of Persia to form part of the Achaemenian empire (*c.* 550). The new state is mentioned as Armina and Armaniya in the Bisitun inscription of Darius I and, according to Herodotus, formed part of the 13th satrapy, the Alarodioi forming part of the 18th. Xenophon in his *Anabasis* gives a description of the country in 400 which shows the local government to have been in the hands of village headmen, part of whose tribute to the Persian king consisted of horses. Although Alexander the Great never himself set foot in Armenia, which continued to be governed by Persian or native satraps, it became part of the Macedonian empire (331) and of the Seleucid empire which succeeded it (301).

The Artaxiads.—After the defeat of Antiochus the Great by the Romans in the battle of Magnesia (winter 190–189) the two Armenian satraps of Antiochus, Artaxias (Artashes) and Zariadres (Zareh), revolted, established themselves with Roman consent as kings of Greater Armenia and Sophene respectively and united their efforts to enlarge their domains at the expense of neighbouring rulers. These two kings were the creators of historical Armenia, and little more than a century later Strabo could record that the many different regions spoke one tongue. Artaxias built his capital Artaxata, on the Araxes (now Aras or Araks) river to the southwest of Lake Sevan (near the modern Yerevan); the capital of Sophene is named as Carcathiocerta by Strabo. An attempt to end the division of Armenia into an eastern and a western part was made about 165 B.C. when the Artaxiad ruler sought to suppress his rival, but it was left to Tigranes (Tigran) II the Great, who reigned from *c.* 94 to *c.* 56 B.C., to establish by his defeat of the Zariadrid Artanes and by his annexation of Sophene a unity that was to last for nearly 500 years.

Under Tigranes, Armenia ascended to a pinnacle of power unique in its history and became, albeit for a brief period, the strongest state in the Roman east. Extensive territories were taken from the Parthians who had previously held Tigranes hostage on the defeat of his father Artavasdes (Artawazd) II but who were now unable to halt his advance to the gates of Ecbatana and compelled to sign a treaty of alliance. The Transcaucasian states of Atropatene, Iberia and Albania had already accepted his suzerainty when in 83 B.C. the Syrians, tired of anarchy, offered him their crown. Tigranes penetrated as far south as Ptolemais (Acre). Deeming Artaxata too far north to serve as the capital of his new empire, the Armenian king founded a new one, Tigranocerta (Tigranakert; possibly Silvan, formerly Mayafarkin), nearer the centre of his domains. Although Armenian culture at the time of Tigranes was, as it had been and as it was fundamentally to remain for many centuries, Iranian, the testimony of Plutarch shows that Hellenic scholars and actors found a welcome at the Armenian court, while Tigranes' son Artavasdes III was the author of works in Greek. The Armenian empire lasted until Tigranes became involved, more by accident than design, in the struggle between his father-in-law, Mithradates VI of Pontus, and Rome. Lucullus, although he captured Tigranocerta in 69 B.C., failed to reach Artaxata, but in 66 Pompeius Magnus, aided by one of Tigranes' sons, succeeded and compelled the king to renounce Syria and other conquests in the south and to become an ally of Rome. It has been the fate of Armenia throughout a long and turbulent history to be a small state struggling to preserve its independence between two powerful neighbours; it now became a buffer state, and often a battlefield, between Rome and Parthia.

The Arsacids.—Both Rome and Parthia strove for a century to establish their own candidates on the Armenian throne until a lasting measure of equilibrium was secured by the treaty of Rhandeia concluded in A.D. 63 between the Roman general Corbulo and Tiridates (Trdat) whereby an Arsacid occupied the throne of Armenia, but as a Roman vassal. A dispute with Parthia concerning the Armenian throne led to the country's annexation by Trajan in A.D. 114, but his successor, Hadrian, withdrew to the Euphrates. A similar dispute resulted in the destruction of Artaxata by Marcus Aurelius' general Priscus in 163 and in the building of a new capital, Kainepolis (Vagarshapat; modern Echmiadzin). After Caracalla's capture of King Vagarshak and his unsuccessful attempt to annex the country in 216, his successor, Macrinus, recognized Vagarshak's son Tiridates II (Khosrov the Great in Armenian sources) as king of Armenia (217). Tiridates II's resistance to the Sassanids after the fall of the Arsacid dynasty in Persia (224) ended in his assassination by their agent Anak the Parthian (*c.* 238?) and in the conquest of Armenia by Shapur I, who placed a vassal king named Artavasdes on the throne (252). Under Diocletian, however, after Roman military successes, the Persians were forced to relinquish Armenia, and Tiridates III, the son of Tiridates II, who had been brought up in Constantinople, was restored to the throne under Roman protection (*c.* 287).

The reign of Tiridates III determined the course of much of Armenia's subsequent history. His conversion by St. Gregory the Illuminator and the adoption of Christianity as the state religion (*c.* 300) created a permanent gulf between Armenia and Persia, and the Armenian patriarchate became one of the surest stays of the Arsacid monarchy while it lasted and the guardian of national unity after its fall. The Mamikonian family, which played a similar role, also came to the fore in his reign with the aggrandizement of their domains as a recompense for their defense of the throne against a rebel feudal family. Tiridates' assassination by his own chamberlain in league with the *nakhararq* (barons) of Siuniq illustrates the turbulent and disloyal nature of many of the local nobles whose revolts and quarrels fill the pages of the Armenian historians.

The dissatisfaction of the *nakhararq* with Arsaces (Arshak) III led to the division of Armenia into two sections, Byzantine Armenia and Persarmenia (*c.* 390). The former, comprising about one-fifth of Armenia, was rapidly incorporated into the structure of the Byzantine empire. The latter continued to be ruled by an Arsacid in Dwin, the capital since the reign of Khosrov II (330–339), until the deposition of Artaxias IV and his replacement by a Persian *marzpan* (governor) at the request of the *nakhararq* (428). Although the Armenian nobles had thus destroyed their country's sovereignty, the cause of national unity was furthered by the development, after the invention of the Armenian alphabet by St. Mesrop (*q.v.*), of a national Christian literature; culturally, if not politically, the 5th century was a golden age (*see* ARMENIAN LITERATURE).

The Marzpans.—The Persians were not so successful as the Byzantines in their efforts to assimilate the strongly individualistic

Armenian people. The misjudged attempt of Yazdegerd II to impose Mazdaism (Zoroastrianism, or the worship of Ahura Mazda) upon his Armenian subjects did much to reunite them as a nation. In the war of 451, which resulted from this attempt, the Armenian *sparapet* (commander in chief) St. Vardan Mamikonian and his companions were slain at the battle of Avarayr, but the Persians renounced their plans to convert Armenia by force and deposed their *marzpan* Vasak of Siuniq, the archtraitor of Armenian history. The revolt of 481 led by Vahan Mamikonian, which lasted until 484 when the Hephthalite attack in the east forced the Persians to negotiate, secured religious and political freedom for Armenia in return for military aid, and with the appointment of Vahan as *marzpan* the Armenians were again largely the arbiters of their own affairs. Their independence was further asserted in 554, when the second Council of Dwin rejected the duophysite formula of the Council of Chalcedon (451), a decisive step which cut them off from the west as surely as they were already severed from the east.

In 536 Justinian had reorganized Byzantine Armenia into four provinces and by the suppression of the power of the Armenian nobles and by transfers of population he completed the work of hellenizing the country. In 591 its territory was extended eastward by the emperor Maurice as the price of re-establishing Khosrau II on the throne of Persia in place of the usurper Bahram Chobin. After transferring many Armenians to Thrace, Maurice, according to the Armenian historian Sebeos, advised the Persian king to follow his example and to send this "perverse and unruly nation, which stirs up trouble between us," to fight on his eastern front. During the war between the emperor Phocas and Khosrau, the Persians occupied Byzantine Armenia and in 612 appointed a series of *marzpans*, only to be ousted by Heraclius who, aided in his advance by the Armenians, captured Dwin and Nakhichevan in 623. In 628, after the fall of Khosrau, the Persians appointed an Armenian *nakharar*, Varaztirotz Bagratuni, as governor. He quickly brought Armenia under Byzantine rule but was exiled for plotting against Heraclius (635). The noble who was appointed governor in his place, Dawith Saharuni, was overthrown by his fellow nobles (638).

The Bagratids.—The first Arab raid into Armenia in A.D. 640 found the defense of the country in the hands of the Byzantine general Procopius and the *nakharar* Theodor Rshtuni; the latter successfully ambushed the invaders and then withdrew, but Procopius' attack was repelled. Unable to prevent the pillage of Dwin in 642, in 643 Theodor gained a victory over another Arab army and was named commander in chief of the Armenian army by Constans II. In 653, after the truce was concluded with Mu'awiya, then governor of Syria, Constans voluntarily surrendered Armenia to the Arabs, who granted it virtual autonomy and appointed Theodor as *ostikan* (governor).

Theodor's successor, Hamazasp Mamikonian, sided with Byzantium, but after 661 Arab suzerainty was re-established, although Byzantine-Arab rivalry and Armenian nationalism and reluctance to pay the tribute made the region a difficult one to govern. An unsuccessful revolt led by Mushegh Mamikonian (771–772) resulted in the virtual extinction of the Mamikonian family as a political force in Armenia and in the emergence of the Bagratuni and Artsruni as the leading noble families. The Arabs' choice in 806 of Ashot Bagratuni the Carnivorous to be prince of Armenia marked the beginning of the establishment of his family as the chief power in the land. The Bagratids were more diplomatic than the Mamikonians in their dealings with their foreign overlords. The governor Smbat Ablabas Bagratuni remained loyal to the caliph al-Mutawakkil when he sent his general Bugha al-Kabir to bring the rebellious *nakhararq* to submission, although he also was dispatched in 855 with the rest of the captive nobles to Samarra.

The election by the *nakhararq* of Smbat's son Ashot I the Great, who had been accepted as "prince of princes" by the Arabs in 862, to be king of Armenia in 885 was recognized by both the caliph and the emperor, and it was he who by his successful defense of his country against local Arab chieftains laid the foundations of a new golden age of Armenian history. Throughout the 10th century art and literature flourished. Ashot III ("the Merciful"; 952–977) transferred his capital to Ani (near modern Anipemza) and began to transform it into one of the architectural gems of the middle ages.

The Bagratids of Ani, who bore the title of *shahanshah* ("king of kings") first conferred by the caliph in 922 upon Ashot II the Iron, were not the sole rulers of Armenia. In 908 the Artsruni principate of Vaspurakan became a kingdom recognized by the caliph; in 961 Mushegh, the brother of Ashot III, founded the Bagratid kingdom of Kars; and in 970 the prince of East Siuniq declared himself king.

By the time of the Seljuk Turkish invasions in the 11th century the Armenian kingdoms had already been destroyed from the west. The important province of Taron had been annexed to the Byzantine empire in 968 by Nicephorus II Phocas, and the expansionist policy of Basil II finally extinguished Armenian independence. The possessions of David of Tayq were annexed in 1000 and the kingdom of Vaspurakan in 1022. In the latter year the Bagratid king of Ani, Yovhannes-Smbat, was compelled to draw up a will which made the emperor heir to his estates, and in 1045, despite the resistance of Gagik II, Ani was seized by Constantine IX Monomachus. The Byzantine conquest was to be ephemeral in the extreme: in 1048 Togrul led the first raid of the Seljuk Turks into Armenia, in 1064 Ani and Kars fell to Alp Arslan, and after the battle of Manzikert (1071) most of the country was in the hands of the invaders. In 1072 the Kurdish Sheddadids received Ani as a fief. A few native Armenian rulers managed to survive for a time in the Kiwrikean kingdom of Lori, the Siunian kingdom of Baghq or Kapan, and the principates of Khachen (Artzakh) and Sasun. In the 12th century many ex-Armenian regions became part of Georgia, and between 1236 and 1242 the whole of Armenia and Georgia fell into the hands of the Mongols. Armenian life and learning, centred around the church, continued as best it could.

Little Armenia.—On the collapse of Greater Armenia many Armenians emigrated to Georgia, to Poland and to Galicia, while others crossed into Cilicia, where at the end of the 10th century some colonies had settled. One of Gagik II's lieutenants, a certain Ruben, established himself about 1080 at Bardzrberd in the Taurus mountains, and another noble named Oshin at Lambron; the former became the founder of the Rubenid dynasty of barons and kings who ruled Cilicia until 1226 and the latter was the ancestor of the Hethumid dynasty which succeeded them and ruled until 1342. The barons Constantine I (1092–1100), Thoros I (1100–29) and Leo I (1129–39) greatly enlarged their domains at the expense of the Byzantines who had occupied the Cilician plain and by 1132 Vahka, Sis, Anazarbus, Mamistra, Adana and Tarsus were under Rubenid rule. Although John II Comnenus succeeded in annexing the whole of Cilicia during 1137–38, Thoros II (1145–68) recaptured the mountain fortresses and Mleh (1170–75), with the aid of the Turks, recaptured the cities of the plain and restored Armenian rule. Leo II (I) the Great (1187–1219), who had been the ally of Frederick I Barbarossa, received the royal crown from the latter's son Henry VI and Pope Celestine III and in 1199 was crowned king of Armenia in Tarsus by the cardinal Conrad von Wittelsbach. The Byzantine emperor lost no time in sending a crown also, but Little, or Lesser, Armenia was now firmly allied to the west.

Intermarriage with crusading families was common and Frankish religious, political and cultural influence, though resisted by the more nationalistic barons, was strong. Leo reformed his court and the administration of his kingdom on western models and many French terms entered the language: the *nakharar* became a baron, the *sparapet* a cunstabl. Little Armenia played an important role in the trade of the Venetians and Genoese with the east, and the port of Lajazzo (on the Gulf of Iskenderun) rivaled Alexandria. Leo II left no son and the throne passed to his daughter Zabel. Her first husband, Philip of Antioch, who despised his Armenian subjects and refused to accept the Armenian faith—Leo II's lip-service to Rome as the price of his coronation was largely ignored—was deposed by the barons, and the regent Constantine, baron of Lambron and a descendant of Oshin, arranged the marriage of Zabel to his son Hayton (Hethum) I (1226–69), the first of the Hethumid dynasty. According to Armenian chroniclers, Hayton

conceived the idea of employing the Mongols against the growing menace of the Mamelukes of Egypt; he was present with the Mongol army that entered Aleppo and Damascus in 1260, but the subsequent Moslem victory at Darbsak cost him dearly. His successors followed the same policy, but the Mongols were weakening and after their defeat in 1303 near Damascus were unable and unwilling to protect Cilicia against the Mamelukes. The latter's chief objective was the port of Lajazzo; having destroyed it a first time in 1322, in 1337 they compelled Leo V (IV) (1320–42) to undertake to demolish its fortifications.

On the death, without heir, of Leo V the crown passed to Guy de Lusignan, the eldest son of Hayton II's sister Zabel and her husband Amaury de Lusignan (Amalric of Cyprus). He was assassinated by the barons in 1344 for doctrinal reasons and the next two kings, Constantine IV and V, were elected from their own ranks. On the assassination of Constantine V the crown passed again to a Lusignan, to Guy's nephew Leo VI (V) (1374–75). By this time, as a result of the Mameluke advance, little remained of Armenia except Sis and Anazarbus; Lajazzo had finally fallen in 1347, and Adana, Tarsus and the Cilician plain in 1359. In 1375 the capital Sis fell to the Mamelukes and the last king of Armenia was captured; ransomed in 1382, he died in Paris in 1393. The title "king of Armenia" passed then to the kings of Cyprus, from them to the Venetians, and was later claimed by the house of Savoy, but from the end of the 14th century the history of Armenia as a separate state is replaced by the history of Armenians under foreign domination.

The Turkish Conquest.—After the capture of Constantinople by the Ottoman Turks in 1453 the Armenian bishop of Bursa, transferred to the capital with the rank of patriarch, was appointed political leader of the Armenians in the Ottoman empire. The Armenians thereby acquired, in addition to religious freedom, a large say in the management of their own affairs. Their numbers were increased at the beginning of the 16th century by the conquest of Cilicia and Greater Armenia.

On the death of Timur in 1405 the eastern Armenian regions had passed into the hands of the Turkmen grouped into two rival confederacies, the Kara-Koyunlu (Black Sheep) and the Ak-Koyunlu (White Sheep), until the defeat of the latter by the Persian shah Ismail I in 1502. Armenia again became the battlefield for the armies of two powerful neighbours, and in 1514–16 the Ottomans wrested it from Persian rule. During the war that broke out in 1603 Shah Abbas I strove to regain the lost territories, and in 1605, with the aim of stimulating trade in his dominions, he forcibly transferred thousands of Armenians from Julfa (in northwest Persia) to Isfahan (central Persia), where those who survived the march settled in the quarter known as New Julfa. At the peace of 1620, while the greater part of Armenia remained in Ottoman hands, Persia regained the regions of Yerevan, Nakhichevan and Karabakh. In the mountainous region of Karabakh a group of five Armenian maliks (princes) succeeded in conserving their autonomy and managed, during the struggle between Persia and Turkey at the beginning of the 18th century, to achieve a short period of independence (1722–30); despite the heroic resistance of David Beg, the Turks occupied the region, but were driven out again by the Persians under Nadr Kuli (the future Nadir Shah) in 1735.

Armenia and Europe.—At the beginning of the 19th century the Russians advanced into the Caucasus. In 1813 the Persians were obliged to acknowledge Russia's authority over Georgia, northern Azerbaijan and Karabakh, and in 1828 they ceded Yerevan and Nakhichevan. Contact with liberal thought in Russia and western Europe was a factor in the Armenian cultural renascence in the 19th century, and leading writers like Abovian and Raffi (*q.v.*) did much to awaken the national consciousness of the Armenians, who became increasingly impatient with foreign rule. In Turkey the Armenians benefited with the rest of the population from what measures of reform there were, and in 1863 a special Armenian constitution was recognized by the Ottoman government. But social progress in Turkey was slow and the Armenians in Anatolia were subject to many abuses. After the Russo-Turkish War of 1877–78, in which Russian Armenians had taken part, Russia insisted in the treaty of San Stefano that reforms should be carried out among the sultan's Armenian subjects and that their protection against the Kurds should be guaranteed. This demand was reiterated at the congress of Berlin, and the "Armenian question" became a factor in international politics in which Great Britain showed a particular interest.

The Hënchak (socialist) party was founded in 1887 and the Dashnaktzutiun (Dashnak, nationalist) party in 1890, and in the face of growing Armenian nationalism the Turkish and Russian governments became increasingly hostile toward their unruly subjects. In 1895, after the Turkish sultan Abdul-Hamid II had promised Great Britain, France and Russia to carry out reforms, large-scale systematic massacres took place in the provinces. In 1896, after the desperate occupation of the Ottoman bank by a group of 26 young Dashnaks, more massacres took place in the capital. In 1903 Russia confiscated the property of the Armenian Church. The greatest single disaster in the history of the Armenians came with the outbreak of World War I. In 1915 the Turks, regarding the Armenians, despite pledges of loyalty, as a dangerous foreign element with friends among the enemies who had launched a campaign against the Dardanelles and with brothers in the Russian armies on their eastern front, decided to deport the whole Armenian population of about 1,750,000 to Syria and Mesopotamia. The operation was carried out with the utmost barbarity. It is estimated that about 600,000 Armenians died or were massacred en route. About one-third escaped deportation.

In 1916 the Turkish Armenian regions were captured by the Russians but in 1918, after the Russian Revolution of 1917, the Armenians, who continued the struggle against the Turks, were forced to fall back to the prewar Russo-Turkish border.

(C. J. F. D.)

Short-Lived Independence.—Together, on April 22, 1918, the Georgians, Armenians and Azerbaijanis had formed a Transcaucasian federal republic. On May 26, 1918, however, this was broken up into three independent republics. On June 4, 1918, R. I. Kachaznuni and A. I. Khatisian, both of the Dashnak party, who were respectively premier and foreign minister of the republic, were compelled to sign a peace treaty with Turkey at Batumi, by which Armenia lost Kars and its boundary with Turkey was fixed on the Arpa and Aras rivers (*i.e.,* the pre-1878 Russo-Turkish frontier). This treaty, however, was not ratified because of the military collapse of the Ottoman empire. After the Mudros armistice (Oct. 30, 1918) the Allied powers controlled the Black sea and this enabled them to establish direct contact with the Transcaucasian republics. The Turks were forced to withdraw their troops from the Armenian republic to the pre-1914 Russo-Turkish frontier. Soon afterward Armenia was involved in territorial disputes and in some fighting with both Georgia (for the Borchalo, now Marneuli, district) and Azerbaijan (for the Karabakh district). The British, politically in control of Transcaucasia, tried to arbitrate without recognizing the existing local governments. In Nov. 1919 the Soviet Russian government, having disposed of Gen. A. I. Denikin's White Russian army, concluded its first agreement with the Turkish nationalist government of Ankara. The Allies countered on Jan. 15, 1920, by the *de facto* recognition of the three Transcaucasian republics. Less than four months later Azerbaijan was conquered by the Red army and this was followed in May by an abortive Communist rising in Armenia.

The Allies were sponsoring the formation of a single Armenian state uniting Russian and Turkish Armenia. Great Britain and France hoped that the United States would accept a mandate over Armenia, but the U.S. senate declined such a responsibility (June 1, 1920). Nevertheless, on Aug. 10, 1920, the Allies recognized the Armenian republic *de jure* by admitting its representatives to sign the peace treaty of Sèvres with Turkey.

The treaty of Sèvres recognized Armenia as a "free, independent state," and Pres. Woodrow Wilson was asked to fix the boundary between Armenia and Turkey. On Nov. 22, 1920, he announced a line which awarded to Armenia Trabzon (Trebizond), Erzincan, Erzurum, Mush and Van, an area of about 40,000 sq.mi. within the pre-1914 Turkish frontier.

Both the treaty of Sèvres and Wilson's award remained a dead

letter. The fate of Armenia was decided by the armed forces of Soviet Russia and nationalist Turkey. At the end of Sept. 1920 the Turks attacked the Armenian republic; at the same time the Russians advanced from Azerbaijan. On Dec. 2, 1920, a peace treaty between Armenia and Turkey was signed at Alexandropol (Leninakan) which not only annulled the provisions of the treaty of Sèvres concerning Armenia but also stripped from it the Kars district which was Russian between 1878 and 1914. In the Alexandropol treaty the Armenian signatory recognized that there were no Armenian majorities anywhere in Turkey.

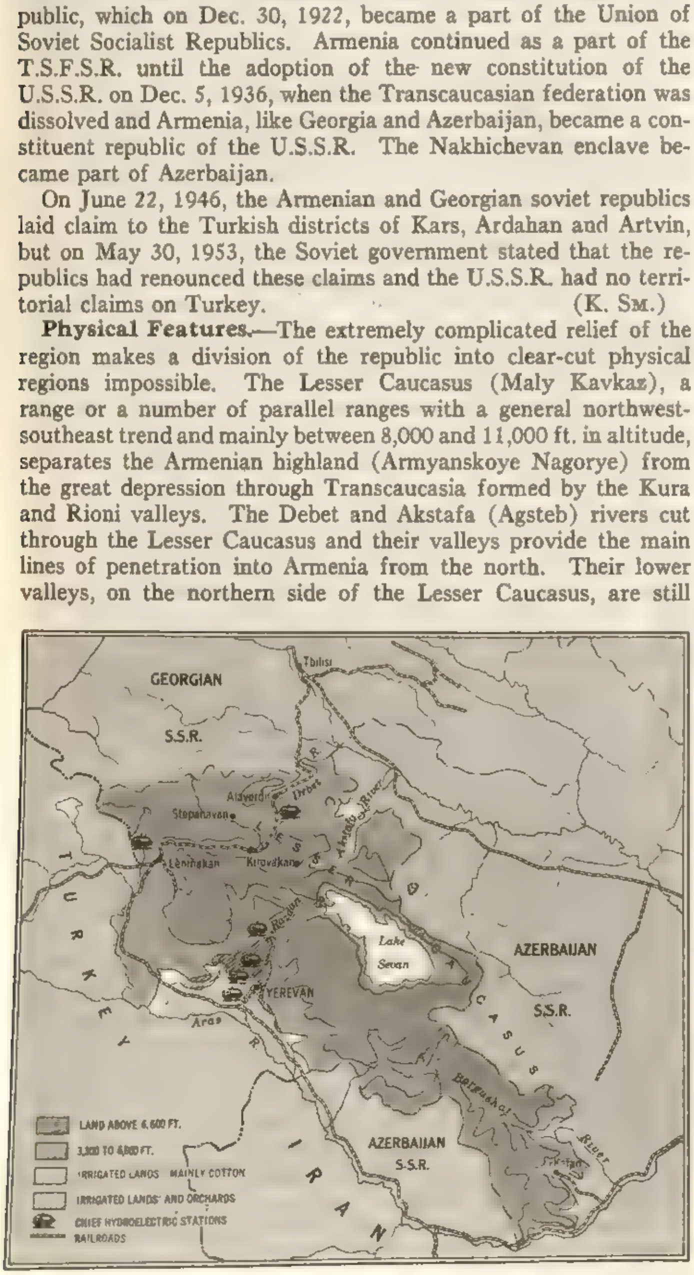
THE ARMENIAN SOVIET SOCIALIST REPUBLIC

On the same day that the Alexandropol treaty was signed the Armenian council of ministers at Yerevan ceded authority to Gen. Dro Kanayan, commander in chief. The next day (Dec. 3, 1920) a new government composed of Communists and Dashnakists proclaimed Armenia a Soviet republic. Shortly afterward the Dashnakists were eliminated from the government. One of them, S. Vratzian, led an armed anti-Communist rising in Feb. 1921, but since no help was forthcoming from abroad this ended in failure.

On March 12, 1922, Armenia, Georgia and Azerbaijan were combined to form the Transcaucasian Soviet Federated Socialist Republic, which on Dec. 30, 1922, became a part of the Union of Soviet Socialist Republics. Armenia continued as a part of the T.S.F.S.R. until the adoption of the new constitution of the U.S.S.R. on Dec. 5, 1936, when the Transcaucasian federation was dissolved and Armenia, like Georgia and Azerbaijan, became a constituent republic of the U.S.S.R. The Nakhichevan enclave became part of Azerbaijan.

On June 22, 1946, the Armenian and Georgian soviet republics laid claim to the Turkish districts of Kars, Ardahan and Artvin, but on May 30, 1953, the Soviet government stated that the republics had renounced these claims and the U.S.S.R. had no territorial claims on Turkey. (K. Sm.)

Physical Features.—The extremely complicated relief of the region makes a division of the republic into clear-cut physical regions impossible. The Lesser Caucasus (Maly Kavkaz), a range or a number of parallel ranges with a general northwest-southeast trend and mainly between 8,000 and 11,000 ft. in altitude, separates the Armenian highland (Armyanskoye Nagorye) from the great depression through Transcaucasia formed by the Kura and Rioni valleys. The Debet and Akstafa (Agsteb) rivers cut through the Lesser Caucasus and their valleys provide the main lines of penetration into Armenia from the north. Their lower valleys, on the northern side of the Lesser Caucasus, are still within Armenia. The Armenian highland, to the south of the Lesser Caucasus, is higher in the north and slopes toward the Aras river. It is broken by steep-sided ranges and interrupted by extinct volcanoes of which the highest is Mt. Aragats (Alagez), 13,418 ft. in altitude. A remarkable feature is the large Lake Sevan (*q.v.*), the surface of which is 6,279 ft. above sea level. The extreme southeast of the republic, drained mainly by the Bargushat (Vorotan) river, is very rugged. Least rugged is the Aras valley in the southwest. The Aras, which forms the international boundary between the U.S.S.R. (Armenia) and Turkey, drains most of the republic, including Lake Sevan via the Razdan (Zanga) river. About 50% of the republic is above 6,000 ft. and only about 3% is below 2,000 ft.



MAP OF ARMENIAN SOVIET SOCIALIST REPUBLIC SHOWING PHYSICAL FEATURES

Altitude affects climate in Armenia, contributing to a considerable diurnal range of temperature and, of course, making mean temperatures lower than might be expected at sea level in this latitude (41°–39° N.). Mountain barriers on almost every side, shutting off influence from already distant seas, produce large seasonal variations in temperature. Mean January temperature in the Armenian highland is around 32° F., while mean July temperature exceeds 80° F. Annual precipitation tends to increase with altitude, being only 8–12 in. in the lower parts of the Aras valley, 12–24 in. elsewhere in the highland but as much as 30 in. on the highest ranges.

A little deciduous forest is found in the more humid parts of the Lesser Caucasus ranges, but generally natural vegetation consists of xerophilous shrubs or mountain steppe plants in the higher parts, and steppe or even semidesert vegetation in the Aras valley. Among the chief wild animals in Armenia are the gopher (*Citellus xanthroprymnus*), the jerboa (*Alactaga williamsi*), the hamster (*Mesocricetus auratus*), the mole rat (*Spalax monticola*) and the fox (*Vulpes vulpes kurdistanica*). Wild boars are found in the remoter mountain districts. (J. P. Co.)

The People.—The Armenians are the descendants of a branch of the Indo-Europeans, represented by Herodotus and Eudoxus as related to the Phrygians who entered Asia Minor from Thrace, and the peoples of the ancient kingdom of Urartu upon whom they imposed their rule and their language. Known to the Persians as Armina, Arminiya-, and to the Greeks as Armenioi, the people call themselves Hay (pl. Hayq) and their country Hayastan, and look back to an eponymous hero Hayk. Both groups of appellations are of obscure origin; any connection of Hay with the land of Hayasa mentioned in Hittite sources is doubtful. Ancient Armenian writers call the Armenians descendants of Togarmah or Ashkenaz, the sons of Gomer, son of Japheth. F. von Luschan's postulation of an "Armenoid" race (brachycephalic, with flattened occiput, fleshy, convex nose) forming the basis of the population of Anatolia, Kurdistan, Syria and Iran has been rejected by R. Kherumian who considers the predominant element among the Armenians, who like all nations are mixed, to be Dinaric, a fact he takes to support the theory of the Thraco-Phrygian origin of the Armenians. The Armenian language is Indo-European (satem branch), but the phonetics and grammar have some features in common with the Caucasian languages. There are many cultural loans from Iranian, but the greater part of the vocabulary is unexplained; it is possible that some words derive from the extinct languages of the non-Indo-European substratum, but no convincing Urartian-Armenian "equations," for example, have been made. The standard language of the republic is Eastern Armenian (*rusahayeren*), which is written in the Armenian (Mesropian) character; the most important minority language is Azeri Turkish. The Armenians are traditionally monophysite Christians and belong to the Armenian Apostolic (Orthodox) Church, which has its centre at Echmiadzin (*q.v.*), the seat of the supreme catholicos. (*See* Armenian Language; Armenian Literature; Armenian Church.) (C. J. F. D.)

Population and Administration.—Armenians make up about 80% of the total population of the republic. The remainder consists of Azerbaijanians from the neighbouring republic, of Russians and Ukrainians, and of small groups of peoples, such as Kurds, long settled in the region itself. In 1959 the population of 1,763,048 was divided equally into urban and rural (in 1939 only

28.6% was urban). Of the 881,844 urban dwellers, 509,340 live in Yerevan (*q.v.*) and 108,446 in Leninakan, the only other town with more than 100,000 inhabitants.

Yerevan is the administrative, cultural and commercial centre. It is the seat of the presidium and the location of the state university, the academy of sciences and more than 40 technical and scientific institutes.

Economy.—After 1930 considerable industrial development took place, transforming the predominantly agricultural economy of Armenia. Several important mineral deposits are exploited, while a number of sizable hydroelectric power stations form the main source of energy for industrialization. Leninakan is the principal urban centre of the northwest and Stepanavan, Kirovakan and Kafan are small centres.

About 16% of the total area of Armenia is sown land (1,190,000 ac. out of 7,400,000 ac.). Part of this area, centred mainly in the Aras valley around Yerevan, is irrigated. The Aras, the Kasakh and Razdan from the north, and other rivers, feed irrigation channels. However, most of the sown area depends upon the generally inadequate precipitation. There is therefore a great contrast, in productivity per unit of area and in crops grown, between the limited irrigated lands and the rest of the sown area. Cotton, the mulberry tree, tobacco and the vine are grown on irrigated lands; wheat, which covers almost half of the sown area, and barley are among the nonirrigated crops. More than half of the remainder of Armenia consists of moderate to poor quality grazing land, which may be divided into winter pastures in the semiarid, nonirrigated parts of the Aras valley, middle altitude pasture used all the year and high summer pasture in areas above about 8,000 ft. Livestock products include meat, wool and milk. Unlike neighbouring Georgia and Azerbaijan, Armenia does not make any vital, special contribution to Soviet agriculture as a whole, and, apart from a limited surplus of fruits, cotton, wool and cheese, farming is largely organized to serve local needs.

Armenia has a large number of commercial mineral deposits. Copper, mined at Alaverdi and Kafan, is the principal mineral produced, but Armenia accounts for only a small part of the total Soviet output of this metal. Zinc and lead ores are also extracted near Kafan, and chrome ores near Lake Sevan. Armenia has a great variety of building stones.

In the absence of significant coal and oil deposits Armenia depends upon hydroelectricity as a source of energy. There are many favourable sites for small power stations with large vertical falls of water. In particular the Razdan river, which descends more than 3,000 ft. in its 50 mi. course between Lake Sevan and its confluence with the Aras, has several power stations. Lake Sevan makes a useful natural reservoir for the power stations and irrigation supply, but evaporation from its extensive surface is wasteful. It is planned to lower the level of the lake by cutting a tunnel from the western end into the Razdan, leaving only the deeper western part. The exposed lake bed will then be used for agricultural purposes. By the early 1960s most of the state and collective farms had been electrified.

Armenia has a wide range of light manufacturing, but, apart from the refining of copper and other metals heavy industry is hardly represented. Yerevan and Leninakan are the principal industrial centres, with light engineering, textile manufacturing and food processing.

Communications.—Armenia has about 300 mi. of railway. The principal line enters the republic from Tbilisi (Tiflis) in Georgia and climbs through the Lesser Caucasus range by the Debet valley to reach the Armenian highland near Leninakan. It then follows the Aras valley, descending southeastward into Azerbaijan, and runs most of the way close to the river and international boundary. Roads and tracks are the principal forms of communication in the rest of the republic. *See* also references under "Armenia" in the Index.

(J. P. Co.)

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(J. P. Co.; C. J. F. D.; K. Sm.)

ARMENIAN ART. Very little is known about the pagan art of Armenia. The ruined temple of Garni is one of the rare survivals of this early period; the plan, the sculptured friezes, the pavement mosaic with mythological figures relate this monument to late Greco-Roman art. With the establishment of Christianity as the official religion in the first years of the 4th century, a new era began, and an art that had a truly national character was developed.

The principal periods of artistic activity correspond to those of national independence or semi-independence. The first and most fruitful period extends from the 5th century to the Arab conquest in the middle of the 7th century; the second, from the establishment of the Bagratid kingdom in the late 9th century to the Seljuk conquest in the middle of the 11th century; the third, from the end of the 12th to the middle of the 14th century, when the northern provinces were ruled by Armenian princes under Georgian or Mongol suzerainty, and an independent kingdom was established in Cilicia.

Architecture.—The feudal organization and the simultaneous existence of several local kings explain the erection of so many important buildings in several parts of the country; the absence of a strong centralized government and, consequently, of an official art may also have contributed to the great diversity of architectural types. The walls of the churches were faced, both inside and out, with carefully cut stone and the core filled with rubble.

The vaulted basilican plan, exemplified by the church of Ereruk, was abandoned fairly soon in favour of a centralized plan, crowned with a dome that had a typical conical roof. This type of church may already have been built in the 5th century, as evidenced by the foundations of the church of Echmiadzin, and from the 6th century on it became the predominant form. The monuments of the first period display imaginative variations of the basic, centralized scheme: different adaptations of a square buttressed by niches (Bagaran, St. Hrip'sime), or of the cross inscribed in a rectangle (St. Gayane, Mren); trefoils (Thalin), quatrefoils (Zvarthnots), hexagons, octagons or other polygonal types. The complexities of the inner disposition contrast with the massive simplicity of the exterior; the niches, the subsidiary chambers and even the main apse are often hidden in the thickness of the walls, the uniform surfaces of which are broken up by decorative arcades and by triangular slits or recesses marking the location of the inner divisions.

The architects of the second and third periods frequently reverted to the earlier models, but the general proportions tended to become more elongated and new structural features were developed.

At the cathedral of Ani, completed in 1001—the masterpiece of the architect Trdat, who was invited to Constantinople to repair the dome of Hagia Sophia—the clustered piers support pointed arches and the slightly pointed vaults are ribbed. In other churches, wall ribs, radiating arches or complex systems of cross ribs bear the weight of the stone web. Thus the problem of the vaulted stone structure received an earlier and different solution in Armenian art than it did in Gothic art.

Armenian architecture holds an important place in the history of medieval art. As in other eastern Christian countries, the ultimate sources of the monuments may be discerned in the edifices of the late classical period or in those of Persia and Mesopotamia, but because of the preference given to certain architectural types, the significant modifications that were found for structural problems, the Armenian churches differ from those of the neighbouring countries and have their own individual character. (*See* BYZANTINE ARCHITECTURE.)

Sculpture.—The stone construction lent itself to carved decorations, and architectural sculpture was more extensively used in Armenia than in any other country of the near east except Georgia.

The reliefs of the 4th-century hypogeum at Aghts and those on numerous funerary steles antedating the Arab conquest show the early stages of stone sculpture. Beginning with the 6th century, and perhaps even earlier, floral and geometric motifs as well as figure representations were carved around the windows of the churches, between the arches of the blind arcades, on the lintels and the lunettes over the doors. Decorative ornaments became increasingly intricate in the later periods.

The outstanding example of architectural sculpture is the church of the Holy Cross, built in the early 10th century on the island of Aghthamar in Lake Van; this is the earliest medieval example, either in the east or in the west, of a stone building entirely covered with relief sculpture. Around the dome and on the four façades may be seen a variety of animals, vine and other floral scrolls, and large figures of saints and scenes from the Old Testament. The portrait of King Gagik, offering to Christ the model of the church he had erected, appears on the west façade. Such donor portraits, sometimes carved in the round as at Ani, were one of the characteristic features of the decoration of Armenian churches.

Painting.—Remnants of mosaics and frescoes show that, from an early period, the interiors of the churches were adorned with scenes from the Gospels, images of Christ, of the Virgin and of saints. But it is principally through illustrated manuscripts that the development of Armenian painting can best be studied. Though the earliest examples have disappeared, there is an almost uninterrupted series of significant works ranging from the late 9th to the 17th century. These are distinguished first by the richness and diversity of their ornamental designs; floral, geometric and animal motifs are painted in vivid colours on a gold background around the canon tables of the Gospel manuscripts, on the headpieces, in the margins and ingeniously adapted to the capital letters.

The iconography of the Gospel scenes is based on the types evolved in early Christian and Byzantine art, but the Armenian painters, especially those of the medieval kingdom of Cilicia, often displayed a marked independence and interpreted, in a more lively or dramatic manner, the age-honoured formulas. In the manuscripts of Greater Armenia two artistic trends can be discerned: one, more eastern in character, tends to simplify the human form and subordinate it to the ornamental interest; the other, more influenced by Byzantine art, results in a subtle blending of naturalism and stylization. This latter trend was predominant in Armenian Cilicia, where a flourishing school developed under the patronage of the court and of the church. The high artistic quality of the 13th-century manuscripts, in particular, places them in the first rank of medieval illumination. Through contacts with the crusaders and the Mongols, the painters of this period became acquainted with the art of the Latin west and of the far east, and this broadened horizon resulted in the production of richly imaginative works.

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"BAPTISM OF CHRIST." ARMENIAN ILLUMINATION FROM TREBIZOND GOSPELS, 11TH CENTURY. S. LAZZARO, VENICE, ITALY

Manuscripts continued to be illustrated in the Armenian monasteries and in the various centres outside their native country where the people settled after the destruction of the kingdom of Cilicia. These works are often inferior to the products of the earlier period, but some original schools developed, for instance, at Khizan, south of Lake Van.

The 17th century witnessed a revival of ancient forms, skilfully executed, as well as interesting imitations of western art, especially in the illustrations of the Old Testament and of the Book of Revelation.

A few silver reliquaries and bindings of manuscripts of the 13th and 14th centuries, with figure representations, give an idea of the art of the goldsmiths and silversmiths, which was also widely developed in medieval Armenia.

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ARMENIAN CHURCH, the national church of Armenia, whose official title is the Armenian Apostolic Church. It is frequently supposed to be monophysite in belief (*see* MONOPHYSITES) because it rejects the Council of Chalcedon (*see* below), but its doctrine on the person of Christ as stated in its own official formularies readily admits of orthodox interpretation.

History.—Armenian tradition ascribes the first preaching of Christianity in Armenia to St. Thaddaeus and St. Bartholomew. Such apostolic claims were commonly made as a matter of prestige in early centuries, and in this case the evidence is inconclusive. Eusebius' *Church History* refers to a bishop in Armenia during the reign of Decius (*c.* 250). But the conversion of the Armenian people was mainly due to St. Gregory the Illuminator (*q.v.*), from which fact the Armenian Church is sometimes termed Gregorian. Gregory preached in Armenia as a layman and converted King Tiridates in about 300. Armenia then became the first country to adopt Christianity as the state religion.

The history of the church reflects that of the nation. Situated between the two great powers of Byzantium and Persia, its attitude toward the councils of the church was affected by political influences. In Persia it faced the stronghold of the Nestorian heresy and in Byzantium the upholders of the orthodoxy of the Council of Chalcedon; in maintaining a dogmatic position independent of either, the Armenian Church symbolized the efforts of the nation to regain its own independence.

Gregory was ordained priest and consecrated bishop by Leontius of Caesarea (Anazarbus) about 300. It is not clear how far the new bishop was subject to the jurisdiction of Caesarea, but the continuation of the patriarchate in Gregory's family suggests considerable independence, and the connection with Caesarea was finally broken in 374. Early in the 5th century the catholicos Sahak (Isaac) the Great, a scholar skilled in Greek, encouraged the monk Mesrop (*q.v.*) who invented an alphabet for writing the Armenian language, and together they began to translate into Armenian a series of Greek and Syriac theological works as well as the books of the Bible. (*See* ARMENIAN LITERATURE.)

In 451, when the Council of Chalcedon promulgated the orthodox doctrine of the two natures of Christ, Armenia was not represented, being politically under the control of the Persians and engaged in a fierce struggle against Zoroastrianism. In about 632 the Armenian synod of Karin (Erzurum), in the presence of the

Byzantine emperor Heraclius who had conquered the Persians, reached theological agreement with the Byzantine Church by avoiding any mention of Chalcedon, but in about 645 at the third Council of Dwin the one nature of Christ was again proclaimed.

The Arab conquest of Armenia, which soon followed, effectively cut the Armenians off from their Byzantine neighbour, who after condemning them at the Trullan council (692) tended to regard them as hated heretics. The two churches were also divided by certain different ritual and disciplinary practices, which further exacerbated the theological and national animosity between them. In the 9th century, when Armenia had received a measure of independence, the Byzantine patriarch Photius tried to persuade the catholicos to accept Chalcedon, but without success. Similar fruitless attempts were made in the following centuries. By the end of the 10th century the religious authorities of both churches, beginning with the Byzantines, were rebaptizing those members of the other church residing in their territory. It then became necessary for Armenians living within the Byzantine empire to have Armenian bishops of their own.

During the period of the crusades, most of which passed through Armenian territory, the Armenian Church tried to come to agreement with the Latins, who made a number of converts and continued to work in the area. The Armenian Church was represented at the Council of Ferrara-Florence (1438–*c.* 1445), where its delegates signed the decree of union, but this act was repudiated by the Armenian Church as a whole.

After the Turks had conquered Constantinople (1453) they appointed Hovakim of Bursa as Armenian patriarch of Constantinople (1461). Through him and his successors the Armenian church and nation were, together with other monophysite churches in the Ottoman empire, governed as a minority community, the *Ermeni milleti.*

From the 18th century onward the Latins were active in proselytization, and in 1717 Mekhitar of Sebastia (Sivas) went to San Lazzaro outside Venice and established there a colony of Armenians, called Mekhitarists (*q.v.*), in communion with Rome. Protestant proselytization began in the 19th century, but neither Latins nor Protestants affected more than a small minority of Armenians. From 1894 to 1917 the Armenian people suffered from periodic massacres by the Turks, which pitifully reduced their numbers. The supreme catholicos of the Armenian Church now resides at Echmiadzin in Soviet Armenia. There are strong Armenian minorities in both Constantinople and Jerusalem, where they are allotted a portion of the old city and share the church of the Resurrection (or Holy Sepulchre) with the Greeks and the Latins. Armenians have emigrated to most parts of the world, and colonies of them are settled chiefly in Iran, the middle east, eastern Europe, France and North and South America.

The Armenian Church is identified closely with the Armenian people, and through it the national consciousness has mainly been expressed. It has played an active part in common Christian activity in the World Council of Churches and it has had particularly friendly relations with the Anglican churches.

Doctrine.—The Armenian Church, together with the other eastern churches, repudiates the western doctrines of purgatory, the juridical primacy of the pope and the double procession of the Holy Spirit. It accepts the first three ecumenical councils, but differs from the Orthodox Eastern Church as well as from the western churches in rejecting the fourth (Chalcedon, 451), which promulgated the doctrine of Christ's two natures (*see* COUNCIL). It holds that this council was not fully ecumenical, because certain eastern churches were not represented there. It believes that if Christ has two natures then he must be two persons, and it agrees with the much-quoted formula *Mia physis tou theou sesarkomene* ("one incarnate nature of the godhead"), which was composed by Cyril of Alexandria before the word *physis* ("nature") had acquired the precise sense in which it was later used by the orthodox in their controversies with the monophysites. The Armenian Church anathematizes Eutyches (*q.v.*), the originator of monophysitism, as well as Nestorius. Its creed (an Armenian redaction of the so-called commentary, wrongly ascribed to Athanasius, on the Nicene Creed), which it has used since the 6th century, includes the statement "by whom [the Holy Spirit] he [the Logos] took body, soul and mind and everything that is in man, truly and not in semblance," a phrase inconsistent with full monophysite belief.

Organization and Customs.—The Armenian Church has four patriarchates, two of which have the dignity of catholicates. The catholicos of Sis resides at Antilyas near Beirut and has jurisdiction over Lebanon, Cyprus and parts of Syria. There is a patriarch of Jerusalem as well as of Constantinople. Only the supreme catholicos consecrates bishops for the whole church; the catholicos of Sis consecrates only for his own area. Clergy who wish to marry must do so before ordination; otherwise they must remain celibate. Bishops are chosen from the unmarried clergy. Monasteries now exist only as seminaries for the training of the clergy. The laity substantially outnumber the clergy in the councils electing bishops and patriarchs, and have always taken full part in discussions on doctrine and discipline.

Armenians theoretically maintain seven sacraments, but extreme unction has fallen out of use. Unleavened bread and wine not mixed with water are used for Holy Communion; communion is in both kinds by intinction (*i.e.*, the bread is dipped into the wine), and reservation for the sick is practised. Divorce is occasionally permitted under canonical rules. Vestments and ceremonial show traces of Latin influence, though the liturgy (*q.v.*) is mainly that of St. Basil. The liturgical language is ancient Armenian. Armenian churches are usually rectangular in shape with an altar raised on a platform five or six steps above the level of the nave; only one liturgy is permitted on any one day. There are no statues in the churches, and icons are far less prominent than in Orthodox churches.

The Armenian patriarchate of Jerusalem continues, like other Eastern churches in the holy city, to keep the Julian calendar, which is 13 days behind the Gregorian. The rest of the Armenian Church, however, changed to the Gregorian calendar in 1922. Fixed feast days are kept on the nearest Sunday to their calendar date, save that Christmas, which is not a separate festival but is included in Epiphany as in the early Eastern Church, always falls on Jan. 6 except in the United States, where it too is kept on the nearest Sunday.

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ARMENIAN LANGUAGE. The Armenian language is an independent member of the Indo-European family of languages which, spoken in a mountainous region, has never spread widely or permanently. It possesses great vitality despite many persecutions. It was not reduced to writing until the spread of Christianity in Armenia when, according to tradition, in the 5th century, an alphabet was drawn up to suit it.

In the language as then written were composed translations of the Bible and other pious works as well as original compositions such as that by Bishop Eznik. This language is still preserved as the ritual language of the Gregorian or Armenian Church and up to the 19th century was the language used by Armenian scholars.

The spoken language meanwhile evolved independently and in all parts of the country differed widely from the literary language. Lay writers used the forms current in their region, so that from the time of the crusades there are historic texts in the vulgar speech of the Armenian kingdom in Cilicia as then constituted. When in the 19th century modern literary languages appeared, there was great diversity in form.

Some Armenians were then Russian subjects, others under Ottoman rule, yet others under Persia. One literary language developed at Yerevan under Russian rule and was used by the numerous Armenians settled at Tbilisi (Tiflis). Another was formed at Constantinople, where from the days of the Byzantine empire there had been an important Armenian colony. Both these languages deliberately eliminated words brought in under Islamic and Turkish domination and replaced them by true Armenian

Capital	Lower Case: Regular Type	Lower Case: Shēghākēr Type (since 1860)	Lower Case: Nōdr Type	Armenian Name in English Equivalents	Sound	As in
Ա	ա	ա	ա	ip	ä	fäther
Բ	բ	բ	բ	pĕn	p slightly voiced	pĕn
Գ	գ	գ	գ	kim	k slightly voiced	cane
Դ	դ	դ	դ	tä	t unvoiced explosive	time
Ե	ե	ե	ե	yĕtch	y, ĕ	*
Զ	զ	զ	զ	zä	z	zone
Է	է	է	է	ē	ē	ēnd
Ը	ը	ը	ը	üt	ü	ürn
Թ	թ	թ	թ	tō	t slightly voiced	talk
Ժ	ժ	ժ	ժ	zhē	zh	azure
Ի	ի	ի	ի	ēnē	ē	ēvent
Լ	լ	լ	լ	lūn	l	late
Խ	խ	խ	խ	khē	kh	†
Ծ	ծ	ծ	ծ	dzä	dz	bids
Կ	կ	կ	կ	gēn	g unvoiced	again
Հ	հ	հ	հ	hō	h	hat
Ձ	ձ	ձ	ձ	tza	tz unvoiced explosive	tzar
Ղ	ղ	ղ	ղ	ghōd	gh	‡
Ճ	ճ	ճ	ճ	jē	j	joke
Մ	մ[1]	մ	մ	mēn	m	men
Յ	յ[2]	յ	յ	hē	h, y	§
Ն	ն	ն	ն	noo	n	name
Շ	շ	շ	շ	shä	sh	shop
Ո	ո	ո	ո	vō	v, ō	‖
Չ	չ	չ	չ	tchä	tch unvoiced explosive	watch
Պ	պ	պ	պ	bē	b	be
Ջ	ջ	ջ	ջ	chē	ch slightly voiced	church
Ռ	ռ	ռ	ռ	rä	rr trilled	¶
Ս	ս	ս	ս	sē	s	so
Վ	վ	վ	վ	vēv	v	vote
Տ[3]	տ	տ	տ	dün	d	day
Ր	ր	ր	ր	rē	r	red
Ց	ց	ց	ց	tsō	ts slightly voiced	bats
Ւ	ւ	ւ	ւ	hün	v	♀
Փ	փ	փ	փ	pür	p unvoiced	pure
Ք	ք	ք	ք	kē	k unvoiced	kick
Օ	օ	օ	օ	ō	ō	old
Ֆ	ֆ	ֆ	ֆ	fē	f	fill

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ARMENIAN ALPHABET

* Initially y as in yet; medially ĕ as in end (*Condĕmnation*)
† No equivalent sound in English; a strong guttural sound as in German *noch*
‡ No equivalent sound in English; a soft guttural sound similar to uvular r of French and German
§ Initially h as in hot; medially y as in beyond; finally y as in boy or else silent
‖ Initially v as in vote; medially o similar to second o in photo
¶ Rolled tongue-tip r as in Spanish *sierra*
♀ a. v as in revive
b. In combination with ու = o͞o as in poor
c. In combination with իւ = ü as in cure
1. Also formerly written as մ or մ
2. Also formerly written as յ
3. Also formerly written as Տ

words largely taken from the old written language, and thus in vocabulary both agree in many points. Pronunciation and grammar have diverged considerably though true to the general linguistic type. Thus in Yerevan Armenian, Jacob is pronounced *Hakob* and in Turkish Armenian is *Hagop*.

Armenian is the continuation of a group of Indo-European languages intermediate between Indo-Iranian (Aryan) and Greek but distinct from both. As a result of contact with other languages, Armenian has developed in its own way and is widely removed from the early Indo-European type.

The consonantal system coincides largely with that of the southern group of Caucasian languages, represented by Georgian. The so-called occlusive consonants, *p, t, k* and *b, d, g,* have undergone complete mutation, so that where Indo-European has a *d*, there is a *t;* thus the numeral *tasn* for ten corresponds to the ancient form *decem* as in Latin, *cf.* Armenian *hayr* ("father"), Gothic *fadar* and Latin *pater*.

The changes from the original form have been considerable as in the numerals "two" and "three," which in Latin are *duo* and *tre* and in Armenian are *erku* and *erekh*.

The grammatical forms are traceable to Indo-European origins but assumed new shapes. Thus grammatical gender had disappeared from Old Armenian. A good number of old words have been preserved, such as *kov* ("cow"), showing the mutation of *g* to *k*. The old form had a *g* as in the Sanskrit *gav*. Words of higher culture are mainly borrowed since Armenian has always been exposed to foreign influence. From the 3rd century B.C. to the 3rd century A.D. the country was ruled by a Parthian aristocracy, so that the language has many Iranian words. The terminology of Christianity came with the spread of the Syrian and Byzantine churches, and there are Greek words and, from the time of the crusades, French words.

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ARMENIAN LITERATURE. There is evidence that a pagan oral literature of ritual songs, epic poems and plays existed in Armenia before the invention of the alphabet in the 5th century A.D., but owing to the zeal of the early Christian priests, little of this has been preserved. In his *History of Armenia* Moses of Khoren cites fragments of songs and poems composed about the god Vahagn (the Iranian Verethragna) and King Artavasdes which he says, were still sung in his day (5th–6th century A.D.). Apart from early court theatres on classical models (Plutarch mentions a performance of Euripides' *Bacchae* at the Armenian court and records that Artavasdes II [*c.* 53–34 B.C.] himself wrote tragedies histories and orations in Greek), primitive native plays or mimes were enacted by the *gusans* and *vardzaks* (male and female singers and dancers).

For about a century after their conversion to Christianity (*c.* 300), the Armenians had to rely for the scriptures and religious books upon works in Greek and Syriac that were unintelligible to the common people, and to remedy this St. Mesrop (Mashtotz) invented the Armenian alphabet (*c.* 410). The catholicos Sahak the Great and St. Mesrop, encouraged by King Vramshapuh (*c.* 392–414), formed a school of translators who were sent to Edessa and to Constantinople to procure and translate Syriac and Greek copies of the scriptures and other important works.

Much of the literary activity of the 5th century, the golden age (*oskedar*) of Armenian literature, was devoted to such translations; original works, however, although some of those traditionally ascribed to this century are almost certainly later compositions, are not wanting. The masterpiece of classical Armenian writing is the *Refutation of the Sects* of Eznik Koghbatzi. This is a polemic work, composed partly from Greek sources, in defense of orthodox Christian belief against—and thereby providing valuable information about—pagan Armenian superstitions, Iranian dualism, Greek philosophy and the Marcionite heresy. Its pure classical style is unsurpassed in Armenian literature.

The writing of history is the principal genre in ancient Armenian literature, and many histories are attributed to the 5th century

The best-known is the *History of Armenia* of Moses of Khoren (*q.v.*). The *History of Armenia* of Faustus (Phaustos) Biuzandatzi belongs to the 5th century, although he has been said to have been a Byzantine of the 4th century writing in Greek. From this lively and honest work, of which only books covering the brief period *c.* 316–390 are extant, a passage is quoted by the 6th-century historian Procopius. Toward the end of the 5th or at the beginning of the 6th century Ghazar Pharbetzi wrote a *History of Armenia* (388–485) having been requested by the *marzpan* Vahan Mamikonian (*c.* 485–505) to continue the history of Faustus. To some extent a panegyric of the Mamikonian family, it is nevertheless the best factual history after that of Faustus.

As well as these predominantly political histories, others were written dealing with religious affairs and hagiography. A work by Agathangelus relates the life of St. Gregory (Grigor) the Illuminator. Speculation has been rife about the identity of its author, ranging from the traditional view that he was the Greek secretary of King Tiridates (Trdat) II (278–332) and wrote in Greek in the 4th century, to the view that Agathangelus is not the name of a person, but an epithet ("bearer of good tidings") used of St. Gregory. The work was probably written in Armenian in the 5th century.

To the 6th century belongs Bishop Peter (Petros) of Siuniq (547–556), whose principal work was a *Panegyric on the Mother of God.* From the end of the 5th to the 7th century the so-called Hellenistic school translated many Greek works. Most of the works attributed to a certain David the Invincible belong to this period. The Midas touch of Armenian tradition has made of this enigmatic David a golden age disciple of Sahak and Mesrop who studied in Athens and Constantinople, but his identity is not known. The language of the Hellenistic school was artificial in character. Of original literature, the 7th century produced the important *History of Heraclius* by Bishop Sebeos, an account of the war between Byzantium and Khosrau II of Persia and of the Arab conquest. Anania Shirakatzi wrote works on arithmetic, astronomy and possibly the geography once attributed to Moses of Khoren. In the 8th century Ghevond Vardapet wrote a *History of the Caliphs,* and Catholicos John IV of Odzun (717–728), various theological works.

In the 10th and 11th centuries, which witnessed the maturity of the independent Bagratid kingdom of Armenia, the Artsruni kingdom of Vaspurakan and the kingdom of Siuniq, Armenian literature, art and architecture flourished more freely than at any time since the 5th century. The principal literary figure of the 10th century was St. Gregory Narekatzi (951–1003), the first great Armenian poet, renowned for his mystic poems and hymns as well as for such prose works as the *Commentary on the Song of Songs.* Earlier in the same century, Thomas (Thovma) Artsruni wrote a *History of the House of Artsruni* which, in spite of its family bias, is the chief source of information on the history of Armenia down to 936; an anonymous writer continued the work to 1121. The *History of Armenia* by Catholicos John VI Draskhanakertzi (897–925) is of great value for its account of Arab relations with Armenia, for the author was himself an important participant in the later events he describes. At the turn of the 10th to 11th centuries Bishop Ukhtanes wrote a *History of Armenia* and a *History of the Schism between the Georgians and Armenians.* The beginning of the 11th century saw the completion of the reliable and well-written *Universal History* of Stephanos Asoghik. The *History of Armenia* by Aristakes Lastivertzi, relating the fall of the Bagratid kingdom (1045), the destruction of Ani (1064) and the victories of the Seljuks, is almost as much a prose elegy as a history.

After the political collapse of Greater Armenia at the end of the 11th century, the cultural centre shifted to Little or Cilician Armenia. Literature did not cease to be written in the occupied territories, however, and Armenian literature may thereafter be divided into a western and an eastern branch. In both regions works began to be written in the spoken as well as the classical language. The greatest poet of the 12th century in Cilicia was Catholicos Nerses IV Shnorhali ("the Gracious," 1102–1172), the author of many poems and hymns. In prose one of his important works is an *Epistle on the Question of Union With the Greek Church.* Catholicos Grigor IV Pahlavuni (1173–1193), nephew and successor of Nerses Shnorhali, composed an *Elegy on the Capture of Jerusalem* and various epistles. In the east, the priest Samuel of Ani wrote a *Chronicle* (to 1179). In Caucasian Albania, Mkhithar Gosh (1133–1213) compiled a *Lawbook* which became a basis for subsequent Armenian law.

In the 13th century, eastern Armenia proved at least as fertile in literary production as Cilicia. Kirakos Gandzaketzi's *Concise History*, Vardan Vardapet's *Universal History* and the *History of the Archers* (formerly attributed to Malachia the Monk but now to Gregory of Akner in Cilicia) are valuable for the history of the Mongols. Mkhithar of Ani wrote a *Universal History* of which only a fragment remains. In Cilicia, Vahram Rhabuni composed a *Rhymed Chronicle* of the Rubenid dynasty down to the reign of Leo III (1269–1289) at the latter's request, and Smbat the Constable (1208–1276) wrote a *Chronicle of Little Armenia* (from 952 to 1274, continued anonymously to 1331) and a translation of the *Assises d'Antioche*, the French text of which is lost.

Whereas in Cilicia, in the 14th century, many laymen took to writing, all the principal works of the eastern regions were produced by the clergy. A *History of Siuniq* was written by Stephanos Orbelian (d. 1304), archbishop of the province, who also wrote a *Lamentation on the Cathedral of Echmiadzin.* Gregory Tathevatzi (1346–1411) wrote a book of *Questions and Answers* dealing with Manichaean and Islamic "errors," and a collection of sermons. The monasteries of Tathev and Gladzor in Siuniq and Nor Getik in Caucasian Albania were, like Skevra and Akner in Cilicia, important centres of literary activity during this period, while the Uniate monastery of Krnai was zealous in the translation of Latin works, including the *Summa* of St. Thomas Aquinas (1347). Of the poets, the most important was Frik (*c.* 1236–1315).

The events of the last quarter of the 14th century—the Cilician kingdom fell to the Mameluks in 1375 and Timur invaded the east in 1385—ushered in a long period of political and cultural decadence in Armenia, but despite unfavourable conditions, some works of importance were produced. Thomas of Metsob (1379–1446) wrote a *History of Timur;* Amirdovlath of Amasia (*c.* 1415–1496), living in Constantinople, henceforth the centre of western Armenian culture, wrote two medical works compiled from Arabic, Greek and other sources; and Araqel Siunetzi, abbot of Tathev (fl. 1407), wrote various works in prose and verse, his chief poem being the *Book of Adam* which has been called (generously) "an oriental *Paradise Lost.*"

The besetting gloom of the period of decadence was illumined from the 16th to the 18th centuries by the rise of a number of popular bards or troubadours called *ashugh* (Arabic *ashiq* "lover") who, though to a large extent subject to foreign influence in matter, style and vocabulary, composed verses of merit. The two outstanding troubadours of this period were Nahapet Kuchak (d. *c.* 1592), one of the rare Armenian poets to sing unambiguously of profane love, and, most famous of all, Aruthin Sayadian, called Sayat-Nova (*q.v.*). Many folk songs—laments, lullabies, love songs, marriage songs, work songs, etc.—have been preserved in contemporary manuscripts. A folk epic, *Sasuntzi Davith* ("David of Sasun"), said by some to date from the 8th to 10th centuries, was current among the people, and was first written down in 1873. In the 17th century Araqel of Tabriz, a monk at Echmiadzin, wrote a *History* of the years 1602 to 1660, dealing with the events in Armenia during the Perso-Turkish wars and the forced emigration of Armenians to Persia under Shah Abbas I. Oskan of Yerevan (1614–1675), who was born at the new Armenian colony of New Julfa at Isfahan, printed the first Armenian Bible at Amsterdam in 1666, but the first Armenian printed book, a directory of church feasts, had appeared in 1512. Eremia Chelebi Kömürjian (1637–1695) wrote various works on Ottoman history and a description of Istanbul, as well as some poems.

The 18th century witnessed an Armenian cultural and intellectual renaissance symbolized to some extent by the establishment of the Uniate congregation of Mekhitharists at Venice, and later also at Vienna; both the classics and original works of scholarship were—and still are—printed on their own presses. By the middle

of the 19th century, the soil was prepared for a reburgeoning of Armenian literature; contributory factors were the temporary improvement in the lot of the sultan's Armenian subjects and the increase in the number of national schools and newspapers. The Armenian language, however, was in a chaotic state, and the question as to which form should serve as the vehicle for the new ideas of the time led to controversies, both in Turkish and Russian Armenia, between the champions of the old classical language and those of the modern spoken languages. Eventually the latter prevailed, with the result that the eastern literature is written in the so-called Ararat dialect (*rusahayeren*) and that of the west in the dialect of Istanbul (*dachgahayeren*). For their models, and for many of their ideals, the Armenian writers looked to Europe (those of the west to France, those of the east to Russia) and the divers literary fashions of Europe found an echo in Armenian writing. Among western authors, Tovma Terzian (1840–1909), Mrktich Peshikthashlian (1828–1868), Petros Durian (1851–1872), Daniel Varuzhan (1884–1915) and Vahan Tekeyan (1877–1944) composed lyrical poetry; in prose Hakob Paronian (1842–1891) and Eruand Otian (1869–1926) were outstanding satirical novelists, and Grigor Zohrab (1861–1915) the author of realist short stories; the theatre, although the Mekhitharists had paved the way with historical plays and comedies, was perhaps best represented by Paronian, whose comedies (*e.g.*, *The Dowry*, *Master Balthazar*, *The Oriental Dentist*) are still popular.

The serious novel, comparatively weak in western Armenian literature, was strongly represented in Russian Armenia where it became the vehicle for Armenian moral, social and political aspirations. Khachatur Abovian (1805–48), called the "father of modern Armenian literature," wrote his *Wounds of Armenia* in 1840, although it was not published until after his death, in 1858. The most celebrated Armenian novelist is Hakob Meliq-Hakobian or Raffi (*q.v.*). Among the eastern poets Hovhannes Thumanian (1869–1923) must be mentioned; he wrote both lyric and narrative poems and his masterpiece, the short epic *Anush*, full of songs that have become well-nigh traditional, was early adapted as an opera. The most outstanding Armenian dramatist was Gabriel Sundukian (1825–1912), whose comedies (*Hullabaloo*, *Pepo*, *The Broken Hearth*) portray the contemporary Armenian society of Tbilisi in whose dialect most of them were written.

The rapid decline of Istanbul as the principal western Armenian literary centre (after the massacres of the first quarter of the 20th century) brought about a new period of decadence in Armenian literature, although the Armenians of the diaspora continued to write in Paris, Beirut and Boston. Some Turkish Armenians fled to the east where they enjoyed a certain degree of autonomy and where, after the foundation of the Armenian Soviet Socialist Republic in 1936, national literature was encouraged, and controlled, by the state. There were numerous eastern Armenian writers of varying quality, as for instance, the poet Avetiq Isahakian (1875–1957), but eastern literature tended toward monotony. The university and the Academy of Sciences of Yerevan, however, did much to encourage the study of Armenian literature.

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(C. J. F. D.)

ARMENTIÈRES, a town in northern France, in the *département* of Nord, is situated in flat country on the Lys close to the Belgian frontier 10 mi. W.N.W. of Lille by road. Pop. (1954) 24,274. The town, entirely rebuilt after destruction in World War I, presents a uniform appearance with its red-brick buildings. There is an annual fair in September. Armentières is on the main railway from Lille to Dunkerque and Calais. Flax and cotton, beer, and machinery are produced. Armentières was two miles behind the battle line throughout World War I and from April until Sept. 1918 was in German possession. The marching song about the mythical "Mademoiselle from Armentières," sung by British and U.S. troops, dates from this period. During World War II the town was bombed and was occupied by the Germans from May 1940 until Sept. 1944.

ARMERIA, a genus of plants of the north temperate zone, belonging to the Plumbaginaceae family and consisting of about 60 species of small perennial herbs, many of which are commonly known as thrift or sea pink. They have rosettes of narrow evergreen leaves on the ground and simple naked scapes terminated by a head of pink, lilac or white flowers. *A. maritima* (formerly *Statice armeria* and *S. vulgaris*) is the thrift so widely grown in beds, borders and rock gardens. It succeeds in almost any well-drained soil in the full sun, being hardy and free growing. Many of the species and their varieties hybridize freely and much of the horticultural material is a mixture of various forms. Propagation is by division of clumps and by seeds. (J. M. Bl.)

ARMFELT, GUSTAF MAURITZ, Count (1757–1814), Swedish statesman prominent both in diplomacy and in military affairs, was born at St. Mårtens near Turku in Finland on March 31, 1757. Appointed gentleman to the crown prince Gustavus II Adolphus in 1781, Armfelt made a brilliant career at the court. He was employed by Gustavus III of Sweden in the negotiations with Catherine II of Russia (1783) and with the Danish government (1787) and was one of his most trusted and active counselors during the Russian war of 1788–90. He displayed great valour in the field. In 1788 when the Danes invaded Sweden and threatened Göteborg, Armfelt, under the king's direction, organized the Dalarna levies. He remained faithful to Gustavus when nearly all the nobility deserted him; brilliantly distinguished himself in the later phases of the Russian war; and was the Swedish plenipotentiary at the peace of Värälä (1790). During Gustavus III's last years his influence was paramount, though he protested against his master's headstrong championship of the Bourbons.

On his deathbed Gustavus III (1792) entrusted his infant son to Armfelt and made him a member of the council of regency; but the duke-regent Charles (afterward Charles XIII) sent Armfelt as Swedish ambassador to Naples to get rid of him. From Naples Armfelt communicated with Catherine II, urging her to make a military demonstration in favour of the Gustavians. The plot was discovered by the regent's spies, and Armfelt only escaped with the assistance of Queen Caroline of Naples (1794). He then fled to Russia. When Gustavus IV attained his majority, Armfelt was rehabilitated and sent as Swedish ambassador to Vienna (1802), but was obliged to quit that post two years later for sharply attacking the Austrian government's attitude toward Napoleon Bonaparte. From 1805 to 1807 he was commander in chief of the Swedish forces in Pomerania, where he retarded the French conquest.

After the deposition of Gustavus IV (1809), Armfelt was the most courageous supporter of the crown prince Gustavus. Expelled from Sweden in 1811, he found refuge in Russia, where he obtained great influence over the emperor Alexander I. He contributed more than anyone else to the erection of the grand duchy of Finland as an autonomous state and participated in the planning of the Russian defensive campaigns against Napoleon and in the conference between Alexander and the Swedish crown prince (Bernadotte; the future Charles XIV John) at Turku in Aug. 1812. He died at Tsarskoe Selo, on Aug. 19, 1814.

See Elof Tegner, *Gustaf Mauritz Armfelt*, 3 vol. (1883–87); Carl von Bonsdorff, *Gustav Mauritz Armfelt*, 4 vol. (1930–34). (E. O. H J.)

ARMIDALE, a city in Sandon county, situated on the New England tablelands, New South Wales, Austr., lies 350 mi. N. of Sydney and 287 mi. S. of Brisbane by road. Pop. (1954) 8,661. The plateau, consisting of Silurian rocks buttressed by granite, is bounded on the east by steep escarpments and rugged country. In spite of its latitude (30° 32′ S.), the altitude of Armidale (3,265 ft.) gives it a cool, bracing climate and a sufficient rainfall (mean annual 31–32 in.) derived mainly from the Pacific side. It is the centre of a thriving agricultural and pastoral area (sheep, cattle, fruit, etc.). Mining of tin, gold and antimony is also carried

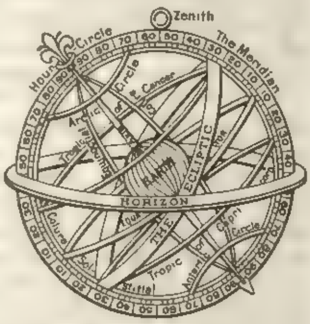
on locally, though to a much lesser extent than formerly. Hydroelectric power is generated from the falling waters of the Oaky river.

Climate, scenery and a halfway position on the main railway line from Sydney to Brisbane (to both of which there are also air services) have helped to make Armidale an educational, cultural, ecclesiastical and sporting centre. It possesses fine schools, a university, a teachers' training college (with a notable art gallery) and an Anglican and a Roman Catholic cathedral. The town was first laid out in the 1840s and became a city in 1884. (Ro. A. B.)

ARMIGER: *see* Esquire.

ARMILLARY SPHERE, an ancient astronomical device for representing the great circles of the heavens, including in the complete instruments the horizon, meridian, equator, tropics, polar circles and an ecliptic hoop. It is a skeleton celestial globe, with circles divided into degrees for angular measurement. In the 17th and 18th centuries such models, either suspended, rested on a stand or affixed to a handle, were used to show the difference between the Ptolemaic theory of a central earth and the Copernican theory of a central sun.

The earliest known complete armillary sphere with nine circles is believed to have been the *meteōroskopion* of the Alexandrine Greeks (*c.* A.D. 140), but earlier and simpler types of ring instruments were also in general use. Ptolemy in the *Almagest* enumerates at least three. The simplest of all was the equinoctial armilla, a ring of bronze fixed in the plane of the equator. At Rhodes and elsewhere the arrival of the equinoxes was noted by observing when the shadow of the upper half of the ring exactly covered the lower half. Similarly, the solstitial armilla, a double ring erected in the plane of the meridian with a rotating inner circle, was used for measuring solar altitudes, and probably by Eratosthenes (*c.* 276–*c.* 192 B.C.) for measuring the obliquity of the ecliptic. Hipparchus is stated to have used (146–127 B.C.) a sphere of four rings, and in Ptolemy's instrument, the *astrolabon*, there were diametrically disposed tubes upon the graduated circles, the instrument being kept vertical by a plumb line.



AFTER BLUNDEVILLE, "A PLAINE TREATISE . . . OF COSMOGRAPHIE," 1594

AN ARMILLARY SPHERE

The earth is equipped with a visible axis, and the imaginary circles of astronomy are represented by metal rings

The Arabs employed similar instruments with diametric sight rules or alidades, and it is likely that those made and used in the 12th century by Moors in Spain were the prototypes of all later European armillary spheres.

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ARMINIANISM, beginning early in the 17th century, a liberal reaction to the Calvinist doctrine of predestination, asserting that God's sovereignty and man's free will are compatible.

Jacobus Arminius (*q.v.*), Dutch Reformed theologian of the University of Leiden (1603–09), an irenic scholar, was unwillingly precipitated into a highly publicized debate with his colleague F. Gomarus (*q.v.*) concerning the Calvinistic interpretation of the divine decrees respecting election and reprobation. The point at issue was the relationship of the divine omniscience to the sovereign acts of God's love and wrath. Were the divine decrees of election and reprobation (as effective for every human being in the whole stream of human history) projected from the inscrutable mystery of the ultimate divine will? Or were these decrees predicated upon the omniscient divine foreknowledge of the freely willed response to or rejection of God's proffered love? Arminius sought to affirm the latter alternative, adding that the divine omniscience knows that the divine will effects sovereignty through a love that is so omnipotent as to suffer the contradictions of human rejection. (*See* also Predestination.)

In short, Arminius saw the divine will in terms of the power of love rather than of unmitigated force. This point of view is to be sharply distinguished from the assertion that the divine decrees are based on the foreknowledge of man's choice. It is, for Arminius, God's will as unceasing love that is ever the determinative initiator and arbiter of human destiny. The theological movement designated Arminianism, however, while precipitated by the long controversy at the University of Leiden, in retrospect failed to apprehend the discriminative nuances of Arminius.

Dutch Arminianism was originally articulated in the Remonstrance (1610), a theological dictum written by J. Uytenbogaert, signed by 45 ministers and submitted to the states-general. The Synod of Dort (Nov. 13, 1618–May 9, 1619) was called by the states-general to pass upon the Remonstrance (*see* Dort, Synod of). Eminent defenders of this document were Simon Episcopius (*q.v.*), Philipp van Limborch and Hugo Grotius (*q.v.*), none of whom had come under the tutelage of Arminius. The "five points" of the Remonstrance asserted: (1) election (and condemnation in the day of judgment) was conditioned by the rational faith or nonfaith of man; (2) the atonement, while qualitatively adequate for all men, was efficacious only for the man of faith; (3) unaided by the Holy Spirit, no person is able to respond to God's will; (4) grace is not irresistible; and (5) believers are able to resist sin but are not beyond the possibility of falling from grace.

The import of the Remonstrance, understood (deceptively) as the theological structure of Arminianism, was that it apparently relieved the divine sovereignty of efficacious responsibility in the process of redemption. Elements of Renaissance humanism, with its affirmation of man's inalienable initiative and self-determination, found in it a brilliant Protestant theological articulation. The crux of this Remonstrant Arminianism lay in the assertion that human dignity requires an unimpaired freedom of the will. This freedom is in no sense mitigated by divine acts or decrees. While reason proposes validly live options for the decisions of free will, some of these options, if they are to appeal to faith, must be provided by grace alone; and this grace is always resistible. The will acts as guided by reason. Hence, the freedom of the will is expressed in decisions of faith that are grounded in rationally accepted options; these options, in turn, may be actualized only by the immanent aid of the Holy Spirit, granted as a superadded gift of prevenient grace (*i.e.*, grace [*q.v.*] given freely by God, and unmerited, so that the person who receives it may be led to choose the good).

Opponents discerned that in the delineation of this process, for Remonstrant Arminianism, it is reason rather than alienable love that is chiefly determinative of human choice. Furthermore, this analysis provided *de facto* denial of both the supralapsarian and infralapsarian views of the divine decrees of predestination (*q.v.*), and these views had become such acceptable alternatives among the controversial parties of scholastic Calvinism that their denial could be considered characteristic of anti-Calvinism and, accordingly, in opposition to the mandatory theology of the state church.

Suspected of political (republican) motivation, the Remonstrant Arminians were attacked by Prince Maurice and later were condemned by the Synod of Dort. Many were banished, some adhered to the Roman Catholic Church, and others were persecuted. By 1630, the Dutch Remonstrants were legally tolerated. It was not, however, until 1795 that the Remonstrant Brotherhood was officially recognized. This movement continues to assert effective liberalizing tendencies in Dutch Protestant theology. (*See* also Netherlands, The: *History*; Oldenbarnevelt, Johan van.)

In England, in the 17th century, Arminianism was a term used by opponents to denigrate the Laudian theories of episcopacy and church discipline, though this movement was only slightly, if at all, influenced by the work of Arminius. The latitudinarians of Oxford and Cambridge likewise were called Arminians, though their rationalism was admittedly a revival of Platonism (*see* Cambridge Platonists).

In the 18th century the Wesleyan movement was at first distinguished from the revivalism of George Whitefield by the phrase "Methodist Arminianism." Later John Wesley accepted the term in the title given to the publication he edited from its first issue,

Jan. 1, 1778, to the time of his death. *The Arminian Magazine* would maintain, he wrote, "that God willeth all men to be saved, by speaking the truth in love." Wesley went to Amsterdam, Neth. (Nov. 1777), and secured the data for the article on the life of Arminius that was published in the first issue. He concluded that Arminius was "a person with whom those, who mention his name with the utmost indignity, are quite commonly unacquainted." Accordingly, Wesley initiated a reappraisal of the theology of Arminius based on that author's works and sharply distinguished from the "Arminianism" of the rationalistic Remonstrants of Holland as well as the "Arminianism" of England in the preceding century.

The Wesleyan revival of the study of Arminius' theology was a major factor in the coherent development of Methodist doctrinal affirmations in Great Britain. In the United States, Methodist theology as articulated by systematic theologians in the theological schools (1845–85), contrariwise, failed to follow Wesley's concern for the study of the works of Arminius and reverted to the Remonstrant theology of Philipp van Limborch and Simon Episcopius. Hence American Methodist "Arminianism" has never been rooted in the basic affirmations of Arminius. This fact accounts, in some measure, for the theological disparities between British Methodist theology and that of 19th-century American Methodism.

Jonathan Edwards' critique of New England Arminianism in the 18th century attacked positions that had little in common with the theology of Arminius. New England Arminianism indicated a theological ferment uniquely relevant to the new world as distinct from Britain and the continent.

In later times the renascence of Calvinism under the influence of Karl Barth, as well as expanded studies of John Calvin and the cultural, social and political influences of Calvinism in history, occasioned revived interest in Arminius and re-evaluations of Arminianism.

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ARMINIUS (18 B.C.?–A.D. 19), German leader who inflicted a major defeat on Rome by destroying three legions in the battle of the Teutoburg Forest (*q.v.*). He was a chief of the Cherusci (*q.v.*), and in Roman service had obtained both citizenship (perhaps as C. Julius Arminius) and even equestrian rank. The circumstances of the rising of A.D. 9 are unknown, but the attack on the Roman general Quintilius Varus as he left his summer camp was cleverly organized and Roman power east of the Rhine was abruptly broken. In A.D. 15 Germanicus Caesar (*q.v.*) engaged Arminius again, taking advantage of the latter's quarrel with his father-in-law, Segestes. Arminius' wife, Thusnelda, was captured, but the next year he survived a full-scale Roman attack with considerable credit. When Roman operations were suspended in A.D. 17, Arminius became involved in war with Maroboduus, king of the Marcomanni, and, although successful, was subsequently murdered by his own people.

The conception of Arminius as a German national hero, which reached its climax in the late 19th century, can claim support from Tacitus' judgment of him as "unquestionably the liberator of Germany" (*liberator haud dubie Germaniae*); and it is clear that Augustus' plans for the country between the Rhine and Elbe rivers, though their exact nature is uncertain, were severely checked in A.D. 9. Yet Arminius was leader of a single tribe, and in his day a united "Germany" was not even an ideal. His greatness lay in his obvious ability as a military commander, and he is a most interesting example of the "Romanized" native chieftain at a very early period of the empire.

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ARMINIUS, JACOBUS (JACOB HARMENSEN or HERMANSZ) (1560–1609), Dutch theologian and founder of Arminianism, was born in Oudewater, Holland, Oct. 10, 1560. His evocative writings and public disputations occasioned a long controversy in the scholastic Calvinism of his era over divine sovereignty and human freedom. Calvinist polemics long was arrayed against the theological position associated, erroneously, with his name. His father died when Arminius was an infant and Theodore Aemilius adopted the child and provided for his schooling in Utrecht. Upon the death of Aemilius in 1575, Rudolf Snellius (Snel van Roijen, 1546–1613), a professor at Marburg and a native of Oudewater, became the patron for his further education at the Universities of Leiden (1576–82), Basel and Geneva (1582–86). After some time in Rome he returned to Amsterdam where he was ordained in 1588. In 1603 he was called to a theological professorship at Leiden, which he held until his death, Oct. 19, 1609.

Arminius was a man of mild and liberal spirit, averse to coerced uniformity. The uncongenial controversies forced upon him involved his critical denial of the stern Dutch Calvinist scholasticism, which affirmed a supralapsarian decree of predestination; *i.e.*, the divine decree determining the elect was effected prior to the Adamic fall. Consequently, human decision was asserted to be wholly irrelevant even as a secondarily causal factor in salvation. Arminius asseverated a conditional election in which the divine proffer of salvation might or might not be accepted by a validly free will.

After his death the theological movement associated with his name developed a rationalistically systematized theology that eschewed many of his convictions and organized the Remonstrant Brotherhood in Holland. (*See* also ARMINIANISM.)

The works of Arminius (in Latin) were published in a single quarto volume at Leiden in 1629, and at Frankfurt in 1631 and 1635. Two volumes of an English translation, with copious notes, by James Nichols, were published at London, 1825–28; three volumes (complete) at Buffalo, N.Y., 1853.

BIBLIOGRAPHY.—A life was written by Caspar Brandt, son of Gerard Brandt, the historian of the Dutch Reformation, and published in 1724; republished and annotated by J. L. Mosheim in 1725; and translated into English by John Guthrie in 1854. James Nichols also wrote a life (1843). (DA. C. S.)

ARMISTICE, an agreement for the general cessation of active hostilities between two or more belligerents. Distinguished from general armistices are arrangements for a short-term or partial suspension of arms called local armistice or truce which may be made between commanders in the field, for a variety of purposes such as burying the dead. General armistices are made by commanders in chief, usually pursuant to political decision of the governments concerned. An armistice does not put an end to the state of war. Unless the agreement provides otherwise, belligerents may continue to exercise rights of war such as blockade, visit and search, and seizure of contraband. Armistices, whether for a fixed or indefinite term, are considered temporary, leading to final peace or resumption of hostilities. According to the 1907 Hague convention respecting the laws and customs of war on land, any serious violation gave the other party the right to denounce the armistice or to resume hostilities.

World Wars I and II.—The scope and function of armistices have undergone a significant evolution since World War I. The armistice agreement of Nov. 11, 1918, with Germany, was preceded by negotiations between the belligerents resulting in a so-called "pre-armistice" agreement. The Armistice departed from the usual form also in including political and financial clauses in addition to the military terms. Furthermore, the latter made the resumption of hostilities virtually impossible for Germany. The policy of unconditional surrender adopted by the United Nations during World War II changed the pattern of armistice agreements. The "Conditions of an Armistice" presented by the commander in chief of the Allied forces, Gen. Dwight D. Eisenhower, were accepted on Sept. 3, 1943, by Marshal Pietro Badoglio as head of the Italian government. An "Act of Military Surrender" was signed by representatives of the German high command at Reims on May 7, 1945, and at Berlin on May 8, 1945, whereby they were to "surrender unconditionally to the Supreme Commander, Allied

Expeditionary Force and simultaneously to the Soviet High Command all forces on land, sea, and in the air . . . ." Hostilities in the Pacific ceased on Aug. 14, 1945, when Japan accepted the terms of the Potsdam declaration of July 26, 1945. A formal "Instrument of Surrender" was signed on Sept. 2, 1945, on board the U.S.S. "Missouri," by representatives of the emperor of Japan, the Japanese government and the Japanese imperial general headquarters. In it they proclaimed "the unconditional surrender to the Allied Powers of the Japanese Imperial General Headquarters and of all Japanese armed forces and all armed forces under Japanese control wherever situated." The instrument also declared that, "the authority of the Emperor and the Japanese Government to rule the state shall be subject to the Supreme Commander for the Allied Powers . . . ."

It is clear that the unconditional surrender of the opponent rules out any possibility of resuming hostilities. The juridical difference between the instruments imposed upon and accepted by Italy, Germany and Japan and the traditional armistice is to be found in the absence of any limitation on the freedom of action of the victor save such restriction as resulted, in the case of Japan, from the presurrender agreement constituted by the offer and acceptance of the terms of the Potsdam declaration. Still, juridically, even unconditional surrender does not end the state of war between the parties.

After World War II.—The Security council of the United Nations (UN) had on several occasions called for a cease fire or truce during the hostilities in Indonesia, 1947–48, Palestine, 1948, Kashmir, 1948, and Korea, 1950. In all cases but one, armistice or truce agreements were signed by the parties. The exception was Kashmir where, formally, a cease-fire agreement of Jan. 1, 1949, was signed by India and Pakistan. The truce ("Renville") agreement of Jan. 17, 1948, between the Netherlands and the Republic of Indonesia was of short duration, hostilities having been resumed by the Netherlands on the ground of alleged violations of the truce terms by the republic. In Palestine separate armistice agreements were entered into in 1949, by Israel, on the one hand, and Egypt, Syria, Lebanon and Jordan, on the other. An elaborate system of demarcation lines, demilitarized zones and supervisory agencies (the United Nations Truce Supervision organization and several Mixed Armistice commissions) characterized these agreements.

In accordance with traditional international law regarding armistice agreements, Egypt claimed the right to stop, visit and search for contraband ships passing through the Suez canal and the Gulf of Aqaba and carrying cargo to and from Israel. Israel protested, arguing that the armistice agreements were *sui generis* (unique) and excluded all acts of hostility, as did the UN charter. The Security council, by a resolution adopted unanimously on Sept. 1, 1951, called upon Egypt to terminate interference with shipping and declared that "neither party can reasonably assert that it is actively a belligerent or requires to exercise the right of visit, search and seizure for any legitimate purpose of self-defense." In declaring further that the armistices contemplated "the return to permanent peace in Palestine" the Security council rejected for members of the UN the traditional concept of armistice which permits, legally, a return to active hostilities. The United Nations acted on this theory after the outbreak of hostilities in the Sinai peninsula between Egypt and Israel on Oct. 29, 1956. The agencies mentioned above were charged to supervise the armistice regime and handle complaints subject to the authority of the Security council. This regime was substantially strengthened in 1956 by the stationing, pursuant to general assembly resolution of Nov. 7, 1956, of the United Nations Emergency force on the Egyptian side of the demarcation line with Israel.

Hostilities in Korea were brought to an end formally by the Panmunjom armistice agreement of July 27, 1953, between the commander in chief, United Nations command, on the one hand, and the supreme commander of the Korean People's army and the commander of the Chinese People's Volunteer army, on the other. It provided for "a complete cessation of hostilities and of all acts of armed force. . . ." A demilitarized zone, a Military Armistice commission and a Neutral Nations Supervisory commission (Sweden and Switzerland for the United Nations command; Poland and Czechoslovakia for the other side) were established. The latter commission ceased to function as it was denied free movement to investigate the implementation of the armistice on the North Korean side. Unlike the traditional armistice, this agreement excluded a legal return to active hostilities. Under sec. 62 it was to remain in effect "until expressly superseded . . . by provision in an appropriate agreement for a peaceful settlement at a political level between both sides." Sec. 13-d prohibited any reinforcement of the forces in Korea. In view of the vast build-up of forces in North Korea in violation of this section of the armistice agreement, the United Nations command announced on June 21, 1957, that it would modernize the United Nations forces in order to restore the balance which the agreement was intended to preserve.

The conflict in French Indochina was terminated by the Geneva "Agreement on the Cessation of Hostilities in Viet-Nam" of July 20, 1954, between the commanders in chief respectively of the French Union forces in Indochina and the People's Army of Vietnam. A demilitarized zone and an international commission (Canada, India, Poland) were set up. This agreement did not refer to an "armistice" as the hostilities were not of international character and, therefore, not war in the technical sense of the term. Moreover, a resumption of hostilities was not excluded as according to art. 1, the demilitarized zone was "to act as a buffer zone and avoid any incidents which might result in the resumption of hostilities." However, the emergence of several states in the area (Laos, Cambodia, North Vietnam and South Vietnam) deprived this clause of practical significance.

Compared with the purely military function of the traditional armistice, the later practice indicates a growing political significance. Some of the later armistices (Palestine, Korea) operated as, admittedly unsatisfactory, substitutes for formal peace treaties. Although technically a state of war subsisted, hostilities definitely stopped. Resumption of hostilities, even as a matter of formal right, under international law, was excluded by virtue of the charter of the United Nations. The charter prohibits resort to force or threat of force, except in self-defense against armed attack, and a resumption of hostilities would come under this prohibition.

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ARMISTICE DAY: *see* Veterans Day.

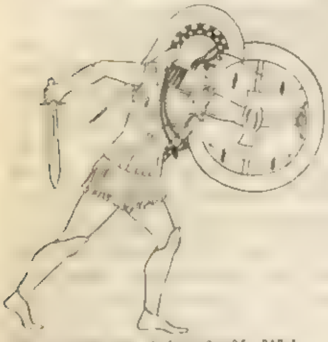
ARMORICA (Aremorica), the Latin name for the northwestern extremities of Gaul (*q.v.*), derived from two Celtic words, *ar*, "on," and *mor*, "sea." In Celtic, Roman and early Frankish times Armorica comprised not only the later Brittany but also the western part of what was afterward Normandy. In Julius Caesar's time it contained five principal tribes, the most important being the Veneti (*q.v.*). Under the Roman empire it formed part of the province of Gallia Lugdunensis but was never thoroughly romanized. From the second half of the 5th century Armorica received many Celtic immigrants from the British Isles. *See* Brittany.

ARMOUR, the name of a family of U.S. businessmen who helped to create a new industry in meat packing. Philip Danforth Armour (1832–1901) entered the grain and pork-packing business in 1863 with his brother Herman Ossian Armour (1837–1901) and John Plankington. In 1870 Armour and Company was formed as a family partnership of Philip D., Herman O. and Andrew Watson Armour (1829–92). Philip D. served as president from 1875 to 1901 and was responsible for introducing new methods for utilizing waste products and employing refrigeration. He founded the Armour Institute of Technology at Chicago in 1892. His son Jonathan Ogden Armour (1863–1927) became president at his father's death. Under his leadership the business continued to prosper and expanded into new fields. When J. Ogden retired in 1923 the company was the largest meat-packing firm in the world. Grandsons of Philip D. and Andrew Watson served on Armour and Company's board of directors after J.

Ogden's retirement, but the direct control did not remain in the family.

See H. Leech and J. C. Carroll, *Armour and His Times* (1938).
(J. R. Lt.)

ARMOUR, BODY. In Homeric and Hellenistic times, bronze was the metal most frequently used for body armour. The armour of the Greeks of historic times and of the Etruscans was highly developed, the forms and outlines pleasing to the eye and the surfaces embossed, engraved and sometimes inlaid with precious metals. The head was protected by a bronze helmet (*q.v.*), often with a dyed horsehair crest supported on a high semicircular plume holder. The body was protected by a bronze cuirass, often modeled to the muscles, and breast- and backplate were joined over the shoulders with braces. A large circular or kidney-shaped shield with a bronze covering was carried in the left hand. The thighs were loosely protected by labels hanging from the cuirass, arms and knees were left bare for the sake of easy movement and the shins were protected by bronze greaves shaped to the leg. The organized armies of the Roman empire were given standardized equipment. The arming of an officer and centurion, who often wore a solid cuirass, was more elaborate than that of the legionary, who was given a round iron helmet (*cassis*) and a cuirass (lorica), which in imperial times consisted of hoops of metal or leather around the body, joined by similar hoops passing over the shoulders. The shield was rectangular and curved to the body. The principal weapons of the legionary were the throwing spear (pilum) and a short sword. The ax sometimes took the form of a *bipennis* (two-edged), which was part of the lictor's insignia. (*See* also Weapons, Primitive.)



FROM AN ATTIC VASE IN THE LOUVRE, PARIS

FIG. 1.—GREEK SOLDIER (HOPLITE), 5TH CENTURY B.C.

A very important development in body armour was the introduction of garments composed of interlinked metal rings, known as mail. Mail is found on Roman sites throughout the empire covering a long period of time. It is clearly represented in Roman art, but its use seems to have been limited. It is generally thought that mail was not indigenous to the empire but was introduced from outside. Mail falls into two classes. In one the rings are secured, either by each link having its ends riveted together or by alternate links of solid, punched rings joined by riveted rings; in the other the rings have their ends butted together. The latter is much weaker than the former and there is a notable division between west and east—*i.e.*, Europe and Asia—in that western mail was almost always riveted and oriental mail more often constructed of butted rings. Scale armour was also used by the Romans.

FROM THE COLUMN OF MARCUS AURELIUS, ROME

FIG. 2.—ROMAN LEGIONARY, 2ND CENTURY A.D.

Besides defensive armour made of metal plates and of mail, there are other categories that can be regarded as substitutes; one is padded armour, consisting of a linen shirt padded with tow and quilted, which was much cheaper and easier to make than mail. It was often worn as an undergarment with mail to deaden the effects of blows that would otherwise badly bruise the body. Such padding was used with Sudanese mail as late as the battle of Omdurman in 1898. Various alternatives were tried, especially in 14th-century Europe when mail was being superseded once more by plate armour and the two were often worn together; the resulting weight sent man looking for substitutes for metal. Horn and boiled leather (called *cuir bouilli* in Norman-French) were tried. Among primitive peoples there were attempts to make armour of wooden slats strung together, and among the Micronesians of the Kingsmill group (Gilbert Islands), even of plaited rope.

FROM THE BAYEUX TAPESTRY

FIG. 3.—ENGLISH INFANTRY AND NORMAN CAVALRY AT THE BATTLE OF HASTINGS, 1066

In the early middle ages in Europe, combatants, especially mounted ones more able to carry the weight, wore helmets of iron usually with a nasal (nose guard), mail shirts reaching to the knee and with short wide sleeves, and carried shields. Armour of the period is extremely rare because of the cessation of the pagan custom of burying arms with the dead.

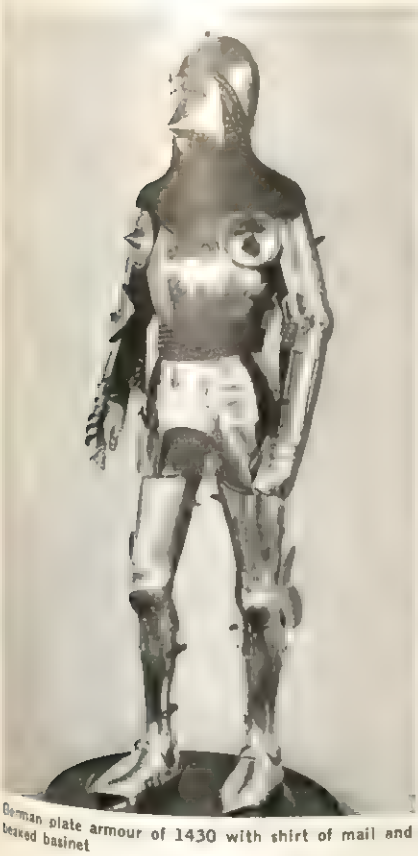
FROM A JEWISH PRAYER BOOK, UNIVERSITY LIBRARY, LEIPZIG

FIG. 4.—MOUNTED KNIGHTS OF ABOUT 1280

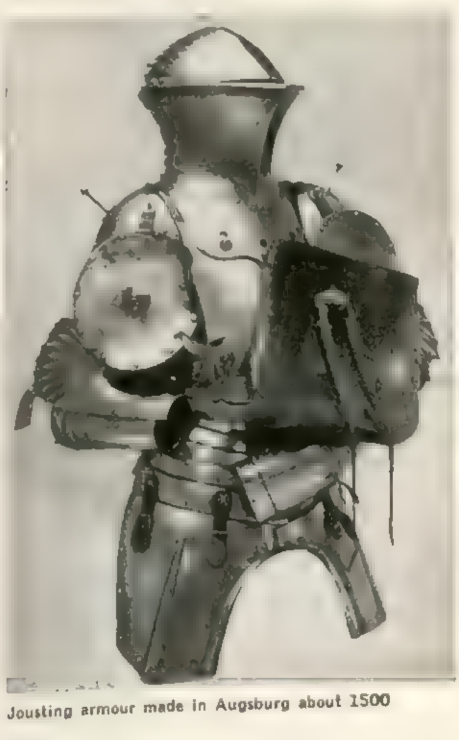
Mail continued to be the main defense of the body and limbs during the 12th and 13th centuries. The sleeves of the hauberk were lengthened and a hood of mail covered the head and neck. Leggings of mail were more freely used than previously. At the end of the 12th century the great cylindrical helm was introduced, and in the course of the century the shield was shortened and made straight across the top, forming a triangle with curved sides. Under the feudal system a personal and hereditary form of heraldry was developed which was freely used to decorate the shield and the linen surcoat (which after about 1200 was worn over the mail shirt), the textile trapper of the horse and, in fact, any other surface or detail of equipment on which it could be applied (*see* Heraldry). The medieval knight on his horse was a highly picturesque and brightly coloured figure. Mail, however, had its disadvantages. It did not possess the rigid, glancing surface of plate armour, and as soon as this could be made responsive to the movement of the body by ingenious construction, it replaced mail, except as a subsidiary. Plate armour of iron and steel required great skill in the making and became the specialized product of certain cities (*see* below). Similarly, the making of swords became largely concentrated in such places as Passau and Solingen in Germany, and later Toledo in Spain. The wearing of fine armour marked out the squire or the knight, to whom the only profession open was military service. The common soldiers had to wear what they could afford or pick up on the battlefield and, being footmen, they could not carry too great a

Coat of mail, Turkish, 16th century, consisting of linked steel rings

German armour for man and horse, Gothic pattern, made at Landshut about 1480



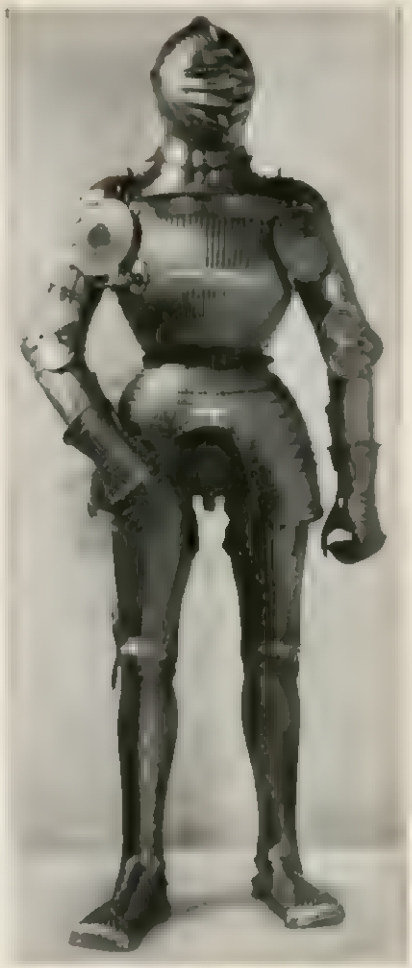
German plate armour of 1430 with shirt of mail and beaked basinet



Jousting armour made in Augsburg about 1500

Parade suit of King Sebastian of Portugal (1554–78), made by Anton Peffenhauser of Augsburg

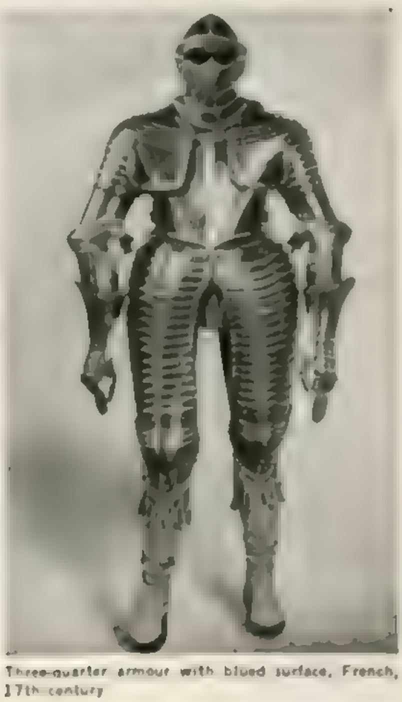
ARMOUR, BODY



"Maximilian" armour of 1510 (above) and about 1525 (right), noted for its elegant fluting and named after Emperor Maximilian I (1459–1519). Fluting presented a glancing surface and increased the strength of the armour. Visor with human face (above) was worn only in pageants and parades

Port ons of a … armour about … in Augsburg … by Kolomar …

Blued, etched, and gilded armour of George Clifford, third earl of Cumberland (1558–1605), made in the royal workshops at Greenwich, Eng., about 1590



Three-quarter armour with blued surface, French, 17th century

Japanese armour of 1700 made of iron … laced with silk braid

BY COURTESY OF (TOP LEFT) THE METROPOLITAN MUSEUM OF ART, ROGERS FUND, 1904, (TOP CENTRE, TOP RIGHT) WALLACE COLLECTION, (BOTTOM LEFT) METROPOLITAN MUSEUM OF … SEY FUND, 1932, (BOTTOM CENTRE, BOTTOM RIGHT) …

[illegible] Their equipment generally comprised [illegible] cap, a shield and a sword and [illegible] a shirt of mail or a brigandine, [illegible] was a form of scale armour made [illegible] plates of metal riveted inside [illegible] of textile. The brigandine, because of its flexibility, was a useful substitute for the solid cuirass.

The history of body armour is the record of continual rivalry between weapons of [illegible] and of defense. For each new [illegible] that was introduced or improved [illegible] defense had to be found. The [illegible] horseman became a victim to [illegible] skill in archery, in which the English excelled. The size of horses made them especially vulnerable, and they had to be armoured, at first with mail trappers and later with plate comprising a chamfron for the head, crinet for the neck, poitrel for the chest and crupper for the hindquarters. The great victories won by Edward III the Black Prince and Henry V in the Hundred Years' War (1338–1453) were largely the result of the expert skill of the English bowmen. They wielded the longbow (from five to six feet in height, [illegible] for which both muscular strength and long training were needed to secure proficiency. The English archers shot so fast and with such accuracy that their fire resembled that of the machine gun of later days and their opponents could not come within hand strokes.

FIG. 5.—KNIGHT WEARING ARMOUR OF MIXED MAIL AND PLATE, ABOUT 1340

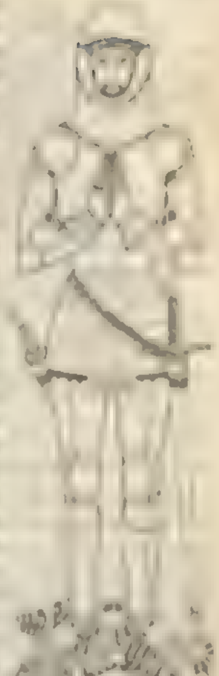
[illegible] the 14th century mail was gradually superseded by plate armour of steel, at first by local additions to knees, elbows and shins, until eventually the complete covering of articulated plates was evolved. In the second half of the 14th century the long surcoat was replaced by the short, tight-fitting gipon or jupon and the shield was discarded for war. Great skill and knowledge were lavished on making plate armour flexible by means of overlapping pieces held together on the inside by leather straps. The great helm was replaced by the lighter basinet with movable [illegible] in the 14th century. This was followed by the sallet [illegible] in the next century. [illegible]

Complete plate armour of steel, called "all-white" armour, of the 15th century followed the lines of the human body with subtle variations which make the armour known as that of the Gothic period so pleasing to the eye. It is so called because the forms of its decoration were [illegible] those of the style of architecture [illegible] name, with its points and cusps and [illegible] surfaces. It was especially favoured in Germany and was produced in Augsburg and Nurnberg in the second [illegible] 15th century. At the same time the [illegible] of Milan produced armour of superb quality, the steel being of the finest temper, but the forms were smoother and more rounded. The defenses of the left or bridle arm were built up more [illegible] the [illegible] from these two sources, [illegible] was made by native craftsmen, as the existence of city guilds testifies. [illegible] attain the same [illegible] centres of south Germany [illegible]

FIG. 6.—MONUMENTAL BRASS OF JOHN CRAY, [illegible] 1390

The Gothic style was replaced early in the 16th century [illegible] protection.

Hard on the heels of full-plate armour came gunpowder (q.v.). Cannon appeared in [illegible] in the first half of the 14th century, but some [illegible] before their full effect was felt. [illegible] finest armour ever fashioned was made long after the introduction of gunpowder. The centres of Augsburg and Nurnberg produced families of artist-craftsmen, among them the Colmans, the Siebenburgers, Lochner [illegible] duced the M[illegible] and Piccinin[illegible] Henry VIII set up his [illegible] where [illegible] officer by its magnificence, it was [illegible] a convenient diplomatic gift. [illegible] armour to survive its [illegible] smooth surface of the [illegible] (early 16th century). The influence of the Renaissance in painting and sculpture affected the armourer's craft to a marked degree. Embossing tended to make armour a work of art rather than a useful [illegible] face, disappears when the finish is broken up by protuberances in the form of scenes of classical mythology and Medusa heads.



[illegible] ABOUT [illegible]

FIG. 7.—MONUMENTAL BRASS OF ROBERT LORD FERRERS OF CHARTLEY ABOUT 1410

Once firearms could be made in quantity, men trained in their [illegible] wreak havoc on the armed chivalry of Europe. In the course of the 16th century the armoured man gradually disappeared from the field and only the heavy cavalry or lancers remained for shock tactics. The centralized monarchies of the 16th [illegible] mustered trained armies with specialized corps, with mercenaries such as the *Landsknechts* (infantry), targeteers, pikemen and harquebusiers. (See ARMY, TACTICS.)

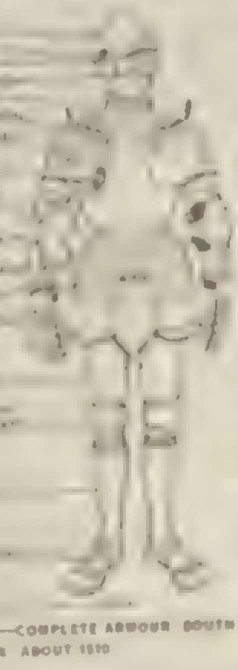


FIG. 8.—COMPLETE ARMOUR SOUTH GERMAN ABOUT 1510

When armour was falling into disuse, such substitutes as the jack (a form of brigandine) and later the buff coat (a garment of cowhide which could stop a sword slash) were worn. [illegible] wore half-armour and heavy cavalry during the first half of the 17th century wore three-quarter armour with long tasses and high boots. During the English Civil War of the 1640s the bulk of the infantry were pikemen who wore broad-brimmed helmets, breast- and backplates and square tasses on the thighs. Some of the cavalry wore cuirassier armour at the beginning of the war but quickly abandoned it. Most officers and mounted troopers wore steel helmets and a cuirass consisting of a breast-

AFTER JAKOB DE GHEYN, "EXERCISE OF ARMES FOR CALIVRES, MUSKETTES AND PIKES"

FIG. 9.—PIKEMAN, 1607

and backplate with a buff coat, and carried a brace of pistols and a broadsword. The lance was temporarily in abeyance until reintroduced from Poland in the 18th century. The musketeers or "shot" wore no armour and were equipped with broad-brimmed hats to shield their lighted matches.

Toward the end of the 17th century, armour increased in weight in order to remain effective against musket fire. At the same time, however, new strategy and tactics called for greater infantry mobility, and armour fell into general disuse and was not widely used again until World War I. (J. G. Mn.; X.)

Modern Armour.—The increased use of high-explosive artillery shells in World War I resulted in a high proportion of wounds caused by shell fragments. Steel helmets were designed, and after the first year of war, were worn by all troops. Torso armour of both fibre and steel was issued to troops for special purposes but was generally too heavy for full acceptance. In World War II, casualties from shell fragments rose to 80%, and, with 70% of all wounds affecting the torso, it became highly desirable to produce a suitable body armour. Armour for bomber crews and ground troops was developed of steel, aluminum, and resin-bonded fibre glass plates, as well as of heavy nylon cloth.

By the second half of the Korean War all U.S. combat troops were equipped with an effective body armour developed by the U.S. navy and marine corps. It consisted of a 10-lb. vest and a 4-lb. lower torso protector. For the flexible portions a 13-ply nylon cloth was used, while the vest had 22 5×5-in. overlapping plates of fibre glass cloth bonded by a thermosetting polyester resin.

After the Korean War the U.S. army developed $8\frac{1}{2}$-lb. vests that gave slightly less protection. One was made entirely of nylon cloth, the other of 3×3-in. titanium plates. In the war in Vietnam, both army and marine corps armour was used by U.S. combat troops. Crew members of low-flying aircraft wore a 25-lb. aluminum oxide ceramic breastplate that was effective against high-velocity bullets, and the U.S. navy developed a 4-lb. armour vest and buoyant life jacket made of a synthetic felt that entangled fragments. Efforts to produce better armour centred around protecting vulnerable portions of the body and developing stronger and lighter materials. Thus armour boots to deflect and absorb fragments and blast of mines were introduced, as well as flexible stainless steel inner soles for protection against steel and bamboo spikes. Also developed for armour applications were synthetic fibres of greater strength and harder but lighter ceramics, such as boron carbide. (F. B. Ni.)

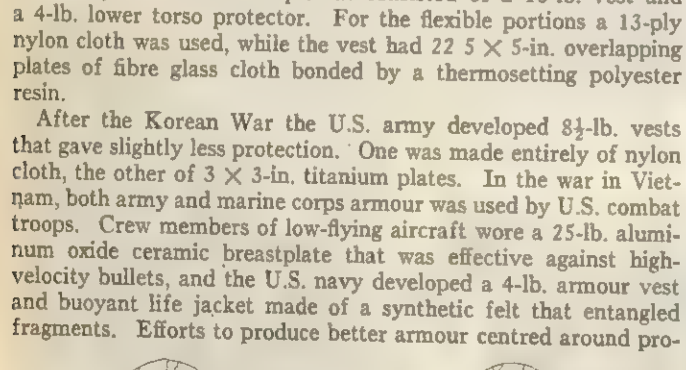


FIG. 10.—U.S. BODY ARMOUR, 1951–67

Other Countries.—The story of arms and armour outside Europe is a varied one. In the hot near eastern climate and in India, mail was preferred for its flexibility to complete armour of plate. Although plates were used for certain parts of the body, body armour of plate was never developed to the same extent as in Europe. Indo-Persian armour consisted as a rule of a helmet with nasal and three plumes, a coat of mail with four plates, front, back and sides, known as the "four mirrors," and short vambraces on the forearms, and a circular metal shield with four bosses. Rich ornamentation was lavished upon it, especially damascening with gold and silver. Changes of form were not as rapid as in the west. As a substitute for mail a padded garment faced with velvet and studded with rivets was worn, known as "the coat of the thousand eyes."

Japan produced a distinctive armour of its own which from time to time was influenced by contact with the west. (*See* JAPAN: *Defense.*) The helmet (*kabuto*) with its large neckguard was often given a most ferocious mask. The Japanese continued to wear armour until the modernization of the country in the third quarter of the 19th century. In 1908 the British army encountered mailed horsemen for the last time in the highlands of Tibet.

The arming of other peoples depended on the standard of their culture and the materials at hand as well as on climate and terrain. Whereas in the north of Africa mail was worn, as it was in Turkey Persia and India, the Kaffir of the south fought almost naked and carried only a large hide shield for his defense. His arms were the throwing spear (assagai) and club (knobkerrie) until he acquired flintlock "trade guns" of European export.

The North American Indian wore no armour, and his weapons were the spear, the bow and the tomahawk (ax). The Indians of Central America and Mexico had decorative breastplates of gold or silver, and the Aztecs of Mexico wore quilted cotton vests.

See also references under "Armour, Body" in the Index.

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For oriental arms *see* G. C. Stone, *A Glossary of the Construction, Decoration and Use of Arms and Armour in All Countries and in All Times* (1934); Lord Egerton of Tatton, *Indian and Oriental Armour* (1896), *Guide to the Ethnographical Collections*, British Museum, P. Holstein, *Armes orientales*, 2 vol. (1931); *Catalogue of the Moser Collection* (Berne); M. Garbutt, "Japanese Armor From the Inside," *Trans. Japan Soc., Lond.*, vol. xi.

For Greek and Roman arms see *Guide to the Antiquities of Greece and Rome*, British Museum; P. Couissin, *Les Armes romaines* (1926) (J. G. Mn.)

ARMOUR, NAVAL. The idea of giving extra protection to the hulls and decks of war vessels is a very ancient one. Archimedes, in building the famous "Syracusan"—that most palatial of ancient ships—for King Hieron about 250 B.C., provided for "mats composed of stout ropes suspended by brazen chains." No doubt these were a provision against ramming and missiles; and the a-

bles that were made taut around the hulls of Greek ships served at least in part the same purpose. The "Syracusan," too, was completely surrounded by an iron balustrade, but its vertical dimensions are unknown. In Rome there was an accepted technical distinction that divided all war vessels into *apertae* (with uncovered deck) and cataphracts such as the quinqueremes, in which the wall of the ship was raised beyond the main deck as a protection to the rowers. In Byzantine times, when combustible—and perhaps explosive—missiles came into use, leather curtains or saturated woolen sheaths were adopted. By the 11th century the Scandinavian sea kings had vessels that were armoured in the modern sense. There is mention of this in the *Svarfdaela:* "Ljot the Pale is in the east in the Swedish isles; he has . . . a 'dragon' covered with iron above the sea; it goes through every ship." There was another such vessel owned by Fridthjof's father, Thorstein, "and its sides were sheathed with iron" (*Fridthjof's saga I*). The iron bands over the prows of the medieval ram-ships are well known. A manuscript of about 1430 mentions a "covered" ship of that type as in use by Catalonians, a formidable ship that has also been mentioned in other historical documents.

Until the close of the Napoleonic wars ships of the line were virtually armoured, for their sides of almost two feet of oak were nearly shotproof to naval artillery of the day at all but short ranges. The increase and more effective use of gunpowder toward the middle of the 19th century made metal armour indispensable.

Historically, the earliest of modern proposals to employ armour for ships of war appears to have been made in England by Sir William Congreve in 1805. In the *Times* (London) of Feb. 20 of that year, reference is made to Congreve's designs for an armoured floating mortar battery that the inventor considered to be proof against artillery fire. Among Congreve's unpublished papers there is also a suggestion for armour plating the embrasures of casemates. Nothing, however, seems to have come of these proposals, and a similar lack of appreciation befell the next advocate of armour, John Stevens of Hoboken, N.J., who submitted the plans of an armoured vessel to the U.S. congress in 1812. The Stevens family, however, continued to work at the subject, and by 1841 had determined by actual experiment the thickness of wrought-iron armour that was proof against the projectiles then in use.

In 1827 a proposal to apply iron for defensive purposes was put forward by Major General Ford of the royal engineers who suggested iron bars as a protection for the face of masonry in forts, but the result of the experiment was not encouraging. In 1840 experiments were conducted by the British admiralty to ascertain the effect of shot on iron plates backed with various soft and elastic substances. These experiments were instituted not so much for the purpose of testing the value of defensive armour against shot but to ascertain the value of iron as a material of construction for ships of war. The employment of thick iron plates as an external casing for the protection appears first to have been carried out by the French, who in the Crimean War employed three iron-cased floating batteries in the attack upon Kinburn fortress on Oct. 17, 1855. These batteries, one of which was appropriately named the "Congreve," were exposed to a heavy fire at a distance of 700 yd. for about three hours, unsupported by the fleet, and although some casualties occurred from shell and shot entering the large old-fashioned portholes the floating batteries themselves were practically undamaged. Early in the American Civil War the value of protective armour was again conclusively proved in the battle, March 9, 1862, between the "Monitor" and the "Merrimack," both armoured vessels. (*See* "MONITOR" AND "MERRIMACK," BATTLE OF.) In the Civil War, railroad iron was sometimes used for side armour, and turret armour was built up of laminated one-inch plates. Thenceforth the utility of iron armour in protecting ships of war became apparent, and this article describes below the successive steps by which modern armour has been evolved.

In 1857 experiments were made at Woolwich, Eng., with a set of four-inch iron and steel plates, and it was found that in some cases the plates offered good resistance at 600 yd. to 68-pounder solid shot, but that with a repetition of blows the plates were broken up. Wrought-iron shot appeared much more destructive than cast-iron shot, and as a defensive material steel plates were far inferior to wrought iron in point of resistance. Tests were also made on the resistance of cast-iron blocks. These blocks were 8 ft. long, 2 ft. broad and 2½ ft. thick, fitted together by tongues and grooves. They were fired at from a 68-pounder with cast-iron solid shot, and wherever the shots struck, radiating cracks were formed, sometimes extending through the block. A greater effect was produced with wrought-iron shot which recoiled unbroken, whereas the cast-iron shot always broke up.

For the purpose of investigating thoroughly the application of iron to defensive purposes of war, a special committee on iron was appointed in 1861 by the British secretary of state for war with the concurrence of the admiralty. This committee sat until 1864 and conducted a large series of investigations and experiments.

The committee came to the conclusion that a steel material, either alone or in combination with iron, was unsuitable, and the most practical material was simple wrought iron, which at its best combined in the greatest degree the qualities of softness and toughness. In order to allow the energy of the shot to be absorbed in indenting and battering the plates without producing further fracture, rolled iron plates were on the whole found to be better than hammered plates, as hammered plates generally had the tendency to be hard and unequal, though at the same time rolled plates were frequently affected by unsound welding.

Great interest had always been given to the question of which backing was most suitable for ship armour plates. When armour plates were first used they were fixed directly upon the hull of timber ships, and when first applied to iron ships it was thought expedient to imitate the former condition by placing a backing of wood between the armour plate and the hull of the vessel. Many objections were raised to this, among them being the liability of the wood to decay and to destruction by fire and shells, but the committee was unable to recommend that wood backing could be dispensed with, as it appeared to perform important functions for which no good substitute could be found. The wood backing was finally thinned down until its use was confined to fairing the surface of the ship so that the armour could be really fitted to it.

Iron Armour.—The earliest armour was therefore made of wrought iron using both rolled and hammered plates. The French ship "Gloire," a wooden frigate protected by a complete belt of iron armour 4¾ in. in thickness, completed in 1859, was the first armour-clad ship of war. The British ship "Warrior," completed in 1861, was the first armour-clad warship to be built entirely of iron, the armour belt consisting of iron armour 4½ in. thick. Laminated wrought iron was used on American vessels during the Civil War, since there were no facilities available at that time in the United States capable of producing single plates of the required thickness. The increase in calibre of guns and the use of steel shot necessitated an increase in thickness of armour, and on the "Bellerophon," completed in 1866, a thickness of six inches of armour was fitted. The introduction of Palliser's ogive-pointed chilled-iron shot and further improvements in size and penetrative power of naval ordnance were met by further increases in thickness of armour, resulting in the "Inflexible," completed in 1881, carrying a belt 24 in. thick, worked in two layers of 12 in. each.

It was becoming increasingly clear that some way had to be found to give armour a very hard face with a tough back. Several proposals to weld or cement steel plates to wrought iron were made between 1860 and 1870, but none succeeded since techniques were needed that were beyond the capacity of the metallurgists at the time. Interest then shifted to steel plate as a result of the development of the Bessemer process of making steel in a converter and the Siemens-Martin open-hearth process of producing steel.

Steel Armour.—The superiority of steel armour was clearly demonstrated in 1876, when a 22-in. mild steel plate made by the French firm Schneider et Cie defeated projectiles from the largest guns then in use in a trial at La Spezia, Italy. This plate was forged from open-hearth steel, and although it had greater resistance to penetration it showed more of a tendency to crack and break up, particularly with repeated blows. This fault led to renewed interest in built-up or compound armour which consisted of a steel face backed with wrought iron.

Compound Armour.—The first satisfactory compound armour

plates were introduced by the two Sheffield firms, Cammell and Brown, the processes being known as the Wilson-Cammell and the Ellis-Brown respectively. In the Wilson-Cammell process a wrought-iron plate, while red hot, was placed in a mold, and liquid steel was poured on top. As the temperature of the liquid steel was much in excess of the welding heat of iron, the surface of the iron plate became partially fused by the liquid steel, and thus a complete union between the two metals was obtained. In this case, the weld was not limited to a simple line of junction between the iron and steel, but the change from iron to steel was gradual. When the steel became solid, the plate was removed from the mold, and after reheating was rolled down to the thickness required. At the La Spezia trial in 1882, Cammell's plate was rolled down from a thickness of 30 in. to 18.9 in., the final hard-steel face being about 6 in.

In the Ellis-Brown process, a steel plate for the face and a wrought-iron plate for the back were united by running molten steel between them, the combined plate being subsequently rolled down to the correct thickness. In Brown's 18.9-in. plate also tested at La Spezia the final hard face was about 3 in. thick, the total thickness of steel being about 6 in. As a result of these trials, a proportion of about one-third steel and two-thirds iron was found to give the best results.

Compound armour was first used on the turrets of the "Inflexible" and continued in general use in the British navy up to the "Royal Sovereign" class (1892). In this class of ships the belt was of compound armour 18 in. thick. The superiority of compound armour over iron was computed to be in the proportion of about three to two.

The introduction about 1886 of the Holtzer and other forged steel armour-piercing shot, which could not be shattered as the Palliser shot had been, presented fresh problems. The compound plate relied upon breaking up the shot, but if the shot pierced the hard face without breaking up, the soft iron back could not offer much resistance.

The attention of makers who favoured compound armour was thus directed to the necessity of increasing the hardness of the steel face, and in 1887 Capt. T. J. Tresidder patented a method of rapidly chilling the steel face by means of jets of water under pressure. From 1882 to 1890 several international trials took place at which various makes of compound and all-steel armour were tested, and although compound armour was generally adopted in Great Britain, yet in Europe the superiority of this armour over all-steel armour was not universally acknowledged, and French ships of this period were protected by steel and compound armour in about equal proportions.

Nickel-Steel Armour.—A further advance was made by the French firm of Schneider in 1889, when nickel was added in the manufacture of all-steel armour to increase its strength and toughness. A gain of approximately 5% in the resistance of armour was achieved by using about 4% nickel. The manufacture of armour was begun in the United States about this time, by the Bethlehem Iron company and the Carnegie Steel company under Schneider patents, to provide nickel-steel armour for the battleships "Texas," "Maine" and "Oregon." The success of nickel-steel armour caused the elimination of compound armour as a competitor, and interest then centred on better methods of achieving a hard face and tough back in a single heavy plate.

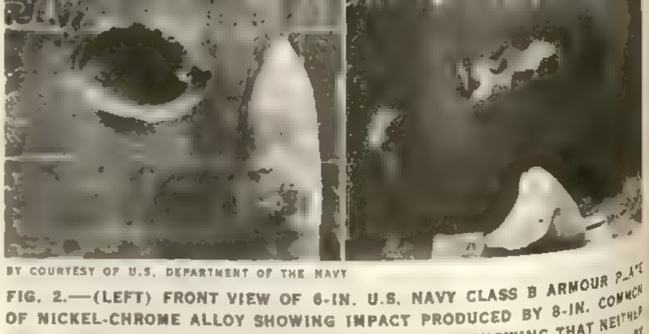
Harvey Armour.—The next important improvement was the introduction in 1891 of Harvey armour. H. A. Harvey, a U.S. metallurgist who had obtained considerable success in water-hardening cemented steel in the case of small articles, turned his attention to the manufacture of armour plates by the same process. The method consisted in carburizing or cementing the face of a steel armour plate by keeping it at a high temperature in contact with finely divided charcoal, so that the heated surface absorbed a certain amount of carbon, which penetrated about one inch. After cementation, the plate was allowed to cool to a dull red heat and was then chilled by the application of water, but by a less perfect method than that employed by Tresidder. Steel plates treated by the Harvey and Tresidder processes combined possessed nearly twice the resisting power of wrought iron, and about one and a half times the resisting power of the former steel armour and compound armour. The best American results had been obtained with Harveyized nickel steel, but there was considerable difference of opinion about the value of introducing nickel, and its adoption was not universal in England. Harveyized armour was first used in the British navy in the "Renown," laid down in 1893, where the belt armour was ten inches thick

BY COURTESY OF U.S. DEPARTMENT OF THE NAVY

FIG. 1.—FRONT VIEW OF 14-IN. HARVEYIZED NICKEL-STEEL PLATE (LEFT) 10-IN. PROJECTILES PENETRATED ABOUT 9 IN. AND WERE BROKEN UP. (RIGHT) 12-IN PROJECTILES PASSED COMPLETELY THROUGH THE PLATE AND FRACTURES DEVELOPED UNDER REPEATED IMPACT

Krupp Armour.—The basic invention in all modern armour was Harvey's method of carburizing the front face of the plate, but the back of the plate was not sufficiently tough, and, after various experiments with steel of different composition, Krupp, of Germany, produced Krupp cemented plate in 1894, based on Harvey's invention. This was a nickel-chrome alloy. The addition of chromium permitted the carburization to extend deeper into the armour plate and increased the toughness of the entire plate. The outstanding development in Krupp cemented plate was the introduction of decremental face hardening. This consisted in heating the carburized face to a temperature sufficient to produce a glass-hard surface when water-quenched, at the same time keeping the back to a much lower temperature, in order to produce a tough and fibrous back. Both face and back were water-quenched simultaneously. This process, with slight variations, is usually adopted in modern armour making. Krupp cemented plates gave results that indicated they were equal to wrought-iron plates of nearly two and a half times their thickness. Krupp armour was first fitted in the "Canopus" class laid down in 1896 and to U.S. warships in 1900. The Krupp method of decremental hardening was also applied to thinner plates that were not carburized. These were known as Krupp noncemented plates. The manufacture of cemented armour is a specialized process, involving great care in the selection of materials and the subsequent casting and heat treatments. The details of composition and manufacture vary to some extent among different makers, but an average composition is 0.35% to 0.5% carbon, 3.5% to 4% nickel, 1.5% to 2.5% chromium, 0.4% manganese and 0.15% silicon.

Deck Armour.—During World War I naval engagements first occurred at long ranges with the consequent result that the deck



BY COURTESY OF U.S. DEPARTMENT OF THE NAVY

FIG. 2.—(LEFT) FRONT VIEW OF 6-IN. U.S. NAVY CLASS B ARMOUR PLATE OF NICKEL-CHROME ALLOY SHOWING IMPACT PRODUCED BY 8-IN. COMMON PROJECTILES. (RIGHT) BACK VIEW OF SAME PLATE SHOWING THAT NEITHER PROJECTILE PASSED COMPLETELY THROUGH AND BOTH WERE DEFORMED BY THE PLATE

of naval ships had to be protected against plunging fire of heavy guns. The increasing threat of aircraft attack further emphasized the need for deck armour. The attack from heavy projectiles striking at oblique angles could best be resisted by an armour having great strength and toughness that would be capable of suffering considerable deformation without rupture and thereby deflect the projectile. This armour should also be capable of detonating aircraft bombs and, when fitted on more than one deck level, should prevent or restrict the entry of bomb splinters into the vitals of the ship. A hard, brittle, face-hardened armour similar to Krupp armour would be unsuited for this purpose, since it would tend to crack before the attacking projectile was deflected.

A noncemented armour was developed in the form of a nickel-chrome alloy, the composition of which varies with different manufacturers. Its ballistic properties result from the heat treatment to which the plate is subjected during manufacture. Specimens subjected to tensile tests have shown ultimate tensile strength as much as 120,000 lb. per square inch with an elongation in two inches of 23%.

Beginning in World War I, with renewed emphasis in World War II and the Korean war, light armour was developed to resist penetration of machine-gun bullets and aircraft bomb splinters. The plate had to be sufficiently soft in the untreated condition to permit machining, and hard enough after treatment to resist perforation by bullets or bomb fragments. Although strength was important, the necessity for good ductility was predominate. Various alloys, including nickel, chromium, cobalt, manganese and vanadium, have been tested, but a nickel-chrome alloy has given the best results. (W. J. B.; R. W. McN.)

In face of the added danger to the crews of minor war vessels and merchant ships caused by aircraft machine-gun fire and bombing in World War II, it became virtually impossible to meet the extra demands for steel armour plates. The "plastic armour" then developed in Britain was a valuable substitute and saved many lives. It was made of bitumen incorporated with granite chips and cast as slabs in light steel casings; it was proof against bullets and splinters. These slabs of plastic armour were widely used for protecting the bridges and exposed positions in landing craft, auxiliary war vessels and merchant ships.

Formulas for predicting or assessing the penetration of steel armour by projectiles ordinarily take into account the thickness of the armour, the striking velocity, weight and calibre (diameter) of the projectile, and the angle of impact. Such formulas may be used to furnish a rough comparison of performance between projectiles and plates of varying dimensions, provided the factors involved do not differ too widely. (X.)

ARMOUR, TANK AND AIRCRAFT, consists of any material intended to protect men, installations and equipment from attack by missiles and other weapons intended for their destruction. Although the history of the development and employment of armour extends back beyond recorded times, the modern use of armour dates from the mid-19th century when wrought-iron plates were fastened to the sides of floating batteries and warships in the Crimean and American Civil wars. (*See* ARMOUR, NAVAL.) The use of armour to protect soldiers had been practically abandoned by the 18th century but underwent a rebirth during World War I. (*See* ARMOUR, BODY.)

Tank Armour.—To overcome the static battlefield situations of World War I caused by the supremacy of antipersonnel weapons, the British introduced the tank in 1916, and first employed this new weapon in the battle of the Somme. (*See* TANK.) The early tanks were caterpillar-tracked boxlike vehicles whose crews were protected from machine-gun fire and shell fragments by steel armour plates from three-eighths to three-fourths of an inch in thickness. The advent of tanks led to the development of special antitank guns and armour-piercing projectiles, the latter consisting of solid steel shot with sharp pointed noses heat-treated to very high hardnesses to improve their armour penetrability. During World War I and up to a few years before World War II, armour-piercing projectiles were generally of small size, ranging from 7.6 mm. to 37 mm. (.30 in. to $1\frac{1}{2}$ in.). During World War II tank armour increased in thickness to 6 in., and armour-piercing ammunition in calibre to 155 mm. (6 in.), although by far the greater number of antitank guns were in the range of calibres from 50 mm. (2 in.) to 90 mm. (3.5 in.).

The material most commonly used as armour is heat-treated alloy steel, although many other materials, such as alloys of aluminum, magnesium and titanium and nonmetallic materials such as plastic laminates, nylon fabric, concrete and mastic-stone composites, have been and are being used in armour applications. Steel armour consists of two main types: homogeneous and face-hardened. Homogeneous steel armour is further subdivided into two classes—wrought or rolled armour and cast armour. Homogeneous armour possesses uniform chemical composition, mechanical and ballistic properties throughout its section thickness; face-hardened armour is specially processed to produce a very hard, penetration-resistant surface layer on the face exposed to attack, with a softer and tougher core to support the hardened case. The depth of the hardened layer may represent 10% to 40% of the total armour thickness and may be produced by a variety of means including carburization, which produces a high-carbon surface layer hardened to a high degree by heat-treatment. Other methods include flame hardening of one surface, a practice employed on German tank armour during 1940–43; nitriding (*q.v.*), which develops a thin, very hard surface layer by producing metallic nitrides (this practice was generally confined to thin aircraft armour); and duplex rolling, whereby a higher-carbon, higher-alloy steel is fused to a billet of lower-carbon, lower-alloy steel and then rolled to desired thicknesses and, upon heat-treatment, a hard face is developed on a softer, tough core.

Face-hardened steel armour was very effective against early types of armour-piercing projectiles since the noses of the projectiles shattered against the hardened surface, destroying their penetration effectiveness. It was discovered early in the 20th century that thick, face-hardened naval armour could be defeated by making the noses of armour-piercing projectiles blunter, and fitting them with soft steel caps which lessened the impact forces on the nose of the shot in the early stages of armour penetration. Steel-capped armour-piercing projectiles had, by the time of World War II, long been standard for naval use. Armour-piercing caps were applied during World War II first by the Germans, then quickly by the Allied armies, to antitank projectiles of all calibres. Capped armour-piercing projectiles quickly overcame the initial advantage of face-hardened armour, and since this type of armour was considerably more expensive and time consuming to manufacture and to fabricate into vehicles than homogeneous steel armour, its use in armoured vehicles was generally abandoned early in World War II.

Rolled armour is produced by casting large ingots, hot-rolling them down to slabs and billets and finally down to plates of desired thickness and size. Because of the large amount of hot-working, rolled armour generally possesses a fine-grained, uniform structure throughout and, in thinner sections at least, usually exhibits somewhat better mechanical and ballistic properties than cast armour. Very thick armour plates are usually wrought rather than rolled; *i.e.*, the ingots are heated and pressed between large flat dies until they are worked down to the required thickness.

Steel armour castings for tanks were first employed by the Germans in the early 1930s and were made in the U.S. by 1933. The first castings were relatively small, and were used as bolted attachments to cover protruding sections where riveted armour sections were excessively cumbersome to fabricate. With the tremendous expansion of tank production caused by World War II, there was insufficient production capacity to roll all the armour plate needed for armoured vehicles, and the steel castings industry was called upon to produce large shaped castings. By 1942 tens of thousands of tons per month of steel armour castings for tank turrets, hull front housings and other components were being produced in the U.S. alone. Although cast armour is somewhat inferior in ballistic performance to rolled armour in thicknesses under approximately $1\frac{1}{2}$ in., it is generally equivalent in protection performance at greater thicknesses. Since medium and heavy tanks during the latter years of World War II carried armour from two to six inches in thickness, cast and rolled armour were

essentially equal in ballistic performance in these vehicles.

Before and during World War II, moderately alloyed steels were employed for rolled armour. These steels contained up to 6%–8% total alloy content with chromium-molybdenum-vanadium, chromium-nickel, chromium-nickel-molybdenum and nickel-molybdenum-vanadium alloy steels predominating. These steels were hardened by being heated, air cooled or oil quenched, and then tempered to the desired hardness. The early tank armour steels often contained from 0.35% to 0.50% carbon and, because of both high carbon and alloy contents, were not considered weldable. Alloy shortages during World War II required all combatant nations to cut back on the alloy content of their armour steels, and the change-over to welded construction necessitated a reduction in carbon content to the range of 0.25%–0.30%.

With the reduction in heat-treatment response occasioned by lower carbon and alloy contents, the United States resorted to water-quenching practices to harden armour steels, and found that the over-all mechanical, metallurgical and ballistic qualities of the drastically quenched low-alloy armour steels were uniformly superior to those of the older highly alloyed steels. Small traces of boron and other needling compounds were added to rolled armour steels to increase their hardening ability and these additions permitted the scarcer alloys such as nickel, chromium and molybdenum to be either eliminated or drastically reduced. Manganese was also employed as an alloying element to conserve alloys in short supply, and manganese-molybdenum, manganese-molybdenum-boron and manganese-chromium-molybdenum steels containing often less than 2% alloy content were used from 1942 on.

The British generally retained the oil-quenching practice for hardening armour steels, and consequently required higher alloy contents than prevailed in U.S. practice. The Germans employed a variety of alloy compositions among which chromium-nickel and manganese-chromium-silicon steels were included. Severe alloy shortages during the latter years of World War II caused a drastic cutback in alloys available for armour manufacture, and by the end of the war the Germans often used as-rolled carbon steels for tank armour. The Soviets generally employed rather highly alloyed steel for armour, and a manganese-silicon-chromium-nickel steel was widely used, which was often heat-treated to considerably higher hardnesses than the same thicknesses of armour made by other nations.

During the years from 1916 to 1940, tank hulls and turrets were fabricated by riveting and bolting together rolled armour plates. Such structures performed adequately against the small-calibre armour-piercing projectiles which then prevailed. When struck by larger-calibre shot, however, the rivet heads were sheared off by the shock impact and could rebound within the crew compartment at high velocities and cause severe casualties. During 1941–42 a complete change-over was made to welded construction since, after an accelerated development effort, it was found possible to weld together both cast and rolled armour to produce joints having a high resistance to ballistic attack. Welding was initially performed with high-alloy steel electrodes containing up to 25% chromium and 20% nickel which produced extremely tough joints. Wartime shortages of alloys necessitated the development and use of low-alloy welding rods and several low-alloy steels were successfully employed for welding electrodes.

The principal factors governing the degree of protection afforded by armour are its thickness and its angle of slope with respect to the line of fire. The thickness of armour is critical in determining the weight of vehicles, and a constant struggle faces armoured-vehicle designers who must decide whether to reduce armour thickness to increase the mobility of vehicles or increase armour thickness to maximize the protection afforded by it. Steel armour one inch in thickness weighs 40.8 lb. per square foot. A light tank fitted with more than 500 sq.ft. of one-inch-thick armour would thus carry more than ten tons of armour. Highly sloped armour is effective in causing breakup and deflection of shot. It also lengthens the path through the armour taken by a penetrating projectile, thus absorbing more of the latter's energy. With a given weight of armour to shield a fixed volume of space behind it, considerably greater protection is afforded by using a longer, thinner plate sloped at an angle of 60° from the line of fire than by using a shorter, thicker plate positioned perpendicular to the line of fire. Advantageous use of highly sloped armour was made early in World War II. German tanks and highly sloped armour designs were quickly adopted by Soviet, British and U.S. tank designers. The frontal armour on hulls and turrets of tanks was sloped at angles in the range of 50°–60°, and the Soviets, by using compound slopes on the front of the JS–3 tank, achieved angles of 70° from the line of fire. Cast armour readily lent itself to highly sloped designs wherein full hulls and turrets could each be cast in one piece, and the thickness of the armour was adjusted to provide thicker sections in the less highly sloped areas and thinner sections in the more highly sloped areas. By the end of World War II, tank designs had evolved to the point where it was possible to design armoured vehicles to achieve equal levels of protection from selected calibres of projectiles striking any frontal area from any direction of fire.

The table presents a picture of the hull and turret armour dispositions on World War II tanks and is generally representative of vehicles made by all the major belligerents.

Type of tank	Tank weight (tons)	Frontal armour		Side armour thickness (in.)
		Thickness (in.)	Angle of slope	
Light	15–20	1.0–1.5	45°–60°	0.75–1.0
Medium	25–45	2.0–4.0	30°–60°	1.5 –2.0
Heavy	50–65	4.0–6.0	50°–70°	2.0 –3.0

Three developments in antitank weapons made during World War II rendered armour considerably more vulnerable to attack. The first was the improvement in antitank guns and propellants that enabled muzzle velocities to increase from approximately 2,000 ft. per second at the beginning of the war to 3,500 ft. per second by its end. Since the energy of projectiles increases with the square of the velocity, this produced a threefold increase in the penetration ability of projectiles. The superiority of the much vaunted German 88 was attributable to the fact that this gun, thoroughly tested in the Spanish civil war, had a muzzle velocity of approximately 3,400 ft. per second. The second development was the use, first by the Germans, of armour-piercing projectiles which had light outer cases and armour-piercing cores of tungsten carbide, an extremely hard substance almost twice as heavy as steel. Because the over-all weight of these projectiles was less than that of conventional solid steel shot, they could be fired at higher muzzle velocities and since only the relatively small core penetrated the target, a large amount of energy was applied to a small target area, resulting in very much greater penetration. The third and most potent development in armour-defeating ammunition was the shaped-charge or "bazooka" round first used by the U.S. army. This ammunition contains a charge of high explosive cast behind a conical metal liner. When the charge is detonated the liner is collapsed and projected forward as a narrow beam of extremely high-velocity incandescent particles which perforate armour much as a high-velocity water jet blows through an earth embankment. (*See* AMMUNITION, ARTILLERY.)

Defense against these improved armour-defeating rounds was often improvised during World War II by bolting additional thicknesses of armour around tank turrets and to hull fronts, by attaching sandbags around turrets, by spaced armour arrangements and by attaching spare sections of track to the glacis, or upper hull front plate. Later designs involved placing tool boxes and other battle-expendable gear on the outside of the tank so that projectiles might be deflected or caused to function prematurely before striking the main armour.

Tests have demonstrated that armour plating offers considerable advantages in nuclear warfare. By virtue of their necessarily rugged construction to withstand attack by armour-piercing and explosive ammunition, tanks, armoured cars and personnel carriers offer a high level of protection against the blast effects, shock waves and thermal radiation generated by the detonation of atomic weapons. The armour plating on even lightly armoured vehicles provides adequate protection against the alpha- and beta-particle

radiation from nuclear bursts, but steel armour on the heaviest tanks (six to eight inches thick) is not sufficient to shield crews from gamma and neutron radiation. It is possible, however, to provide a high degree of shielding capability to armoured vehicles by inserting within their armour envelopes additional materials capable of absorbing highly penetrative radiation. Lead and other materials of high atomic number provide good shielding from gamma radiation while paraffin and other hydrogenous materials are effective in decreasing neutron flux. Combinations of such materials, in conjunction with the basic steel armour, can be effective in providing immunity from the destructive effects of atomic explosions even at moderately short range.

Nuclear weapons may be used not only for their direct destructive capabilities but also to deny the enemy access to transportation routes and strategic areas by rendering these radioactive. It is very probable that specially modified armoured vehicles could be used extensively in atomic warfare to transport troops and equipment through radioactive areas.

Aircraft Armour.—Aircraft armour came into use in the years following World War I and was extensively used during World War II. Aircraft armour falls into two distinct categories: fixed armour attached permanently to the aircraft structure, and movable armour either worn by air crewmen or suspended around them as protective curtains. Aircraft armour must, of course, be of minimum weight since weight detracts so greatly from the speed, range and maneuverability of aircraft. Fixed armour is generally applied to fighter planes and low-flying aircraft used in support of ground troops, and is often formed into seats to protect the pilot from attack from the rear and from beneath. The engines and vulnerable areas of engines, controls and instruments are also protected by armour in some types of aircraft. Armour installations of these types are generally intended to provide protection from calibres .30 and .50 machine-gun fire from hostile aircraft and from machine-gun and rifle fire from the ground.

The materials most often employed for aircraft armour during and after World War II included hard homogeneous and face-hardened (either carburized or nitrided) steel, nonmagnetic alloy steel armour (sometimes used around magnetic and electrical equipment) and aluminum alloy armour. Steel aircraft armour is generally one-fourth to one-half inch thick (10–20 lb. per square foot) and is made of higher-alloy steels than corresponding thicknesses of tank armour since it was found that the higher-alloy steels could be heat-treated to possess better toughness at very high strength levels. Aluminum alloy armour was successfully employed to protect low-flying aircraft used by the United States navy in the Korean war. Plates attached to the entire undersurface of the aircraft offered considerable protection from small-arms fire.

Movable aircraft armour was most often used to protect bomber crews. Armoured jackets containing overlapping steel platelets very similar to medieval body armour were developed in 1943 to protect bomber crews of the U.S. 8th air force from the heavy flak encountered over Germany. These proved very effective and armour developments were extended to the point where complete armoured outfits including helmets, jackets, aprons and groin coverings were issued to bomber crews. The armoured clothing could be readily discarded by pulling a ripcord. Armoured flexible curtains were also used to protect defensive machine-gun emplacements on bombers. While the fixed armour installed in fighter and strafing aircraft was intended for protection from machine-gun and rifle bullets, the flexible armour used in bombers was designed to offer protection primarily against shell fragmentation from antiaircraft cannon. (A. Hu.)

ARMOURED CAR. The military armoured car is a wheeled motor vehicle with light protective armour, usually equipped with machine guns or a light artillery piece and a radio. It is used chiefly for reconnaissance or for pursuing a fleeing enemy. Civilian armoured cars are far less elaborate than their military counterparts, often being simply standard passenger cars equipped with bulletproof glass and with armour plate concealed in the upholstery to provide protection against small-arms fire. They are used in many countries for the protection of high government officials against assassins.

For the early history of armoured vehicles, *see* TANK: *Predecessors.* The use of armoured cars in modern times is said to have originated with European smugglers before World War I; some smugglers' cars were designed so they could be driven and steered from either end to facilitate escape when faced with road barricades erected by customs officials. During the first half of the 20th century many commercial firms used armoured trucks manned by armed guards to transport money or valuables.

The origin of military armoured cars in the United States may be traced to 1898 when Maj. R. P. Davidson of the Illinois national guard built at the Duryea corporation in Illinois a light car equipped with a small steel shield and a Colt machine gun. At the same time, F. R. Simms in England built a similar car. But in neither country were the military authorities favourably impressed. In the years that followed, inventors nevertheless continued to develop new and improved types, including some powered by steam. In 1903 Simms brought out a six-ton vehicle with two rotating turrets, and the following year the French firm Charron, Girardot et Voigt built a completely armoured and turreted car. With horse cavalry fast losing its importance in the face of barbed wire and new rapid-firing weapons, military men began to take an interest in the great variety of armoured vehicles offered by inventors. Italy is generally credited with giving armoured cars their baptism of fire in actual military operations against Tripoli and Cyrenaica in 1913. Meanwhile, Germany, Russia, France and other countries experimented with various types of military cars and used them in World War I, improvising tactics as they went along. The great difficulty with all such machines was that, because of their weight, they easily bogged down in mud or sand, in spite of having four or more driving wheels.

BY COURTESY OF DEPARTMENT OF DEFENSE; U.S. ARMY PHOTOGRAPH

M-75 ARMOURED TROOP CARRIER

Continued efforts went into development of improved armoured cars as "motorized cavalry" in the 1920s and 1930s. After the outbreak of World War II, British forces employed a half-dozen different types with good results. Germany used a light four-wheel car with a 20-mm. automatic gun, several types of eight-wheel cars (with power at all wheels), and a variety of half-tracked armoured personnel carriers. The standard light armoured car of the U.S. army in World War II was a six-wheeled vehicle with power at all wheels. It carried one 37-mm. gun and two machine guns, all mounted in a turret. Smaller four-wheel cars known as "scout cars" also saw service, as did a seven-ton armoured utility car that mounted one machine gun and carried six men. Larger armoured vehicles equipped with wheels in the front and tracks in the rear were known as "half tracks," and still larger armoured vehicles, as large as tanks, took the name of "gun motor carriages." After World War II the U.S. army retained its four-wheel scout cars but discarded its large armoured cars because they had insufficient cross-country mobility. The U.S. army gave increased attention

to armoured personnel carriers that rode on tracks rather than wheels.

In the 1950s the British army made use of two types of armoured cars known as the Saracen and the Saladin. The latter had six driving wheels, mounted a three-inch gun in a revolving turret and was employed for reconnaissance and pursuit. The Saracen, also a six-wheel-drive vehicle, was an armoured personnel carrier capable of accommodating 12 men, including driver and commander. Of the many Russian types the most widely used was the BA-64, a lightly armoured four-wheel car mounting one machine gun. The French army meanwhile adopted the EBR (Engin Blindé Reconnaissance) designed and manufactured by the Panhard firm. It mounted a 75-mm. gun and could travel forward or backward at high speed on good roads. A unique feature of the EBR was a double set of cleated metal wheels that could be lowered for added traction when needed for cross-country mobility.

See Charles R. Kutz, *War on Wheels* (1940); Robert J. Icks, *Tanks and Armoured Vehicles*, ed. by Phillip Andrews (1945). (H. C. T.)

ARMOURED FORCES are bodies of troops who move and, for the most part, fight in automotive vehicles. Their equipment includes tanks and other vehicles provided with varying amounts of protective armour. However, the term armoured forces, frequently abbreviated to armour, gives undue emphasis to the least important of the three characteristics—weapon power, mobility and protection—of such forces. It is less appropriate than the earlier and synonymous term mechanized forces.

World War I.—Tanks are the principal fighting vehicles of armoured, or mechanized, forces and in general the evolution of the latter followed the introduction of the former in 1916.

The first properly constituted armoured units were detachments of armoured cars attached to French cavalry corps from Sept. 1914 and the armoured car squadrons of the Royal Naval air service created between Sept. and Dec. 1914. The decision to form the first tank units was taken by the British army in Feb. 1916; in June the organization of what was called the heavy section, machine-gun corps, was fixed at six companies, each of 25 tanks. Three months later two companies were rushed into action to bolster a British offensive on the Somme and on Sept. 15, 1916, tanks were used in battle for the first time. They achieved little, but their moral effect was sufficient to induce an expansion of the British tank forces to nine battalions of 36 tanks each.

The formation of French tank units also began in 1916, but they did not go into action until April 16, 1917, when 128 tanks, organized into *groupes* of 16, were used in a manner consistent with their designation as *artillerie d'assaut*. They achieved little, mainly because of the limited trench-crossing ability of the vehicles. Similarly, further employment of British tanks, particularly at Passchendaele in July 1917, met with little success because of inept piecemeal use over unsuitable ground that had been turned into a morass of mud by prolonged shelling and rain.

It was on Nov. 20, 1917, at Cambrai that British tanks were first used effectively in a massed surprise assault over suitable ground. The whole of the newly formed tank corps was concentrated, nine battalions with a total of 476 tanks, and the result was a spectacular break through a triple line of trenches, but the success was not exploited.

At Amiens, in Aug. 1918, all the available tank corps units were again concentrated—11 battalions with 604 tanks—and the success of Cambrai was repeated. In July 1918 the French army also used tanks in mass at Soissons, where about 480 tanks were assembled. Numerous smaller actions followed and the number of Allied tank units grew. By Nov. 1918 the British army had 18 tank battalions in France and 8 in training. The French had 21 light tank battalions and smaller units of medium tanks. The U.S. army created a tank corps, in Jan. 1918, and planned to expand it to 15 brigades, each of 3 battalions; only 3 battalions were actually equipped—with British and French tanks. The German army lagged far behind in the employment of tanks. It formed its first detachment of 5 tanks in Jan. 1918, but up to the end of the war only 20 German tanks were completed against 2,636 British and 3,870 French.

In addition to numerical expansion, the Allies had also planned new tactics for 1919. Methods practised so far had consisted of frontal assaults executed by waves of tanks advancing behind an artillery barrage and followed closely by infantry, which mopped up and occupied entrenchments overrun by tanks. The principal task of the tanks was to destroy hostile machine guns, and they worked closely with the infantry distributed by companies or battalions between infantry brigades or divisions. But in 1918 the British tank corps planned an extension of the heavy tank and infantry frontal assaults by sending units of faster medium tanks through against headquarters and other objectives behind enemy lines. The French army elaborated the technique of the tank breakthrough by echeloning tanks in two waves, the leading wave consisting of very heavy tanks and the second of light tanks which brought on the infantry.

Post-World War I Developments.—All the plans were nullified by the Armistice of 1918. The development of tanks was halted and it was even argued that there was no future for them beyond the siegelike conditions of trench warfare. Tanks survived not because their wider potentialities were recognized but because they came to be regarded as a useful auxiliary to the infantry, and most tanks were retained in this role up to the outbreak of World War II. The French army had a large number of light tanks—3,737 in 1921—which were suitable for little apart from an infantry-accompanying role, and in 1920 it made tank regiments an integral part of its infantry. This example was followed by armies of other countries, including that of the United States. The accepted practice was to attach a tank battalion to an infantry division and to split it by companies among infantry battalions. The only more advanced method was the use of the more powerful tanks ahead of the light infantry-accompanying tanks along the main line of effort of the supported infantry division or corps. Tanks intended for this role were designated "leading tanks" by the U.S. army and *chars de manoeuvre d'ensemble* by the French.

A notable exception to the prevailing trend was the position of tank units in the British army. Although reduced to four battalions they were formed in 1923 into the royal tank corps and their relative independence, together with new, more mobile equipment in the shape of about 160 Vickers medium tanks, provided opportunities for the development of new operational methods. The first step was the formation, in May 1927, of an experimental mechanized force. This consisted of a battalion of medium tanks and other armoured and motorized infantry and artillery units and was the first self-contained force based on motor vehicles. In 1928 it was renamed the armoured force and then disbanded, but its trials set off a series of experiments toward a mobile employment of tanks, no longer tied to the slow pace of the infantry, and foreshadowed the armoured forces of the next decade.

In July 1928, as a direct result of the British experiments, an experimental mechanized force was assembled in the United States at Ft. Meade, Md. It was quickly disbanded, but the experiment was resumed in 1930 at Ft. Eustis, Va., and this led to the formation, between 1932 and 1938, at Ft. Knox, Ky., of the 7th cavalry brigade, mechanized. British trials also influenced the exercises held in France in 1932 and other contemporary mechanized experiments in the U.S.S.R. and Germany. In Britain itself experiments were resumed in 1931. and the establishment of 1st tank brigade of the royal tank corps in 1934 provided the first instance of as many as four tank battalions maneuvering together under one command; it pioneered the technique of operating large numbers of armoured vehicles and demonstrated a far more mobile and effective use of tanks.

Some of the inspiration for this originally came from the technologically more advanced field of naval warfare, but although the influence of analogies between tanks and warships helped to free the former from the confines of trench warfare, it also strengthened an unfortunate tendency to create mechanized "fleets" of tanks. More practical and lasting were comparisons with cavalry, whose roles were gradually assumed by mobile armoured forces. With the development of faster tanks, mechanized forces had acquired the ability to perform the functions of a mobile arm and filled the place left vacant by horse cavalry. Un-

fortunately, armoured forces were not regarded as the decisive mobile arm which cavalry once was, and which armoured forces proved to be during World War II. They were confined to the strategic reconnaissance and exploitation to which horse cavalry had been reduced toward the end of its existence.

This was illustrated in Britain by the mobile division of 1937–38, which combined the tank brigade with two mechanized cavalry brigades equipped with light tanks. In France formations with similar limited roles were evolved by a gradual mechanization of horse cavalry divisions; the first *division légère mécanique* was formed in 1934 and although its organization resembled that of the later armoured divisions it was still only intended for a limited cavalry role. The same applied to the 7th U.S. cavalry brigade and the contemporary Soviet mechanized brigades.

German Panzer Divisions.—The advance beyond the confines of the limited cavalry role and toward the fullest use of tanks was left to the *Panzer* divisions. Conceived as versatile fighting formations, they combined tanks with other arms into new-style divisions which had greater striking power and greater mobility than other contemporary formations; they were equally capable of obtaining a decision in battle and of mobile exploitation after it. The first three were created in Oct. 1935 and by the outbreak of World War II there were six. By then each consisted of a tank brigade with four battalions, a motorized infantry brigade with four rifle battalions, an artillery regiment, reconnaissance, antitank and engineer battalions and service units. They formed the decisive striking force of the German army in its campaigns against Poland in 1939 and against France in 1940. In the latter case there were ten divisions incorporating all the German tanks in the field—2,574 out of the 3,400 which Germany possessed. Nine out of the ten divisions, concentrated in four *Panzer* corps, broke through the French front and by a rapid drive to the channel coast virtually decided the campaign. The number of *Panzer* divisions was soon doubled and in 1941, 17 of them, grouped in 4 *Panzer* armies, spearheaded the German invasion of the U.S.S.R. by a series of deep thrusts.

In 1939 other armies still divided their armoured forces into tank units for infantry support and mechanized formations for limited mobile roles. The former predominated, organized into battalions or, in the British and Soviet armies, into brigades, but the latter only for administrative purposes. The French army formed its more powerful infantry tanks into divisions intended to break through enemy lines. They were all used piecemeal, in their limited roles, and were routed accordingly. In France, in 1940, the Germans defeated, one by one, four infantry *divisions cuirassées* and three cavalry *divisions légères mécaniques*, as well as one British armoured division and smaller tank units (the French army alone possessed 3,800 modern tanks). In 1941 the Germans defeated Soviet armoured forces whose stock of tanks amounted to more than 20,000 against Germany's 5,264, out of which only 3,350 were actually deployed against the U.S.S.R.

Armoured Divisions.—The successes of the German *Panzer* divisions during 1939–41 provided an example to other armies, which made haste to create a maximum number of armoured divisions on the German pattern. Thus, in July 1940 the U.S. army abandoned the separation of tanks between the infantry and cavalry and created an armoured force with 2 armoured divisions, subsequently expanded to 16. The British army started the war with only 2 incomplete armoured divisions but after 1940 raised the total to 11, although it also retained a large number of tank units for infantry support and, unlike all others, continued to dissipate its efforts between the narrowly specialized categories of cruiser and infantry tanks. Italy completed the formation of three armoured divisions created in 1939, and Japan formed its first two in 1940, followed by a third later. Even Australia, with all its logistical problems, created three armoured divisions in 1942. The Soviet army employed a total of 65 tank divisions during the 1941 campaign and although they were lost through inept piecemeal employment it managed to rebuild its armoured forces, creating 258 tank brigades. The German army itself raised its total to 25 armoured divisions in 1942, subsequently joined by 8 *Waffen-SS. Panzer* divisions. The production of armoured vehicles greatly increased after 1940; German tank production rose from 1,460 in 1940 to a peak of 9,161 in 1944; British production rose much more rapidly from 1,399 in 1940 to its peak of 8,611 in 1942, and the U.S. even more so, from a mere 331 in 1940 to 29,497 in 1943.

Campaigns of World War II.—In the meantime, major campaigns continued to be decided by armoured formations. One British armoured division played a decisive part in the defeat of the Italian forces in Cyrenaica in 1940–41, and the subsequent counterstrokes of the Germans owed their success to the concentrated employment of two *Panzer* divisions. It was not until three British armoured divisions and 1,441 tanks, backed by a reserve of 1,230, were concentrated at El Alamein in 1942 that the German force with its 219 tanks was crushed. In Russia the major effort of the 1942 campaign was made by two *Panzer* armies which had nine *Panzer* divisions and 1,900 tanks, and the decisive Soviet encirclement at Stalingrad was led by tank and mechanized corps. For its last major offensive in Russia, against the Kursk salient in July 1943, the German army again concentrated 17 *Panzer* divisions; it never had the resources for another large-scale offensive, but *Panzer* divisions continued to play an important role in local counteroffensives and as the mainstay of the German defense against the Soviet advance which, in turn, was spearheaded by six tank armies.

In the west, in 1943, as operations shifted from Africa to less favourable conditions in Europe, emphasis was again placed on small tank units for close infantry support and the once discredited doctrine that armoured formations could only be used for exploitation reappeared. The British army retained only five armoured divisions. By the end of the war the U.S. army had no less than 60 independent tank battalions, intended chiefly for infantry support, which contained more tanks than its armoured divisions. Nevertheless, three British armoured divisions played an important role in the 1944 Normandy campaign, where they tied down the bulk of the opposing *Panzer* forces and thus helped the breakout of the bridgehead elsewhere; U.S. armoured divisions played a major part in the drive across France and the fighting on the German border. When fighting stopped in 1945 western Allied armies contained 28 armoured divisions—16 U.S., 5 British, 3 French, 2 Canadian, 1 South African and 1 Polish. However, they never used their armour in the concentrated and decisive manner which had marked German operations, but relied on an over-all numerical superiority and masses of tanks spread over a wide front in different type units.

The 1944 Normandy campaign was noteworthy for the large-scale use of tanks in an amphibious assault landing. Ten British and United States amphibious tank battalions were prepared for it and, altogether, amphibious and other tanks landed in the British-Canadian sectors amounted to three brigades, which accounted for much of the success of the assault. D-day in Normandy was also notable for the first use of air-borne tanks, seven British Tetrarchs being landed by glider. Even greater was the use of amphibious armoured vehicles by U.S. forces in the Pacific. Called "landing vehicles tracked," or LVT's, they were originally adopted in 1940 by the U.S. marine corps as unarmoured supply carriers, but on Tarawa in Nov. 1943 they were employed as armoured assault carriers and were then joined by turreted gun versions. Eight marine and army LVT battalions led the amphibious assault on Saipan in June 1944, and by the end of World War II the marine corps alone had 12 LVT battalions in the Pacific.

Post-World War II.—After World War II doubts arose once more about the future of armoured formations. Their full effectiveness was not recognized, nor was the advantage of concentrating tanks in fully mechanized forces instead of dispersing them among the less mobile infantry formations. The effect of armour-piercing weapons was exaggerated and there were doubts about tanks because their value was still wrongly supposed to be in their armour protection. In consequence, British and U.S. armoured forces were cut down to one division each. Only the Soviet army maintained large armoured forces, reorganized into tank and mechanized divisions, in place of the earlier tank and mechanized corps. The mechanized corps corresponded to the German *Panzer*

grenadier divisions and were, in essence, motorized infantry formations with some tanks; the tank corps, and the later tank divisions, corresponded to the NATO armoured divisions mentioned below. According to NATO estimates, in 1953 the Soviet army had 63 tank and 36 mechanized divisions and, in striking contrast to the NATO armies, the ratio of Soviet armoured to infantry formations had increased to one to two.

The growth of the Soviet armoured forces and the havoc wrought in Korea in 1950 by Soviet-built tanks helped to revive NATO armoured forces; the number of armoured divisions in western Europe increased to 11—3 British, 3 French, 3 Italian, 1 U.S. and 1 Belgian. The position of the armoured forces was later strengthened by the premium placed on mobility and dispersion by tactical nuclear weapons. Their vehicles, with all their armament and communications equipment, provided the necessary basis for mobile ground tactics and effective dispersion. The same vehicles also offered the possibility of effective operation in relative proximity to nuclear explosions by virtue of their inherent protection against blast and radioactivity, first demonstrated in May 1955 by the participation of an armoured task force in U.S. nuclear tests in the Nevada desert.

Organizational Developments.—To fulfill their potentialities, armoured forces had to undergo several changes in organization and tactics. The first advance beyond the primitive basis of battalions of 30 to 60 tanks was the formation of tank brigades. These, typified by the British tank brigade of 1934, combined up to four tank battalions under a single command and marked the first attempt at more mobile and effective employment. However, the capabilities of such all-tank formations were sufficient for a limited "cavalry role" but not for more effective and versatile employment. They were displaced by armoured divisions which combined a tank brigade with a complementary brigade of motorized infantry, a regiment of artillery and an engineer battalion. Such, in essence, were the *Panzer* divisions and most other armoured formations at the beginning of World War II, and the relative lead of the former in the effective combination of different arms accounted for much of their initial tactical success.

Once the interdependence of tanks and other arms was recognized, their combination spread down to subdivisional battle groups, such as the German *Kampfgruppen*. This was followed by the reorganization of armoured formations into self-contained battalions of different arms which could be combined into combat commands or other mixed brigade-size tactical groupings. This type of organization was introduced by U.S. armoured divisions in 1942–43, but toward the end of World War II the combination of different arms spread down even lower and after the war led to still smaller mixed units, such as the tank regiments of the Soviet divisions and the French *régiments inter-armes*, which combined riflemen with tanks and other heavy equipment into battalion-size mechanized units.

The formation of mixed armoured battle groups was greatly helped by the provision of self-propelled gun carriages and armoured personnel carriers. The former came into widespread use in 1942, although up to 1945 only the artillery of the U.S. armoured divisions was fully equipped with them. Armoured carriers, of the half-track type, were used by the *Panzer* divisions in 1940, but up to the end of World War II only one out of the four rifle battalions in each division was fully equipped with them. The same applied to the contemporary British divisions, but the three armoured infantry battalions of each U.S. armoured division were fully equipped with half-track armoured carriers, and after World War II the U.S. army led in the development of fully tracked carriers. The lack of armoured personnel carriers had been responsible for much of the opposition to including infantry in armoured formations by those who wished to exploit the mobility of tanks to the utmost, and who regarded the unarmoured wheeled vehicles of the motorized infantry as an unwarranted drag. In practice the combination proved essential, but the problem of large numbers of unarmoured vehicles remained. The *Panzer* division of 1939, with 328 tanks, had 2,095 other vehicles and 1,294 motorcycles. This led to the problem of fuel supply, which has risen steadily and which is the Achilles' heel of armoured formations. The *division légère mécanique* of 1938, with 220 tanks, 1,780 wheeled vehicles and 1,500 motorcycles, required 38,400 U.S. gallons (32,000 imperial gallons) to move 100 mi., while the 1950 U.S. armoured division, with its 373 tanks, 636 other armoured vehicles and 2,094 trucks, required 228,000 U.S. gallons (190,000 imperial gallons) to move the same distance.

Tactics also changed. The initial successes of the *Panzer* divisions were based on the firepower of their tank brigades used in mass, and the speed with which they attacked. The rapid tempo of the attack gave a minimum of time to opposing defenses and the concentration of the tank brigade on a narrow front ensured saturation at the decisive point. After the latter part of World War II these methods were superseded by the employment of progressively smaller subdivisional teams of all arms, ensuring closer co-operation between complementary elements under conditions of mobile warfare over wide fronts. Each mixed armoured battle group forms a mechanized multiple-weapon system well fitted to uphold the importance of armoured forces under conditions of dispersed mobile operations. *See* TANK; ARMOURED CAR.

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(RD. M. O.)

ARMSTRONG, ARCHIBALD (d. 1672), court jester, called "Archy," was a native of Scotland or of Cumberland, and according to tradition first distinguished himself as a sheep stealer; afterward he entered the service of James VI, with whom he became a favourite. When the king succeeded to the English throne, Archy was appointed court jester. He became presumptuous, insolent and mischievous, excited foolish jealousies between the king and Henry, prince of Wales, and was much disliked by the members of the court. In 1623 he accompanied Prince Charles and the duke of Buckingham in their adventure into Spain, where he was much caressed and favoured by the Spanish court and, according to his own account, was granted a pension. His conduct there became more intolerable than ever. He rallied the infanta on the defeat of the armada and censured the conduct of the expedition to Buckingham's face. Buckingham declared he would have him hanged, to which the jester replied that "dukes had often been hanged for insolence but never fools for talking." He retained his post on the accession of Charles I and accumulated a considerable fortune, including the grant by the king of 1,000 ac. in Ireland. After the death of Buckingham in 1628, whom he declared "the greatest enemy of three kings," the principal object of his dislike and rude jests was Archbishop Laud, whom he openly vilified and ridiculed. He died at Arthuret, Cumberland, in 1672, and was buried on All Fools' day. *A Banquet of Jests: a Change of Cheare*, published about 1630, a collection chiefly of dull, stale jokes, is attributed to him and with still less reason probably *A Choice Banquet of Witty Jests . . . Being an Addition to Archee's Jests, Taken Out of His Closet But Never Published in His Lifetime* (1660).

ARMSTRONG, HENRY EDWARD (1848–1937), one of the most outstanding personalities in British chemistry who did much to improve the teaching of science and reveled in controversy. Born on May 6, 1848, at Lewisham, Kent, he studied chemistry from 1865 to 1867 under Edward Frankland (*q.v.*) at the Royal College of Chemistry (afterward united with the Royal School of Mines), London, and went to Germany to study under Hermann Kolbe (*q.v.*) at Leipzig in 1867, returning in 1870. In 1871 he became professor of chemistry at the London institution, Finsbury circus (later Finsbury Technical college), and in 1879 was appointed with W. E. Ayrton to organize the teaching of chemistry and physics at the City and Guilds of London institute. In 1884 he became professor of chemistry in the new Central institution, South Kensington (which became the Central Technical college in 1893), retiring in 1911 when the college became part of the Imperial College of Science and Technology. He was elected a fellow of the

Royal society in 1876. He was secretary of the Chemical society from 1875 to 1893 and president from 1893 to 1895.

Armstrong's first original work (with Edward Frankland) led to a method for the determination of organic impurities (sewage) in drinking waters that resulted in typhoid fever becoming a preventable disease. His more classic researches in chemistry dealt with substitution in the hydrocarbon naphthalene, a problem on which he published some 60 memoirs, which, with the work of his collaborators, securely established the chemistry of a substance and its derivatives that were of the greatest technical importance in the dyestuffs industry.

Armstrong devised, independently of Adolf von Baeyer, a centric formula for benzene; he was a pioneer in crystallographic measurements of organic substances; he propounded the quinone theory of colour in organic compounds; he contributed much to the understanding of the chemical constitution of camphor and the related terpenes; and he opposed, often in picturesque terms, the ionic hypothesis of dissociation, preferring to explain chemical reaction as a kind of reversed electrolysis.

He died at Lewisham, by then part of Greater London, on July 13, 1937. (D. McK.)

ARMSTRONG, JOHN (1758–1843), U.S. soldier, diplomat and political leader, was born at Carlisle, Pa., on Nov. 25, 1758. He was a student at the College of New Jersey (now Princeton university) when the American Revolution broke out. He left his studies and became an officer in the continental army in 1775, eventually attaining the rank of major. At the close of the war, when distrust of the congress under the Articles of Confederation was rampant among officers of the army, it was apparently Armstrong who was the author of the "Newburgh Addresses" attacking the congress. The sentiment of these addresses had support among the officers until General Washington intervened. After the war, Armstrong married a sister of Chancellor Robert R. Livingston (*q.v.*) of New York, took up residence in that state and entered upon a political career.

He was for two brief periods a member of the United States senate, and, from 1804 to 1810, United States minister to France. With the outbreak of the second war with England in 1812 he served as a brigadier general, and later as secretary of war in the cabinet of President Madison. Although sharply critical of Armstrong, Henry Adams wrote (in his *History of the United States, 1801–1817*) that Armstrong as secretary of war "introduced into the army an energy wholly new," the results of which were apparent "for half a century." Armstrong died at Red Hook, N.Y., April 1, 1843. (E. E. R.)

ARMSTRONG, SAMUEL CHAPMAN (1839–1893), U.S. soldier and educator, was born on Maui, one of the Hawaiian Islands, on Jan. 30, 1839, the son of American missionaries. He graduated from Williams college, Williamstown, Mass., in 1862 and then entered the Union army, receiving the brevet rank of brigadier general at the end of the Civil War. His command of Negro troops led to his interest, after the war, in the care and education of Negroes. From 1866 to 1872 he served in the educational department of the Freedmen's Bureau (*q.v.*). Meanwhile, his interest led him in 1868 to found an industrial school for Negroes at Hampton, Va., and he served as its head until his death on May 11, 1893. After 1878 Indians were also enrolled in the Hampton institute, and Armstrong gave much of his time to the Indian question."

See *Samuel Chapman Armstrong, a Biographical Study* (1904) by his daughter, Edith Armstrong Talbot. (E. E. R.)

ARMSTRONG, WILLIAM GEORGE ARMSTRONG, BARON (1810–1900), English engineer who revolutionized the manufacture of large guns and invented high-pressure hydraulic machinery, was born in Newcastle Upon Tyne, Nov. 26, 1810. He studied law but also made scientific experiments and invented a hydroelectric machine, which generated electricity by steam escaping from an insulated boiler through nozzles. Abandoning law in 1847, he founded the engineering works at Elswick-on-Tyne to build hydraulic cranes. In 1850 he invented a hydraulic accumulator comprising a vertical cylinder into which water was steadily pumped under a sliding ram loaded with weights; by thus raising the pressure in the supply pipes to 600 lb. per square inch, hoists, capstans, turntables, dock gates, etc., could be worked anywhere.

Armstrong next concentrated on improving ordnance for the British army in the Crimea. The bursting pressure of cast-iron and bronze guns was low and he therefore shrunk metal rings onto an inner steel barrel, later coiling a strip of wrought iron into a long helix and welding it into a solid tube. He presented this invention to the nation in 1859, for which he was knighted and appointed director of rifled ordnance, Woolwich. He resigned in 1863 and returned to the Elswick works, where the sizes of ordnance were continuously increased until, by 1878, guns with a 17¾-in. bore, weighing 100 tons, were being manufactured. Armstrong designed powerful hydraulic machinery for controlling them, introduced both screw and wedge methods of closing the breech and, to increase accuracy of shooting, applied "rifling" by cutting spiral grooves in the bore to impart rotary motion to the shell. He was elected fellow of the Royal society in 1843 and, later, president of the British association. Created baron in 1887, he died at Cragside, Northumberland, on Dec. 27, 1900. (AR. S.)

ARMY is a term with a dual meaning: a sizable body of men armed and organized for the primary purpose of warfare on land; or the entire trained manpower serving a king or a state for the same purpose. The latter use includes the full-time professionals and the part-time reserves, but differentiates armed forces for land warfare from naval and air forces. For the history and modern condition of the principal armies of the world, *see* also under the country heading.

Throughout history, the character and organization of armies have changed. Social and political aspects of nations at different periods resulted in revision in the make-up of armies. New weapons influenced the nature of warfare and the organization of armies. At various times armies have been built around infantry soldiers, or mounted warriors, or men in machines. They have been made up of professionals or amateurs; of mercenaries fighting for pay or for plunder or of patriots fighting for a cause. Consideration of the development of armies must be made in the light of the times in which the particular army was forged and the campaigns it fought.

This article traces the development of armies to the mid-20th century and is divided into the following sections:

The many facets of the history, organization and structure of armies can be found in such articles as ARTILLERY; CAVALRY; ENGINEERS, MILITARY; OFFICERS, MILITARY; STAFF, MILITARY; etc. For a more complete listing *see* MILITARY AFFAIRS (ARTICLES ON).

I. ANCIENT ARMIES

The origin of armies cannot be dated. Nonetheless it may be assumed that the appearance of the city-states in Mesopotamia and Egypt, their continuous struggle for arable land and water rights, the creation of fortifications and the expansion of the city-states into kingdoms and empires must have been paralleled in those focal areas of the ancient world by the appearance and growth of army organization. Four types of armed forces may be discerned in the early history of the Fertile Crescent and the Nile valley. Paramount was a warrior caste which formed the ruler's bodyguard and "ate before the king." Much scholarly debate revolves around the origins, in the various states of antiquity, of this caste system. In some cases, the warrior caste simply represented the retention of arms in the hands of a conquering people who had disarmed and reduced to serfdom an earlier group of inhabitants. In other cases, the warrior caste appears to have been simply the product of birth or race. Next in importance to the guard attached

to the person of the monarch were the provincial troops who served in districts outside the capital under a royal governor or great prince. A third class of soldiery common in antiquity were the mercenaries, sometimes slaves as were the Nubians who served the first Pharaohs, or freebooters such as the Philistines, who were found in armies the length and breadth of the ancient near east. Finally, there seems to have existed from the earliest times, and in all societies, the institution of the *corvée* or forced levy of troops from the ordinary population. This levy was often associated with public works, but in wartime could augment the regular forces with lightly armed auxiliaries and road builders. They could also reinforce the mass of service troops by bearing burdens, building earthworks during siege warfare and burying the dead. As a rule, command in battle was personally exercised by the king, just as he performed the functions of chief priest and supreme judicial authority. Armies were regarded not as a drain on national revenues, but rather as an economic instrument for building the wealth of the ruler through the acquisition of slaves, booty and tribute.

Sumeria.—The Sumerians provide the first historical evidence of an army organization, this in the 4th millennium B.C. The so-called "standard," discovered in one of the royal graves of Ur, depicts infantry in formal ranks, armed with short spears, wearing conical copper helmets and given body protection by thick cloaks. In this period, war chariots already were employed, but they must have been unwieldy and slow since they had four wheels of solid wood and were drawn by asses. Later the Sumerian army standardized on a 6-man-deep phalanx; the first rank went into combat carrying large rectangular shields and the troops bore heavy pikes and battle axes. There is some indication that Sargon I of Akkad broke the power of the kings of Lagash by using a more open formation against the unwieldy phalanx. Apparently, also, the armies of Akkad relied to a great extent on missile fire with the bow and the javelin.

Babylonia.—The code of Hammurabi provides a fairly detailed description of army recruitment and duties in Babylonia at the beginning of the 2nd millennium B.C. The regular army was recruited from a soldier class granted hereditary land rights by the king. While on foreign service the soldier had to pay one-third of the land's produce to his wife or son, but in this and other matters he was protected by special laws while on campaign. The regular soldier, as a member of the first social class, must have been rigidly disciplined because the penalties assessed for crimes of violence were more severe for this first class than for the lower social orders. The middle class, second in the social hierarchy, were subject to the military levy—possibly in return for the royal right to trade or fish—but their place in the army was that of light-armed archers or service troops. Ultimately they were allowed to purchase exemption from army duty.

About the 18th century B.C. a great barbarian irruption struck the Fertile Crescent from the northeast. These invaders brought horses and light, two-wheeled war chariots. Within two centuries this new arm had become fairly common, but the invaders, such as the Hittites and Mitanni, who had introduced the swift horse-drawn chariots, for a time held the palm. Despite recent archaeological finds, little is known of the army organization in the new states established by the invaders. The strength of their armies lay in the aristocracy of chariot warriors who held grazing lands as fiefs from the king. It is known that the Hittites had a state-controlled arms industry which, at the battle of Kadesh on the Orontes, permitted a Hittite king to put in the field 3,500 chariots and 17,000 foot soldiers. A Hittite code of laws shows that the army was assembled annually at a place designated by the king; it also fixed the terms under which the nonwarrior class had to care for the soldier's land while he was in service. Theoretically, the Hittite armies took the field only during the yearly campaigning season, but in fact one Hittite ruler kept an army in Syria for 20 yr.

Egypt.—In Egypt the armies of the old kingdom seldom fought foreign wars but were usually employed for plundering expeditions and slave raids. The soldiers depicted in hieroglyphs are Nubians, who were apparently used by the despotic Pharaohs in a combination military-labour *corvée* to build the great monuments. During the middle kingdom period the great princes raised armies on a fief system from free landowners; however, the art of war saw little development until the invasion of the Hyksos. Amasis I expelled the Hyksos by adopting their military techniques. He created a standing army of two divisions recruited from the free middle class and called "citizens of the army." His troops fought with copper battle axes and bows, using the quiver—brought from Asia—to give volley fire. Wings and centre, flanking movements, recruit training and cadence step were introduced at that time. Under Rameses II (reigned 1292–1225 B.C.) the Egyptian army reached its ultimate stage of organization. The professional standing army was augmented in time of war by compulsory service from a warrior caste. Body armour, consisting of laminated linen cloth and leather caps became uniform. The army tactical formations were standardized on a square 100 men deep; ration lists, organized wagon trains and a state armament industry are all found in the records. Nonetheless the armies of the empire which annually invaded Syria remained small, probably less than 20,000 men. Ultimately the Pharaohs lost their power to the priests and princes, and military service became a legal fiction. Herodotus says there were more than 400,000 military fiefs held by Nubian, Libyan and Greek mercenaries who had settled in Egypt.

Assyria.—The creation of the Assyrian empire by Assur-nasir-pal II in the 9th century B.C. introduced an army organized as a state; all political, cultural and economic life was subordinated to the support and perfection of the army. Wars were fed by wars. If a city fell to the sword, those of its defenders not massacred were enrolled in the Assyrian forces. If a kingdom bought its life and bowed as a vassal, the price included chariots, siege engines and soldiers. Nineveh was more than the capital city, it was a general headquarters handling thousands of military reports.

The royal army had as its shock troops, the king's bodyguard, but was permanently enlarged by conscription from fief holders throughout the empire. In large operations, each village and each vassal kingdom furnished a contingent of troops. The size of the Assyrian armies cannot be reckoned accurately but on the eve of the empire age, Shalmaneser II (d. 824 B.C.) could boast of his ability to raise a levy of 120,000 men. The main strength of the Assyrian army lay in its archers, and mounted lancers who fought from horseback without saddles. To increase mobility, many of the infantry were mounted but actually fought on foot. A two-man team was developed to protect the archers, one man wielding the composite bow and the other carrying a man-size wicker shield. The regular soldiers wore cone-shaped helmets and breastplates with metal pieces sewed on leather or linen. A well-organized engineer corps conducted siege warfare and built roads or cleared obstacles. Siege engines, some of iron, became highly effective in the hands of the Assyrians—although it is not clear from the inscriptions what all of these machines were. Perhaps the greatest weapon of the Assyrian armies was the terror they inspired wherever they marched. The rapid collapse of the Assyrian empire at the close of the 7th century B.C. remains a historical enigma but may be ascribed in part to the depopulation by constant war of the original Assyrian provinces that furnished the backbone of the armies.

Persia.—The Persian empire, heir to the Assyrian, produced no new army organization or tactical concepts. At the centre of the Persian army system, stood the hereditary Persian warrior caste, bound by ties of blood to the ruler and known as his "companions." Like those of Assyria the armies of the Persian kings relied on chariots, cavalry and archers. Unlike the Assyrians, the Persians lacked a well-disciplined, heavily armed infantry. Ultimately the Persians turned to the mercenaries of Greece in an attempt to give tactical stability to the lightly armed levies that composed the bulk of their great armies. However, the Persian army destroyed by Alexander the Great was essentially the same as that which conquered Nineveh.

Greece.—In Greek history, warfare was a normal state and seasonal occupation. With the disappearance of the Homeric age marked toward its close by the Trojan War, the individual hero and bands of companions, whose feats in combat had ruled the battlefield, slowly were replaced by organized armies drawn in

time of need from the free citizens of the city-state. Each able-bodied male citizen as a youth received physical training adapted to military skills. Between the ages of 18 and 20 he did garrison duty on the border; thereafter he was liable to be called up with his age group for training or war. In Sparta, where the youth began continuous military training at the age of seven, the obligation to bear arms continued until the age of 60; but at the battle of Leuctra, as an example, only the classes 20 to 35 years old were in the ranks.

Originally a Greek citizen could personally equip himself for war and thus, since wealth was based on real property, the soldier-citizen was a landowner. The rich furnished the cavalry; the middle class provided the heavy infantry, or hoplites; and the poorer citizens served as lightly armed infantry or oarsmen in the navy. Ultimately, in some of the Greek cities, a class of landless citizens appeared who received pay for service in the fleet and, as in Athens, the navy became the "popular" service. Extraordinary military expenses for fortifications and ships normally were provided by free gifts from the wealthy or by profit from state enterprises in which all citizens shared; thus Themistocles took the proceeds from the Laurium (Laurion) silver mines to build the Athenian fleet and Pericles amassed a war chest from state profits and tribute. The Spartan system retained the citizen in garrison until the age of 30, and provided subsistence to all citizens on the basis of military rations from the state. According to tradition, from the time of the battle of Plataea onward, the Athenian soldier on long-term service received payment in coin. In the period of expansion after the Persian Wars, Greek economy became so solidly based on slavery that the only careers left to citizens were war or politics.

The tactical formation developed by the ancient Greeks and maintained throughout their history was the phalanx, an unbroken linear array of heavily armed infantry standing shoulder to shoulder in files that were normally 8 men deep but sometimes deeper. Apparently the use of the phalanx spread throughout Hellas during the 7th century B.C. The Greek hoplite who manned the phalanx was equipped for a standing fight in a warm climate with a round shield, a heavy corslet of leather and metal, greaves (armour for shins), an 8-ft. pike for thrusting and a 2-ft. double-edged sword. Since the phalanx held in solid ranks and was divided only into the centre and wings, there generally was little need for an officer corps; the whole line advanced in step to the sound of the flute. The Spartans, however, did train officers to maneuver the phalanx and appointed permanent generals who also held political office as kings. In Athens one of the archons (chief magistrates) elected for the year served as the field general.

The Greek cities calculated the strength of their armies in terms of the number of hoplites only. In Sparta, however, four or five lightly armed soldiers or slaves accompanied each hoplite, while in Athens and Thebes at least one light infantryman took the field with each member of the phalanx. Since there was little grazing land and because horseshoes, necessary for the stony ground of Greece, were unknown, the city-states paid scant attention to the cavalry arm. Neither Athens nor Sparta seems to have been able to put more than 10,000 citizen hoplites in the phalanx, but during the Peloponnesian Wars both doubled or trebled this number by the addition of allies and noncitizen residents.

Throughout the Hellenic age there was no major change in the organization of the Greek armies. The Greek city-states produced no innovations in tactics or weapons save the oblique phalanx, heavily weighted on the assaulting flank, which was developed by Epaminondas (*q.v.*) and which catapulted Thebes briefly to power. The long period of the Peloponnesian Wars bled white and impoverished the social classes which had formed the city-state phalanx and thus cleared the way for Macedonian hegemony (*see* PELOPONNESIAN WAR). But perhaps, as suggested by Arnold Toynbee, the toils of great traditions and universal contempt for all that was non-Hellenic in origin, made it impossible for the Greeks to discard the city-state, the phalanx and hoplite as these became obsolescent, thus hastening the imposition of rule by others who possessed new, vigorous political and military organizations.

Alexander.—Alexander's army was built around the phalanx, composed of his best Greek and Macedonian hoplites. Alexander's basic unit in the phalanx was the syntagma, normally 16 men deep, and each soldier armed with a spear (*sarissa*) said to be 21 ft. long. In battle, the first five ranks held their spears horizontally in front of the advancing phalanx, the files being practically on the heels of the men in front when in battle formation. The remaining 11 ranks presumably held their spears vertically or rested them on the shoulders of those in front.

This 256-man syntagma was unwieldy, particularly if its tight formation was broken by rugged ground. It had the advantage on level ground of being able to form a wedge, or a "V"; it could march to the flank, wheel and countermarch. Four of these bodies formed a chiliarchia, and four chiliarchiae, or 4,000 men, composed a grand phalanx. An army was composed of a grand phalanx supplemented by lightly armed soldiers (psiloi), cavalry and irregular troops.

In front of the core of the army, the hoplites of the phalanx, were slingers and archers while cavalry armed with swords and lances protected the flanks. When the lightly armed skirmishers were driven back in battle, they withdrew around the flanks to join the auxiliaries in the rear of the phalanx.

In Alexander's army were forerunners of modern artillery, the catapult and ballista, some siege equipment and even the first medical service. Hippocrates had left his imprint upon the Greeks to the extent that Alexander carried a personal physician while a man named Onasilos attended the warriors.

Alexander's army numbered between 30,000 and 40,000 in his campaigns in Asia Minor and India. Issus and Gaugamela were two of his greatest battles. Tactical skill in the use of cavalry on the flanks, while utilizing the phalanx as a solid centre line, brought Alexander overwhelming victories against massive Persian forces. Of great assistance was the prevailing breakup of an army when its leader had been killed or had fled. For at Gaugamela, Darius' hasty flight resulted in the complete undermining of the Persian will to fight. (*See* ALEXANDER III.)

Civil wars, the decline of the phalanx as a fixed fighting force and the breakup of his empire followed Alexander's death. The place of Greece and Persia in the history of warfare was taken by Carthage and the Roman republic in the Punic Wars of the 3rd century B.C.

Carthage.—The short-lived, mothlike history of Carthage's battle for supremacy in the western Mediterranean is one of brilliant generalship, supported reluctantly at home by the merchants. After the loss of Sicily, Sardinia and Corsica in the First Punic War, Carthage turned to Spain as a source of wealth and as a military base for operations against Rome.

Hannibal (*q.v.*) was the model of Carthaginian military greatness. In the service of a nation which little appreciated his gifted leadership, he welded together a fighting force of nonnationals—Numidians, Gauls, Africans, Spaniards and soldiers of fortune from the Mediterranean area. His leadership carried these diverse nationalities to victory after victory, much as did Albrecht W. E. von Wallenstein centuries later. These mercenaries, called into service only when needed and discharged when no campaigns impended, often rebelled or deserted since they had no patriotic motive for fighting. The military situation was consistent with the desires of the commercial men who dominated Carthage. They put their interest in a large navy, had no standing army and hired one only when the situation warranted.

Discipline was rarely good. It was not a national army supported by the people. The generals were chosen by the people, and control of operations was exerted by the senate who sent a deputy commander as its representative to make certain that the plans were carried out. Victory was achieved despite the system.

The model for the Carthaginian army was the Greek. Shock tactics by the centre, composed of Gauls, Spaniards and Libya-Phoenicians, were supported by heavy cavalry on the flanks and by numerous light Numidian cavalry. The skirmish line in front was composed of slingers and other light troops, and later a line of elephants. As the wars progressed, the phalanx took on the nature of the Roman legion while the Romans, in turn, copied the Carthaginian cavalry.

Hannibal was a master strategist in selecting the ground for battle so as to favour his troops. Furthermore, he employed ruse and stratagem to surprise the Romans. Much of his success was the result of an elaborate system of spies. He paid great attention to supply lines since his base in Spain was far from his operations in Italy. Also, the provision of weapons for his troops was a constant problem because of the nature of his mercenaries. For example, the Spaniards wanted swords for cutting and thrusting; the Gauls for cutting only. The African infantrymen preferred long lances and bows and arrows. The Numidian cavalry, armed with lances, darts and swords, used leopard skins as shields.

Hannibal employed his cavalry for shock action against the Romans at Cannae, following up after the successful onslaught by pursuit with the Numidian cavalry. As the wars wore on, it became obvious that Hannibal could never hope to defeat the Romans completely, he lacked naval support against a strong Roman navy, his supply lines were long and his recruitment of mercenary replacements depended on the whim of the Carthaginian senate and the availability of such soldiers of fortune. His polyglot army could not withstand the patriotic, consistent endeavours of the Roman citizen-soldiers.

Rome.—The history of Rome is the history of its armies. The strategic policy of Rome, if it can be so called, was to avoid the necessity of having a navy; save for the shipbuilding race with Carthage, the expansion of the Roman world was conducted by marching soldiers. The history of the Roman armies, in turn, is that of the legion (*q.v.*), which term in its origin may have meant those who were "chosen" for military service during the annual assembly of citizens. The legion cannot be considered a static organization because of its tactical form; its equipment and its sociopolitical significance varied greatly through the long history of the republic and the empire.

As a small Latin city-state, Rome relied on its land-owning citizens to provide soldiery for the defense of villages and crops. The soldier's arms and place in the ranks were based on five classes of wealth, each of these classes furnishing a certain number of companies known as centuries or hundreds. At the close of the monarchy there existed 210 centuries of infantry (21,000 men) and 18 of cavalry (1,800 men). Each citizen was liable to duty in the field between the ages of 17 and 46, but all citizens could be called to the defense of the city walls until the age of 60. There were three categories of mobilization: (1) the *dilectus* was the normal annual selection of the required number of soldiers for training and garrison duty; (2) the *tumultus* assembled all citizens liable to military service; and (3) the *evocatio* (actually a national religious rite) was used in times of great peril to bring the young, the aged, noncitizens and even slaves into the ranks as volunteers.

From the founding of the city until the close of the 2nd century B.C., Rome was served by a nonpermanent army of citizens. Armed after the Etruscan and Greek pattern, the Roman legion first copied the solid Greek phalanx, suitable to the plains of Latium, and used as its basic weapon the *hasta* (a thrusting spear) from which the heavy-armed infantry took their name *hastati*. Tradition assigns the first paid foreign service army to the close of the 5th century B.C. and the siege of the Etruscan city of Veii (*q.v.*).

As Rome expanded from Latium into the hills and valleys of central Italy, the phalanx, too unwieldy for fragmented fighting on broken ground, went into eclipse and the Romans began the long process of tactical and technical innovation which distinguishes their military history. Roman writers ascribe the legion, as a new tactical form, to the period of the Samnite Wars, but the transition from phalanx to legion must have been very gradual. Some modern scholars assign the tactical legion to reforms instituted shortly after the sack of Rome by the Gauls in 390 B.C. The original identifying mark of legion organization was the tactical subdivision into small groups, or maniples, of 120 men. But weapons changed as well: the *pilum*, a 7-ft. throwing spear with a soft metal head and shank replaced the *hasta;* small shields replaced the large, unwieldy Greco-Etruscan variety; the helmet became smaller with a metal crest and cheek pieces to protect the face; and, over an extended period of technological change, the famous legionary short, stabbing sword evolved.

The passages from Livy and Polybius which describe the legion of the middle republic are rather obscure. Apparently the maniples were arrayed in echelon on some checkerboard fashion. The first line consisted of the *hastati*, a purely honorary name since they were armed with the *pilum;* the next line was composed of the *principes*, another traditional name since these soldiers were no longer of the front rank or of higher property classification; in the third line—armed with a long spear instead of the *pilum*—were the *triarii*. The *triarii* probably stood three deep, the other maniples in files of six. Prior to the Punic Wars the Roman cavalry played no important role and the *equites* had political rather than military significance. During the early days of the republic the peacetime army normally consisted of two Roman legions plus two legions provided by the Italian allies (*auxilia*). These earlier legions varied between 4,000 and 6,000 men.

As Rome extended its hold on the Italian peninsula the rights and duties of citizenship expanded. Even after the bloody defeat suffered at Cannae (216 B.C.) Rome was able to call up 23 legions. In the course of the long wars of the 3rd century B.C. against Pyrrhus of Epirus, and Carthage and Macedon, the Roman armies became masters of the art of war, although often at the expense of severe reverses in battle. But the social, political and economic cost was high and the middle-class citizen and property owner, backbone of the legion, decreased in numbers and lost his civic-military status. Modern historians calculate that the Second Punic War cost Rome one-third of its citizens. During the economic depression and social upheaval which followed these wars, the annual levy of citizens for service in the army was retained only as a legal fiction. The citizen-soldier's oath of service, taken once each year, was replaced in the time of Gaius Marius by an oath binding the soldier to his commander for ten years or until such time as a consul gave permission for retirement. From about 107 B.C., therefore, the citizen-army of Romans was replaced by an army consisting of the landless proletariat and newly made Italian citizens whose allegiance was to their commander rather than to the Roman state and whose pay, in land grants or money, had to be extorted by the general from conquered peoples or the reluctant senate. The army was mercenary but not yet considered as having long-term service, since the economic organization to support such a permanent force was lacking.

Marius drastically reorganized the legion, numbering it at 4,500 and substituting a 600-man cohort for the old maniple in an attempt to meet the shock tactics of the Germans encroaching on the borders. The old division into *hastati*, *principes*, etc., disappeared and the patrician cavalry was disbanded. Marius gave the legions their famous eagles but the system of permanent numbers was not introduced until the time of Julius Caesar. With professional soldiers a higher degree of military training was possible. Regular drill with the short Roman sword was instituted on the model of the gladiator schools; a precise marching step was introduced even on route marches; logistics were regularized with two centuries per legion as service troops, a train of 3,600 mules for each consular army and a system of magazines along the great military roads. As Theodor Mommsen suggests, the army system created by Marius probably helped pave the way for the empire.

Augustus, founder of the empire, succeeded in restoring civil control over the Roman army but despite the experiences of the civil wars decided to retain the professional soldiery. He cut the number of legions from about 60 to 28, required permanent service for 20 years, and created a military treasury (supported by sales and inheritance taxes in Rome) to pay off veterans at the end of their service. The empire, therefore, began with the permanent, mercenary army. Under the empire the legions occupied home stations behind the long lines of fortifications (*limes*) which Augustus, Domitian, Trajan and Hadrian built to hold the barbarians at the limits of Roman power. But the legions still possessed the ability to deploy swiftly by marching at set pace with each man carrying about 40 lbs. of equipment, along the great system of military roads which knit the garrisons on the Rhine,

Danube and Euphrates together.

From the end of the 2nd century A.D. three main armies existed, in Gaul, Italy and the east. These armies were equipped from 34 great arsenal cities and were supplied by the provinces they guarded. Raised from barbarians on the borders and from the serfs provided by the great provincial landowners, the legions slowly lost their Roman character and the hard core of sturdy Italian citizenry. In the 3rd century A.D. sweeping military reforms were initiated by Diocletian. Flagging discipline in the heterogeneous legions was restored by a severe code of punishment; each legion was reduced to 2,000 men in an attempt to attain the mobility required in the border wars; and the strength of the army was raised to nearly 500,000—inducing a financial strain which contributed to the subsequent economic downfall of Rome. Constantine (*q.v.*) undertook the last major army reform, creating a mobile field army (*comitatenses*) as strategic reserve in the interior of the empire, and reorganizing the legions on the border (*ripenses*) as frontier guards.

When, in the 4th century, Constantine reunited the empire, military supremacy began the shift from Rome to Constantinople. This century may be said to mark a revolution in the art of war and the character of armies. In the preceding two centuries the saddle, stirrup, horseshoe and a new breed of heavy war horse had appeared in the Ukraine and on the Persian plateau, for the first time making it possible to mount a horseman wearing heavy armour and to employ cavalry as a shock weapon. This innovation spread to the Goths and Huns, then to the Roman armies which enlisted these barbarians as cavalry. The overwhelming defeat suffered by the legions of the emperor Valens at the hands of the Visigoth cavalry in 378 may also have had some influence. The heavy-armed cavalry, not the infantry, came to rule the battlefield and to dominate the armies of Europe for the next 1,000 years.

The Eastern Empire.—The fall of Rome witnessed the transfer of Roman traditions and institutions to Constantinople and the Eastern Roman empire. There, for 500 years, military institutions were the keystone of the struggle to stave off the barbarian floods sweeping into western Europe, Africa and the near east. From the 5th to the 7th centuries the Byzantine emperors relied on the navy and small, well-trained professional armies recruited from the barbarians and landless peasants. The theory of citizen service remained, but city dwellers, persons of property, artisans and the numerous clerics all were exempted from bearing arms. In Constantinople were quartered the *scholae*, or imperial bodyguard, recruited from the patriciate and mercenary soldiers, composed of both cavalry and infantry, equipped with heavy body armour, and garrisoned strategically to control the rulers of the eastern empire. In the border provinces existed permanent detachments of professional soldiers who were often settled on the land and of little use except as a kind of local police.

The nucleus of the field armies which campaigned with Narses and Belisarius (*qq.v.*) was the commander's bodyguard, organized much like the imperial bodyguard but attached to the person of the commander in the field. This professional army, despite its polyglot character, proved more than a match for the barbarians. Tactical innovation was introduced to meet each new enemy. Superior firepower in the form of portable missile-throwing machines compensated for their small numbers. This was an army based on heavy, iron-mailed cavalry wielding bows or lances; indeed, the emperor Maurice, reputed author of the *Strategon*, writes that the infantry had been so long neglected "that it does not exist any more." Rather than bear the expense of maintaining the large forces required to man the old Roman system of long walls, the Byzantines relied on a system of small garrisons strung in fortified posts (*castella*) along the main roads. The long-term professional army, expensively equipped and paid in gold, was always small in size. When Belisarius defeated the Persians in A.D. 530 his army numbered only 25,000, a small number from an empire of nearly 50,000,000 population.

The crises of the 7th century, arising from Arab and Persian expansion, resulted in military change. The invention of Greek fire (*q.v.*) gave the empire a formidable secret weapon which saved Byzantium on at least two occasions. The loss of imperial provinces in Syria and North Africa altered the strategic posture of the empire, pared away the useless border troops and led to the concentration of the army in Asia Minor. Political administration became subordinate to the military; a system of themes, or military districts, was created in which the *strategos*, or viceroy, controlled both army and civilian administration. This army was recruited from the settlers of the military and crown lands, which were granted the soldiers and their heirs in return for military service. The recruits provided their own horses and arms.

The new soldiery, well equipped and fanatic in the defense of the Christian faith, enabled the empire to take the offensive and double its extent during the 10th century. The victories of that era, however, were followed by a decline in military spirit. The pacific successors of Basil II feared the hereditary military caste and conspired with the great landowners and Byzantine patriciate to strip the soldier of his small holdings and special privileges. In the 11th century the Seljuk Turks began inroads into Asia Minor, slowly stripping from the empire those lands which had been the "soldier mines" of Anatolia.

During the span of life which remained to the eastern empire, the Byzantine armies were largely composed of Slav, Italian, German and Arab mercenaries. *See* BYZANTINE EMPIRE: *Defense*.

II. MEDIEVAL ARMIES

During the long centuries after the breakup of the Roman empire, various nations appeared on the scene and then disappeared. The Muslims roamed almost unchecked throughout the Mediterranean world, save for a number of unsuccessful sieges of Constantinople. In western Europe, the Franks utilized their inheritance of the Roman system to develop into the defenders of France against the Muslims. Later, under Charlemagne, the first signs of the feudal system began to appear. Knighthood developed in western Europe, sending many of its finest warriors to the eastern shores of the Mediterranean to fight the infidel.

In the final period of the crusades, the Mongol hordes of Genghis Khan and his successors flowed out of Asia until they were stopped near present-day Budapest on the Danube. There was little development of the military art during this period when heavy and light cavalry swept enemies before them. Only in England and Denmark did the infantryman retain a semblance of his ancient prestige.

Muslims.—Something new was added to the spirit of armies with the inclusion of a religious fanaticism. In fighting the Christian, the soldiers of Allah found their salvation, for "The sword is the key to Heaven and Hell" in the words of the *Koran*. Peaceful conversion to his cause having failed, the Muslim extended his religion by the sword. Hardy men, well disciplined and well led, they seemed to rely on brute force rather than upon newly conceived tactics. Wearing mail and helmets, but without shields, they brought terror to their ineffectual enemies by the sword, javelin, bow, dagger and scimitar. The last, a curved weapon, made of the finest Damascus or Toledo steel, was devastating in the hands of a believer. Besides scimitars, the infantry carried long, straight swords. The mounted men also carried straight swords, but relied mainly on their Arab lances, which were almost six feet long and tapered to long, slender points.

The Muslim forces lived on the country, enthusiastic to a point of foolishness over plunder. They were able to induce their conquered enemies to join them, either by force or through recruitment. Eventually, when they understood the value of a strong centre, like that of the legion and phalanx of old, they utilized European mercenaries for that purpose. The cavalry arm was reserved for Muslims.

For 100 years until the battle of Tours (A.D. 732) they were the scourge of the countries bordering on the Mediterranean. Believing that the time had come after a succession of triumphs to add Europe to the caliphate, they crossed the Pyrenees with 80,000 men. Plundering and burning, they came to Tours where Charles Martel and his Franks prepared to fight in defense of

Christendom. In six days of maneuvering, the Muslim cavalry found its equal in the Frankish infantry. When the tide was turning in favour of the Muslims on the afternoon of the seventh day, rumours that the Frankish cavalry was in the rear of the Muslims sacking their camp with its plunder, resulted in some of the Muslims turning from the main objective. Martel won a tremendous victory, in what is considered one of the decisive battles of history. The Muslim threat against Christendom was never again to reach so far into Europe.

Feudal System and the Crusades.—Under the Franks, a system of landholding and military service grew up in France which was called feudalism. The conquerors became the lords; the conquered, the serfs. The lords were the primary warrior class, assisted by some partially armed serfs and by unarmed serfs as servants. Because land was inherited, the serf could not rise in the social scale. The lord thereby commanded because of his position, not necessarily because of ability. Furthermore, land being broken up into small areas, each lord became a law unto himself, unless he owed allegiance to a higher lord. There was a certain hierarchy among the lords, up to the king, the lesser being a vassal to his superior. The vassal had to furnish a certain number of armed men to fight in his lord's service for 40 days a year. As a result, warfare was confined to short campaigns and often to periods of the year when men could be spared from the fields.

Forty-day army duty was insufficient for the long tenure of the crusades and other campaigns, resulting in the return of professional armies. The hiring of professional soldiers was made possible through the alternative permitted to vassals of sending gold instead of armed men when called upon for their levy.

All eyes were upon the individual knight. His exploits as an individual, even as a knight-errant, were sung in song and story. The personal element was inimical to discipline and teamwork, and prevented the creation of a chain of command. Serving the lordly caste were the despised and poorly armed foot soldiers. Their part in battle was negligible, the poor knaves having to fend off the charges of even their own knights in their efforts to do battle against the opposing knights. (*See* KNIGHTHOOD, CHIVALRY AND ORDERS.)

The crusades (*q.v.*), seven in number between A.D. 1096 and A.D. 1279, were fought by the heavily armoured mounted knights, accompanied by light-armoured feudal tenants, and supported by serfs, retainers and a few mercenaries as foot soldiers. Out of these individualistic endeavours, in the service of particular lords rather than of nations, there were no developments from a military standpoint. The faults of the crusaders, of mediocre generalship, lack of coherent action and failure to establish proper supply bases pointed up the need for organization of armies.

The crusades never achieved their objective of liberating the Holy Land from the Muslims. However, partially because of the death of many nobles, the system of landholding was gradually abolished, as was serfdom. From the military mistakes of earlier crusades, there developed better leadership in that of Frederick Barbarossa and Richard the Lion-Heart. Armour proved too unwieldy and hot in tropical lands, and the importance of supply bases became apparent to all. Furthermore, the crusaders learned much about the attack of fortifications from their experiences. During the later crusades, warfare in Europe began to draw the attention of the knights, as did a new menace from the eastern steppes. Another wave of barbarians threatened Christendom at home.

Mongols.—During the 13th century Genghis Khan and his hordes swept across Asia and into Europe, until they had conquered half the known world. Known as the Golden Horde (*q.v.*), the Mongol invaders were a well-disciplined, highly organized and trained army. Leadership was superb and youthful, such men as Chépé and Sabutai rising to high command by the age of 25.

The Mongol army, practically all cavalry, was organized on the decimal system. The touman of 10,000 horsemen was the largest independent unit, corresponding to cavalry divisions of later centuries. An army was usually composed of three toumans, each with ten regiments of 1,000 men each. The regiment had ten squadrons, each of the latter with ten troops of ten men.

Their battlefield maneuvers were regulated by black and white flags, thus eliminating oral or written orders. Mobility and speed were main factors as well as the shock effect of the first two of five lines of horsemen. Horses and men of the first two lines wore leather armour and fought with sabres and lances. The following three lines were armed with javelins and bows but were unarmoured.

From a military standpoint Genghis Khan was a master strategist and tactician. He knew how to organize an army, how to use spies for intelligence and how to propagandize enemy peoples. In battles like Bukhara and Gran, the Mongol army exhibited a capacity for synchronizing the arrival of different columns at a rendezvous point hundreds of miles distant which would be brilliant even in the age of radio and telephone. Again and again Mongol armies under a number of different leaders used ruses to win victories, just as in many of their battles the leaders showed a fine strategic sense in the selection of distant battlefields. A similar capacity won for Napoleon much of his fame in his Italian campaigns. Though the high point of the Mongol advance was attained at Gran in Hungary and resulted in the annihilation of the Hungarians, the Mongols turned home. The breakup of their control at home and competition for power upon the death of the leaders, prevented the Mongols from attempting to overrun Europe.

End of Feudal Armies.—In the long period from about A.D. 1300 to the Thirty Years' War (1618–48), feudalism came to an end. Cavalry was replaced by infantry. There was almost continuous warfare in Italy, Spain and the Netherlands, and the Hundred Years' War between France and England from the middle of the 14th to the middle of the 15th century.

During the later middle ages the warfare of the knights in Europe was of mixed character, some battles being fought by the armoured knights on foot, others by infantry drawn from the burghers of France, who were successful against mounted knights. The burgher militia of the cities of Flanders, numbering 20,000, defeated a feudal army of 50,000 at Courtrai (A.D. 1302). The Flemish foot soldiers were successful partly because of their own circumspection in placing ditches to their front and flanks, and partly because of the false sense of chivalry of the French in maintaining that they must attack straight ahead in an arrogant but futile dash against the main strength of the burghers.

The crossbow was becoming the main armament of the foot soldiers, despite the fact that it had been banned as a deadly weapon by a Lateran council in A.D. 1139. Throughout Europe the crossbow became the main weapon of armies, along with the pike. But it was never accepted by the British, who preferred the longbow.

In England the armies were turning from feudalistic practices through a long series of legal acts. For instance, the practice of hiring foreign mercenaries common in the 12th century had been checked by the Magna Carta. A system of payment for military service became accepted, mostly because of the realization that feudal service had yielded a poorly trained and undisciplined mob looking forward to release after 40 days. Military service gradually became a duty insisted upon by all freemen, and the armies drew their foot soldiers by levy upon the counties.

Two developments stand out in this period of warfare—new weapons and mercenaries. The English longbow dominated the field of weapons for more than a century even after the appearance of the first firearms. The longbow, about five feet high, shot arrows a yard long with deadly accuracy up to 200 yd. The fact that it could shoot as many as 20 aimed shots a minute made it superior to the crude firearms for a long time. The longbow made its dramatic debut on the continent when English yeomen stemmed the charge of the French knights at Crécy (1346). Their volleys darkened the sky and their arrows found their mark even through armour.

Though the longbow defeated the French cavalry, it did not of itself bring back the supremacy of the foot soldier. Bowmen were dependent upon the weight of massed infantrymen to defeat cavalry. It took the Swiss pikemen to confirm the decision in

favour of the foot soldier; the pike brought about the return of the Greek phalanx in a Swiss counterpart, and in the later Spanish square.

The cycle had come full turn. The mobility developed by the cavalry for 1,000 years was sacrificed for firepower and the weight of mass manpower. For three centuries the variations in the Greek phalanx won victories in Europe. The Swiss usually could not afford horses and armour; they won victories through the homogeneity of their solid mass. By constant drill they were able to advance and to maneuver in a limited fashion in their tight formation. Ahead of them were their pikes which became the scourge of mounted men. Other nations copied the Swiss, or hired Swiss mercenaries to fight for them.

In time the Swiss phalanx gave way to the Spanish square. This facsimile of the phalanx was a square with 50 men on a front and in file. Its claim to domination of the battlefield came from its combination of the pike with the sword and musket, all placed for greatest tactical advantage in the human mass. Behind the front-rank pikemen were several lines of swordsmen, ready to cut down the enemy pikemen brought to bay by their front ranks. At the corners of the formation were a number of musketeers. After a single laborious shot, the musketeer filed to the rear to reload. In support of the square were cavalrymen armed with pistols. They, too, presumably followed the role of the musketeers, galloping to the front, firing and then going to the rear to reload.

During three centuries of this period, war became more professional than at any time in history. Free companies were formed of men whose business was to fight, for pay and plunder. This "trade guild" of war was brought into existence by the fact that burghers were unwilling to undertake wars of aggression. Hired by princes as companies already organized, unlike mercenaries of previous days who were hired individually, they gave to their effort a certain experience and discipline. However, as professionals, they showed a disinclination to bloodshed, and inconclusive campaigns were the rule. Undoubtedly they were the best troops in existence but lack of a cause in their fighting made them a poor substitute for the citizen-soldier of earlier times. Their one contribution to the development of armies was their organization. Leadership among small units assumed an importance which continued to modern times. Furthermore, some authorities aver that the free companies set the pattern for the professional soldier, who made his career in the art and science of warfare. A glimpse at the various free companies by nationality is of interest as a preview of the national armies which stemmed from them.

Condottieri.—The original free companies were the Italian condottieri, translated contractors, in the meaning that leaders contracted to furnish disciplined, experienced organizations to fight for princes in return for money. The condottieri were so skilled that they were able to put on a long-drawn-out campaign with the casualties being only those unfortunate victims of accidents incident to the movements of large numbers of men. Machiavelli reported some of the condottieri battles in Renaissance Italy with profound disgust. In several battles only a few deaths occurred, and the sole winners were the condottieri who bled Italy of gold. There was a tournament spirit about free-company battles. Emphasis was on showmanship rather than the creation of new tactics. Machiavelli believed that medieval warfare was obsolete and that it should be replaced by national armies and new tactics. (*See* CONDOTTIERE.)

Swiss.—In contrast to the condottieri were the Swiss mercenaries who proved they were worth their hire. Again and again they fought fiercely and capably even though motivated only by profit. In the late 15th century the Swiss made their reputation in a series of three decisive victories over Charles the Bold, duke of Burgundy. Subsequently, the Swiss were acknowledged champions of Europe. Despite their successes, they sought neither to change the methods of warfare nor to conquer new territories. Gold was their one desire. The spirit was communicated to the succeeding generations of Swiss to the end that every boy yearned only to be trained as a soldier so that he too could enter the state profession and courageously earn the profit due him.

This predilection for paid warfare was exported across the borders into Germany, where the competing free companies became known as *Landsknechts.* While at first clumsy in their imitations of the Swiss phalanx, they became in time hardy infantrymen and innovators in tactics and in the use of the new firearms. Like the Italians and Swiss they were freebooters and blackmailers whose business of fighting became a paltry and sad one. The *Landsknechts,* like other free companies, developed organizational forms, followed the colours of a leader and contributed something of the regimental spirit with its arbitrary customs and manners which became tradition in latter day armies.

Spanish.—The Spaniards themselves never succumbed to the lure of service in free companies. However, during the age of Charles V in the first half of the 16th century, Spanish armies were made up largely of non-Spanish mercenaries, particularly German, Italian and Walloon. Charles outdid Charlemagne in the extent of his conquests. His army, though largely mercenary, was led by Spaniards and a fine strain of Spanish blood filtered throughout. A spirit of patriotism, of loyalty to Charles V, was infused into the entire army.

It was an intelligent army, capable of appreciating the requirements which new weapons made on tactics. In the Spanish square, described above, the old (pike and sword) was amalgamated with the new (the arquebus) for the first time. The latter, the first real hand gun, had a fuse which was brought against the powder in the priming pan when activated by the pressure of the trigger.

Organizationally, the Spanish contributed to the development of the regiment with their *tercio* composed of 12 companies of 250 men each. From their battle experience the arquebusiers were increased until they equalled in number the pikemen in the *tercio.* The colonel of this tactical unit was assisted by a sergeant major, an adjutant, a quartermaster, a chaplain and a medical staff.

Dutch.—The Spanish phalanx met its defeat at the hands of the Dutch patriots, organized for victory by Maurice of Nassau. His constant drill of the sturdy Dutch citizen-soldier brought into being a force which maintained its ground against the best Spanish forces in the years preceding the Thirty Years' War. In the evolution of armies the Dutch passed on the passion for drill and their addiction to the science of warfare. The ground was being laid for the creation of national armies and for greater attention to maneuver and to fortification.

III. DEVELOPMENT OF STANDING ARMIES

The Thirty Years' War between the Protestants of the north and the Catholics of the south was a turning point in methods of warfare and particularly in the organization of armies. The free companies of infantry armed with pike and musket had ended the long cycle of cavalry supremacy. Armies were again modeled on those of Greece and Rome, with cavalry supporting the infantry. Armour had disappeared, mainly because it was not proof against firearms. It constituted a hazard because it made the wearer ungainly and, when struck by ball, tended to splinter. Leather boots and buffcoats replaced armour for protection. Shock tactics were replaced by firepower tactics; the lance by the musket.

Gustavus II Adolphus.—The improvements in tactics, weapons, organization and administration were brought together into a new military system by Gustavus II Adolphus (*q.v.*), king of Sweden. From its first battle at Breitenfeld in 1631, the army of this champion of Protestantism fought a series of six campaigns during the next 16 yr. As a result, Gustavus earned the right to be called the father of modern war, even though he was killed at Lützen (1632) while leading his victorious troops.

Before his campaigns, he forged a national standing army in Sweden, a development common to Europe for the next century and a half. All men over 15 years of age, with some exceptions, were liable for military service. While this draft of manpower was not sufficient in a country with the small population of Sweden to meet the army's requirements, he utilized the Swedes for the hard core. Mercenary troops, Scots and Germans, augmented his infantry strength, but even these men came under the spell of his leadership and his requirement that war be conducted within the bounds of Christian teachings.

Utilizing the draft of manpower, Gustavus developed a regular

army organization based upon a company of 150 men, 6 files deep. Four companies comprised a battalion, and three battalions a brigade. Recognizing the fact that firearms could be developed to dominate the battlefield, he brought about the invention of a lighter musket improved to permit faster loading. He also reduced the weight of the musket by replacing the heavy iron fork by a thin spike, which served as a rest for the musket. His men used paper cartridges containing a prepared charge of powder and ball. When the Swedish soldier reloaded he bit off the end of the cartridge and pushed it home with a ramrod.

Increased firepower was also assured by the inclusion of artillery as a part of the army, about six cannon being furnished for every 1,000 men. The cannon were four-pounders drawn by one or two horses. The artillery was made very mobile in order that it could operate in support of the heavy cavalry. With this increased firepower Gustavus worked out tactics which included the shock of a cavalry charge in conjunction with infantry and field artillery. This combination of arms was the first known in modern warfare. In addition Gustavus developed what became known as linear tactics, employing two lines of troops and a third line as a reserve.

In battle he formed his army with the infantry regiment in the centre and with cavalry on the front. The cavalry regiments attacked with speed but at a trot, which was a departure from the idea that cavalry charges should be at a gallop. As the three ranks of cavalry advanced, the front rank fired its pistols and after firing charged with drawn sabres. The infantry meanwhile moved forward on foot, stopping now and then to fire their weapons. The front rank would kneel and the other two ranks would fire from a standing position. By such tactics Gustavus defeated all the troops that he met and in time his tactics and organization were imitated by all the armies in Europe.

Before his time artillery, cavalry and infantry operated more or less independently. Gustavus co-ordinated their activities by using his artillery first to soften up the enemy, followed by cavalry charges which cracked the enemy's resistance. The infantry was then used to mop up the disorganized opponent.

As a further contribution to warfare, Gustavus, on the basis of a Dutch engineering system, utilized field fortifications as a normal part of his tactical dispositions. He organized units of sappers to dig troop entrenchments and cannon positions.

Cromwell.—In contrast with other European nations England had little military tradition. The navy was its chief reliance. In the constitutional quarrel in England, Oliver Cromwell (*q.v.*) fashioned his "new model" army on that of the Swedes. There was little about his tactics or organization which was an improvement upon that of Gustavus; rather, Cromwell's army was new only in its religious fervour. He instituted the idea of a basic training period of several months during which the men were drilled hard and introduced to an iron discipline. He dressed the men in scarlet coats with facings bearing regimental colours, a uniform which became traditional in England. Like the Swedes, Cromwell's men were armed with muskets and pikes. However, the musketeers were armed with the old matchlock which took some 95 motions to load and fire. Even with well-drilled and disciplined troops the slow rate of fire made it difficult to repulse cavalry charges.

The example of Cromwell disappeared in Britain, though later Frederick the Great introduced similar ideas in Prussia.

French.—During the latter part of the 17th century, Louis XIV was assisted by a number of specialists whose names became famous in the art of warfare. The minister of war François Michel Le Tellier Louvois began a reorganization of the army which included inspections of the troops by a separate group of administrators. One of the inspectors Jean Martinet left his name as a synonym for severity of discipline. Promotion was made on merit, thus eliminating the former practice of purchasing commissions. Battalions were organized into permanent regiments under designated commanders. Lastly, he brought into practice the method of taking formation at a command rather than the laborious practice of having the sergeant major place each man.

Another of Louvois's contributions to administration was the creation of a quartermaster department. He trained a staff to supervise the procurement and transportation of supplies. His reforms, the first in this field in history, included the improvement of roads for the movement of supplies and the establishment of storage areas where food and ammunition could be strategically located. The latter device made it possible for troops to be maneuvered for the sole objective of winning battles instead of fighting battles where the troops could live off the country.

In another long-neglected field Louis XIV was fortunate enough to obtain the services of a young engineer Sebastien Le Prestre de Vauban who invented a systematic method of attacking fortresses so successfully that it governed siegecraft for the following century and a half. His method of attack was known as the "approach by parallel line." His first move was to surround a fortress and cut off its communications from the outside. Then concentrating upon one side of the fortress he brought up artillery to within 600 yd. of the walls. Behind the guns he dug trenches parallel to the fortress walls for the protection of the infantrymen so that they could defend the batteries from capture should the defenders make a sortie. Meanwhile approach trenches were dug in zig-zags so that the men would be safe from the gunfire from the fortress.

From the approach trenches, a second parallel nearer to the wall was dug and the guns moved forward. Normally a third parallel was sufficient to bring the attackers to the walls of the fortress. The artillery from this vantage point could fire directly at the masonry of the scarp. Once that was breached, fortresses usually surrendered. There was nothing infallible about Vauban's system; it could be varied depending upon the type of fortress under attack. Oddly enough fortresses were classified according to their expected period for holding out without relief. Vauban's methods made military engineers an important part of the new armies.

Despite the improved administration and methods of siege warfare introduced by the French, the army was undisciplined, poorly paid and in due course often defeated. The day came when the French army assisted the revolutionaries against the king.

Frederick the Great.—Frederick the Great is remembered more for his tactical skill and iron discipline than for the strategic employment of his army. Generally he improved upon the organization, equipment and training of the armies of his predecessors, and most importantly brought mobility to the modern battlefield. His military successes were in large part the result of his indomitable will, great energy, unwavering control of his men and his position as both king and commander.

From the experiments of the previous century he concluded that infantry could be developed to deliver heavier fire while moving forward. His ideas of fire and movement were maintained through World War II. With a thin line of infantry which deployed from a marching column at about 1,000 yd. from the enemy, it advanced in parade-ground formation, marching in step to music. The two or three long lines, each three ranks deep, held their fire until they were about 100 yd. from the enemy. The troops would deliver volleys in quick succession and reload while advancing a few paces. The final assault was made with a bayonet which had been developed by Vauban. Supplementing his infantry were three kinds of cavalry, called the cuirassiers, dragoons and hussars. The last named were the light cavalry used for scouting; the dragoons were mounted infantry using their horses as a means of getting rapidly from place to place; the cuirassiers were the heavy cavalry used in conventional manner on the flanks of the advancing infantry. (*See* CUIRASSIERS; DRAGOON; HUSSAR.)

Frederick initially was slow to use artillery. However, in time he saw its advantage and placed his batteries on the wings in the front of the line. As the infantry was depleted in successive campaigns, Frederick came to depend more and more upon his artillery.

In addition to the thin-line tactics, Frederick also introduced, as a result of his drill formation, a maneuver of wheeling his line to change direction. As a further development he reinstituted the oblique tactics of the Greeks in which he placed his

troops in echelon so that he refused one flank of his army to the enemy.

Frederick's method became the basis for the organization of armies for the next century and a half. Imitation of Prussian drill, uniforms and even hair powder spread throughout Europe and to America. Baron von Steuben, as Washington's drillmaster, was clever enough to realize, though, that the Prussian system was best adapted to private soldiers who waited for commands rather than for independent colonists fighting for their independence.

American and French Revolutions.—In the development of tactics during the 18th century the light skirmish line of the American frontier riflemen made its imprint upon armies. The thin line was so successful over the British heavy infantry in mass formation that the nations of Europe began to consider this improvement over Frederick's method as worth imitation. The skirmish line became a very loose formation and mobile since the men were burdened with less equipment. It was a great change from the Swiss phalanx and the Spanish square, increasing the infantry's flexibility in battle.

The development of standing armies was a great change from the previous period when mercenaries made up most of the armies. Standing armies brought into being a regular system of recruitment, which previously had often been impressment. Soldiers were paid, and served for long periods. Officers were appointed and the professional military man was more aware of his duties to the state which were written down in what became known as the "Articles of War." Uniforms became universal and the relationship of the soldier and the civilian became more distant.

The armies themselves remained generally under the strength of 100,000 men. The units such as regiments and battalions became tactical as well as administrative units. Because of tactical requirements, drill became more severe and discipline harsher. Warfare itself was fought along conventional lines and the troops no longer plundered the countryside as the free companies had done in the past. Happily too the people of that time were as a whole less affected by war. It was the king's business and fought by professionals along regularly prescribed lines. Out of this orderly warfare of the standing armies came the next great development, that of the nation in arms. The middle-class revolt as a social phenomenon brought about a great change in armies.

The French Revolution produced the new soldiery for the Napoleonic triumphs but into their hands were placed a new mobile, heavier artillery, a convenient divisional organization tailor-made for large armies and a general staff to control the armies. Napoleon an artillery officer, reaped the benefits of these developments of his French predecessors—Jean Baptiste de Gribeauval, Marshal de Broglie (Victor François, duc de Broglie), and Pierre-Joseph de Bourcet. Their developments occurred during the period between the close of the Seven Years' War and the French Revolution.

Napoleon said later that "The cannon has made a complete revolution." Guns had been heavy, unwieldy and insufficiently mobile to accompany armies readily. Frederick the Great had depended upon two 6-pounders and one 7-pounder with each battalion. Gribeauval, determining that by reducing the charge he could increase the range of the projectile, made the guns lighter and more mobile by reducing the thickness of the walls of the tube. His big guns, 12- and 18-pounders, were able to accompany the army, and even his 4-pounders could fire three or four times faster than the old guns. Artillery tacticians then developed the use of these new guns to accompany the armies and to blast a path for the infantry by knocking out enemy strongpoints.

De Broglie was the initiator of the articulated and mutually supporting divisional system of organization, two or more divisions being integrated into a corps. Washington had organized the American armies in this manner, and even when they were separated by several days' march, arranged that they could be readily united for battle.

Lastly, a staff system was developed in France as well as in Prussia. Bourcet had proposed that a staff corps be created to produce maps, make reconnaissances and to prepare war plans. The French system had previously developed a need for inspectors, quartermasters, ordnance and artillery staff officers. To meet the demand for trained staff officers a staff school had been established and was producing trained men before the Revolution. Though a number of the royalist staff officers emigrated at the beginning of the Revolution, a strong nucleus remained. (*See* STAFF, MILITARY.)

IV. THE NATION IN ARMS

The French Revolution was six years old before Napoleon became prominent. One of the greatest changes in the development of armies during this period occurred in 1798. The professional soldier was succeeded by the citizen-soldier fighting out of a patriotic spirit and with an enthusiasm unknown to the professional armies. Desertion became less common. Fighting moved into open formations similar to those of the American colonial soldier.

Unable to stop the advance of the Austrians and Prussians, the republican government of France conscripted 300,000 men of the national guard in Feb. 1793, and later made a general levy of all able men between the ages of 18 and 25. There were no exemptions except for the disabled, and punishment was severe for those who resisted service. The nation's call to arms produced in a few months more than 1,000,000 men, a number unknown in armies after the days of ancient Persia. That draft of manpower was a forerunner of the almost universal dependence on conscription as a basis of recruitment from that day forward. (*See* CONSCRIPTION.)

This social phenomenon of the nation in arms induced tremendous changes in warfare. The tactics and strategy of the professional armies of the past needed revision to meet the new requirements of the conscripted armies. Another feature of the nation in arms was the appeal to patriotism and to the individualistic spirit of each citizen. The army was made up of men from all strata of society. The old differences between the nobility and the peasantry were broken down. Napoleon himself had risen from nowhere to become a general, and out of his experience he told his men that every man carried a baton in his knapsack. There was no insistence on noble ancestors, and many of Napoleon's marshals would never have been more than sergeants in the old French army.

Napoleon.—In 1795 Napoleon first came into favour with the Republican government. His activities as an artillery officer in the regular army had brought him into discredit and he had been dropped from the rolls. In 1795 he was in Paris when the Royalists attempted to overthrow the government. In command of the army in Paris he put down the uprising and thereby won himself the command of the army in Italy. From that day until the battle of Waterloo the history of warfare and of armies centred around Napoleon.

As an artillery officer he knew how to use that weapon. He brought together the infantry, cavalry and artillery into the division. The divisions in turn were drawn together into army corps which varied in size and organization. His new tactics utilized the drafted men who became veterans in the shock of infantry attack together with artillery fire. The usual tactic was to feel out the enemy's front to find his weakest point. Weight of fire and men then were brought to bear to make a breach.

In this strategy Napoleon was a master at bringing his troops together before a battle on ground most often of his own choosing. Flank attacks and envelopments were common to most of his battles. Once the enemy was upset he used his reserves for a decisive thrust. Simplicity was common to his methods.

In the open order fighting Napoleon formed his infantry in three ranks and the cavalry in two. However, he was an exponent of flexibility and broke up his units into small columns for maneuver and assault. While his troops were numerous he made great use of individual initiative in utilizing small groups against enemy masses. As the calibre of his men deteriorated and his army became a polyglot mass of all nationalities of Europe he increased the proportion of artillery and concentrated his troops into mass

for attack. His weapons were similar to those used in Frederick's army, but the greatest improvements had been made in artillery. He put great trust in the bayonet saying "it is the arm best suited to the French soldier." From 1796 through 1806 Napoleon won a steady succession of victories in northern Italy, in Prussia, Austria and Spain. (*See* NAPOLEON I; NAPOLEONIC WARS.)

Armies of Liberation.—After the defeat at Jena, Prussia was compelled by a treaty of peace to limit its army to 42,000 men. However, by passing the men through the ranks as soon as they had been trained, new recruits were constantly added to the army and the reserve was filled with trained men. Prussia too undertook the conscription of its manpower. A new army under Gerhard Johann David von Scharnhorst (*q.v.*) arose from the ashes of Jena, an army totally different from that left by Frederick. The Prussians maintained a few officers and noncommissioned officers as a permanent cadre to conduct the training of the conscripted army. The first meetings of the new Prussian army with Napoleon ended in defeat, for Napoleon was at the height of his soldierly skill, but the Prussians adopted the open-field tactics of the French, and in time managed to win in combat against all the French leaders except Napoleon himself. The real triumph for the Prussians was Waterloo, where the training of Scharnhorst decided the conflict in favour of Gebhard Leberecht von Blücher (*q.v.*). Of the other armies opposing the French during the Napoleonic era those of Austria and Britain were designed much like the French army itself. Wellington commanded the British army conscripted in the same manner as the French. The conscript system of recruiting troops became common throughout Europe even in Russia, where there was a mass levy of peasants to fill the ranks of the army. (*See* WATERLOO CAMPAIGN.)

1815–70.—After Napoleon's defeat a military peace settled over Europe and America for several decades. Long-service armies proved themselves to be the best form of military protection for the countries of Europe and for use in the colonies. All attention in the military field was concentrated upon a study of Napoleon. Every commander read of Napoleon's battles and of the reasons for his decisions. Two military scholars Baron Antoine Henri Jomini and Karl von Clausewitz (*qq.v.*) made exhaustive studies of Napoleon's tactics and strategy. The fame of both became known in all armies and eventually Germany developed several leaders who utilized Clausewitz' studies as a basis for their strategy against France. His book, *On War*, remained a textbook for military leaders for a century. He set forth the relationship between the army leaders and the leaders of the state in clear-cut fashion. He discussed at length the first rule of war, that of gaining decision in battle.

The first half of the 19th century saw little change in the organization or administration of armies. The big changes came in technical improvements. The industrial revolution had a great influence upon the technical equipment in armies, though development was slow as there were no large scale conflicts requiring the use of an industrial potential. Muskets were equipped with hammerlocks and percussion caps. There were many new inventions in firearms, but in most cases the new improvements were tried out in sporting guns before being used in the army. (*See* SMALL ARMS, MILITARY; ARTILLERY.)

The advance in technology resulted in the introduction into armies of inventions such as steam engines and later the telephone, wireless and bicycles. To use these inventions properly the number of technical troops in armies increased greatly. The division organization was expanded to include more technical troops while other technical units were attached to the headquarters of corps. Another development of the 19th century was that of the staff. Prior to that time commanders had generally been their own staff assisted by a few assistants, spies and quartermaster officers. After Napoleon's time the Prussian staff system which was built upon the French became the model for the nations of Europe, certain adaptions being made to fit the individual situation. (*See* STAFF, MILITARY.) The first military test of the industrial revolution was the American Civil War. Not only did production become important but the railway was used to transport troops more speedily than at any time before in history. (*See* LOGISTICS.)

American Civil War.—This tremendous struggle was the first great war of the modern period where industry and transportation played a decisive part. The tactics and weapons are still readily identifiable with those of World Wars I and II. Compared with previous armies and the areas in which they operated, the Civil War was a gigantic conflict. The theatre of operation extended 1,500 mi. on its long axis and 800 mi. on its short axis. The railway and telegraph became of primary importance in the handling of the large number of troops in this war. Besides the first battle between ironclad warships, there was the first recorded use of the submarine and of the electrically exploded torpedo. Metal cartridges were invented for the breech-loading repeating rifle; military observation balloons appeared along with the land mine and hand grenade.

The moral question of slavery was one of the issues in the conflict. As a result a greater proportion of the population turned out to fight than had been the case in previous wars. The South with 9,000,000 had an army of as many as 500,000 while the North with 22,000,000 inhabitants produced an army of a maximum strength of more than 1,000,000. Apart from a few thousand professional soldiers and some draftees both of these forces were mainly volunteers. The majority of the commanders on both sides were products of the same schooling at the United States Military academy and as a result the organization of the army on each side was almost identical. The infantry regiments numbered about 1,000 men and consisted of ten companies. There was a general use of skirmish lines, and the attack formation called for each regiment to advance on a two-company front. As the war continued a number of revisions were made such as the advance by rushes, half the men firing, while halted, the other half running forward simultaneously. Cavalry was of great importance in the war, and the regiment was approximately the same size as that of the infantry. Normally there were 12 troops each numbering 70 men. The cavalry normally fought dismounted under Gen. Philip Sheridan in the Northern army while the Southern cavalry under Gen. J. E. B. Stuart and Nathan B. Forrest fought on horseback. The artillery battery composed of six guns was employed separately at the beginning of the war. Later they were organized into brigades of five batteries, a system which permitted heavy concentration of artillery fire at key points on the battle front. There was no general system for training the troops. Most of them obtained their training at the whim of the locally appointed officer. However, there was a certain amount of standardization in drill, markmanship and tactics since there had been a general publication of these matters in the *Field Service Regulations*.

Staff systems were greatly developed during the war, there being in each army staff officers for duties such as quartermaster, inspector general, adjutant general and others. Greater attention was paid to the medical care of the troops than at any time previously and nursing by women was a great contribution to the relief of the wounded; nevertheless, the war cost 500,000 lives. Tremendous strides were made in military engineering because of the demand for bridge building and for entrenching and mining. River crossing in the huge area of operations was a continual difficulty to both forces. Pontoon bridges were manufactured of both wood and canvas, the pattern being set for such bridging for the next 75 years.

Hasty field fortification was another endeavour which became a normal battlefield task for the first time in warfare. Almost without instruction the U.S. soldier began entrenching and constructing obstacles in preparation for battle. The work was crude and improvised but the results were effective. Another form of protection was the log breastwork which enabled the men to load their muskets in a standing position.

The importance of railways in the Civil War was evidently due to the size of the combat area. The armies could not live off the country and were dependent upon supplies sent by railway, often over long distances. The railways were few in number and most of them single tracked with poor roadbeds. Also for the first time the operation of military and civilian traffic over the railways

became a matter of concern to the government. An army came to realize the necessity for traffic other than purely military. Steel and coal had to be kept moving to provide materials to fill the demands for munitions. As an instance of the importance of railways to military transportation, a movement of reserve troops by the union army at Chickamauga involved 23,000 men with artillery and supplies over a distance of 1,200 mi. in seven days. Though it involved few changes in organization and training, this war emphasized that industrial revolution had taken its hold on armies and their tactics. (*See* also AMERICAN CIVIL WAR.)

The lessons of the Civil War made only a small imprint upon the Germans and none at all upon the French when they went to war in 1870.

Franco-German War.—Bismarck's policy of blood and iron brought on a war with France in 1870, the first major conflict in Europe since 1815. Both armies had been trained under systems which had become obsolete. The German doctrine was one of offensive while the French had been trained to use their long-range rifle on defensive until an opening appeared for an attack. The Germans were recruited under much the same system as Scharnhorst had used in 1807, all physically fit German men being liable for service at the age of 20. The enlistment was for three years after which there were varying periods of duty in the reserve. In France the service was five years in the regular army followed by four in the reserve. Each conscription group became known as the class of a certain year, usually the year when contemporaries came of military age. Experience in the battle of St. Privat indicated to the Germans that their attack in company column laid them open to the effective fire of the French weapons. The regimental attacks failed when, about 500 yd. from the French position, their cohesion was destroyed by the accuracy of the French rifle. As a result of this experience the Germans quickly adopted the line of skirmishers employed by the Americans in the Civil War and also the system of advancing by rushes. Armed with breechloaders, the men not advancing were able to fire from a prone position. The French infantry weapon was the chassepot rifle, effective at 1,300 yd., which was almost twice the range of the German needle gun. Moreover the French rifle was superior in every other way to the German rifle. The Germans, however, overcame the single French advantage of the rifle by the weight of their superior forces, by their artillery and by the adoption of the wide-open tactics of the skirmish line. The Franco-German War (*q.v.*) was, however, only a prelude to the much greater conflict between these two nations in 1914. Preparations began almost at once for a re-enactment of the war, but by 1914 many other nations were involved in what became a world war.

V. DEVELOPMENTS PRIOR TO WORLD WAR I

The German system became the model for the armies of Europe and also of Japan. The success of the German army over the professional long-term army of the French gave a pattern to military organization for the succeeding 40-odd years. Wartime conscription was replaced by universal liability to serve in peace as well as war. In Germany every man was required to perform active service for three years beginning at age 20. After he had completed his active service he was placed in the reserve where there were occasional training periods. At 27 years of age he became a member of the national guard where there was less frequent training. Finally until he was aged 50 he was a member of the inactive reserve but still available for special duties. This system required service of every man and did not, like conscription, make service a matter of drawing lots or of paying someone else to perform this duty.

Size and Organization.—European nations increased the size of their peacetime armies to some extent during this period, but the great increase was in the military potential in manpower. Germany, for example, doubled the size of its peacetime army from 400,000 to 850,000, but had in addition more than 4,000,000 trained men. France kept pace with Germany with similar strength in its army. However, with a smaller population France could not afford to exempt certain groups from military service. So universal was the French military service, that even medical students and priests served in the ranks as common soldiers. In France, service in active forces as well as that in the reserve was extended beyond that of Germany so that France's strength might be comparable. In Austria-Hungary the active army was 500,000 in strength with a potential of more than 2,000,000 trained men. In Russia only a small proportion of the population was touched by compulsory service to produce a regular army of 1,500,000 men and a trained reserve of 6,000,000. In the smaller states of Europe the armies followed the pattern of their larger neighbours. Continental Europe had become an armed camp.

Only in Great Britain and the United States was compulsory service not adopted. It was in the tradition of these people to maintain small armies recruited by voluntary enlistment. Moreover, Britain was essentially a sea power and the navy took first priority on manpower. The army's principal task was to garrison the colonial possessions with small units of troops. Strangely enough the voluntary system with a long-service army was in some respects relatively more expensive for a nation since the men had to be better paid and the conditions of service made more attractive.

Two great changes occurred in the organization of armies during this period: the development of the three fields of military forces—combat units, service troops and command and staff; and the increased amount of artillery and other technical equipment by the larger manufacturing nations. The combat troops were still essentially infantry, cavalry and artillery. Some improvement was achieved in the combination of these three elements, but the greatest improvement was in the development of their auxiliaries. For example the wireless, and later the telephone, made signal communications and signal troops immensely important. Field entrenchments, bridge building, and other engineer works required more engineer troops. Both these services were also developed for front-line action with the combat arms. Other technical services, including administrative troops, were greatly increased in size and strength, particularly in the supply and medical functions. The control of the combat and technical services, as well as the growing complexity of armies, demanded a more elaborate system of command. Staffs became larger so that the troop commander of larger units became an executive served by specialists in many fields. For example, Count Helmuth, Carl Bernhard von Moltke (*q.v.*) superintended a number of the battles of the Germans in 1866 and 1870 without leaving his office in Berlin.

Each nation during this period of the armed camp sought the best proportions of weapons to manpower. In France and Germany, cavalry was still important; the proportions were roughly 120 sabres and 6 artillery guns to each 1,000 rifles. Understandably the Austrian and Russian armies, supported by less industrial strength, had fewer guns and more cavalry. Also their armies had a smaller requirement for technical troops. However, the true worth of the factor of industrial strength was not fully realized during this period; when war came, industrial developments compelled an increase in the proportion of technical troops. Moreover, industrial production of artillery and machine weapons brought a demand for more troops to man them, beyond the proportions determined in the prewar period.

The infantry organization became rather standardized with the battalion of 450 men as the basic unit, subdivided into four companies. The company in turn included three or four platoons, the smallest command given to an officer. This continental system was not used by the British, whose battalion included eight companies. The usual practice in Europe was to group three or four battalions into a regiment, two regiments into a brigade and two brigades into a division. The cavalry was organized into squadrons of approximately 150 horsemen subdivided into four troops, but the number of squadrons in a regiment varied from three to six and the strength from 500 to 1,000.

The battery of from four to eight guns was the basic unit of artillery. It was divided into two sections, this being the smallest command of a field artillery officer. Three batteries normally comprised a group of artillery; two or three groups became a regiment.

As mentioned above the junior officer or second lieutenant normally commanded a platoon or section of 50 to 75 men. Along with the first lieutenants and captains who commanded the companies and batteries, they furnished the basic tactical leadership of the troops. The next higher rank, that of major, was in command of a battalion of infantry or a group of artillery. Regiments were commanded by colonels. These ranks held generally for continental European armies and for the United States, but in Great Britain the units were commanded normally by officers of one rank greater than that of other armies. The organization and command of the technical and administrative services were developed on similar principles. During this period the army of the United States had no higher organization than the regiment and the British none higher than the division.

As part of the new importance given to attack, the idea of adding artillery and technical equipment to units above the size of a division became common. Though in peacetime there were no armies, maneuver groupings brought three or four divisions together as a corps, and two or more corps as an army. The term "army" came into common usage as something less than the total armed strength of a nation. Corps and armies became a useful method of adding cavalry, engineers, additional artillery and other technical troops so that the offensive could be given more impetus. The tactics of the higher units were not much developed during this period, attention being given to the relative merits of the triangle or square formation for attack. The possibility of the movement of armies under a strategic plan was however not dismissed since Moltke and later Gen. Alfred von Schlieffen developed the grand strategy of holding on the left while striking with a strong right through the Low Countries against France.

VI. WORLD WAR I

The test of battle was given to the preparations made by the European armies. The fulfillment of all preparations seemed to bring about the inevitable conclusion of armed conflict. Questions asked later were: How did the armies take the field? How did they stand the tactical test? How did they react to the new methods of warfare which appeared?

The mobilization of both the German and French armies was more rapid than anything known formerly. Within 48 hr. 2,000,000 men on each side were in motion, and within 5 days 1,000,000 Germans were actually across their frontiers and into Belgium. The gathering of the army of Germany was a prime example of efficiency. The troops moved to the attack with a spirit perhaps born of the hope that the war would be short. The German infantry was drawn up for attack in dense lines with small intervals between men. It was expected that the infantry and artillery could attain fire superiority and then move to the assault. Advancing at a walk or by short rushes up to 600 yd. from the enemy, the infantry was then to make an overwhelming assault upon the enemy at a trot. The Germans, like soldiers everywhere, tended to bunch up, making themselves a target for the effective French fire. The first great surprise of the war from the viewpoint of the soldier was the effectiveness of weapons. In no time at all the infantry began to dig in.

There were surprises for the artillery too. No longer was it possible to fire from open positions. Artillerymen had thought that a great gun duel would mark the opening of the war. They believed that artillery fire would be so devastating that the enemy artillery would be put out of action for the remainder of the battle. Subsequently artillery was to be used against the enemy infantry, thus assuring quick success. Similar ideas were held by airmen at a later date, but again the capacity of the individual to withstand heavy fire proved surprising. One of the great disappointments was suffered by the cavalry, whose doctrine was the attack; but rapid-fire guns eliminated large-scale cavalry attacks in World War I. Its chief value was in reconnaissance by small units.

Underestimation of the power given to defense by modern firearms caused tremendous changes in tactics by the fall of 1914. The conflict became a war of position on the western front by that time and on the eastern front a little later. The German idea of quick victory which dated back to Frederick had not been achieved. French valour and hastily formed reserves stopped the Germans just short of Paris. Much of what had been prepared in the years since 1870 then needed revamping, for the war of position influenced not only tactics, but organization, operations, morale and industrial support at home.

Though no organizational change occurred in the infantry, certain improvisations were put into effect to fit the system of trench warfare. Normally half the infantry of each division held the trenches while the other half remained in a rest area behind the lines. The square formation of four battalions in a regiment, two regiments in a brigade and two brigades in a division was extremely suitable for this requirement. The artillery brigade included three regiments of artillery, one of heavier calibre to support the whole division and the other two regiments of lighter calibre, each to support a brigade. Depleted divisions were sent to rest areas so that they could be brought up to strength with replacements and given a brief training period to assimilate their recruits. (For discussion of World War I tactics and armament *see* ARTILLERY; TACTICS; TANK; WORLD WAR I.)

During World War I it became obvious that warfare had become a business of all the people; every citizen was affected directly or indirectly. Governments and statesmen began to study warfare to a greater extent than at any time in history. Industry became a teammate of the military. Military leadership was confronted with the problem of properly handling masses of men, technological improvements and combat operations in vast areas. Continents became combat theatres; warfare became three-dimensional, orders were speeded by telephone and the truck made supply quicker. But strangely enough there was no shortening of the length of war or the duration of battles. Warfare became a matter of continuous fighting.

World War I also brought out the great importance of the morale of the fighting man and of the populations at home. Never before, except in the early years of the French Revolution, had so much enthusiasm for war been developed among the peoples as was common in Germany, France, Britain and the United States during World War I. The peoples' enthusiasm was the soldier's enthusiasm: their depression was likewise communicated home. Out of this necessity rose the great new emphasis on propaganda utilizing mass communication to weaken the will of the enemy. (*See* PSYCHOLOGICAL WARFARE.) Many of these innovations in weapons and the idea of total warfare were to appear in new and more devastating form in World War II, but in the interim it did not become apparent that science was changing warfare and that techniques of production and transportation would be closely interlocked with military combat. (C. L. Bo.; H. M. Ce.)

VII. BETWEEN WORLD WARS I AND II

Between World Wars I and II the technique of warfare was gripped by lethargy. Though World War I had brought the internal-combustion engine to a good state of development, had seen the arrival of military aircraft and computing devices for the control of gunfire and had seen the first beginnings in the use of radio these modern scientific techniques were little used between wars. Meanwhile new machines were created for commercial purposes and were available for adaption to military use when war did come.

The history of the period 1918–39 includes a number of localized wars such as the Russian Revolution, the Chinese civil war the Sino-Japanese War and the Spanish Civil War. The first three produced no new technical improvements but were fought mainly in the method of World War I, though later, toward the end of the 1930s, the Japanese employed tanks and aircraft in combination with their infantry. In Russia, the communists relied heavily upon military forces in their revolution. In 1917 Lenin said that the Soviets were a new state apparatus with an armed force of workers and peasants and that this force was not divorced from the people, like the old standing army, but closely tied to them. During the 1920s the Red army was utilized mainly in support of domestic policy. Its 500,000 men were trained and equipped in World War I fashion and it was not until Soviet production became strong that munitions for warfare were developed

In the few years before 1939 Lenin's concept that national defense could only be assured by the building of a powerful economy began to take shape. The army grew in number to 2,000,000 men and developed as a force more slowly than did the armies of western Europe though it did effect a few innovations in tactics and employment of troops, particularly parachutists.

Among the victorious democracies there was the belief that a beaten and disarmed Germany could not again arise in opposition. The belief that another war would never come was also widespread. Military expenditures were reduced and the armies of Great Britain and the United States, based on voluntary enlistment, were smaller than the peacetime armies of Yugoslavia, Poland and similar national states created by the peace treaty. France continued to rely on conscription but its army, too, was restricted in size by lack of funds. Youth in all these countries turned away from military service. Conscription and voluntary methods produced small-scale regular armies with difficulty.

While the western Allies were lethargic about preparation for their own defense, the defeated Germans were evading the terms of the Versailles treaty. Schemes were developed for producing forbidden munitions of war and the industrial plant to manufacture them. Thus Germany was free to develop modern machinery for war; every effort was made by German scientists and industrialists to perfect a peacetime industry whose tools could be switched quickly to mass production of munitions.

The acquisition of a trained reserve was a little more difficult. In some ways the solution was more flexible than that which Scharnhorst evolved in 1807 to raise a German army in violation of the treaty of Tilsit. At that time the treaty army of 42,000 was used to train a group, move them out into the reserve and draft another treaty force. That possibility as a loophole was excluded in the Versailles treaty since the enlistment period of the 100,000 men was fixed at 12 years. This provision of the treaty was not evaded by the Germans, who merely utilized the army to train a large officer corps for a new army. On the side athletic groups of all descriptions were established. Physical culture became a mania in Germany. This method of forming quasi-military clubs provided Germany with the organization and training of a reserve army. Though wooden models of weapons were used, a supply of armament was secretly accumulated by the Germans. When Hitler came to power he was blatant about his military strength, and in an open manner began his attempt to remake Germany into a first-class military power. Again a German leader sought a device or tactical scheme which would assure him of a quick victory. Where his forerunners had analyzed the problem out of their military experience, Hitler was free of any dependence upon tactical doctrines inherent in a military education. His major efforts were confined to the air arm and its use in conjunction with his army while at the same time increasing mobility of the army. He developed a combat team of tanks supported by aircraft.

Japanese military doctrine was similar to that of Germany. The resources of the country were utilized to develop the strength of the armed forces. Industry was turned to the munitions, and the army and its equipment were put through the school of conflict in China. Too little was known of the developments of that war as it concerned Japan and too little understood was the possibility that Japan was developing the resources with which it could strike the western democracies. The Japanese military society took on many of the same characteristics as that of Germany; the man in uniform received the adulation of the people and became a law unto himself.

In France the spirit of the people was ground down by the possibility of another war with Germany, the third in three generations. France's population had not kept pace with that of Germany and a pacifist spirit had taken hold. The great depression of the early 1930s made it imperative that every possible economy be made in military expenditures. This was the spirit of democracy which France shared in company with the United States and Great Britain. Dictatorships in Italy, Germany and the Soviet Union had no such difficulty since the productive effort of the people would be turned over to munitions in whatever proportion the leader dictated.

In the United States and Great Britain the small regular armies were trained mainly as a base for expansion in case of war. Emphasis was laid upon the training of reserve units and upon the schooling of officers and noncommissioned officers who would be called upon for leadership. Weapons were rarely new and the troops depended mainly on the use of pilot models for the development of their tactics. New weapons became obsolete so fast that no nations except the dictatorships were willing to expend huge sums for production of armament and equipment. For discussion of new weapons, tactics and training *see* ARTILLERY; TACTICS; OFFICERS, MILITARY.

Principal Characteristics of Armies.—During the interim between World Wars I and II military development did not keep pace with that of industry. The dependence of the military upon industry, however, was gradually becoming more evident. Two other factors influenced military development: the army and the navy had been joined by the air force to make war three-dimensional; and total warfare promised that armies would move faster, co-operate over greater areas, be more difficult to control and be more specialized than in the past.

The social and total aspects of war were well illustrated in the growing effectiveness of propaganda and of nerve warfare in the years immediately preceding 1939. From the time of Alexander commanders had used spies in warfare but never before had the practice become as common as was evident at the outset of World War II. The fifth column—the traitor amidst the national population—served his master well through the use of rumour, misinformation and sabotage. The objective of the fifth column was to work on the fears of the people so that in the crowded roads of Europe their movement to some place of refuge would complicate the already complex deployment of modern armies. (*See* INTELLIGENCE, MILITARY AND POLITICAL.)

By 1939 the world had had a taste of a number of small wars including one of the oddest civil wars in history. In Spain the opponents were assisted by fascists on one hand and the communists on the other. Volunteers came from all over the world either as individuals or as regular members on leave from the armed forces of Germany, Italy and the Soviet Union. On a small scale the use of airplanes in conjunction with tanks and the strafing of infantry troops was given a trial. Warfare found a larger stage when the Germans moved against Poland on Sept. 1, 1939.

VIII. WORLD WAR II

In a measure the new war began where the last one left off. Germany was again the aggressor in Europe and within three years, the war which had been confined to central Europe at the outset had spread to Russia, the near east, North Africa and the Pacific. Global warfare had come to the earth. Land campaigns were being carried out in desert, mountain, jungle and island areas. The first terrible impression was that of the blitzkrieg of the German army. The Germans had broken abruptly with the past by mechanizing their artillery and by such devices as making their well-known 88-mm. gun a triple-purpose weapon for use as a field artillery piece, antitank gun or antiaircraft gun. Attack was the watchword and lightning war was in every mind. The Germans had succeeded not only in indoctrinating their troops with the idea of the superman and of warfare for space for empire, but had also through propaganda sowed the idea of an invincible army. That legend was not dissipated until the Germans had been stopped at Stalingrad and at El Alamein. In the Pacific, the Tokyo end of the Berlin-Rome axis had demonstrated a similar capacity for lightning action and for propaganda which enhanced its capabilities and detracted from those of its enemies. The Japanese reliance was upon jungle and amphibious warfare in Indonesia and later in the southwest Pacific.

No longer were armies engaged in warfare apart from other fighting services. Land warfare became interwoven with air and amphibious operations. Land campaigns, it is true, remained a phase of warfare and the major task of armies, but they were no longer carried out separately. The army combination of infantry, artillery and tanks became a much more involved effort than in

World War I. Not only was the faster moving, heavier artillery of an army augmented by the artillery effect of aircraft, but in a number of land campaigns navy ships moved in close to shore and supported land attacks. The deadlock of World War I was not to be repeated. The German army showed that masses of mobile artillery could knock holes in an enemy and the tank-air team could move through and fan out into the enemy rear. Orthodox resistance was useless before such an effort. The initial strike of the Germans also utilized dive-bombing techniques to knock out antitank and antiaircraft guns. Radio communication was used between air and ground in the frontal areas without recourse to involved channels of command. (*See* AIR POWER.)

After the German army overran the continent it might well have conquered England had amphibious warfare and its necessary equipment been perfected by that time. In addition there was a feeling by Hitler that he could bring Great Britain to its knees and compel it to sue for peace by bombing the British population. British determination and the magnificent defense by the royal air force in the battle of Britain upset that calculation. For the remainder of the war on land the Allied endeavour was to accomplish the breakthrough of defensive lines after amphibious assaults had placed them in position for land conflict.

Size and Organization of Armies.—Armies were numbered in the millions among all the leading opponents. In general they were brought together by the use of the German system of universal liability for service. Three-dimensional warfare also required that the manpower of the nation be allocated to the air and naval forces as well as to the army. In the United States armed forces, about 11,000,000 men were in service at peak strength, of which 5,000,000 were in the army and approximately 3,000,000 in each of the other two services. However, the air force was largely supplied by the service troops of the army including port battalions, quartermaster, engineer and signal troops.

The armies of the other major nations were of like number and the Soviets the largest of all, with about 12,000,000 in the army and smaller numbers in the air force and navy. Such numbers required tremendous organization, so that army groups began to appear. In most cases an army group included two to five armies, each of the latter in turn containing from two to six corps. The Russian army groups contained in some cases as many as 2,000,000 men and 100 divisions. The U.S. division being larger, the army group under Gen. Omar Bradley included 2,500,000 men in 60-odd divisions.

During the war the expression was often heard that a nation's army reflected its social customs. That there was a great deal of truth in the statement was shown in the fact that the U.S. soldier had more vehicles and more radios than any other army in the world's history. In this same willingness to utilize mechanical advantages the U.S. army created an organization with an overwhelming proportion of artillery. Only the Russians had anything comparable in numbers of guns. Toward the end of the war the Germans complained, rather strangely, that they were being defeated by superior machine power and inferior military manpower.

The organization of the units underwent no great changes from the prewar period. The divisions throughout the world were generally from 11,000 to 15,000 men, except for airborne units, which varied between 6,000 and 10,000. The idea of a division was expanded to include what is known in military terminology as the service support or ancillary troops. The division had to be supplemented by several thousand engineer, signal, medical and quartermaster troops who were attached to serve with it. The army corps became far more than a combination of two or more augmented divisions since it was used administratively to carry tremendous numbers of additional troops. The larger calibres of artillery in great numbers were assigned to a corps for special operations. There were separate regiments of infantry, special service troops, psychological warfare units and troops to exercise dozens of other specialties of modern warfare. This supplementation of troops was even greater in armies and in army groups. Here were included uniformed women serving in clerical and signal work, overseas as well as at home. The preparation of these vast organizations required elaborate systems of training and a great amount of improvisations in tactics in their employment. For tactics, training and armament of World War II *see* TACTICS; ARTILLERY; TANK.

Command.—The units commanded by the various officer ranks remained unchanged throughout the war. The significant change in the chain and method of command and staff procedure was in the creation of joint and combined commands. In most cases the armed forces, including army, navy and air force of one nation, were placed under a single commander in a theatre of operations. Two alternative methods were used. One method was to organize a joint staff, including proportionate numbers of army, navy and air officers, while in the other the commander utilized the staff of his own service, augmenting it with a number of officers from the other two services. Similar procedures were carried out in combined commands where two or more nations were involved. Gen. Dwight Eisenhower in his supreme headquarters integrated British and U.S. officers on an equal basis throughout his staff. (*See* STAFF, MILITARY.)

Conclusion.—During the last year of the war the campaigns on land followed the pattern of the early German blitzkrieg. There was a breakthrough, wide sweeps by tanks and the speed and complexity of mobile warfare. In the Pacific battle areas amphibious armies were utilizing new techniques to get ashore rapidly. Once on land their tactics were similar to those in combat in Europe. There was no tactical deadlock as in World War I, yet the facilities and the strength of the defense had improved tremendously.

It was the co-ordination of the troops, their fire and movement, the shock effect of tanks upon an exhausted enemy and the leadership of able men which made possible the success of offensive tactics against the greatly strengthened defense during the last year of war. (*See* WORLD WAR II.) (C. L. Bo.)

IX. ARMIES AFTER WORLD WAR II

By 1950 there had developed a remarkable readiness on the part of anti-communist nations to unite in determined measures not alone for their own defense but for the maintenance of peace and order the world over. The past had witnessed countless alliances for a limited season of defense or offense; this mid-century development, following closely on World War II, was founded on a broader base and upon a more efficient pattern. That is, while each participating nation retained its complete sovereignty and its right of withdrawal from the alliance, each also, in two notable cases, without question accepted the principle of a supreme command to whose authority each sovereign state committed the control of its forces and its resources.

The cases referred to are the United Nations (UN) action in Korea, beginning in 1950, and the organization of the 15-state North Atlantic Treaty organization (NATO), made up in 1950 of Belgium, Canada, Denmark, France, Iceland, Italy, Luxembourg, the Netherlands, Norway, Portugal, the United Kingdom and the United States, with Greece, Turkey and the German Federal Republic entering later. The NATO establishment was specifically for the defense of the west, through a co-operative upbuilding of military and economic resources of member nations. All were politically equal; Iceland, with no military forces but with a geographical position of importance in sea or air activities, had a vote as large as that of the United States, and political decisions at the NATO council were made on the basis of equal voice. But the supreme military command was genuinely supreme, in that whatever resources were tendered by the member states were administered under direction of the high command, whether the naval command in the Atlantic or the military command in western Europe.

It was inevitable that so long as the Soviet threat was thought to be severe the assignment of forces to the NATO supreme command was generous; later, when the threat was thought to have lessened (both because Moscow began giving assurances of benign intentions and because most of the western nations were conspicuously stronger than in 1950) the actual assignment of forces was in many cases reduced. However, the principle of co-operation was never altered.

The co-operation in Korea sprang from the same general

motive; that is, a willingness to unite for the preservation or, in this case, the restoration of peace. Unified action came about not after months of consideration, as did NATO, but with great suddenness. Before the North Korean forces could push far beyond the border, the Republic of Korea (South Korea) had called for help, and the United States had urged intervention by the UN to halt the invasion. Because the United States was clearly best fitted to supply major reinforcements for the South Koreans, the UN forces were assigned to the United States far east commander. It is important to note, however, that the command so exercised was that of the UN, and that the several national contributions were by UN members who were at all times fully sovereign and at liberty to withdraw, yet submitted voluntarily to the supreme command.

This whole development must have been influenced by the harmony of British and U.S. co-operation in World War II, when separate sovereignty was never in question, yet the supreme command was also a reality, first in northwest Africa, then in the Mediterranean and finally in the campaign across France in 1945. The co-operation which had proved practical even under the strains of World War II proved equally applicable to the "cold war" in the west and to the limited war on the Korean peninsula.

This development of far-reaching military alliances and genuinely supranational military forces, however, formed only part, a dependent part, of the new picture of warfare. For these political developments, new as they were in scope and conception, reflected merely the attempts of the western nations to deal with a new way of life.

The dropping of the atomic bomb over Hiroshima on Aug. 6, 1945, followed by another over Nagasaki, heralded more than the surrender of Japan and the end of World War II. It marked also the dawn of a new era in warfare, in which nuclear fission (and later nuclear fusion) would prove employable in a variety of ways. That for years thereafter nuclear weapons were used only in proving-ground tests, rather than in actual warfare, was the world's good fortune and easily explained. Conflicts of the decade immediately ensuing, such as that in Korea, required no such immense destructive powers as all early atomic weapons possessed; only as nuclear technology improved was it found that the essential "critical mass" could be reduced far below the 1945 estimate and the minimum destructive power accordingly be so decreased as to permit smaller weapons and a degree of flexibility in battlefield operations.

Immediately after World War II military technologists in co-operation with nuclear scientists began to study with great earnestness the problem of reducing both the weight and the bulk of the Hiroshima-type atomic bomb. Progress was soon apparent both in the production of a fission bomb so much smaller than the 1945 prototype that it was readily portable in a moderate-sized plane instead of a heavy bomber and, by 1952, in the production of a heavy artillery shell. By the mid-1950s there resulted a considerable series of atomic weapons, all being supplied to specially trained gun, mortar and rocket battalions, including some allotted to the North Atlantic Treaty organization's European headquarters.

The rapid development of nuclear weapons (and a little later the much more powerful thermonuclear weapons as well) had a revolutionary effect in several areas of military planning. Inevitably new weapons call for new tactics and these for new organizations to exploit both weapons and tactics. They also call for new counterweapons. The nuclear weapon obviously was a very great addition to firepower, but its true importance was determined also by the means of propelling it, and the means of guiding it precisely toward a target. The guns and heavy mortars of the army had more accuracy than range; the propeller-driven plane which had launched the first bomb at Hiroshima possessed great range but inadequate speed; but the swiftly developed successors to these launching devices, both from the surface and from the air, added greatly to the nuclear threat, combining speed, range, altitude and firepower, and inevitably added to the problem of devising defenses against such a threat.

Thus, when for many combat purposes the propeller plane was succeeded by the jet-driven plane, and when at about the same time atomic bombs were being both compressed into smaller packages and produced at a tolerable cost, it became apparent that this destructive power could be transported by an enemy at a much faster pace than in 1945 and in greater numbers and hence with wider dispersion. When, in succession to the jet, the rocket, revived by the Germans during World War II in the form of the V-2, was more fully developed in succeeding years, it emerged as a potent partner for an atomic warhead. For the high-thrust rocket, with electronic guidance, provided the atomic warhead with hitherto undreamed-of speed, range and trajectory in space, and hence with a high degree of invulnerability to most then-existent means of intercepting it or even of detecting it in time for useful action.

Early discussions of what could be done, theoretically, by the intercontinental ballistic missile, once perfected, fairly shook the reason of laymen over much of the civilized world. This mechanical monster was described so vividly that many were persuaded that it was an early prospect rather than a mathematical possibility which could come into being only several years in the future. A missile traveling at 18,000 m.p.h. or more, most of the way high above the earth's atmosphere and thus defying detection by radar, and plunging with its thermonuclear warhead to the target 5,000 mi. from the launching point, was patently something defying all defensive measures of the day. It was necessary, therefore, for planners in the mid-20th century first to point out that moderate precision would be necessary for an effective assault weapon, and that technologists had not yet achieved precision with a ballistic weapon of much shorter range. Next it was necessary to give assurance that, costly and complex as it must prove, interception even of such a monster was theoretically possible. Of greater comfort to some was the viewpoint, offered by many authorities, that, with more than one great nation experimenting in nuclear weapons on a grand scale, a standoff was increasingly possible; that is, the certainty that nuclear aggression would be instantly followed by retaliation, and that even the victor would be terribly shattered in such a duel, could offer hope that aggression would be automatically deterred.

The human longing to accept this viewpoint as assurance rather than hope did not, however, blind chiefs of state to the need for thermonuclear armaments for both offensive and defensive action. Rather, it made the need seem imperative. As the sixth decade of the 20th century advanced, accordingly, the U.S. and the U.S.S.R. were engaged in building up ever greater strength in nuclear weapons and in devising means of delivering them against a foe by long-range missiles, medium-range missiles launched from advanced land bases, surface and submarine vessels and high-altitude aircraft. In both countries, moreover, there was experimentation with defenses against such weapons. Of the U.S. efforts it is possible to speak with greater exactness, for the publicity permitted in the United States, in contrast with Soviet silence, included description not only of the interception equipment (planes at readiness and strategically situated batteries of guided missiles) but also of the early-warning detection systems. These reached as far as the Arctic circle and were linked to a mechanically operated network of computers and directors to provide fair promise of detection of an enemy attack and of almost instantaneous direction of interceptors to their fast-moving target. This represented a knitting together of land, sea and air forces to a degree never before attained. Although it came about gradually in the United States, this unity of forces had in fact been rendered inescapable.

Speed, all but annihilating historic concepts of distance, transformed early plans for the division of responsibility among the armed services, and there was an unprecedented mutual dependence among them, however reluctantly admitted.

Air power, which during World War II had grown vastly in importance by reason of the immense advance in the airplane's speed, power, range, versatility and reliability, continued to progress in most nations. The new army concept was of infantry divisions barely distinguishable from air-borne divisions, in that they would be transported largely by wing and rotor rather than by wheels.

In the meantime, military commands of all countries were compelled to work desperately to obtain popular support and sufficient funds to maintain armies at current strength. Atomic weapons plus supersonic propulsion systems formed a combination which to many seemed to press the conventional ground forces far toward obsolescence and hence to remove justification for all large armies. However, it was argued that, while the fear of an atomic war undoubtedly had deterred aggression which might bring atomic-weapon retaliation, it had failed to prevent local aggression and "fringe" fighting which was just short of provoking such retaliation; in fact, local communist aggression had demonstrably proceeded in Europe and Asia, and had led to communist absorption of large areas and populations. The reasoning, therefore, was that while powers of massive retaliation should be maintained and even increased, the tendency to whittle away the conventional forces (those not armed with atomic weapons) should be halted, for on these forces would depend the outcome of the only predictable wars—namely, such further local wars as had already thrived in the shadow of the atomic bomb threat.

Upon the ground forces, therefore, fell the responsibility for maintaining armies that would not only be in readiness for the quick suppression of local wars in which atomic weapons would not be used but would also be capable of offense and defense alike in a major war employing atomic weapons. With necessary concern over costs, the effort was to serve both purposes so far as possible with the same means. This led to sharp concentration on new equipment and tactics, seeking maximum mobility, communications and firepower. Only with these possessions could the new tactics be devised. These tactics contemplated a wide but methodical dispersion of units and installations to avoid providing profitable targets for the enemy, and a rapid concentration of force needed for air-borne assault on a profitable enemy target, to be followed by rapid withdrawal and another dispersal. The new tactics called for great division of responsibility among lesser commanders, and this in turn demanded both a high degree of training and an unprecedented network of radio communications. Courage and devotion remained essential as always; yet, as always, these were not nearly all that was required; advanced technologies became far more important than ever before; aggressive and resourceful leadership, too, had to be asserted at every level of command. Organization itself, accordingly, had to be radically revised.

In the Soviet army the mechanized and armoured divisions which in 1947 were outnumbered 2 to 1 by the infantry divisions were thought to have approached parity with the latter in the mid-1950s. In all types of Soviet divisions, however, there was a new integration of infantry, tanks and self-propelled artillery into smaller groupings. Until 1958 Great Britain retained the "triangular" division which came out of World War II, with three composite brigades, each comprising one armoured regiment and three infantry battalions, and each brigade supported by one light artillery battalion and one medium artillery battery. This division was air-transportable except for its tanks and medium artillery. In 1958 the British decided to make the brigade group the basic formation instead of the division. The British army thereafter consisted of armoured and infantry brigade groups. Divisional headquarters were retained where necessary and had under them a varying number of armoured or infantry brigade groups. In France, reorganization begun in 1955 developed the *Régiment Inter-armes,* a small regiment combining tanks, riflemen, antitank guided missiles and 120-mm. heavy mortars. This type regiment was used in the *Division Mécanique Rapide* and was extended to infantry divisions as well. In the United States the name "pentomic" was coined for new types of airborne, infantry and armoured divisions organized for employment in either atomic or conventional war. The first pentomic division, the 101st airborne, was organized in the mid-1950s with plans for all U.S. divisions to eventually take this form. The strength of the new airborne division was reduced from 17,000 men to about 11,500. The organization was pentagonal with five battle groups, each with five infantry companies and a heavy mortar battery, five 105-mm. howitzer batteries, a battery of 762-mm. Honest John rockets, an engineer battalion, a signal battalion, a command and control battalion and a support group to handle supply and maintenance. The new infantry division had the same pentagonal arrangement of battle groups but more divisional artillery. The latter was divided into a battalion of five 105-mm. howitzer batteries and a battalion containing the heavy fire support; *i.e.,* two 155-mm. howitzer batteries, a battery of 8-in. howitzers and a battery of Honest John rockets. This infantry division contained tanks only in its reconnaissance battalion and numbered 13,750 men instead of the original 17,455. The pentomic armoured division looked much like its immediate predecessor using four tank battalions and four armoured infantry battalions, each with four companies. As part of the pentomic reorganization, the U.S. army included Army missile commands, ranging in size from 1,200 to 5,000 men, which were built around the Honest John rocket and the Corporal ballistic-type guided missile. These missile commands were capable of attachment to U.S. armies and corps, or could be used in support of allied armies lacking integrated atomic fire capability.

With these reforms and a continuous advance in its integral air mobility, it was felt that for a permanent establishment in the United States and overseas a regular army of 1,000,000 men would suffice, provided there was a highly professional standard of skills in new technologies and that ready reserves for the army's ultimate support in the field could be assured continuous training.

There remained, however, in many minds a suspicion that the new warfare would require forms of defense markedly different from those of the army program. This suspicion was strengthened by the announcement of the U.S.S.R. in 1955 of its intention to reduce by nearly one-third the Soviet Union's immense army of, by report, 4,000,000. Exploited by Moscow spokesmen as evidence of the U.S.S.R.'s disposition to reduce armament, the proposed 1,200,000 drop was interpreted abroad, variously, as resulting from a desire to enter more workers in industry, from a readiness to reduce garrisons in Asia as permitted by the new Chinese alliance (itself adding perhaps 4,000,000 disciplined troops to world communist resources) or from a professional judgment that the new warfare would engage missiles rather than masses of infantry. The last of these views was already widely held elsewhere; the United States defense establishment had re-evaluated manpower requirements and had sharply reduced the numbers in army and navy while pointedly increasing those services' total firepower, thanks to the new weapons. Great Britain at the same period was cutting the size of its forces, and smaller powers of western Europe, which had only lately built up their military units under their obligations to the North Atlantic Treaty organization, were either reducing them in numbers of active divisions or reducing the period of individual conscription and training—partly by reason of increased firepower per unit, but more by a subsidence of their earlier alarm over Soviet intentions. From whatever reasoning, the mid-1950s disclosed a strong trend among world armies in general toward greatly increased reliance upon the deadlier weapons, with a lessened zeal for numerically large establishments.

Army planning, in this case enveloped in a good deal of secrecy, included also that for advanced technologies in chemical, biological and radiological (CBR) warfare. (*See* BIOLOGICAL WARFARE; CHEMICAL WARFARE.) It had become apparent that terror weapons could be potent as well as terrible. These included gases far more lethal than those used in World War I, yet in some cases so quickly dissipated that, in theory, the aggressive forces would be able to move forward briskly into an area whose defenders were gone but whose buildings and highways were usable by the occupying forces, there having been no attack by explosives or incendiaries. Biological warfare might introduce poisons as well as disease germs to food or water supplies; radiological assault would be a by-product of atomic attack. So great was public revulsion against these methods that their proponents worked largely in secrecy, protesting that they had to develop these arts in order to understand how to devise countermeasures and also in order to have CBR warfare techniques ready for instant use in retaliation against their prior employment by an enemy. The principle of deterrence, in brief, was applied here, precisely as in the case of nuclear weapons.

At the same time there was intensive research among the world's armies into readaptations of conventional techniques. The U.S. army in 1961 experimented with a new and, it was hoped, more flexible divisional structure (*see* DIVISION, MILITARY) consisting of a common division base and three tactical brigades containing variable mixtures of combined arms. New weapons and detection systems seemed to rule out future amphibious operations exposing vast forces to possible annihilation. Dispersal of matériel also demanded ingenuity in devising workable installations and encouraged the use of light, high-speed transportation equipment to permit swift concentration and dispersal. These were the necessary instruments of a new warfare for armies as contemplated in the mid-20th century, which called for swift raids and withdrawals and for persistent and piecemeal demoralizing harassment of an enemy rather than fixed lines and massive clashes.

But always the new warfare called for missiles of varying capabilities—those of long, medium and short range, of low and high trajectories (each of value in defeating enemy detection and interception)—and for maximum mobility of the missiles' launching apparatus, whether the target should be on the ground, in the sea or in the air. The great advances in the technologies of nuclear fission and fusion, of rocket propulsion and of electronic guidance, had combined to transform the characteristics of armies and the thinking of military men to a greater extent than had all the previous innovations since the creation of gunpowder.

In the early 1960s military theorists in the western world were re-evaluating the roles and missions of the armies of the future and asking whether the introduction of new weapons had not finally erased the historic distinctions between ground, naval and air forces. In the U.S.S.R. and Communist China, however, military and political leaders continued to view the role of the army as separate and necessary. *See* AIR POWER; AMPHIBIOUS WARFARE; ARTILLERY; ATOMIC ENERGY; CIVIL DEFENSE; ROCKETS AND GUIDED MISSILES; TACTICS; *see* also references under "Army" in the Index volume.

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(M. S. WN.; H. M. CE.)

ARMY WORM, the name applied generally to the caterpillars (larvae) of certain kinds of Lepidoptera that sometimes migrate to new feeding grounds in large armies, destroying corn, small grains, sugar cane, cotton and other crops as they move. The name is applied specifically to the true army worm, *Pseudaletia unipuncta* (*Cirphis unipuncta*) of the moth family Noctuidae, which is found in the U.S. and Canada east of the Rocky mountains.

The moths deposit their greenish-white eggs in rows or clusters on the underside of lower leaves of grasses or small grains. They are particularly attracted to rank-growing grains in lowlands but may deposit eggs in lush grain fields anywhere. The larvae hatch and grow slowly, eating small amounts of leaf tissue and causing little if any damage. During the time small grains begin to head, the larvae enter the last larval stage and suddenly exhibit tremendous appetites. This stage, in which they are most destructive, lasts about ten days, during which time the grain fields may be literally overrun with worms up to 2 in. long. The seemingly smooth-skinned larvae are dark green with longitudinal white stripes on their sides and down the back. During the day they hide under pieces of earth or inside plants, emerging at night to feed. The larvae will attack all grasses, some legumes and almost any other plant if grasses are not available.

BY COURTESY OF U.S. DEPARTMENT OF AGRICULTURE

ARMY WORM CATERPILLAR (CIRPHIS UNIPUNCTA) FEEDING ON LEAF

At the end of their voracious period the larvae leave the scene as quickly as they came, partly owing to natural control by predators, lack of food, etc., and partly owing to pupation. Preparatory to pupating the full-grown larvae burrow a short distance into the soil or creep beneath stones and develop into dark brown pupae about ¾ in. long with a tapered tail and blunt head.

About two weeks after the beginning of pupation pale brown or brownish-gray moths emerge having a wingspread of 1½ in. The moths are not immediately ready for egg production and are strongly attracted to molasses baits and other sweets. Three generations and part of a fourth are usually developed in the mid-western U.S. Not all generations are equally destructive.

Several beetles, wasps and flies parasitize the army worm and in most years keep it under control. But when these natural controls are removed, the army worm may destroy farm crops in an area of several hundred square miles. Control measures that man has used against the army worm include sprays and dusts of a mixture of DDT and toxaphene, poison bran, furrows with loose dirt sides (trenching), kerosene and dragging logs.

In some localities the name army worm is used to indicate the

army cutworm (*Chorizagrotis auxiliaris*) or certain species of *Laphygma*, including the fall army worm, beet army worm and nutgrass army worm.

See Butterfly and Moth: *Economic Importance*.

See U.S. Department of Agriculture, *Insects* (1952); C. L. Metcalf and W. P. Flint, *Destructive and Useful Insects* (1951).

ARNAUD, HENRI (1641–1721), Savoyard pastor who led the Waldensian or Vaudois exiles on the *glorieuse rentrée*, their historic journey back from Switzerland to their Piedmontese valleys, was born at Embrun in Dauphiné of parents from Luserna in Piedmont, whither the family returned about 1650. After studying theology in Switzerland (Basel 1662, 1668; Geneva 1666), Arnaud returned to Piedmont and established himself as pastor at Torre Pellice (1685), where he led the resistance of the Waldensians to the persecution inaugurated by Victor Amadeus II of Savoy. Eventually, however, he joined the Waldensian exiles in Switzerland. With help from William III of Orange, Arnaud did much to rally these exiles. In 1689, encouraged by William's accession to the English throne, Arnaud decided to lead them back to Piedmont (they had already tried twice to return, in 1687 and 1688). Starting from Nyon with about 1,000 followers on Aug. 17, 1689, he made an arduous journey over the Alpine passes, reaching the valley of San Martino ten days later. From Oct. 1689 to May 1690, he was besieged in the citadel of Balsille, from which he escaped under cover of fog to the valley of Angrogna. In June 1690, however, when Savoy entered the War of the Grand Alliance against France, Victor Amadeus made peace with the Waldenses, who then took up arms on his side. When Victor Amadeus made peace with France in 1696, persecution began again. About 3,000 Waldenses went into exile in July 1698, under threat of death. Arnaud then went to Germany, where he founded a Waldensian settlement at Schönenberg in Württemberg (introducing the cultivation of lucerne and mulberries). Between 1704 and 1706, during the War of the Spanish Succession, the Waldenses were again tolerated by Savoy in return for support against France, and Arnaud returned to Piedmont to be pastor of San Giovanni di Luserna. He visited England to obtain funds for his co-religionists in 1707. After this he returned to Schönenberg, where he died on Sept. 8, 1721.

As well as general histories of the Waldenses (*q.v.*) in the 17th century, *see* J. Jalla, *Henri Arnaud* (1926); D. Jahier, *Henri Arnaud* (1926). (L. Ma.)

ARNAULD, the name of a French family of the lesser nobility, which came from Auvergne to Paris in the 16th century and is chiefly remembered for its close connection with Jansenism and with Port Royal (*q.v.*) in the 17th century.

Antoine Arnauld (1560–1619) was born in Paris, the son of Antoine Arnauld, seigneur de La Mothe. Well known as an eloquent lawyer, he pleaded for the University of Paris against the Jesuits in 1594 and presented his case so forcefully that his speech on this occasion has been called "the original sin of the Arnaulds," as if it were the first cause of the Jesuits' animosity against the family. He married Catherine Marion de Druy and he had 20 children, 10 of whom died young. All except one of the surviving children were in some way connected with Port Royal. In 1629 Arnauld's widow herself became a nun at Port Royal de Paris, where she died in 1641.

The most notable of Arnauld's surviving children was Jacqueline Marie Angélique Arnauld (1591–1661), known as Mère Angélique. She took the veil at Maubuisson in 1600 and was made abbess of Port Royal in 1602, when she was not yet 12. She had become a nun only by the decision of her parents and had had no vocation for a monastic life, but in 1608 she was converted by a visiting Capuchin friar's sermon. She then undertook to reform her monastery. After an arduous struggle, even against her own family, she succeeded, and Port Royal became a house of deep spirituality. Mère Angélique was later engaged in the reform of several other convents, especially Maubuisson. From 1618 to 1622 she was under the guidance of St. Francis (*q.v.*) of Sales. It was she who in 1625–26 transferred the community of Port Royal to Paris. In 1635 she came under the influence of the abbé de Saint-Cyran (*see* DuVergier de Hauranne, Jean). She was a strong personality, a woman of deep faith and piety, less inclined to mysticism than to asceticism, with a will of iron and inflexibly austere in the conduct that she imposed on herself and on others, but kindhearted. In the Jansenist group her influence was all-powerful. Her last years were darkened by the troubles in which Port Royal became involved because of its Jansenism, but she bore the troubles with constant fortitude and magnificent spirit. "What are men?" she would often say, "Only flies!" On her deathbed she wrote a touching letter to the queen mother protesting against the constraint that was inflicted on her community. She died on Aug. 6, 1661. Some of her writings, including her *Lettres*, were published in the 18th century (1742–44).

The five sisters of Mère Angélique were all eventually nuns at Port Royal, and all attained celebrity. The most remarkable of them was Jeanne Arnauld (1593–1671), known as Mère Agnès, who entered the cloister very young. From 1630 to 1636 she governed the Cistercian monastery of Tard, near Dijon. She then came back to Port Royal, where she was twice elected abbess (1636 and 1658). In Aug. 1664, during the great persecution of the Jansenists of 1661–69, she was taken away from her community and detained in the Visitandines' convent of Chaillot, persistently refusing to subscribe to the formulary condemning Jansen. In July 1665 she was transferred to Port Royal des Champs with the other recalcitrant nuns. After the so-called "peace of the church" or "peace of Clement IX" (1669), which suspended the persecution, she lived quietly for the rest of her life and was held in general veneration. She was sweet-tempered, calm and mystical, unlike Mère Angélique but no less saintly, and was a spiritual writer of distinction, though few of her works were published. One of them, the *Chapelet secret du Saint-Sacrement*, gave rise to an involved controversy in 1633, being condemned by some doctors of the Sorbonne, but defended by Saint-Cyran. She was the principal author of the *Constitutions* of Port Royal, printed in 1665. There is a collected edition of her *Lettres* by Rachel Gillet, with a preface by Prosper Faugère (1858).

Another sister of Mère Angélique, Catherine Arnauld (1590–1651), was married in 1605 to Isaac Le Maître, a king's counselor, but the marriage was an unhappy one and they parted in 1615. After her husband's death, Catherine became a novice at Port Royal de Paris in 1640 and took her vows in 1644. She had five sons who, with one exception, retired to Port Royal des Champs as *solitaires* (*see* below). Two of these sons, though they did not bear the name Arnauld, must be mentioned here.

Catherine Arnauld Le Maître's eldest son was Antoine Le Maître (1608–1658). As a young man he seemed likely to distinguish himself as a lawyer, but disappointment in love and the sudden death of a relative caused him, in 1637, to put himself under the direction of Saint-Cyran and to retire from worldly society. In 1638, with two of his brothers and some other like-minded persons, he established himself at Port Royal des Champs, where he was to spend his days in prayer, study and work in the fields. This was the beginning of the group of *solitaires* ("hermits") of Port Royal, men who lived within the precincts of the convent and devoted themselves entirely to its material and spiritual welfare. At the beginning of 1656, when the attack on the Jansenists was gaining strength, Antoine Le Maître went into hiding in Paris with Blaise Pascal (*q.v.*), the great Antoine Arnauld (*see* below) and Pierre Nicole (*q.v.*). He then collaborated in the composition of Pascal's *Lettres provinciales* and helped in controversy by writing his *Lettre d'un avocat au parlement* (June 1657). Exhausted by hard work and ascetic practices, he finally returned to Port Royal des Champs where he died. He was an excellent translator of Latin and Greek works, particularly of patristic texts.

The fourth son of Catherine Arnauld Le Maître was Louis Isaac Le Maître de Sacy (1613–1684). Showing a religious disposition early in life, Sacy studied the Bible and patristical theology under Saint-Cyran's guidance and acquired a deep knowledge of these subjects. In 1649 he was ordained priest in order to become a confessor to the nuns and *solitaires* of Port Royal. By 1655 he was in contact with Pascal, and the famous *Entretien avec M. de Sacy* is made up of fragments of their correspondence. In 1661 the persecution against the Jansenists forced Sacy into hiding, but in

1666 he was arrested and imprisoned in the Bastille. Released in 1668, he returned to Port Royal des Champs for some years, during which he came to be held in high esteem by the Jansenists as a spiritual director. The renewal of persecution against Port Royal obliged him to retire to the château of Pomponne in 1679, where he remained until his death. His *Lettres chrétiennes et spirituelles*, published in 1690, show the intellectual power and profundity with which he examined religious questions. Sacy moreover must be considered as the principal author of the translation of the New Testament known as the *Nouveau Testament de Mons* (1667; so called because the first edition bore the imprint of Mons though it was really an Elzevir publication), to which the Great Arnauld, Nicole and others also contributed. This version, made from the original Greek text, marked a notable advance in biblical studies, though it was unfavourably criticized by the learned Richard Simon. It was followed by Sacy's translation of the whole Bible from the Latin text (with the notes and commentaries of St. Augustine and other Fathers of the Church), which appeared between 1672 and 1693. Among his numerous other translations the best known is that of the *Imitation of Christ* (1662).

The eldest of Mère Angélique's brothers was ROBERT ARNAULD D'ANDILLY (1589-1674). Employed in the government service, he seemed destined for a brilliant career in it. Though the influence of Saint-Cyran, whose acquaintance he made in 1620, soon led him to consider retiring from the court and worldly society, he decided at first to remain there so as to exercise a form of spiritual influence on his environment. About 1646, however, he withdrew to Port Royal des Champs, having published previously a book of *Lettres* (1645) in justification of his intention. His connection with the French court made him important in Jansenist affairs, and he was also admired for the purity of his literary style. He wrote a number of poems, some of which were published as *Oeuvres chrétiennes* in 1642, his "Ode à la Solitude" being especially beautiful. His *Mémoires* (not printed until 1734) contain much valuable information. Apart from these original works, he edited Saint-Cyran's *Lettres chrétiennes et spirituelles* (1645) and published numerous translations from Latin, Greek and Spanish, the most successful of the latter being those of St. Augustine's *Confessions* (1649) and of the works of St. Teresa of Ávila (1670). His versions are skilful and elegant but sometimes stray from the original text. A collected edition of his works was published in 1675. By his marriage with Catherine Lefebvre de la Boderie he had 15 children, 5 of whom died in infancy.

Robert Arnauld d'Andilly's eldest son, ANTOINE ARNAULD D'ANDILLY (1616-1698), left some interesting *Mémoires* (published in 1756). SIMON ARNAULD DE POMPONNE (1618–1699), Robert's third son, was early employed in the diplomatic service and in 1671 was appointed secretary of state and minister of foreign affairs. Dismissed in 1679, he was recalled to the ministry in 1691. Five of Robert's daughters were nuns at Port Royal des Champs, the best known of them being the one whose religious name was ANGÉLIQUE DE SAINT-JEAN (1624–1684). Educated in the convent and profoundly devout, Angélique de Saint-Jean was considered by all as a prodigy of learning; she was, in fact, kind-hearted and intelligent, with a gift for writing. Those who refused to subscribe to the anti-Jansenist formulary were to a large extent inspired by her. In 1664 she was taken from Port Royal and confined in the convent of the Annonciades in Paris, where she suffered much ill treatment. Back at Port Royal in 1665, she wrote an admirable *Relation de captivité* (printed in 1711). Elected abbess in 1679, she remained at Port Royal until her death. Of her numerous spiritual writings, the best are *Conférences* (published in 1760) and *Exercices de piété* (1787).

HENRY ARNAULD (1597–1692) was a brother of Robert Arnauld d'Andilly and Mère Angélique. After a diplomatic career, he became bishop of Angers in 1649 and took an important part in controversy, his sympathy being with the Jansenists.

The last of Robert's and Mère Angélique's brothers, but not the least of the family, was ANTOINE ARNAULD (1612–1694), known as the Great Arnauld. Brilliant at his studies, first in law and then in theology, he received a doctorate at the Sorbonne in 1642. He had for a time been tempted by worldly ambitions but, under Saint-Cyran's influence, abandoned them and devoted himself entirely to the defense of the truth as he saw it. He started by publishing his treatise *De la fréquente communion* (1643), in which he vindicated Saint-Cyran's views on the Eucharist and on penance. The book had great success in some quarters but also provoked a violent reaction, and Arnauld thought it wise to go into hiding. In the following years he applied himself first to defending the *Augustinus* of Jansen and the Augustinian theories on grace. On this subject he wrote one of his best works, the *Apologie pour les Saints Pères* (1650). With his *Théologie morale des Jésuites* (published in 1643), he began his great attack on the Jesuits, in which Pierre Nicole, a young theologian from Chartres, was to be his collaborator. Two of Arnauld's pamphlets, the *Lettre à une personne de condition* (Feb. 1655) and the *Lettre à un duc et pair* (July 1655), in which he affirmed the substantial orthodoxy of Jansen, gave rise to a complicated dispute that led to his being expelled from the Sorbonne (Feb. 1656). It was in defense of Arnauld that Pascal with the help of the whole Port Royal group, launched his *Provinciales*. During the great persecution of 1661–69, Arnauld was a leader of the resistance and wrote numerous pamphlets.

Pope Clement IX's "peace of the church" (1669) brought Arnauld some years of tranquillity, beginning with the gracious reception accorded to him by Louis XIV, and he next turned to writing against the Calvinists and on subjects disputed between Catholics and Protestants, his most important work of this period being *La Perpétuité de la foi catholique touchant l'Eucharistie*, 3 vol. (1669–74). He then won such fame as a theologian that Pope Innocent XI is said to have considered making him a cardinal. In 1679, however, the persecution of the Jansenists broke out again, and Arnauld had to leave France in June and seek refuge in the Netherlands. After staying at Brussels, Mons, Tournai, Ghent and Utrecht, he settled permanently in Brussels (Oct. 1682), where he was to remain in voluntary exile until his death. Some of his friends joined him there, and from 1685 he had with him the celebrated Pasquier Quesnel (*q.v.*), who was to succeed him as the leader of the Jansenist party. Despite the precarious conditions in which he had to work, the amount of Arnauld's writing during his exile was enormous. He not only resumed his attack on the Jesuit casuists in the last six volumes of his *Morale pratique des Jésuites* (1689–94; the first two had appeared in 1669 and 1682), but also intervened in the dispute over the king's rights in the Gallican church (*see* GALLICANISM) and wrote on English affairs in his *Apologie pour les Catholiques* (1681).

Arnauld was moreover distinguished as a philosopher and as a mathematician. For the *Port Royal Logic* (*La Logique, ou l'art de penser*, 1662) on which he and Pascal collaborated, *see* LOGIC, HISTORY OF. His *Éléments de géométrie* (not published till 1667) won Pascal's admiration. He also took a lively interest in the philosophy of Descartes, though he could not accept it without reservation. At first he had been the friend of Nicolas Malebranche (*q.v.*), but the latter's *Traité de la nature et de la grâce* (1680) seemed to him incompatible with Augustinian principles and began a long and somewhat painful controversy between them which continued unabated until Arnauld's death. His main works in this controversy were the *Traité des vraies et des fausses idées* (1683), in which he refutes Malebranche's theory of "representative ideas" whereby all perception is held to be "in God," and the *Réflexions philosophiques et théologiques* (1685), against Malebranche's theories on grace. Finally, in 1691, Arnauld also had a controversy with Nicole about what Nicole called "general grace," a type of divine grace which, according to Nicole, could be granted to all men, even to non-Christians; but the documents on this question were kept secret and did not appear until 1715. *See* also JANSENISM.

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ARNDT, ERNST MORITZ (1769–1860), German poet and

patriot who expressed the national awakening in his country in the Napoleonic era. He was born on Dec. 26, 1769, at Schoritz in the island of Rügen which then belonged to Sweden. He was educated at Stralsund, Greifswald and Jena, and qualified for the Lutheran ministry. At the age of 28 he rejected his clerical career and for 18 months traveled through Austria, Hungary, Italy, France and Belgium. On returning to his country the sight of the ruined castles along the banks of the Rhine moved him to bitterness against the French enemy. He described the impressions of this journey in *Reisen durch einen Teil Deutschlands, Ungarns, Italien, und Frankreichs in den Jahren 1798/99*, 6 vol. (1801–03). In 1800 he settled in Greifswald as assistant lecturer in history, and in 1803 appeared his *Germanien und Europa* in which he proclaimed his views on French aggression. Then came one of his most remarkable books *Versuch einer Geschichte der Leibeigenschaft in Pommern und Rügen* (1803), a history of serfdom in Pomerania and Rügen that resulted in its abolition, three years later, by the Swedish king Gustavus IV. In 1806 Arndt, appointed to the chair of history at Greifswald university, published the first part of his *Geist der Zeit* (Eng. trans., *Spirit of the Times*, 1808) in which he called on his countrymen to shake off the French yoke. To escape the vengeance of Napoleon he was obliged to take refuge in Sweden, but he continued to communicate his patriotic ideals to his countrymen in pamphlets, poems and songs. The heroic death of the Prussian officer Ferdinand von Schill at the battle of Stralsund in 1809 compelled him to return to Germany. He was closely associated with the field marshals Blücher and Gneisenau and also with the German statesman Baron von Stein. In 1812 Stein summoned him to St. Petersburg to assist in the organization of the final struggle against France. Meanwhile Arndt produced further patriotic pamphlets and songs. When, after the peace, the University of Bonn was founded in 1818, Arndt was appointed to the chair of modern history. In this year appeared the fourth part of his *Geist der Zeit*, in which he criticized the reactionary policy of the German powers. The boldness of his demands for reform offended the Prussian government, and in the summer of 1819 he was arrested. He was soon set free but not allowed to teach. In 1840 he was reinstated and in 1841 was appointed rector of the university. After the revolutionary outbreak of 1848 he took his seat as one of the deputies to the national assembly at Frankfurt am Main. He took part in the deputation that offered the imperial crown to Frederick William IV, but, indignant at the king's refusal to accept it, he retired, with the majority of Heinrich von Gagern's adherents, from public life. He died at Bonn on Jan. 29, 1860.

Not all of Arndt's lyrical poems were inspired by political ideas. Nor was he a merely chauvinistic figure. It has been suggested that Arndt was more liberal-minded than was once thought, having been influenced by the ideals of the French Revolution, the betrayal of which he resented. Many of the *Gedichte* (1804–18; complete ed. 1860) are religious poems of great beauty. Among his other works are his autobiography, *Erinnerungen aus dem äusseren Leben* (1840), the most valuable source of information for Arndt's life, and *Meine Wanderungen und Wandelungen mit dem Reichsfreiherrn Heinrich Karl vom Stein* (1858). Of many editions of Arndt's works, *see* that by H. Meisner and R. Geerds, 16 vol. (1908).

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ARNDT, JOHANN (1555–1621), German Lutheran theologian and mystic, was born at Ballenstädt, in Anhalt, on Dec. 27, 1555, and studied in several universities. At Wittenberg the crypto-Calvinist controversy was then at its height, and he took the side of Melanchthon and the crypto-Calvinists. He became pastor of Badeborn in 1583, but in 1590 he was deposed for refusing to remove the pictures from his church and discontinue the use of exorcism in baptism. He found asylum in Quedlinburg (1590), and afterward was transferred to St. Martin's church at Brunswick (1599). Arndt died on May 11, 1621.

Arndt's fame rests on his writings. These were mainly of a mystical and devotional kind, and were inspired by St. Bernard, J. Tauler and Thomas à Kempis. His principal work, *Vier Bücher vom wahren Christentum* (1606), translated into most European languages, served as the foundation of many books of devotion, both Roman Catholic and Protestant. His *Paradiesgärtlein aller christlichen Tugenden* (1612) also is well known. Arndt has always been held in high repute by the German Pietists.

A collected edition of Arndt's works in three volumes was published in Leipzig in 1734–36, under the editorship of J. J. Rambach.

See C. Oehmann, *Essai sur la vie et la doctrine de J. Arndt* (1861); W. Koepp, *Johann Arndt*, with bibliography (1912).

ARNE, THOMAS AUGUSTINE (1710–1778), English composer, chiefly of dramatic music and songs for London's theatres and pleasure gardens. Born in London, according to tradition, on March 12, 1710, he was the son of an upholsterer in King street, Covent Garden. Educated at Eton, he was intended for the law but by secretly practising he acquired such mastery of the violin and keyboard instruments that his father withdrew all objections to a musical career. Except for some lessons from Michael Festing, later leader of the Italian Opera orchestra, Arne was self-taught, and it was at the Opera (which he attended in a footman's livery to obtain free admission) that his musical taste was largely formed. He taught both his sister, later famous as the actress Mrs. Cibber, and his young brother to sing, and they appeared in his first stage work, *Rosamond* (1733). This opera, based on Joseph Addison's libretto of 1707, was set "after the Italian manner" and its bravura air "Rise, Glory, Rise" was sung at the theatres and pleasure gardens for the next 40 years.

Arne was soon engaged to write musical after-pieces and incidental music for Drury Lane theatre, and with *Comus* (1738), John Dalton's adaptation of Milton's masque, he became established as the leading English lyric composer. Dr. Burney wrote, "He introduced a light, airy original and pleasing melody, wholly different from that of Purcell and Handel," and this individual melodic style can also be heard in *Alfred* (notable for "Rule, Britannia") and *The Judgment of Paris*, both produced at the prince of Wales's residence at Cliveden in 1740. Arne's settings of Shakespeare's songs, written for revivals of *As You Like It, Twelfth Night* and *The Merchant of Venice* in 1740–41 provide the culmination of this early melodious style. Meanwhile in 1737 Arne had married Cecilia Young, who had already sung in Handel's operas and oratorios, and in 1742–44 the couple paid a highly successful visit to Dublin.

On his return Arne was engaged as composer to Drury Lane theatre and Vauxhall gardens, and during the next decade published song collections under such titles as *Lyric Harmony, Vocal Melody*, and *The Agreeable Musical Choice* which, as Burney wrote, were "the standard of all perfection at our theatres and public gardens." In 1755–56 came a second visit to Dublin, at which time Arne became estranged from his wife, who remained in Ireland. The following year he published his *Lessons for the Harpsichord* and his *Sonatas for two Violins and a Bass.* In 1759 he was made doctor in music at Oxford, and two years later his oratorio *Judith* was produced, followed by the opera *Artaxerxes* (1762), for which he provided his own English text, based on Metastasio. *Artaxerxes* held the stage until the early 19th century, but Arne's *opera buffa, The Guardian Outwitted* (1764), was a failure, largely because he was the author of the libretto, and his *Olimpiade* (1765), produced at the Italian Opera, survived only two performances.

In the final decade of his life Arne gave annual concerts of catches and glees, together with musical pieces designed to display the talents of his singing pupils. He set Garrick's ode for the Stratford Shakespeare jubilee of 1769 and composed music for *The Fairy Prince* (1771) and Mason's *Elfrida* (1772) and *Caractacus* (1776). He died, March 5, 1778, after a reconciliation with his wife, and was buried at St. Paul's, Covent Garden, where his birth had been registered.

Arne's early melodic style was natural and elegant, owing something to Scots, Irish and Italian sources. His later music became more Italianate and ornamented, though in his final years there emerged an *opera buffa* style that anticipates Sullivan. As the composer of such melodies as "Rule, Britannia," "Blow, Blow,

Thou Winter Wind" and "Where the Bee Sucks" Arne, like Purcell, added substantially to the English heritage of song.

See the article in Grove's *Dictionary of Music and Musicians*, 5th ed. (1954) which contains the most comprehensive list of Arne's works, especially for the theatre, although it, and other accounts of Arne, should not be relied on entirely. (JU. H.)

ARNETH, ALFRED VON (1819–1897), Austrian historian, important chiefly for his work in evaluating and publishing sources for Austrian history found in the Vienna state archives, was born in Vienna on July 10, 1819. His father, Joseph von Arneth (1791–1863), was custodian of coins and antiquities at the Vienna museum and author of numerous archaeological and numismatic works. His mother Antonie Adamberger (1790–1867), a notable actress at the Vienna Hofburg theatre, had been earlier betrothed to Karl Theodor Körner. Arneth studied law and history at Kremsmünster and Vienna and was appointed by Metternich to the state archives, of which he became keeper in 1868. He supported the opening of the archives to scholars. In 1879 he became president of the Kaiserliche Akademie der Wissenschaften and in 1896 succeeded Heinrich von Sybel as chairman of the historical commission at Munich. Arneth also had a political career, being a member of the Frankfurt assembly in 1848, of the Lower Austria *Landtag* from 1861 and of the *Herrenhaus* from 1869. He supported the liberal constitutional party. He died on July 30, 1897, in Vienna. His chief publications were devoted to the 18th century and derived their value from the special facilities open to him. They include lives of the field marshal Guido von Starhemberg (1853), of Prince Eugène of Savoy (1858–59) and of Maria Theresa (1863–79), and numerous collections of correspondence—between Maria Theresa and Marie Antoinette, Maria Theresa and Joseph II, Joseph II and Leopold and Joseph II and Catherine of Russia. He also published his early reminiscences *Aus meinem Leben* in two volumes (1893).

ARNHEM, the capital of Gelderland province of the Netherlands, lies on the right bank of the Lower Rhine 39 mi. by road east-southeast of Utrecht. Pop. (1960) 120,091. The old town with the business and administrative centres is surrounded by a semicircular boulevard on the site of the former ramparts. The newer residential and industrial areas are separated by traffic arteries and parks. Sonsbeek park, to the north, is laid out in early 19th-century Romantic style. In the old town the 14th-century Roman Catholic church of St. Walburgis is to the southeast and nearby is the Protestant church of St. Eusebius (15th century) on the Grote Markt where the 16th-century town hall and modern provincial government house (Huis der Provincie) are situated. The latter is near the site of the old Prinsenhof, the residence of the dukes and later the stadholders of Gelderland. Outside the old town to the west is the municipal museum and art gallery while 10 mi. N. is the Kröller-Muller state art gallery with modern works and a large collection of Van Gogh's paintings. There is also an open-air museum and zoo. Oosterbeek is the site of the cemetery where British air-borne troops who died in the battle of Arnhem are buried. Arnhem is a tourist centre; it has a theatrical company and a symphony orchestra. Main railways run to Amsterdam, Rotterdam, The Hague and into Germany. There are arterial roads to the west and to Germany. Rayon fibres, electrical equipment, ships, metal work and clothing are manufactured. (J. A. L.)

It was first mentioned in 893. In 1233 Otto II, count of Gelder, lived there, conferring municipal rights on the town and fortifying it. Later it entered the Hanseatic league. Charles the Bold of Burgundy captured it in 1473 and Philip, son of Maximilian I, gave it coining rights in 1505. In 1514 Charles of Egmont took it from the Spaniards; in 1543 Charles V captured it and made it the seat of the council of Gelderland. It came under the states general in 1585 and the following year Sir Philip Sidney died in the town after being fatally wounded at the battle of Zutphen. The French took it in 1672, but left it dismantled two years later. It was refortified in the 18th century. In 1795 it was again stormed by the French and taken by the Prussians in 1813. In World War II it was captured by the Germans in May 1940. On Sept. 17, 1944, British and Polish air-borne troops were dropped there in an attempt to seize the Rhine bridges, but after a heroic resistance they had to withdraw to the south eight days later. Arnhem was not liberated until April 1945. For an account of the Allied air-borne landing *see* WORLD WAR II: *Allied Reconquest of Western Europe*.

ARNICA, a genus of plants belonging to the family Compositae and containing about 50 species, most of which occur in northwestern America. The most important species of the genus, however, is *Arnica montana*, a perennial herb of the mountains and uplands in northern and central Europe. The rootstock of *A. montana* is tough, slender, of a dark brown colour and an inch or two in length. It gives off numerous simple roots from its underside, and shows on its upper side the remains of rosettes of leaves. It yields an essential oil in small quantity and a resinous matter called arnicin, a yellow crystalline substance with an acrid taste. The tincture prepared from it was once commonly used in the treatment of bruises and sprains.

In North America arnicas are most numerous in the Rocky mountain region from Colorado northward, but there are also many in the Sierra Nevada and Cascade ranges. Conspicuous species may be observed in Rocky Mountain, Glacier, Yosemite, Mount Rainier and other national parks of the western United States and Canada. Several species occur in the northeastern United States and adjacent Canada, mostly on the higher mountains.

Typical of the various far northern species is *A. angustifolia*, with very narrow leaves, occurring in arctic Asia and America. The heads of flowers are 2 to 2½ in. across, orange-yellow in colour and borne on the summit of the stem or branches; the outer ray flowers are an inch in length. The fruit is brown and hairy, and crowned by a tuft of stiffish hairs. The plant was introduced into England in the 18th century.

ARNICHES, CARLOS (1866–1943), Spanish dramatist, born at Alicante on Oct. 11, 1866, created a special version of the *género chico* or "little genre," the traditional type of one-act play that has been a feature of Spanish drama since the *entremeses* ("farces") of Cervantes and the *pasos* ("interludes") of Lope de Rueda in the 16th century. Arniches based his plays upon direct observation of the customs and speech of the people of Madrid. His most popular *sainetes* ("one-act plays") and *zarzuelas* ("musical comedies"), such as *El puñao de rosas* (1902), *El amigo Melquiades* and *Don Quintín el Amargao* (both 1924), became classics of Spanish literature and were set to music by popular composers. He died in Madrid on April 16, 1943. (W. F. SE.)

ARNIM, ACHIM (KARL JOACHIM FRIEDRICH LUDWIG) **VON** (1781–1831), made his mark in German literature as a collector and editor of folk songs and as a writer of stories. He was born in Berlin on Jan. 26, 1781, a descendant of an ancient noble family. In his student years he formed a close friendship with Clemens Brentano (*q.v.*), whose sister he married in 1811 (*see* ARNIM, BETTINA VON). While they were studying at Heidelberg, the two friends jointly published a remarkable collection of folk poetry, *Des Knaben Wunderhorn*. (The title derives from the opening poem, which tells of a youth who brings the empress a magic horn.) The first volume (published in the autumn of 1805, dated 1806) was dedicated to Goethe, who reviewed it appreciatively. Though it was criticized for lacking philological accuracy, this collection (completed in 1808) remains an outstanding achievement of German Romanticism. It succeeded J. G. Herder's equally famous collection of *Volkslieder* (1778–79); but whereas Herder's work includes folk songs of many different countries, Arnim's and Brentano's is emphatically German. In the troubled days of the Napoleonic wars, Arnim sought to restore to his fellow countrymen a sense of their national heritage.

Arnim's numerous plays, poems and novels are deservedly forgotten; but a few of his short stories (*Isabella von Ägypten, Der tolle Invalide, Fürst Ganzgott und Sänger Halbgott*) as well as the fragment *Die Kronenwächter*—all of them strangely compounded of realism and fantasy—are notable contributions to German prose fiction.

Arnim died at his country house of Wiepersdorf, Brandenburg, on Jan. 21, 1831.

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ARNIM, BETTINA (Elisabeth Katharina Ludovica Magdalena) **VON** (1785–1859), was born at Frankfurt am Main on April 4, 1785. She is one of the outstanding women writers in modern German literature, memorable not only for her books but for the personality which they reflect; all her writings, whatever their ostensible themes, are essentially self-portraits.

Gifted women played a prominent role in the German Romantic movement, and Bettina was a Romantic *par excellence*. She was unconventional to the point of eccentricity; wayward, yet a loyal wife (she married Achim von Arnim in 1811) and a devoted mother to her seven children; susceptible and passionate, but jealous of her personal freedom; capable of enthusiastic devotion, yet absorbed in a cult of her own personality which verged on narcissism. These paradoxes in her nature she projected into her books. Her three best-known works purport to be records of her correspondence with Goethe (*Goethes Briefwechsel mit einem Kinde*, 1835—the "child," be it noted, was a young woman of 22), with her friend Karoline von Günderode (*Die Günderode*, 1840) and with her brother Clemens Brentano (*Clemens Brentanos Frühlingskranz*, 1844); but the original letters have been rearranged and retouched, the result being a peculiar blend of documentation and fiction, written in a brilliantly vivid, uninhibited style. Her mother, Maximiliane Laroche, had been on terms of affectionate friendship with Goethe both before and after her marriage to Peter Brentano, an Italian merchant settled at Frankfurt. Maximiliane's connection with Goethe ended abruptly because it aroused her husband's jealousy; 35 years later, however, her daughter took her place. Bettina idolized Goethe (who was 57 when she first met him); she had frequently visited Goethe's mother in Frankfurt and made a point of recording the old lady's tales of the poet's childhood. (Goethe later used her notes when he was writing his autobiography, *Dichtung und Wahrheit*.) In her extravagant way, Bettina pursued Goethe with her attentions, until in 1811 a public quarrel between her and Goethe's wife Christiane caused Goethe to disown her.

She took an active interest in politics, sympathizing with the underprivileged and pleading for victims of political recrimination such as the poet J. G. Kinkel and the brothers Grimm (*q.v.*). She stated her views in two books, written for the special benefit of the king of Prussia, Frederick William IV (*Dies Buch gehört dem König*, 1843; *Gespräche mit Dämonen*, 1852).

Bettina was also a gifted sculptor and musician. Her poetic sensibility is seen in her appreciation of Hölderlin (*q.v.*), whose genius she divined long before it was generally recognized. In the diversity of her talents and interests, she exhibits that universality which Friedrich Schlegel regarded as the hallmark of the Romantic spirit. She died in Berlin on Jan. 20, 1859.

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ARNIM, HANS GEORG VON (1581–1641), German soldier and statesman who served different princes according to his personal attitude to contemporary politics, was born of an old noble family at Boitzenburg in Brandenburg. He started his military career in the Swedish service (1613) and fought in Gustavus Adolphus' war against Russia, but quarreled with the king and entered the Polish army in 1621 to fight the Turks. Joining the imperial army under Wallenstein in 1626 and soon made field marshal, he distinguished himself in the campaigns in Silesia, Mecklenburg and Pomerania but failed to take Stralsund in 1628. Sent to Poland in 1629 he defeated Gustavus Adolphus at Sztum. As a strict Lutheran he resigned his commission in protest against the Edict of Restitution and thenceforward worked for the creation of a "third party," under the elector of Saxony, to hold the balance between the imperial court and the encroachment of Sweden, France and Spain. As generalissimo of the Saxon army he fought in the first battle of Breitenfeld and in Nov. 1631 took Prague, but he was ejected from Bohemia by Wallenstein. An opponent of Swedish policy, he approached Wallenstein with a plan for a general pacification which largely coincided with Wallenstein's own ideas, but Wallenstein's assassination in 1634 put an end to these schemes. Leaving the Saxon service in protest against the peace of Prague between the emperor and Saxony (1635), he refused a French commission. Arrested on Swedish orders in 1637 and taken to Stockholm, he escaped to Hamburg in 1638 and was reinstated as imperial and Saxon lieutenant-general. Arnim was occupied with military preparations against France and Sweden when he died suddenly at Dresden on April 28 (new style; 18, old style), 1641.

See also Thirty Years' War.

See G. Irmer, *Hans Georg von Arnim* (1894); K. Wittrich, "Zur Würdigung Hans Georg von Arnims," *Neues Archiv für sächsische Geschichte*, vol. 22 (1901). (S. H. S.)

ARNIM, HARRY (KARL KURT EDUARD), Graf von (1824–1881), Prussian diplomat whose opposition to Bismarck was so indiscreetly expressed that he was accused of treason, was born at Moitzelfitz in Pomerania on Oct. 3, 1824. After studying law, he entered the diplomatic service in 1850, serving in Rome (1853–55) and in Lisbon (1862). He was appointed Prussian envoy to the Holy See in 1864. Before the Vatican council of 1869 he made proposals intended to prevent a declaration of papal infallibility, which, he foresaw, would create serious political difficulties.

Arnim took part in the negotiations to end the Franco-German War and was appointed Prussian envoy to France on Aug. 23, 1871, becoming ambassador on Jan. 9, 1872. In June he arranged the war reparations settlement, but differences soon arose between him and Bismarck. Arnim, who considered that Bismarck's backing of the republican regime in France would encourage opponents of the monarchy in Germany, wished to support the French monarchists, and his intrigues contributed to the fall of A. Thiers (*q.v.*) in May 1873. Arnim's favour at court and his support of the conservative groups among the nobility led Bismarck to suspect that he was planning to supplant him. Then, in 1874 a Vienna newspaper published correspondence on the Vatican council, including confidential dispatches of Arnim's, with a view to showing that he had exhibited greater foresight than Bismarck. It was then found that papers were missing from the Paris embassy. Arnim lost the emperor's favour and, as he refused to return some of the missing documents, Bismarck had him temporarily superannuated and then, on Oct. 4, 1874, arrested. Condemned to three months' imprisonment, Arnim appealed, but the supreme court increased the sentence to nine months. Arnim left Germany and, in 1876, anonymously published *Pro nihilo*, a pamphlet attributing the attack on him to Bismarck's jealousy. Convicted of treason, of insulting the emperor and of libeling Bismarck, he was sentenced *in absentia* to five years' penal servitude.

In Austria, Arnim published two more pamphlets on Prussia's ecclesiastical policy, *Der Nuntius kommt!* (1878) and *Quid faciamus nos?* (1879). His repeated demands for a new trial had just been granted when he died at Nice, in France, on May 19, 1881.

As the legal grounds for the prosecution of Arnim had been rather doubtful, Bismarck, in 1876, carried an amendment to the criminal code, the so-called *Arnim Paragraph*, making the unauthorized disclosure of official documents a criminal offense.

See *Der Arnim'sche Prozess. Stenographische Berichte* (1874); F. Hartung, "Bismarck und Graf Harry Arnim," *Historische Zeitschrift*, vol. 171 (1951).

ARNO (anc. Arnus), the principal river of Tuscany, is second only to the Tiber in importance in central Italy. Its course is 150 mi. long and its drainage basin covers 3,184 sq.mi. The Arno rises on the slopes of Mt. Falterona (5,426 ft.) east-northeast of Florence, and in its upper course traverses the former lake basin called Casentino. Near Arezzo it turns west, flows through a second ancient lake basin, and after the narrow gorge at Incisa enters the third basin, that of Florence. After traversing the

Florence section of its valley, the river enters a last gorge at Golfolina and below it begins its lower course, past Empoli and Pisa, to the Ligurian sea. In the lower section it receives the waters of the rivers Pesa, Elsa and Era. The valley of the Arno was substantially modified by man: in the upper course, the Val di Chiana now drains to the Tiber; flood-control works, some designed by Leonardo da Vinci, control the middle section, though sudden flood in 1966 inundated Florence; while the ancient delta is now reclaimed and the Arno reaches the sea through a single mouth. In its lower course the volume of the river averages 140 sq.yd. per second, with variations from a maximum of 2,600 to a minimum of 2.2; navigation on the river is negligible. Arezzo, Florence and Pisa are the principal cities along the Arno. (G. Kh.)

ARNOBIUS (sometimes called Afer or the Elder), a brilliant Christian apologist, was born a pagan but, as he says himself, had by A.D. 300 become a Christian. Jerome adds other details: Arnobius taught rhetoric at Sicca Veneria in proconsular Africa during the reign of Diocletian, numbering Lactantius among his pupils. Induced by dreams to embrace the newer faith, he met with suspicion because of his former antipathy to Christianity and therefore composed as a pledge of his sincerity the seven "most splendid books" *Against the Pagans* (*Adversus nationes*) and thus received baptism. Hasty readers have done Arnobius grave injustice by too easily viewing the work as the product of a recent convert, not yet perfectly instructed. That he does not, like other apologists, abundantly cite Scripture, implies not his ignorance of it, but that he viewed it as unnecessary to his purpose, which was to defend Christianity by demonstrating to the pagans their own ridiculous inconsistencies. The work is thus a mine of great richness for knowledge of contemporary pagan cults. A general defense of Christianity from pagan calumnies is followed by sustained attacks in turn upon neo-Platonism, anthropomorphism and other weaknesses including myths, and specifically two important myths described in detail, as well as upon pagan temples, images and ceremonials. What appears in earlier printed editions as an eighth book is really the *Octavius* of Minucius Felix, preserved in the same unique manuscript. While the rhetorical style is characteristic of the period, the invective is always brilliant with frequent flashes of humour worthy of a great satirist.

Bibliography.—Latin texts were edited by A. Reifferscheid, *Corpus* (1875) and C. Marchesi, *Corpus Paravianum*, 2nd ed. (1953); for a translation, full introduction (with bibliographies) and commentary, see George E. McCracken, *Arnobius of Sicca: the Case Against the Pagans*, Ancient Christian Writers, 2 vol. (1949). (G. E. McC.)

ARNOBIUS (called the Younger) (fl. *c.* 460), Christian priest or bishop in Gaul, was the author of a mystical and allegorical commentary on the Psalms, first published by Erasmus in 1522, and by him attributed to the elder Arnobius (*q.v.*). He also attacked St. Augustine's doctrine of grace and was author of some notes on the Gospels and of an anti-Monophysite treatise. The opinions of Arnobius, as appears from the commentary, are semi-Pelagian.

ARNOLD of Brescia (Arnaldo da Brescia) (d. 1155), priest and monk, was an outspoken critic of the wealth and corruption of the clergy and became a vigorous opponent of the temporal power of the pope. Born in or near Brescia toward the close of the 11th century, he studied letters and theology, but it is doubtful whether he was a pupil of Peter Abelard, as stated by Otto of Freising (*Gesta Friderici*, ii, 28). Arnold took part in a popular revolt against the government of Bishop Manfred at Brescia in 1137, and was condemned as a schismatic by Pope Innocent II in 1139. Banished from Italy he went to France, where he became a supporter of Abelard, whose errors in Trinitarian doctrine St. Bernard charged him with sharing. At the Council of Sens (1140) both were condemned. While Abelard submitted to authority, Arnold defiantly continued teaching in Paris until he was exiled by King Louis VII at the importunate insistence of St. Bernard (1141). From Paris Arnold fled first to Zurich, then to Passau. There he was protected by Cardinal Guido, legate to Bohemia and Moravia, through whose mediation he was reconciled with Pope Eugenius III at Viterbo (Sept. 1145).

Two years earlier a revolt had broken out in Rome. Pope Innocent II and the cardinals had been expelled, the ancient senate revived and a republic proclaimed by the Roman aristocracy. Pope Eugenius unwisely now sent Arnold to Rome on a penitential pilgrimage. Before long he made common cause with the insurgents and resumed his preaching against pope and cardinals, denouncing Eugenius as "a man of blood" and the papal *curia* as "a house of merchandise and a den of thieves." He was excommunicated in July 1148, and from this point his career was bound up with the fortunes of the Roman republic. Agitation for ecclesiastical reform reinforced and permeated the revolt against the pope as temporal ruler. Arnold speedily acquired a moral and political ascendancy over the Romans through his oratory and gift of leadership. The able and energetic Pope Adrian IV (*see* Adrian) placed Rome under interdict in 1155, and called upon the citizens to surrender Arnold. The senate tamely submitted; the republic collapsed, and the papal government was restored. Arnold, who had fled the city, was captured by the forces of Frederick I (*q.v.*), then visiting Rome for his imperial coronation. Arnold was tried by an ecclesiastical tribunal, condemned for heresy and handed over to the emperor for execution. He was hanged, either at Civita Castellana or at Monte Rotondo, in about June 1155, his body being then burned and the ashes cast into the Tiber lest they should be treasured as relics.

Arnold's character was austere and his mode of life ascetic. St. Bernard, his implacable enemy, described him as "a man who came neither eating nor drinking," and admitted that his morals were above reproach. His teaching was inspired by the gospel, fortified by the example of the early church and more immediately derived from that of the Patarini, a sect that sought to reform the clergy in Lombardy during the 11th century. Essentially an idealist, "he taught things most consonant with the law of Christians, but altogether remote from everyday life" (John of Salisbury, *Historia pontificalis*, xxxi). He left followers, known as Arnoldists, and although the extent of his influence on the heretical sects of the 13th century is problematical, his cardinal tenet of the incompatibility of spiritual power with material possessions was widely held among them. In modern times Arnold has attracted the attention of poets, dramatists and Italian politicians, and his personality has been gravely distorted in the process. He was before all else a religious reformer, constrained by the circumstances of his time to adopt the role of a political revolutionary.

See G. W. Greenaway, *Arnold of Brescia*, with full bibliography (1931). (G. W. Gr.)

ARNOLD, BENEDICT (1741–1801), American officer in the Revolutionary War who deserted to the British, was born in Norwich, Conn., on Jan. 14, 1741. His family had been a distinguished one in Rhode Island. In the fall of 1757 he served with the militia in the French and Indian War, but soon returned home and completed his apprenticeship with a firm of druggists. In 1762 he opened a drug and book store in New Haven. As the store prospered, Arnold bought ships and engaged in trade with Canada and the West Indies.

Late in 1774 he was elected captain of a militia company. When news of the outbreak of hostilities at Lexington arrived in April 1775, Arnold marched his company to Cambridge and immediately proposed the capture of Ft. Ticonderoga and seizure of its cannon. Named a colonel by Massachusetts on May 3, 1775, he was authorized to raise a regiment and proceed with his plan. But he soon found himself forestalled by Ethan Allen (*q.v.*), who had been authorized by Connecticut to undertake the same mission and had already recruited a force. Reluctantly waiving his own claim to command, Arnold joined Allen as a volunteer in the successful attack. He then seized a ship and with a hundred men ran down Lake Champlain and captured St. John's.

When Arnold returned to Cambridge, Washington gave him command of an expedition to Quebec via the Maine wilderness. The march of 700 men was a remarkable feat of woodsmanship and endurance, but Quebec was too strong to be attacked until Arnold was joined by Gen. Richard Montgomery's force from Montreal. The combined assault in a snowstorm on Dec. 31, 1775, failed; Montgomery was killed, and Arnold severely wounded. Congress promoted him to the rank of brigadier general, and he continued to besiege the city until spring when he was forced to retreat to

Montreal and Lake Champlain. Enlarged British forces followed, intent on reaching Albany. Arnold constructed a flotilla on Lake Champlain and inflicted severe losses on a greatly superior enemy fleet near Valcour Island, Oct. 11, 1776. He returned home a hero, but his rash courage and impatient energy had aroused the enmity of several other officers. When in Feb. 1777 congress created five new major generals, Arnold, the ranking brigadier, was passed over in favour of his juniors because of the political necessity of apportionment among the states. Only Washington's personal persuasion kept Arnold from resigning.

Two months later, while he was at New Haven, Danbury was attacked. Arnold took immediate action and drove the British back to their ships. This exploit forced congress to make him a major general but his seniority was not restored, and Arnold felt his honour impugned. He tried to resign but accepted congress' order in July to join Gen. Philip Schuyler above Albany to stem a fresh invasion from Canada under Gen. John Burgoyne (*q.v.*). He marched up the Mohawk valley in August against Col. St. Leger and raised the siege of Ft. Stanwix (Rome, N.Y.). Arnold later commanded the left wing in the first battle of Saratoga (Sept. 19). In the second battle (Oct. 7) he galloped into action, took command of advance battalions, and fought brilliantly and decisively until seriously wounded. For his services he received a new commission restoring him to his proper relative rank.

Since Arnold's wounds had left him crippled, Washington placed him in command of Philadelphia in June 1778. He enjoyed the city's social life, moved among families of Loyalist sympathies, and lived extravagantly. To make money he violated several state and military regulations, arousing the suspicions and finally the denunciations of Pennsylvania's supreme executive council. The charges against Arnold were then referred to congress. Some of the charges were thrown out, but four remained and Arnold asked for a speedy court-martial to clear himself. Meanwhile, on April 8, 1779, four years after the death of his first wife, he married young Margaret (Peggy) Shippen (1760–1804), daughter of a moderate Loyalist. She had been impressed by the society of British officers during the previous winter of occupation and was Loyalist in feeling. Either she suggested that they change sides or readily seconded such a suggestion from Arnold, for early in May he made secret overtures to British headquarters. He was asked to remain on the American side and send information until he obtained an important post or field command that he could betray. Payment was promised, but the British were vague about the amount, to Arnold's irritation. He did forward intelligence from time to time and persisted in asking £10,000 for indemnification plus the rank of major general in the British army for his services. The correspondence lapsed in Oct. 1779.

Arnold's postponed trial finally was held in Dec. 1779, and he was found guilty of two minor offenses and sentenced to a reprimand by Washington. Mild and just as the sentence was, Arnold was furiously aggrieved. He reopened the treasonable correspondence in May 1780, sending news of the proposed invasion of Canada and later revealing that he expected to obtain the command of West Point. Having now an important fort to deliver, he asked £20,000 for betraying it, and half that sum if he failed and fled to the British lines. Maj. John André (*q.v.*) arranged to meet him on Sept. 21 under a misuse of a flag of truce. As the ship that brought André up the Hudson was fired upon and forced to retire, André spent the night within American lines. The next day he was persuaded to don civilian disguise in order to return overland to New York, provided with a pass by Arnold. When notified of André's capture, Arnold managed to escape on the boat that had returned for André, leaving the latter to be hanged as a spy. His wife joined him later in New York.

The sacrifice of André made Arnold odious in New York, but Clinton named him a provincial brigadier general, awarded him £6,000 plus expenses, and authorized him to raise a regiment of American deserters. Only 28 privates responded to his published appeals. He was sent on a raiding expedition to Virginia and captured Richmond, and in Sept. 1781 led a raid on New London, Conn. Upon Cornwallis' surrender, Arnold obtained permission to go to England and sailed on Dec. 15. Naïvely he hoped to succeed Clinton as commander in chief, but the Tory ministry fell; peace was negotiated; and Arnold became a retired colonel on half pay. His wife was given a pension of £500 a year "for her services"; each of his sons was given a military commission and drew pay although too young to serve. Later the younger children were given pensions of £100.

Disappointed at the failure of his plans and embittered by the neglect and scorn he met in England, Arnold spent the years 1787–91 at Saint John, N.B., once more engaging in the West India trade. But he was greatly disliked in Canada and in 1792 returned to London. He failed to get a command in the war with France and fought a duel with an earl who insulted him. Going to the West Indies again to trade, he was captured by the French and escaped but steadily lost money. Inactive at home, ostracized and ailing, he died on June 14, 1801. His faithful wife survived him only three years.

Bibliography.—Willard M. Wallace, *Traitorous Hero* (1954); Carl Van Doren, *Secret History of the American Revolution* (1941) contains the André-Arnold correspondence; James T. Flexner, *The Traitor and the Spy* (1953). (H. H. P.)

ARNOLD, SIR EDWIN (1832–1904), English poet, scholar and journalist best known for his epic poem *The Light of Asia*, was born at Gravesend, Kent, on June 10, 1832, and educated at King's college, London, and University college, Oxford. He was principal of the government college at Poona, India, from 1856 to 1861, when he joined the *Daily Telegraph*, of which he became chief editor in 1873. A brilliant journalist, he was nevertheless better known to his contemporaries as the author of *The Light of Asia* (1879), a poem in elaborate language on the life and teaching of Buddha. This was followed by *The Light of the World* (1891), on the Christian theme, which was not successful. Arnold also published many prose works, including *Education in India* (1860), *Seas and Lands* (1891) and *The Queen's Justice* (1899). He died in London on March 24, 1904.

His *Poetical Works* appeared in 8 vol. (1888).

ARNOLD, HENRY HARLEY (1886–1950), commanding general of U.S. army air forces in World War II, was born at Gladwyne, Pa., on June 25, 1886. After graduation from the U.S. Military academy in 1907, Arnold served in the infantry and then transferred to the aeronautical section of the signal corps, receiving his flying instruction from Orville Wright in 1911.

During World War I he rose from the grade of captain to colonel and was eventually the executive officer to the chief of the air service. In the decade of demobilization and disarmament after the war, he was one of the apostles of air power, following the lead of Brig. Gen. William Mitchell (*q.v.*). In 1931 he was appointed commanding officer of the first wing, G.H.Q. air force where he originated and tested the organization and tactics later employed in World War II.

Arnold reported to Washington in 1936 as assistant chief of the air corps. When his superior, Gen. Oscar Westover, was killed in a plane crash (1938) Arnold succeeded him as chief of the air corps. Anticipating the coming conflict, Arnold strongly pressed for increased air corps appropriations and aid to the Allies against isolationist hostility and military myopia. In 1941 he published, in collaboration with Gen. Ira C. Eaker, a book entitled *Winged Warfare*.

During World War II Arnold was commanding general of the U.S. army air forces throughout the world. He also served as the U.S. air representative on the U.S. joint chiefs of staff and the Allied combined chiefs of staff. In these capacities he was an influential architect of the plans and strategy which resulted in Allied victory. In Dec. 1944 he was one of four army leaders promoted to the five-star rank, general of the army. His title was later changed to general of the air force.

Arnold had long planned and advocated that the air forces have parity with the army and navy in the U.S. military establishment. The National Defense act of 1947, authorizing this organization, was undoubtedly due in no small degree to Arnold's effort and influence. (*See* Air Power.) He died at his retirement home, Sonoma, Calif., Jan. 15, 1950. (I. C. E.)

ARNOLD, MATTHEW (1822–1888), English poet, critic,

and inspector of schools, was born at Laleham, Middlesex, on Dec. 24, 1822. He was the eldest son of the famous Dr. Thomas Arnold (*q.v.*), who was appointed headmaster of Rugby in 1828. From his mother, Mary (née Penrose), he inherited Cornish blood, and with it something of what he would have distinguished as the "Celtic" strain in his sensibility. After a year at Winchester, Matthew Arnold entered Rugby school (1837). His first publication was a Rugby prize poem, *Alaric at Rome* (1840). He went up to Oxford as a scholar of Balliol college in 1841, won the Newdigate prize with his poem *Cromwell* (1843), and graduated with second-class honours in 1844. At Oxford, probably in half-reaction from the earnestness of his father's Rugby, he affected a certain dandyism and ironic detachment, and struck some of his contemporaries as a trifler. But—like his friend Arthur Hugh Clough (*q.v.*)—he was elected to a fellowship at Oriel (1845). Arnold's levity was only a mask; though, actually, "radiant, adorn'd outside," he had even then "a hidden ground of thought and of austerity within." Far from breaking with his father, he reverenced him, and spent much of his later life in advocating and furthering his educational and religious aims. For Oxford, too, Arnold retained an impassioned affection. His Oxford was the Oxford of John Henry Newman—of Newman just about to be received into the Roman Church; and although Arnold's own religious thought, like his father's, was strongly liberal, Oxford and Newman always remained for him joint symbols of spiritual beauty and culture. Oxford, like Newmanism, might be a part of the dead or dying world; it might be "the home of lost causes and impossible loyalties" and yet: "steeped in sentiment as she lies, spreading her gardens to the moonlight, and whispering from her towers the last enchantments of the Middle Age, who will deny that Oxford, by her ineffable charm, keeps ever calling us nearer to the true goal of all of us, to the ideal, to perfection?"

In 1847 Arnold became private secretary to Lord Lansdowne, president of the council during Lord John Russell's Liberal ministries. And in 1851, in order to secure the income needed for his marriage (June 1851) with Frances Lucy Wightman, he accepted from Lansdowne an appointment as inspector of schools. This was to be his routine occupation until within two years of his death, and it has often been thought an incongruous task for so rare and sensitive a spirit. The incessant traveling in all weathers, and the constant exposure not only to provincial hotels but to provincial rawness, Philistinism and Dissent, certainly cost him much in fatigue and lassitude. Yet education was in his blood, and he loyally (if stoically) accepted the role of propagandist and missionary for culture and for state schools. Indeed, his fame as poet and critic should not lead us, as it has often done, to forget the extent and significance of his educational work. At a time when state action of any kind was regarded with suspicion as "interference," he saw the vital necessity in a modern democracy of organizing public education, primary and secondary, for the middle classes and for the populace. Always critical of Victorian insularity and *laissez faire*, and always eager to correct British national complacency from a European standpoint, he made it his business to point out to his countrymen what had already been done in this direction on the continent. He was several times sent by the government to inquire into the state of education in France, Germany, Holland and Switzerland, and his reports show how conscientiously he devoted some of his best energies to the work. For example, in 1859, as foreign assistant commissioner, he prepared for the duke of Newcastle's commission a report (printed 1860) which was afterward (1861) reprinted in the book called *The Popular Education of France, with notices of that of Holland and Switzerland.* In 1865 he was again employed as assistant commissioner by the Schools Enquiry commission under Lord Taunton; and his report *On Secondary Education in Foreign Countries* (1866) was reprinted under the title *Schools and Universities on the Continent* (1868). A later inquiry into specific problems resulted in a parliamentary paper (1886). His annual reports on schools at home, of which 20 were collected by Sir Francis (afterward Lord) Sandford (1889; new ed., with added material and introduction by F. S. Marvin, 1908), attracted wider attention than most "Blue Book" productions, for they were written, not in officialese, but in Arnold's own urbane and civilized prose. Though all this routine work could have been done by lesser men, it is salutary to remember that Arnold did it, especially as a corrective to the notion of him as the "elegant Jeremiah," or the aloof and superior exponent of "culture."

The work which gives Arnold his high place in the history of literature and the history of ideas was all accomplished in the time he could spare from his official duties. Yet there is a unity in his whole output; his verse and his literary, social and religious criticism, no less than his educational reports, proceed from a consciousness exposed to the *Zeitgeist* ("spirit of the age"); a sensibility quick to feel, and an intelligence alert to diagnose, the deeper maladies of the age. His first volume of verse was *The Strayed Reveller, and other Poems, by A.* (1849); this was followed (in 1852) by another under the same initial: *Empedocles on Etna, and other Poems.* In 1853 appeared the first volume of poems published under his own name; it consisted partly of poems selected from the earlier volumes, and also contained the well-known preface explaining (*inter alia*) why *Empedocles* was excluded from the selection: it was a dramatic poem "in which the suffering finds no vent in action," in which "everything is to be endured, nothing to be done." This preface foreshadows his later criticism in its insistence upon the classic virtues of unity, impersonality, universality and architectonic power, and upon the value of the classical masterpieces as models for "an age of spiritual discomfort"—an age "wanting in moral grandeur." Other editions followed; and *Merope,* Arnold's classical tragedy, appeared in 1858, and *New Poems* in 1867. After that date, though there were further editions, Arnold wrote little more verse.

As a poet, Arnold must surely rank amongst the first four or five of his time. In a letter to his mother, written in 1869, he sums up his own poetic achievement thus: "My poems represent, on the whole, the main movement of mind of the last quarter of a century, and thus they will probably have their day as people become conscious to themselves of what that movement of mind is, and interested in the literary productions which reflect it. It might be fairly argued that I have less poetical sentiment than Tennyson, and less intellectual vigour and abundance than Browning; yet, because I have perhaps more of a fusion of the two than either of them, and have more regularly applied that fusion to the main line of modern development, I am likely enough to have my turn, as they have had theirs." He not only "had his turn," but has continued to hold his place as, if not the most admired, yet for many readers the most congenial, of the Victorian poets; as the poet who addresses them with the voice of a human contemporary speaking directly to their condition. Not much of Arnold's verse will stand the test of his own criteria; far from being classically poised, impersonal, serene and grand, it is often intimate, personal, full of romantic regret, *Weltschmerz* and nostalgia. As a public and social character, and as a prose writer, Arnold was sunny, debonair and sanguine; but beneath ran the current of his buried life, and of this much of his poetry is the echo:

> From the soul's subterranean depth upborne
> As from an infinitely distant land,
> Come airs, and floating echoes, and convey
> A melancholy into all our day.

"I am past thirty," he wrote to Clough in 1853, "and three parts iced over." The impulse to write poetry came typically when

> A bolt is shot back somewhere in the breast,
> And a lost pulse of feeling stirs again.

Though he was "never quite benumb'd by the world's sway," these hours of insight became more and more rare, and the stirrings of buried feeling were associated with moods of regret for lost youth, regret for the freshness of the early world, moods of self-pity, moods of longing for

> The hills where his life rose
> And the sea where it goes.

At Fox How, Thomas Arnold's holiday home in Westmorland, Matthew's earlier life had been steeped in Wordsworthian sentiment; he knew and revered the aged poet himself, who lived a

stone's throw away at Rydal Mount. And Arnold may be thought of as a Victorian Wordsworth—a Wordsworth exiled from the hills, dwelling on lower reaches of the river of Time, further from the sources of life and inspiration, and moved to yearning rather than to rapture by Nature's grandeur, calm and self-dependence. Yet, though much of Arnold's most characteristic verse is in this vein of soliloquy or intimate confession, he can sometimes rise, as in *Sohrab and Rustum*, to epic severity and impersonality; to lofty meditation, as in *Dover Beach;* and to sustained magnificence and richness, as in *The Scholar-Gypsy* and *Thyrsis*—where he wields an intricate stanza form without a stumble.

In 1857, assisted by the vote of his godfather (and predecessor) John Keble, Arnold was elected to the Oxford chair of poetry, which he held for 10 years. It was characteristic of him that he revolutionized this professorship, lecturing in English instead of Latin, and concerning himself, not with "the trade in classic niceties," but (in Lionel Trilling's phrase) "with the demand which humanity makes for a poetry *adequate* to the time in which it is written." (Lionel Trilling, *Matthew Arnold*, George Allen & Unwin Ltd.) The keynote was struck in the title and contents of his inaugural lecture: "On the Modern Element in Literature"; "modern" being taken to mean not merely "contemporary" (for Greece was "modern"), but the spirit which, contemplating the vast and complex spectacle of life, craves for moral and intellectual "deliverance." Several of the lectures were afterward published as critical essays, but the most substantial fruits of his professorship were the three lectures *On Translating Homer* (1861), in which he recommends Homer's plainness and nobility as medicine for the modern world, with its "sick hurry and divided aims," and condemns Francis Newman's recent translation as ignoble and eccentric; and the lectures *On the Study of Celtic Literature* (1867), in which, without much knowledge of his subject or of anthropology, he uses the "Celtic" strain as a symbol of that which rejects the despotism of the commonplace and the utilitarian.

It is said that when the poet in Arnold died, the critic was born; and it is true that from this time onward he turned almost entirely to prose. But in fact the critic had been alive in him from the start, and his poetry had itself been the outcome of his effort to apply intelligence, as well as feeling, to the problem of "the world's multitudinousness." It is a mark of Arnold's distinction and many-sidedness that, instead of writing more and worse poetry, he went on to produce those essays which place him first among Victorian critics, and high among those few European critics who have permanently influenced the course of opinion about the nature and function of poetry. In Arnold appears what is virtually a new phenomenon: the "literary" intelligence playing freely upon the great concerns of human life. He saw and proclaimed the importance, for the modern world, of those qualities of mind and spirit which literary culture can give; and literary criticism has gained immensely from his expansion of its scope. There is only space here to consider some of the leading ideas and phrases put into currency in *Essays in Criticism* (First Series, 1865; Second Series, 1888) and *Culture and Anarchy* (1869). The first essay in the 1865 volume, "The Function of Criticism at the Present Time," is an overture announcing briefly most of the themes he developed more fully in later work. It is at once evident that he ascribes to "criticism" a scope and importance hitherto undreamed of. The function of criticism, in his sense, is "a disinterested endeavour to learn and propagate the best that is known and thought in the world, and thus to establish a current of fresh and true ideas." It is in fact a spirit that he is trying to foster, the spirit of an awakened and informed intelligence playing upon not "literature" merely, but theology, history, art, science, sociology and politics; and in every sphere seeking "to see the object as in itself it really is." In this critical effort England has lagged woefully behind France and Germany, and the English have accordingly remained in a backwater of provinciality and complacency. Even the great Romantic poets, with all their creative energy, suffered from the want of it. "Life and the world being in modern times very complex things, the creation of a modern poet, to be worth much, implies a great critical effort behind it." The English literary critic must know other literatures than his own and be in touch with European standards. This last line of thought he develops in the second essay, "The Literary Influence of Academies," where he dwells upon "the note of provinciality" in English literature, caused by remoteness from a "centre" of correct knowledge and correct taste. To realize how Arnold widened the horizons of "criticism" it is enough to glance at the titles (but better to read the contents) of some of the other essays in this volume: "Maurice and Eugénie de Guérin," "Heine," "Joubert," "Spinoza and the Bible," "Marcus Aurelius"; in all these, as increasingly in his later books, he is "applying modern ideas to life" as well as to letters, and "bringing all things under the point of view of the nineteenth century."

The first essay in the 1888 volume, "The Study of Poetry," was originally published as the general introduction to T. H. Ward's anthology, *The English Poets* (1880). It contains many of the ideas for which Arnold is best remembered. In an age of crumbling creeds, poetry will have to replace religion. More and more, mankind will "turn to poetry to interpret life for us, to console us, to sustain us." Therefore we must know how to distinguish the best poetry from the inferior, the genuine from the counterfeit; and to do this we must steep ourselves in the work of the acknowledged masters, using as "touchstones" passages exemplifying their "high seriousness," and their superiority of diction and movement. The remaining essays, with the exception of the last two (on Tolstoy and Amiel), all deal with English poets: Milton, Gray, Keats, Wordsworth, Byron and Shelley. All contain memorable things, and all attempt a serious and responsible assessment of each poet's "criticism of life," and his value as food for the modern spirit. Arnold has been taken to task for some of his judgments and omissions; for his judgment that Dryden and Pope were not "genuine" poets because they composed in their wits instead of "in the soul"; for calling Gray a "minor classic" in an age of prose and spiritual east winds; for paying too much attention to the man behind the poetry (Gray, Keats, Shelley); for making no mention of Donne; and above all for saying that poetry is "at bottom a criticism of life." On this last point it should be remembered that he added "under the conditions fixed . . . by the laws of poetic truth and poetic beauty," and that if by "criticism" is understood (as Arnold meant) "evaluation," Arnold's dictum is seen to have wider significance than has been sometimes supposed.

Culture and Anarchy (1869) is in some ways Arnold's most central work. It is an expansion of his earlier attacks, in "The Function of Criticism" and "Heine," upon the smugness, Philistinism and mammon-worship of Victorian England. Culture, as "the study of perfection," is opposed to the prevalent "anarchy" of a new democracy without standards and without sense of direction. By "turning a stream of fresh thought upon our stock notions and habits," culture seeks to make "reason and the will of God prevail." Arnold's classification of English society into Barbarians (the aristocracy: with their high spirit, serenity and distinguished manners, and their inaccessibility to ideas); Philistines (the great middle class, the stronghold of Dissent, with plenty of energy and morality, but insufficient "sweetness and light"); and Populace (the masses, still raw and blind), is well known. Arnold saw in the Philistines the key to the whole position; they were now the most influential section of society; their strength was the nation's strength, their crudeness its crudeness: Educate and humanize the Philistines, therefore! Remedy their excessive Hebraism by a dose of Hellenism! Arnold saw in the idea of "the State," and not in any one class of society, the true organ and repository of the nation's collective "best self." No summary can do justice to this extraordinary book; it can still be read with pure enjoyment, for it is written with an inward poise, a serene detachment, and an infusion of mental laughter, which make it a masterpiece of ridicule as well as a searching analysis of Victorian society. The same is true of its unduly neglected sequel, *Friendship's Garland* (1871).

Lastly Arnold turned to religion, the constant preoccupation and true centre of his whole life, and wrote *St. Paul and Protestantism* (1870); *Literature and Dogma* (1873), *God and the Bible* (1875) and *Last Essays on Church and Religion* (1877). In these undeservedly neglected books Arnold really founded Anglican

"modernism." Like all religious liberals, he came under fire from two sides: from the orthodox, who accused him of infidelity, of turning God into a "stream of tendency" and of substituting vague emotion for definite belief; and from the infidels, for clinging to the Church and retaining certain Christian beliefs of which he had undermined the foundations. To Arnold himself, it seemed that his religious writings were constructive and conservative. Those who accused him of destructiveness did not realize how far historical and scientific criticism had already riddled the old foundations; and those who accused him of timidity failed to see that religion is the highest form of culture, the *unum necessarium* (one indispensable) without which all secular education is in vain. His attitude is best summed up in his own words (from the preface to *God and the Bible*): "At the present moment two things about the Christian religion must surely be clear to anybody with eyes in his head. One is, that men cannot do without it; the other, that they cannot do with it as it is." Convinced that much in popular religion was "touched with the finger of death," and convinced no less of the hopelessness of man without religion, he sought to find for religion a basis of "scientific fact," which even the positive modern spirit must accept. And of these facts none, he felt, was more unassailable than "that righteousness tendeth to life," that by repentance we may transcend our ordinary selves, and be born again in love and in discipleship to Christ. A reading of Arnold's *Note Books* will convince any reader of the depth of Arnold's spirituality, and of the degree to which, in his "buried life," he disciplined himself in constant devotion and self-forgetfulness.

Of Arnold's "triumphal tour" in the United States (1883–84) there is no room to speak (but *see* his *Discourses in America* [1885]); nor of his home and family life, nor of the charm which made him one of the most lovable of the eminent Victorians. He died suddenly, of heart failure, on April 15, 1888, at Liverpool, and was buried at Laleham, with the three boys whose early loss had shadowed his life.

See also Index references under "Arnold, Matthew" in the Index volume.

Bibliography.—The first collected edition of Arnold's poems was published in 1869; other editions appeared in 1877 and 1881; and a library edition in 1885. A new and complete edition was published in "Oxford Standard Authors Series" (1950), ed. by C. B. Tinker and H. F. Lowry, who also edited *The Poetry of Matthew Arnold, A Commentary* (1940). *Arnold's Letters (1848–1888)*, collected and arranged by G. W. E. Russell (1895, reprinted 1901); Arnold Whitridge (ed.), *Unpublished Letters* (1923); *Letters to Arthur Hugh Clough*, with an introductory study by H. F. Lowry (ed.) (1932). There is a complete edition (literary contents) of *The Note Books of Matthew Arnold*, ed. by H. F. Lowry, K. Young and W. H. Dunn (1952). An edition de luxe of Arnold's complete *Works*, 15 vol. (1903–04) includes a bibliography by T. B. Smart, who published a separate bibliography in 1892. For a more recent bibliography *see* T. G. Ehrsam and R. H. Deily, *Bibliographies of Twelve Victorian Authors* (1936; suppl. by J. G. Fucilla, in *Modern Philology*, xxxvii, 1939). This gives a full bibliography of Arnold's essays, contributions to periodical literature and editions of and introductions to literary works.

It was Arnold's expressed desire that his biography should not be written; there are, however, a number of monographs and biographico-critical works, among them Lionel Trilling, *Matthew Arnold* (1939), the best full-length study; J. Dover Wilson, *Leslie Stephen and Matthew Arnold as Critics of Wordsworth* (1939); Sir E. K. Chambers, *Matthew Arnold; a Study* (1947); J. D. Jump, *Matthew Arnold*, "Men and Books Series" (1955).

Essays on Arnold: Henry Sidgwick, *Miscellaneous Essays and Addresses* (1904); T. S. Eliot in *The Use of Poetry and the Use of Criticism* (1932–33) and "Arnold and Pater" in *Selected Essays* (1953); Basil Willey in *Nineteenth Century Studies* (1949); Merle M. Bevington in *M. Arnold's "England and the Italian Question"* (1953); John Holloway in *The Victorian Sage* (1953). (B. Wy.)

ARNOLD, SAMUEL (1740–1802), English composer and editor of the works of Handel. Born in London, Aug. 10, 1740, and educated at the Chapel Royal, he became composer to Covent Garden theatre, where in 1765 he produced *The Maid of the Mill.* In 1777 he became music director of the Theatre Royal, Haymarket. Between 1765 and 1802, when he died (in London, Oct. 22), he composed music for nearly 100 successful musical productions—ballad operas, farces and pantomimes—and also published sonatas, symphonies and oratorios, the most important being *The Prodigal Son* (1773), and anthems for the Chapel Royal to which he became organist and composer in 1783. In 1793 he was appointed organist at Westminster abbey.

Arnold's fame, however, rests on his edition of the works of Handel (1787–97), which, although defective in the light of later scholarship, merits respect as the earliest attempt to publish an edition of a composer's complete works. His *Cathedral Music* (1790) was intended as a supplement to William Boyce's collection. His own music is facile, although one or two symphony overtures and several of his harpsichord lessons have charm. (Cs. Ch.)

ARNOLD, THOMAS (1795–1842), headmaster and reformer of Rugby school, was born at East Cowes in the Isle of Wight, Eng., on June 13, 1795. He was educated at Winchester and Corpus Christi college, Oxford, and was elected a fellow of Oriel in 1815. After ordination and marriage he settled at Laleham, Middlesex, in 1819 as a tutor to university entrants. His application for the vacant headship of Rugby in 1827 was supported by Edward Hawkins, shortly to become provost of Oriel, who wrote that if Arnold were elected, "he would change the face of education all through the public schools of England."

Arnold was not an innovator in teaching method; his aim was to reform Rugby by making it a school for Christian gentlemen, and he is chiefly remembered for his sermons in the school chapel. Although he did not originate the prefect system, he used prefects more fully than any previous headmaster. After him this system was adopted in countless English secondary schools. Arnold's influence survived him, and the Arnold tradition spread to other schools through Rugby pupils and masters appointed to them. Many of the new schools established after his death were modeled on Rugby. Arnold died suddenly at Rugby on June 12, 1842.

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ARNOLDSON, KLAS PONTUS (1844–1916), Swedish writer and politician, was awarded the Nobel peace prize in 1908, jointly with Fredrik Bajer. Arnoldson was born in Göteborg, Swed., on Oct. 27, 1844. He became a railway clerk and, from 1871, a stationmaster. In 1881, however, he gave up his post on the railways and from that time devoted himself entirely to the causes he had at heart. In 1881 also he was elected to the Swedish *riksdag*. In politics Arnoldson was a radical, in religion a believer in practical Christianity without dogma; above all he was a passionately convinced pacifist. He supported the neutrality of the Nordic countries and in 1883 helped to found the Swedish Association for Peace and Conciliation. His greatest contribution to peace, however, was made in helping to solve the problems of the Norwegian-Swedish union. From about 1890, when the conflict of views in the two countries was critical, Arnoldson used all his powers, including his gift for inspiring oratory, to form a public opinion in both Norway and Sweden that would support a peaceful settlement. In 1905 he saw the result of his work in the agreed dissolution of the union.

Arnoldson edited several daily newspapers and wrote a number of books. He died in Stockholm on Feb. 20, 1916.

ARNOLFO DI CAMBIO (*c.* 1245–1302), Florentine sculptor and architect, who designed the Duomo in Florence, is mentioned in 1265 and 1267–68 as an assistant of Niccolò Pisano in work on the pulpit in Siena cathedral. In 1277 he was active in Rome in the service of Charles of Anjou. From this period the disassembled monument of Cardinal Annibaldi in St. John Lateran (effigy in the church, other fragments in the cloister) and the tomb of Pope Adrian V in S. Francesco, Viterbo, may be dated. In 1281 he was engaged on a fountain at Perugia, figures from which survive in the Galleria Nazionale dell'Umbria. Immediately after he constructed the monument of Cardinal de Braye (d. 1282) in S. Domenico at Orvieto, and two ciboria in Rome in S. Paolo fuori le Mura (1285) and Sta. Cecilia in Trastevere (1293). In 1296 Arnolfo returned to Florence to undertake his most important commission, the building of the Duomo or cathedral. He is mentioned in Florence in 1300 and appears to have died there in 1302.

One of the greatest Italian sculptors, Arnolfo developed a nota-

bly individual style, which reached full maturity in the magnificent sculptures of the De Braye monument. Unlike his contemporary Giovanni Pisano, he was relatively unresponsive to the impact of French Gothic forms and was strongly influenced by the antique. His latest works, the statues carved for the façade of the cathedral in Florence, now in the Museo dell'Opera del Duomo, are some of the noblest sculptures of their time. In his own day Arnolfo was famous as an architect, and he is traditionally credited not only with the design of the cathedral in Florence but with the choir of the Badia, the church of Sta. Croce and the Palazzo della Signoria. The validity of these attributions and the exact extent of his work in the cathedral are uncertain, but he seems to have been responsible for imposing on Florentine Gothic architecture the austere character that it retained throughout the 14th century.

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(J. W. P.-H.)

ARNOULD, (MADELINE) SOPHIE (1744–1802), French actress and operatic singer, was born in Paris, where, from her debut in 1757 to her retirement in 1778, she enjoyed almost unrivaled popularity. In Gluck's *Iphigénie en Aulide* and *Orphée* she created the parts of Iphigénie and Eurydice.

ARNSTADT, a town of Germany which after partition of the nation following World War II was located in the district of Erfurt of the German Democratic Republic, about 16 mi. S.W. of Erfurt on the Gera river on the northern edge of the Thuringian forest. Pop. (1959 est.) 26,486. Northward rise the castle-crowned peaks, the Drei Gleichen (Three Alike). Arnstadt is known for its glove-manufacturing industry; there are also leather-processing, glass, wood-finishing and engineering works, shoe factories and foundries. There are many holiday and convalescent homes belonging to the Confederation of Free German Trade Unions. Arnstadt dates from the 8th century and became a town in 1266. It was bought in 1306 by the counts of Schwarzburg who lived there until 1716. The 13th-century Liebfrauenkirche is Romanesque and the town hall was built in 1583–85.

ARNULF (*c.* 850–899), East Frankish king and last of the Carolingian emperors. An illegitimate son of Carloman, king of Bavaria, he received the march of Carinthia from his father but was excluded from the succession to the kingdom on Carloman's death. Arnulf maintained and consolidated his frontiers, though in constant tension with the Great Moravian kingdom of Svatopluk. In Nov. 887, at Frankfurt, the East Frankish magnates revolted against the incompetent emperor Charles III, who since 885 had been ruling the reunited Carolingian empire, and Arnulf became their leader. Charles yielded without a battle. The West Franks, Burgundy and Italy, however, would not recognize Arnulf but elected new kings from their own nobility. Thus ended an epoch in European history when the Carolingian empire was finally disintegrated. Arnulf, whose base of operations remained in Bavaria, nevertheless successfully defended his authority in Lotharingia west of the Rhine and even maintained a loose feudal authority over the other kings. He was an energetic ruler whose lordship was acknowledged even by the sons of Svatopluk after their father's death (894). In 891 he defeated the Vikings, whose raids up the Rhine ended in 892. He maintained good relations with the nobility and clergy and held a synod at Tribur, near Mainz, in 895. In the same year at a diet in Worms he created his illegitimate son Zwentibold king of Lotharingia.

In 894, at the request of Pope Formosus, Arnulf had invaded Italy against Guy of Spoleto, who had had himself crowned emperor by Pope Stephen V. This first expedition produced no results, but late in 895 Arnulf forced his way to Rome. He was crowned emperor by Formosus (Feb. 896). While preparing to attack Spoleto, however, Arnulf was struck down by paralysis and had to return to Germany, whereupon his successes in Italy dissolved. This ended the hegemony of the East Frankish Carolings in Italy. Having secured the succession to his East Frankish kingdom for his four-year-old son Louis the Child by obtaining an oath of fealty from the magnates in 897, Arnulf died in Regensburg on Dec. 8, 899.

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(T. Sch.)

ÁRPÁD (d. 907), founder of Hungary and of its first dynasty, son of a Magyar chieftain, Álmos, was elected prince by the heads of the seven Magyar tribes about 890. He successfully united his nomadic people and led them from the steppe lying north of the Black sea between the Don and the Dnieper across the Carpathians by way of the Veretski (Verecke) pass into the north-eastern region of what is now Hungary. This migration was completed by 896. Árpád defeated Zalán, prince of the Bulgars; Marót, prince of the Khazars; Gyalu, prince of the Vlachs; and, with the help of the Western emperor Arnulf, Svatopluk of Moravia. He soon found himself master of the middle Danube basin. He settled the Magyars in central Hungary, in the vicinity of the present city of Budapest, among the conquered tribes. He led the Magyars on numerous successful military expeditions through western countries, devastating parts of Austria, Bavaria, Italy and Switzerland. Árpád died in 907 and, according to tradition, was buried somewhere near Budapest. The male line of the Árpád dynasty became extinct in 1301. (Ge. Gr.)

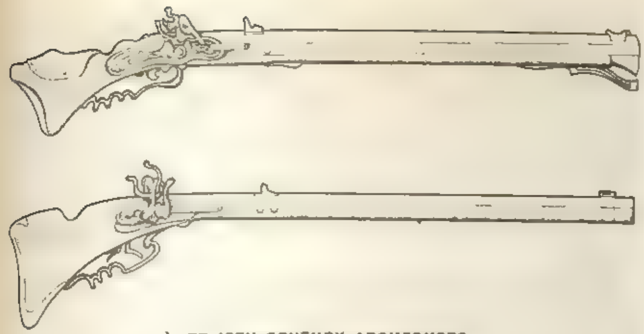
ARPAD, an ancient city identified as Tell-Erfad in north-western Syria, 15 mi. N.N.W. of Aleppo between the latter and 'Azaz. Arpad is frequently listed in the Old Testament with Hamath and other Syrian city states (II Kings xviii, 34; Isa. x, 9). It also appears frequently in Assyrian texts. In 806 B.C. Adadnirari III forced the city to pay tribute in arrear since its rebellion against his father Shamshi-Adad V. Mati-ilu of Bit-Agusi (the area of Arpad) turned against his sovereign Ashurnirari V during a period of Assyrian decline (754 B.C.) and successfully maintained his stand on the side of Sardur II of Urartu until Tiglath-pileser III defeated both Urartu and Arpad, the latter submitting only after a three-year siege (740 B.C.). Basalt blocks that have come to light since 1930 near Sefireh, southeast of Aleppo, contain three treaties from *c.* 750 B.C., made between Barga'yah, ruler of a kingdom designated as KTK, and Mati-el (Mati-ilu). Tiglath-pileser made Arpad capital of a province embracing the western half of northern Syria. Arpad followed the lead of Hamath in a revolt against Sargon II in 720 B.C., but subsequently remained loyal to Assyria. Later the city was capital of a province in the neo-Babylonian empire. (J. S. L.)

ARPINO, a town of central Italy, region of Lazio, province of Frosinone, is 1,476 ft. above sea level and 24 mi. by road east of the town of Frosinone. Pop. (1957 est.) 10,196 mun. Above the town is a castle attributed to Ladislaus of Naples (d. 1414). Nearby on a hill is Civitavecchia, where the sanctuary of the ancient Volscian town of Arpinum was situated. The remains of imposing cyclopean walls of the Volscian period surround the town. These were restored in Samnite, Roman and medieval times, and various towers and gateways were added. An interesting feature is the Porta dell'Arco, a gateway giving on to Civitavecchia. The 15th-century churches of S. Michele and S. Andrea contain pictures by Giuseppe Cesari (d. 1640) commonly known as the Cavaliere d'Arpino, for Arpino was his native place. It was also that of Caius Marius, and M. Vipsanius Agrippa, son-in-law of Augustus. The people are engaged in agriculture, woolen manufacture and the quarrying of coloured marbles.

The Romans conquered Arpinum in 305 B.C. In the middle ages it was sacked by the Longobards, the Saracens and the Hungarians. In 1215 it passed to the Church, which made its southern stronghold there. (M. T. A. N.)

ARQUEBUS, also called Harquebus, Hackbut, etc., a fire-arm of the 16th century. It was the immediate predecessor of the musket (*q.v.*).

The Spanish army was first to replace the handgun, fired from



LATE 15TH-CENTURY ARQUEBUSES

the chest, with the arquebus, which had a stock shaped so that it could be aimed from the shoulder. The improvement that most distinguished this weapon from its crude predecessor was the serpentine—a movable S-shaped clamp holding the smoldering slow-match. Pivoting on a pin, it was connected to a trigger that brought it into contact with the firing pan. The burning end of the match dipped into the priming powder, and the resulting flash ignited the coarse powder in the touchhole and discharged the piece. (*See* SMALL ARMS, MILITARY.)

The French introduced the *arquebus de calibre*, with a standard bore, but the Spanish took the lead in tactical respects. At the battle of Pavia (1525), according to Brantôme, the Marquis of Pescara owed his victory over the French to 1,500 arquebusiers trained "without word of command . . . to wheel round, to face about from this side to that, now there, with the utmost rapidity." This trend toward mobility was short-lived and the heavier musket replaced the arquebus in the last half of the 16th century. *See* TACTICS: *The Military Renaissance.* (LN. MS.)

ARRACK, RACK, or RAK is a name given to many strong, dry spirits, distilled all over the east for local consumption. It is well known in Indonesia, China, India, Ceylon, as well as in Egypt, Turkey and Greece; one variety from the East Indies, of a pale yellow colour, is exported. According to some authorities, the name is derived from the Arabic word *arak* (sweat), *i.e.*, the "sweat" or sap of a certain tree. It is more likely that it is derived from the arecanut, from which a common variety of arrack was long made in India.

Different ingredients are used according to local custom. In Ceylon, arrack is distilled from palm toddy, made from either the palmyra palm (*Borassus flabelliformis*) or the cocoa palm (*Cocos nucifera*). In India, the flowers of the mowrah or mahua tree (*Bassia latifolia*) and fermented rice or millet are generally used as well; sometimes poppy leaves and hemp are also added. The usual fermenting agent is molasses. Some arrack, especially that made in primitive conditions, has a high content of methyl alcohol and a large proportion of by-products, such as fusel oils, which make the spirit both fiery and potentially poisonous. In each case the character of the spirit will depend upon the ingredients used and the method of distillation; local arrack may be injurious, but it may be clean if scientifically distilled.

The manufacture of arrack is diminishing, owing to the wider distribution of more commercial spirits, such as vodka and brandy. Much of the arrack that is manufactured is used (*e.g.*, in India) for industrial purposes. (C. C. H. F.)

ARRAH, a town and headquarters of Shahabad district in Bihar, India, lies 31 mi. W. of Patna and 10 mi. S. of the Ganges. Pop. (1951) 64,205. Area 4 sq.mi. The town has generally one-story buildings and narrow streets. There are three colleges, the library of one of which is in the famous "Little House" at Arrah, a small building defended by the British against Babu Kuar Singh, a leader of the Sepoy uprising of 1857. There is a large playground between the town and courts. Arrah is at the junction of the main line of the Eastern railway with Arrah-Sasaram light railway. (E. AH.)

ARRAN, EARLS OF. The extinct Scottish title of the earls of Arran (not to be confused with the modern Irish earls of Arran, a title created in 1762) was borne by some famous characters in Scottish history. With the exception of Thomas Boyd (d. *c.* 1473), for whom the title was created (*see* BOYD), and of James Stewart (*see* below), all the earls belonged to the Hamilton family.

JAMES HAMILTON (1475?–1529), 1st earl, was the son of James, 1st Lord Hamilton, and of Mary, daughter of James II of Scotland, and was created earl of Arran in 1503 on the occasion of the marriage of James IV with Margaret Tudor. He commanded a naval expedition against England in 1513, but failed lamentably and returned to find his rival, the earl of Angus, supreme at court. He therefore allied with the duke of Albany, regent for James V, and was himself from 1517 to 1520 one of six vice-regents. But in the feuds of these years he had no fixed allegiance. His most spectacular encounter was the fierce fight between the Hamiltons and the Douglases in the streets of Edinburgh known as "Cleanse the Causeway" (1520). When James V freed himself from the power of Angus in 1528, Arran joined him at Stirling. He died at Kinneil in 1529.

JAMES HAMILTON (*c.* 1517–1575), 2nd earl of Arran, was heir presumptive to the throne after the accession of Mary Stuart in 1542, and was appointed governor and tutor. He negotiated for a marriage between Mary and Prince Edward (afterward Edward VI of England), but suddenly abandoned the project and joined the French party. He then agreed to the marriage of Mary with the dauphin of France, receiving the title of duc de Châtelherault at this time (1549); and he resigned office in 1554 in favour of the queen dowager, Mary of Lorraine. On the outbreak of the Scottish Reformation he joined the lords of the congregation (1559) and became the acknowledged leader of the Protestant party. He was exiled in 1565 but he returned to Scotland in 1569 to support the queen's cause, not accepting the fact of Mary's abdication and the regency for her son James VI until 1573. He died at Hamilton, Lanarkshire, on Jan. 22, 1575.

JAMES HAMILTON (1537?–1609), 3rd earl of Arran, was twice considered as a husband both for Mary Stuart and for Henry VIII's daughter Elizabeth (afterward Elizabeth I). During his childhood these projects arose from his father's ambitions; later, when he had returned from commanding the Scots guards in France (1554–59) and had joined the lords of the congregation, the Protestants proposed him as suitor first for the hand of Elizabeth, and then, after Dec. 1560, for that of Mary. He showed signs of insanity in 1562 and the rest of his life was spent in confinement. He died in 1609.

During the insanity of the 3rd earl, his honours were claimed, and for a short time enjoyed, by his cousin, JAMES STEWART, known as earl of Arran from 1581 to 1585. Both he and his rival, the duke of Lennox, were deprived of office when the Protestant lords seized power by the raid of Ruthven (1582); but a year later they in turn were overthrown and driven into exile by Stewart. But his tyranny and insolence alienated many and caused his rapid fall from power. He was accused by Elizabeth I of the murder of Lord Russell on the border in July 1585 and was imprisoned; the banished lords returned and Stewart, proclaimed a traitor, fled in Nov. 1585. From that time his movements are uncertain. He was ordered to leave Scotland in 1586 but may not have done so, and he returned to Edinburgh in 1592 and managed to have himself reinstated at court. He was assassinated near Symington by Sir James Douglas, nephew of the regent Morton whose imprisonment and execution in 1581 he had precipitated.

JOHN (1532–1604), brother of the 3rd earl, became 1st marquess of Hamilton in 1599, and thereafter the Arran peerage was merged in that title. *See* HAMILTON.

See *The Manuscripts of the Duke of Hamilton* (Historical Manuscripts Commission, 1887); G. Hamilton, *History of the House of Hamilton* (1933). (G. S. P.)

ARRAN, the largest island of Buteshire, Scot., at the mouth of the Firth of Clyde. Its greatest length, from the Cock of Arran to Bennan head, is about 20 mi., and the greatest breadth—from Drumadoon point to Kingscross point—is 11 mi. Area 166 sq.mi. Pop. (1961) 3,705.

The scenery of Arran is very fine, and the geological structure complex. The greatest elevations are found in the north, where Goatfell reaches 2,866 ft. The name of this hill is said to be a corruption of the Gaelic *Goadh Bhein,* "Mountain of the Winds."

It belongs to the series of intrusive igneous rocks of Tertiary age—granites—which occupy most of the northern half of the island and form its grandest natural features. These rocks are partly surrounded by an incomplete ring of the oldest rocks in the island—slate, mica-schists and grits—while in the south the rocks are mainly Triassic, the sedimentary rocks, however, being metamorphosed or broken at many points by volcanic intrusions. The island is a favourite place for students of geology.

Many beautiful glens, notably Glen Rosa and Glen Sannox, score the flanks of the mountains, and Lochranza, an inlet in the north, is one of the finest sea-lochs in Scotland. The streams or "waters," as they are called, are generally hill burns, and they and their small mountain-lochs carry trout. Red grouse, pheasant, woodcock, snipe, duck and wild geese are numerous and the northern area is well stocked with red deer. The alpine hare was introduced from the mainland and "wild" goats are also found. Cattle and sheep are raised in considerable numbers.

Brodick is the chief village in Arran. Three miles south is Lamlash, on a fine bay so completely sheltered by Holy Island as to form an excellent harbour. Four miles north lies the village of Corrie, taking its name from a rugged hollow in the hill of Am Binnein (2,172 ft.) which overshadows it. Daniel Macmillan (1813–1857), the founder of the publishing firm of Macmillan and Co., was a native of Corrie.

Steamers from Ardrossan, Fairlie and Gourock communicate with the island, especially in summer when Arran receives many visitors; but some of the services are curtailed in winter. There is a coast road, 60 mi. long, around the island.

About 1½ mi. E. of Lamlash village is Holy Island, 1¾ mi. long, nearly ¾ mi. wide, with a finely marked basaltic cone rising to a height of 1,030 ft. St. Molios, a disciple of St. Columba, founded a church near the northwest point. In the saint's cave on the shore is the rocky shelf on which he lay. Off the southeast coast, 1 mi. from Port Dearg, lies the pear-shaped isle of Pladda where there is a lighthouse and telegraph station from which the arrival of vessels in the Clyde is notified to Glasgow and Greenock.

Standing stones, cairns and other antiquities occur near Tormore, on Machrie bay, Lamlash and other places. The Norse raiders found a home in Arran for a long period until the defeat of Haakon V at Largs (1263) compelled them to retire. Robert Bruce found shelter in the King's caves on the western coast. From the point still known as Kingscross he crossed over to Carrick, in answer to the signal for the supreme effort. Ruins in Glen Cloy bear the name of Bruce's castle, in which his men lay concealed. On the southern arm of Lochranza stands a picturesque ruined castle said to have been his hunting seat. In 1503 the island was awarded by royal charter to Sir James Hamilton of Cadzow, ancestor of the dukes of Hamilton. On the death of the 12th duke most of the island passed to his only daughter who married the duke of Montrose.

ARRAS, the chief town of the *département* of Pas-de-Calais, France, and seat of a bishopric, lies 38 mi. N.N.E. of Amiens on the Paris-Lille railway. Pop. (1962) 40,969. It is situated on the right bank of the Scarpe river at its junction with the little Crinchon river, now covered over. New quarters have been developed on the east, south and southwest.

Many of the old town's ancient buildings, including the 12th- to 14th-century cathedral, were destroyed in the French Revolution. Four years of fighting in World War I again destroyed the greater part of the town, including the celebrated Gothic Hôtel de Ville (16th century) with its belfry, and the abbey church (now restored as the cathedral) and abbey of St. Vaast (18th–19th century). The Hôtel de Ville was rebuilt, but the town suffered further damage in World War II. War monuments include the memorial to soldiers with no known grave (1916–18), the British military cemetery and the memorial to 200 local patriots executed 1941–44. The centre of the town is marked by its two arcaded and linked squares, the Grande Place and the Petite Place, and the town is crossed by the main east-west road. There are *lycées* for boys (18th-century Beaufort palace) and girls (15th-century Carmelite convent), and teachers' training and technical colleges. The museum is devoted mainly to tapestry and French painting, and the library contains a large number of 9th- to 15th-century manuscripts, many illuminated. Arras is a rail and road centre and is served by the tourist airport of Roclincourt. Though chiefly an administrative headquarters, the town has considerable industry including the manufacture of boilers, wagons, cycles, motorcycles, and miners' lamps; rolling and cement plants, oil works, breweries and agricultural-produce factories. For the once famous tapestry industry of Arras *see* TAPESTRY: *European Tapestry*.

History.—Arras was the principal centre of the Atrebates (whence its name), one of the last Gaulish peoples to resist Caesar. Involved in the later troubles of northeastern Gaul, it was destroyed in 407. Its bishopric was promoted by St. Vedast (Vaast) under King Clovis and had a richly endowed abbey in the 7th century. Transferred to Cambrai, the seat of the bishopric returned to Arras in 1094. The town passed to the count of Flanders in 863. The woolen industry was established there at an early date, and Arras, which became the capital of Artois (*q.v.*), had an era of great prosperity in the 12th and 13th centuries, marked by the flourishing of religious and civic communities and of trouvères and dramatists, including notably Adam de la Halle (*q.v.*). From 1110 there are records of a commune, with aldermen, which became a model for many neighbouring districts. In 1180 Arras, with Picardy, formed the dowry of Isabella, daughter of Baldwin V, count of Hainaut, on her marriage to Philip Augustus, king of France. Passing in 1384 to Philip the Bold, duke of Burgundy, Arras became implicated in the rivalry between France and Burgundy. The town gave its name to the peace of Arras (1435) between Philip the Good of Burgundy and Charles VII of France, also to the treaty of 1482 between Louis XI of France and Maximilian I which predetermined the northern frontier of modern France. From 1479 to 1484 Louis XI, after razing the walls, carried out a mass deportation of the citizens, replacing their leaders by French "managers." Charles VIII restored the town's position, and it became the object of contention between him and the Habsburg German king, Maximilian I, who married Mary the daughter of Charles the Bold of Burgundy. The peace of Senlis (1493) gave it to Maximilian and it continued under the Habsburgs until reunited with France in 1640, enjoying thereafter a new period of prosperity. Robespierre, one of the most fanatical of the leaders of the French Revolution, was born in Arras in 1758.

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ARRAS, BATTLE OF, the name given to operations against the Germans by British forces in April and May 1917, during World War I, on a 20-mi. front just east of Arras, in France. The attack was a diversion to the abortive "Nivelle offensive" staged by the French further south.

After a four-day bombardment, which included gas shells, the VII corps of the 3rd army (Gen. Sir E. Allenby) attacked on April 9 and pierced the Hindenburg position, held by the German 6th army (Gen. L. von Falkenhausen) to a depth of 6,000 yd. The Canadian corps of the 1st army (Gen. Sir H. Horne) captured Vimy ridge. Between April 10 and 14, the Germans moved 11 reserve divisions to the area. Further British attacks were made on the Scarpe river (April 23 and 24), at Arleux (April 28 and 29) and again on the Scarpe (May 3 and 4). Finally the 5th army extended the battle area to the south by attacking Bullecourt on May 3, with one Australian and two British divisions. No successes comparable with the first attack were attained. On May 6, the Germans counterattacked, but with only meagre success. Sporadic fighting continued until May 15, when the battle of Arras may be said to have ended. The Australian, British and Canadian forces suffered 158,660 casualties, the German about the same number.

See the British official *History of the Great War—France and Belgium 1917*, vol. i (1940); Sir James E. Edmonds, *A Short History of World War I* (1951).

(C. N. B.)

ARRAU, a large turtle (*Podocnemis expansa*) of the Amazon and Orinoco basins, also called jurara. Its eggs and flesh are an important food for the regional Indians. *See* TURTLE.

ARREST, the placing of a person in custody or under restraint, usually for the purpose of compelling obedience to the law. If the arrest occurs in the course of criminal procedure, the purpose of the restraint is to hold the person for answer to a criminal charge or to prevent him from committing an offense. In civil proceedings the purpose is to hold the person to a demand made against him.

In Criminal Cases.—In Anglo-American law absolute privileges against arrest on criminal charges are recognized in only a limited number of situations. Thus, in the United States, an ambassador or minister representing a foreign nation is exempt from arrest. In England, the limitation applies to the sovereign or to a foreign sovereign. In some states in the U.S. legislators may not be arrested for certain offenses while the legislature is in session. In most states a subsequent arrest may be valid even though the person was brought into the jurisdiction by fraud or illegal force.

Although the law authorizes criminal arrests by a variety of means, the two principal types are (1) those effected pursuant to a warrant (*q.v.*); and (2) those effected without a warrant under legally specified circumstances.

A warrant of arrest may be issued by a court or judicial officer on a showing of probable cause to believe that a criminal offense has been committed and that the person charged in the warrant is probably guilty. The facts constituting "probable cause" must be stated under oath. An arrest warrant may validly be served only by the person or by a member of the class of persons to whom the warrant is addressed. In many states in the U.S. the warrant may be addressed to private persons as well as to peace officers.

At common law a warrant, and hence an arrest effected under its authority, was valid only within the geographical jurisdiction of the judicial officer who issued the warrant. The modern tendency is to relax this limitation. By virtue of the Criminal Justice act of 1925, s. 31(3), a warrant lawfully issued by a justice of the peace, charging either an offense punishable on indictment or summarily, may be executed anywhere in England or Wales. Similarly, statutes of many states in the U.S. now authorize execution of warrants throughout the state. It is usually held that the warrant must be in the possession of the officer at the time of the arrest, but there is no absolute requirement that the warrant be exhibited to the party charged before the arrest is made.

More numerous and of greater practical importance are arrests without warrant. The common-law principles relating to such arrests date from the 17th century and may be stated substantially as follows: A private person may arrest one whom he reasonably believes to have committed treason or a felony if, but only if, treason or felony has actually been committed. A private person may not arrest a misdemeanant unless the offense constitutes a breach of the peace and was committed in the presence of the person making the arrest. The peace officer's powers of arrest are broader than those of a private person in only one respect. Thus, the arrest of a person for treason or felony by a peace officer may be valid even though no such offense was actually committed, provided that the officer reasonably believed the crime to have been committed and the person arrested to be the guilty party.

Because the common law of arrest without warrant antedated development of modern systems of police and law enforcement by some 150 years, it is not surprising that efforts at legislative modification of arrest law have been made in most Anglo-American jurisdictions. Most of these statutory changes are designed to widen the scope of arrest powers, particularly those of the police. Thus, in most states in the U.S. a peace officer is authorized to arrest one committing any misdemeanour in his presence, whether or not the offense constitutes a breach of the peace. The constitutional validity of this and other legislative expansions of arrest powers has ordinarily been upheld in U.S. courts. Although the rules relating to arrests without warrant can be stated with reasonable clarity, their application in concrete situations often involves substantial difficulties. A large body of case law, not in all respects consistent, is concerned with what constitutes "reasonable belief" in various situations. The phrase "in the presence" has usually been interpreted as including not only cases in which the offense occurs within the sight of the arresting party but also those in which he detects commission of an offense through his sense of smell or hearing.

In addition to arrests with or without warrant, valid arrests may be effectuated by other means. Thus an indictment provides sufficient warrant for arrest of the accused, since the return of an indictment by the grand jury constitutes a finding of "probable cause." At common law a bondsman who has provided security for the release of a person on bail may arrest and return such person to custody. Vestiges of the old common-law arrest by hue and cry are found in the statutes of some Anglo-American jurisdictions. Arrests may be made of persons on probation or parole who have violated the conditions of their release, even though such violations do not involve commission of criminal acts. In many cases of minor offenses the accused is not arrested but is notified of the pending criminal proceedings by summons. The familiar "traffic ticket" is one example of a summons.

A decision as to whether the arrest made in a particular case was valid may result in a variety of important legal consequences. Thus a person subjected to unlawful arrest may recover damages in a civil suit against the arresting party. In some circumstances force, even deadly force, may be employed to effect a valid arrest. If, however, the arrest attempted was invalid, the arresting party loses his justification for the use of force and may thereby incur criminal liability. It is generally recognized that a search of the person arrested and of the premises on which the arrest occurred is authorized when "incident to" a lawful arrest. But if the arrest is unlawful, the search is also invalid. A 1961 decision of the U.S. supreme court requires that evidence obtained from defendants by unlawful searches and seizures be barred from criminal proceedings in all state and federal courts. In some situations illegal arrest practices may render a confession of the defendant inadmissible at the trial. Thus in the U.S. federal courts an arrested person must be brought before a magistrate "without unreasonable delay." The U.S. supreme court has held that even a voluntary confession of an arrested party is inadmissible if made in a period of unreasonable delay before he was brought before a magistrate. This rule of the federal courts (popularly known as the Mallory rule) has not been adopted by any of the state systems of criminal justice.

In Civil Cases.—Arrest in civil actions, where authorized, is an auxiliary remedy designed (1) to bring one against whom a demand has been made within the jurisdiction of the court; or (2) to keep the person within the reach of the court's final process and to obtain from him satisfaction of the court's order or judgment.

The use of arrest as a device to compel the appearance of the defendant in a civil suit has a long history in the Anglo-American law. In the early common law no provision was made for default judgments, it being assumed that the court lacked jurisdiction to enter a judgment when the defendant had failed to appear before the court. Much attention was therefore given to devices to compel the appearance of the defendant. In the court of common pleas a succession of writs of increasing severity was made available for this purpose, including the summons and attachments or distress of the defendant's property. If in a suit involving breach of peace, such as trespass, the sheriff returned that the defendant had no property or that attachment had not compelled his appearance, the plaintiff was granted a writ of *capias ad respondendum* for seizure of the defendant's person. Beginning in the middle of the 13th century a series of statutes was enacted making the *capias* available in other actions, so that the writ was ultimately employed in virtually all civil actions. Moreover, the practical effect of the legislation was to relieve the plaintiff of the requirement of first resorting to other devices for compelling the defendant to appear. A somewhat similar development occurred in the court of king's bench and the court of exchequer. The hardships caused by arrest as the mode of initiating civil litigation ultimately produced dissatisfaction. In the 18th century the courts were by statute first granted powers to enter default judg-

ments. Since possession of this power made presence of the defendant no longer essential to the court's jurisdiction, the importance of the *capias* as a method of initiating litigation steadily declined. By an act of 1838 arrest to initiate suit was completely eliminated, although the law still provided for arrest of the defendant by court order after commencement of the suit upon a finding that the defendant was about to leave England. In the United States the laws of some jurisdictions authorize the issuance of a *capias ad respondendum* or a statutory equivalent in such actions as those on contract or for repayment of money where fraud or breach of fiduciary obligation is alleged. Many U.S. jurisdictions authorize arrest of debtors who are about to abscond or leave the state with intent to avoid payment of their debts.

To be distinguished from the use of the *capias* as a method to establish the court's jurisdiction is the use of arrest and detention of the defendant as a device to execute the court's judgment. At common law, in those cases in which an arrest of the defendant to initiate litigation was authorized, the successful plaintiff was entitled to an execution of the judgment by use of the writ *capias ad satisfaciendum.* Under this procedure a debtor was taken and confined until he paid the debt or was otherwise discharged. In England the abuses of the system of imprisonment for debt were only slowly rectified. It was not until passage of the Debtors act of 1869 that the practice was eliminated in all except a few specified situations.

Although imprisonment for debt was practised in the American colonies before the Revolutionary War, provisions in state constitutions outlawing the procedure began to appear as early as 1776. Since that time similar provisions have been included in most of the U.S. state constitutions. These constitutional provisions have usually been interpreted as not applying to tort judgments, on the theory that imprisonment to induce payment of such a judgment is not imprisonment for debt. In most jurisdictions, however, execution upon the person in tort cases is limited to situations in which the defendant's tort involved malice or some other element of aggravation. Despite these and other limitations the U.S. law presents a rather wide range of situations in which imprisonment is authorized, although the occasions on which it can be practised vary considerably from one jurisdiction to another. One typical provision authorizes such action when the judgment debtor refuses to deliver up his estate for the benefit of creditors. Another area in which imprisonment for debt may be authorized is those situations in which the debtor's failure to pay constitutes a contempt of court.

Arrest in civil cases is today regarded as a drastic remedy. In most jurisdictions it is available only in those situations specified in the statutes and is regulated by procedures likewise specified. The Anglo-American law recognizes a series of privileges against civil arrest. Thus in most states in the U.S. a juror is not subject to arrest while serving in his official capacity or when proceeding to or returning from the place of service. The same is true of witnesses attending a place of trial in obedience to a subpoena. A judge is exempt while performing his official duties. Ordinarily a master is not subject to arrest for the tort of his servant unless he participated in his servant's wrong. While formerly a husband might be arrested for the tort of his wife, it is doubtful whether this result would follow under modern law. Various other exemptions are recognized in particular jurisdictions.

Apart from the cases of arrest relating to civil litigation discussed above, arrest of persons may also be authorized in connection with other specialized civil proceedings. Among the most important of these is the arrest of persons suffering from extreme mental disorder. The common-law principle, still generally recognized, is that any person may arrest one who is so insane as to constitute a danger to himself or others. Mental health legislation in many jurisdictions stipulates the conditions in which a mentally disturbed person may be seized and detained as a preliminary to proceedings leading to his commitment.

In English law on arrest there are certain features that require special mention. Not only is the person of the sovereign protected from arrest, but in civil suits no arrest can be carried out of any person of the sovereign's household "*bona fide,* substantially, and continually employed in waiting or attending on the royal person" unless the leave of the lord chamberlain has first been obtained. The same freedom from arrest, except upon a criminal charge, extends in principle to members of the house of lords and the house of commons. This immunity has been held to extend for members of the house of commons to a period 40 days before and 40 days after the sitting of parliament; while the house of lords claims privilege for its members whenever parliament is sitting. Each house claims to be informed whenever one of its members has been arrested or imprisoned upon a criminal charge. It is a question of some doubt whether the doctrine of diplomatic immunity extends so far as to protect ambassadors and diplomatic staff from arrest on a criminal charge.

It is one of the principles of English law on arrest that persons engaged on the business of the higher courts of justice shall be protected from arrest on civil process when about the business of the court, though just how far this privilege extends is not certain. Thus barristers enjoy immunity from arrest when on circuit or while going to or returning from the supreme court. The protection of officers of either house of parliament, as of witnesses, counsel or parliamentary agents who appear before either house or before a parliamentary committee, is an illustration of the same principle.

See also Habeas Corpus; Criminal Law; Extradition; for arrest of a ship *see* Maritime Law. (F. A. A.)

ARRESTMENT, in Scots law, the process by which a creditor detains the goods or effects of his debtor in the hands of third parties until the debt due to him is paid. It is divided into two kinds: (1) arrestment in security, used when proceedings are commencing, or in other circumstances where a claim may become, but is not yet, enforceable; and (2) arrestment in execution, following on the decree of a court, or on a registered document, under a clause or statutory power of registration, according to the custom of Scotland. By the process of arrestment the property covered is merely retained in place; to realize it for the satisfaction of the creditor's claim a further proceeding called "forthcoming" is necessary. By old practice, alimentary funds, *i.e.,* those necessary for subsistence, were not liable to arrestment. By the Wages Arrestment Limitation (Scotland) act, 1870, as amended by the Small Debt (Scotland) act, 1924, the wages of all labourers, farm servants, manufacturers, artificers and working people are not arrestable except (1) in so far as they exceed 35 s. per week; but the expense of the arrestment is not to be charged against the debtor unless the sum recovered exceeds the amount of the said expense; or (2) under decrees for alimentary allowances and payments or for rates and taxes imposed by law.

ARRETIUM: *see* Arezzo.

ARRHENIUS, SVANTE AUGUST (1859–1927), Swedish chemist, was one of the founders of the modern science of physical chemistry. He was born on Feb. 19, 1859, at the estate of Wijk near Uppsala. As a young child he showed an extraordinary facility in calculating, and at school distinguished himself by his mathematical ability. At the age of 17 he entered the University of Uppsala, devoting himself to physics in particular; but, finding that the practical instruction in physics there left something to be desired in those days, in 1881 he went to study under Erik Edlund at Stockholm.

In 1884 he took his doctor's degree at Uppsala with a thesis on galvanic conduction in electrolytes. This thesis, whose development later earned for Arrhenius the Nobel prize, was awarded the lowest "note" which could be granted without a definite refusal. It is divided into two parts, the first dealing with the experimental determination of the electrical conductivity of extremely dilute solutions, and the second with the theory of electrolytic conductivity. This second part expounds his theory of electrolytic dissociation and activity coefficients. It contains some ideas which later investigations have shown to require modification, but forms the foundation upon which all subsequent theories of conductivity of solutions have been built. The revolutionary nature of the theory, which required, for instance, that free sodium ions should exist in a solution of sodium chloride, prevented its being speedily

accepted, and it may be said that it was neglected rather than actively opposed.

Arrhenius himself put on record an anecdote which throws light on the attitude toward his views when they were new: "I came to my professor, Cleve, whom I admired very much, and I said, 'I have a new theory of electrical conductivity as a cause of chemical reactions.' He said, 'This is very interesting,' and then he said, 'Good-bye.' He explained to me later that he knew very well that there are so many different theories formed, and that they are almost all certain to be wrong, for after a short time they disappeared; and therefore, by using the statistical manner of forming his ideas, he concluded that my theory also would not exist long."

In 1887 he published a much revised, extended and consolidated version of his theory of electrolytic dissociation, entitled "Über die Dissociation der in Wasser gelösten Stoffe" in the *Zeitschrift für physikalische Chemie*, which had just been founded. Arrhenius' first thesis had won him the support of Wilhelm Ostwald (*q.v.*), in whose laboratory he worked in 1886, and in 1887 he likewise entered into an intimate friendship with Jacobus H. van't Hoff (*q.v.*). The theories of van't Hoff on osmotic pressure and of Ostwald on the affinity of acids accorded admirably with the views of Arrhenius, and these three friends fought together in unselfish alliance for the new doctrines, which ultimately won general acceptance. Arrhenius had a genius for friendship and in the 40 years between 1887 and his death met practically all the great men of science, and won their affection no less than their regard.

In 1891 Arrhenius declined a professorship at Giessen, Ger., and was appointed lecturer at the Stockholm university; in 1895 he was elected to a professorship in physics there. From 1887 to 1902 he also filled the office of rector of the university. During this time he was occupied in extending the application of the doctrine of electrolytic conductivity to a variety of problems of chemical action, and also, on the supposition that in certain conditions air conducts electrolytically, to the phenomena of atmospheric electricity. Many students from abroad as well as from Sweden worked under his direction. In 1900 he published *Lärobok i theoretik electrokemi* ("Treatise on Theoretical Electrochemistry"), which was translated into German and English, and *Lehrbuch der kosmischen Physik* ("Treatise on Cosmic Physics") appeared in 1903.

Arrhenius was a man of wide interests, and about this time he began to turn his attention to problems of the chemistry of living matter. In 1904 he delivered at the University of California a course of lectures designed to illustrate the applications of the methods of physical chemistry to explaining the reactions of toxins and antitoxins. These lectures were published in 1907 under the title *Immunochemistry*, and in 1915 he published further contributions to exact biochemistry under the title *Quantitative Laws in Biological Chemistry*, in which he again devoted much attention to toxins. He was also much occupied with problems of cosmogony. In his *Worlds in the Making* (1908), an English translation of *Das Werden der Welten* (1907), he combated the generally accepted doctrine that the universe is tending to what Rudolf Clausius termed *Wärmetod* (death of heat) through exhaustion of all sources of heat and motion, and suggested that by virtue of a mechanism which maintains its available energy it is self-renovating, energy being degraded in bodies which are in the solar state, but elevated or raised to a higher level in bodies which are in the nebular state. He further put forward the conception that life is universally diffused, constantly emitted from all habitable worlds in the form of spores which traverse space for years or ages, the majority being ultimately destroyed by the heat of some blazing star, but some few finding a resting place on bodies which have reached the habitable stage. He was one of the first to stress the important part which the pressure of light must play in cosmic physics, and pointed out that the repulsion of the tails of comets from the sun could be explained by this pressure. Astronomical problems, especially the question of the habitability of Mars, are discussed in his *Destinies of the Stars* (1918).

Arrhenius received universal recognition as one of the great men of his time when he was awarded the Nobel prize in 1903 for chemistry "in recognition of the special services rendered by him to the development of chemistry by his electrolytic theory of association." In 1905 after refusing a full professorship and private laboratory in Berlin, he was appointed director of the Nobel Institute for Physical Chemistry at Experimentalfältet, just outside Stockholm, a post which he held until a few months before his death on Oct. 2, 1927. He was buried in Uppsala. In 1910 he was made a foreign member of the Royal society, and in the course of his later career he received numerous honorary doctorates in both the old and new world, as well as the Davy medal of the Royal society and the Faraday medal of the Chemical society. A series of lectures, delivered at Yale university, New Haven, Conn., in 1911 is reproduced in *Theories of Solutions* (1912). He delighted both to visit his colleagues abroad and to receive his contemporaries and students at his home. A genial humour characterized his discourses and his private conversation, and he was welcome at scientific discussions in any land.

Besides the books mentioned above Arrhenius published, in 1926, *Erde und Weltall*, a combined and revised reissue of *Das Werden der Welten* and *Der Lebenslauf der Planeten*. A German translation of his original thesis on "Galvanic Conduction in Electrolytes" was published as no. 160 of *Ostwald's Klassiker* in 1907. The essence of this classic is given in English translation in no. 19 of the *Alembic Club Reprints* (1929).

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(E. N. Da C. A.; R. E. O.)

ARRHYTHMIA, a departure from the normal rhythm of the heart beat. *See* Heart, Diseases and Defects of: *Arrhythmias.*

ARRIAGA (Y BALZOLA), JUAN CRISÓSTOMO (JACOBO ANTONIO) (1806–1826), Spanish composer whose great promise was cut short by his early death. Born in Bilbao, Jan. 27, 1806, 50 years to the day after the birth of Mozart, he showed, like the earlier master, an extraordinary musical precocity; at the age of 13, without having received any lessons in harmony, he composed an opera, *Nada y mucho.* Its success when produced in Bilbao in 1820 led to his being sent to the Paris conservatoire, where he studied the violin under Pierre Baillot and harmony under F. J. Fétis. He matured with phenomenal rapidity, and within two years had written an eight-part fugal *Et vitam venturi*, which Cherubini declared a masterpiece; by the age of 18 he was an assistant professor at the conservatoire. Among his compositions, remarkable for freshness, originality, abundant invention and technical resource, are three string quartets which in style form a connective link between Haydn and Schubert (although the first contains one of Arriaga's rare suggestions of Spanish folk idiom), some French cantatas, a *Mass*, a *Salve Regina*, the opera *Los esclavos felices*, an octet for strings, trumpet, guitar and piano, and a symphony which, like most of his music, combines the classical tradition of Haydn and Mozart with a flavour of Rossini. Arriaga died in Paris on Jan. 17, 1826, and was buried in Montmartre cemetery. The chief theatre in his native Bilbao was later named after him.

See C. A. Figuerido, *El arte y la mente del músico J. C. de Arriaga* (1948). (L. Sa.)

ARRIAN (Flavius Arrianus) (*c.* 96–*c.* 180), Greek historian and philosopher, the most reliable source for the military career of Alexander the Great, was born in Nicomedia in Bithynia, about A.D. 96. He was greatly esteemed by Hadrian, who appointed him governor (*legatus*) of Cappadocia (131–137), where he distinguished himself in a campaign against the Alani. This is the only instance before the 3rd century in which a first-rate Roman military command was given to a Greek. Arrian spent much of his time at Athens, where he was archon during 147–148. In his declining years, he retired to his birthplace, where he devoted himself to literary work. He died about 180. His biography, by Dio Cassius, is lost.

When young, Arrian was the pupil and friend of the stoic philosopher Epictetus. He took verbatim notes of his teacher's lectures, which he subsequently published under the title of *The Dissertations* (*Diatribai*), in eight books, of which the first four are extant and constitute the chief authority for Stoic ethics, and *The Encheiridion* ("Manual") *of Epictetus*, a handbook of moral philosophy. The most important of Arrian's original works is his *Anabasis* ("Expedition") *of Alexander*, containing the history of Alexander the Great from his accession to his death. His chief authorities were, as he explains, Aristobulus of Cassandreia and Ptolemy, son of Lagus (afterward Ptolemy I of Egypt). Both were with Alexander in Asia, and Ptolemy especially, who became one of his leading generals, had access to the best information. It is due greatly to him that Arrian's is the most complete and trustworthy account of Alexander that has survived.

Other extant works of Arrian are: *Indica*, a description of India in the Ionic dialect, including the voyage of Nearchus, Alexander's general, from the Indus to the Persian gulf, which was intended as a supplement to the *Anabasis; Acies Contra Alanos* ("Campaign Against the Alani"), a fragment of importance for the knowledge of Roman military affairs; *Periplus of the Euxine* ("Voyage Around the Black Sea"), an official account written (131) for the emperor Hadrian; *Tactica*, attributed by some to Aelianus, who wrote in the reign of Trajan; *Cynegeticus* (Latin, *De venatione*), a treatise on the chase, supplementing that of Xenophon. The *Periplus of the Erythraean Sea* ("Voyage Around the Red Sea"), attributed to him, is by a later compiler. Among his lost works may be mentioned: *Ta meta Alexandron* ("Alexander's Successors"), a history of the period succeeding Alexander, of which a few pages survive, and an epitome is preserved in Photius; histories of Bithynia, the Alani and the Parthian wars under Trajan; the lives of Timoleon of Corinth, Dion of Syracuse and perhaps of a famous brigand named Tilliborus. The lost work *de rebus Physicis* probably belongs to him too, and not to another Arrian.

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(G. T. Gr.)

ARROL, SIR WILLIAM (1839–1913), British structural engineering contractor responsible for building the bridge across the Firth of Forth, Scot., was born at Houston, Renfrewshire, on Feb. 13, 1839. Apprenticed at 14 to a blacksmith in Paisley, he worked in various places until, in 1868, he opened his own boilerworks. In 1872 he started the Dalmarnock ironworks, which grew into a vast enterprise.

Arrol built many bridges for the Caledonian railway, including the Clyde viaduct at Glasgow, the second bridge across the river Tay and the Forth bridge, on the completion of which he was knighted. He also constructed the steelwork for Tower bridge, London, and the Nile bridge, Cairo. Knighted in 1890, he sat in parliament for South Ayrshire as a Unionist, 1892–1906. He died at Ayr on Feb. 20, 1913.

See Sir R. Purvis, *Sir William Arrol* (1913) and *Engineering, Lond.* (Feb. 21, 1913).
(S. B. Hn.)

ARRONDISSEMENT (from Fr. *arrondir*, "to make round"), a subdivision of the principal French administrative district, *département* (or department) (*q.v.*). The principal cities and their surrounding areas generally constitute the *arrondissements*. There are more than 300 *arrondissements* in metropolitan France, each containing usually from 100 to 150 towns. The administrative officer of the *arrondissement* containing the capital city of a *département* is the prefect; the other *arrondissements* are administered by subprefects. These officials are appointed by the national government. Most *arrondissements* are judicial as well as administrative districts. Before World War II the *arrondissements* had elected councils, but these were suspended in 1940. During most of the Third Republic the *arrondissement* was the basis of the electoral districts for the chamber of deputies.

The cities of Paris and Lyons are divided into local administrative units also called *arrondissements*, and some of France's naval regions are divided into *arrondissements maritimes;* neither of these should be confused with the departmental subdivisions of the same name. *See* also LOCAL GOVERNMENT. (Ry. P.)

ARROWHEAD, a common name for plants of the genus *Sagittaria*, a group of perennial aquatic or marsh herbs of the water plantain family (Alismaceae), so named because the leaves of the best-known species are characteristically arrow shaped. The scapes, which rise from tuberbearing or fleshy knotted rootstocks, are mostly erect though sometimes decumbent and more rarely floating. Though borne on partly submerged stalks, the strongly nerved leaves usually rise conspicuously above the water. The flowers, arranged in whorls of three at the top of the scapes, have three broad white petals alternating with three small green sepals; the fruit is a dense head of small achenes (dry, one-seeded). There are about 40 species, native to temperate and tropical regions, but chiefly American.

The common old world arrowhead (*S. sagittifolia*), found in ditches in England and Ireland, is very widely distributed in Europe and Asia. It grows three to four feet high and bears showy white flowers and orbicular achenes. Many profusely blooming and double-flowered varieties are cultivated in lily ponds and bog gardens. The similar broad-leaved arrowhead (*S. latifolia*), with sharply beaked achenes, grows in shallow water throughout North America except in the arctic region. Its large starchy tubers were used for food by the American Indians. In the lower San Joaquin and Sacramento valleys in California this arrowhead is known as tule potato, and is often cultivated for food by the Chinese of the district in a manner similar to the cultivation for its starchy tubers of *S. chinensis* (which by most botanists is reduced to the widespread *Sagittaria sagittifolia*) in China. The giant arrowhead (*S. montevidensis*) sometimes grows 6 ft. tall with leaf blades 2 ft. long, and bears showy white flowers from 2 in. to 3 in. across, blotched with brownish-purple at the base. This handsome species is native in South America from Peru and Chile to Brazil and Argentina, and was first introduced into cultivation in 1883 from seeds sent to England from Buenos Aires, Arg. It is now planted in water gardens in the warmer parts of the U.S. and has run wild in slow streams in California and the south Atlantic states.

PHOTOGRAPH, JOHN H. GERARD

COMMON ARROWHEAD (SAGITTARIA LATIFOLIA) OF NORTH AMERICA

ARROWROOT. A large proportion of the edible starches obtained from the rhizomes or rootstocks of various plants are known in commerce under the name of arrowroot. Properly the name should be restricted to the starch yielded by two or three species of *Maranta* (family Marantaceae), the chief of which is *M. arundinacea;* and when genuine or West Indian arrowroot is spoken of it is understood that this is the variety meant. *M. arundinacea* is probably a native of Guiana and western Brazil but it has long been cultivated in the West Indies and has spread to most tropical countries. The plant is a herbaceous perennial with a creeping rootstock which gives off fleshy cylindrical tubers, covered with pale brown or white scales and afterward ringed with their scars. When these tubers are gorged with starch, immediately before the season of rest, it is ripe for use. In addition to about 25% of starch, the tubers contain woody tissue, protein and salts. The arrowroot may be separated on a small scale by peeling

the root and grating it in water, when the starch falls to the bottom. The liquor is then drained off and the starch purified by repeated washings. On a large scale the manufacture of arrowroot is conducted with special machinery. Arrowroot is distinguished by the granules agglomerating into small balls, and by yielding with boiling water a fine, transparent odourless and pleasant-tasting jelly. In microscopic structure the granules are oval, marked with concentric lines, similar to potato starch, but having the hilum at the thick extremity of the granule instead of at the thin end. In addition to the West Indian supplies, arrowroot is cultivated in Brazil, southeast Asia, Australia and South Africa. The slender much-branched stem is 5 or 6 ft. high and bears numerous leaves with long narrow sheaths and large spreading ovate blades, and a few short-stalked white flowers.

ARROWROOT PLANT (MARANTA ARUNDINACEA)

(A) Upper part of flowering stem; (B) base of flowering stem and young branch of rhizome; (C) part of the mature rhizome

Tous-les-mois or Tulema arrowroot, also from the West Indies, is obtained from species of *Canna*, a genus allied to *Maranta* and cultivated in the same manner. The granules of tous-les-mois are very large. East India arrowroot is obtained from the rootstocks of species of *Curcuma* (family Zingiberaceae), chiefly *C. angustifolia*, a native of central India. Brazilian arrowroot is the starch of the cassava plant (*Manihot esculenta*), which when agglutinated on hot plates forms tapioca. Tacca or Otaheite arrowroot is the product of *Tacca pinnatifida*, the pia plant of the South Sea Islands. Portland arrowroot was formerly prepared on the Isle of Portland, England, from the tubers of the common cuckoo pint, *Arum maculatum*. Various other species of the arum yield valuable food starches in hot countries. Under the name of British arrowroot the farina of potatoes is sometimes sold. The chief use, however, of potato farina is for adulterating more costly preparations. This falsification can be detected by microscopic examination. Arrowroot contains about 82% starch and about 1% protein and mineral matter. *See* also STARCH.

ARROWSMITH, the name of a distinguished English family of geographers. The first, Aaron Arrowsmith (1750–1823), was born at Winston, Durham, on July 14, 1750. Without a formal education, he went to London, and after working as a surveyor, set up as a map maker and publisher. He became famous for his large chart of the world on Mercator's projection published in 1790. Four years later he published another large map of the world on the globular projection, with a companion volume of explanation. Another important work was his chart of the Pacific ocean in nine sheets (1798). His maps were clearly engraved and free from fanciful decoration. He died in London on April 23, 1823.

He left two sons, Aaron and Samuel, the elder of whom was the compiler of the *Eton Comparative Atlas*, of a biblical atlas, and of various manuals of geography. They carried on the business in company with John Arrowsmith (1790–1873), nephew of the elder Aaron. In 1834 John published his *London Atlas*, the best set of maps then in existence. He followed up the atlas with a long series of elaborate and carefully executed maps embodying the results of contemporary exploration, those of Australia, America, Africa and India being especially valuable. He was an original member of the Royal Geographical society and was awarded one of its gold medals. (G. R. CE.)

ARSACES, an Iranian name borne by the Parthian royal house as being descended from Arsaces, son of Phriapites (date unknown), a chief of the semi-nomadic Parni tribe from the Caspian steppes. The first of his line to gain power in Parthia was Arsaces I, brother of Tiridates, about 247 B.C. (the beginning of the Arsacid era). All Parthian kings after him used Arsaces as their throne name, and with the rare exceptions of usurpers and contestants for the throne, all are so designated on their coins and in official documents. By historians they are generally called by their personal names. The Arsacid dynasty maintained itself, although not in unbroken succession, until its overthrow by Ardashir (*q.v.*) in A.D. 224. During the time of the Parthian empire the Arsacids claimed descent from Artaxerxes II, probably to legitimate their rule over Achaemenian territories. By the Sasanian chroniclers they were linked either with the Achaemenids or with the Kayanians (patrons of Zoroaster); and the period of their rule was shortened to 266 years, because of faulty data and the requirements of Zoroastrian priestly chronology. From the Sasanian chronicles they enter Persian epic under the name the Ashkanian (individual rulers as Ashak, Ashkan).

The name Arsaces was also borne by several kings of Armenia (*q.v.*), who were of Parthian royal blood. It occurs also in cuneiform characters on a Persian seal, probably of the Parthian period. *See* PARTHIA; PERSIAN HISTORY. (MA. B.)

ARS ANTIQUA. The term was originally used in a polemical sense in a 14th-century treatise called *Ars Nova* by Philippe de Vitry to describe the "old technique" of composing from which he and the adherents of the "new style" had progressed. It was intended to refer to the late 13th-century style of writing motets. German musicologists adopted the term and gave it a wider meaning, using it to define the style of the whole polyphonic era, particularly in France, between 1230 and 1320. Further study of polyphonic music, however, revealed the great variety of forms and styles during that period, and the term "*ars antiqua*" reverted to its original meaning.

For bibliography, *see* ARS NOVA. (E. J. WZ.)

ARSENAL, a publicly owned establishment for the manufacture, repair or storage of munitions for land, sea or air forces. The term is used loosely to describe a variety of different types of establishments, including both storage depots and manufacturing plants, and during World War II was applied by Pres. F. D. Roosevelt to the whole United States when he used the phrase "arsenal of democracy." A closely related term, armory, is generally used in the United States to denote an establishment where weapons, usually small arms, are stored and kept ready for issue and where reserve troops assemble for training. But in some instances the term is applied to a manufacturing arsenal, meaning a place where armourers work.

In England the Tower of London served from the Plantagenet era down to the 17th century as a storehouse for weapons and as the official workshop for their manufacture. In modern times Woolwich arsenal has become the most famous British arsenal and since the early 1800s has been designated the royal arsenal. It began in the 17th century as a "gun wharf" on the Thames for the supply of naval vessels and later undertook the manufacture of bronze cannon and other munitions.

In the United States two arsenals, officially called armories, were established in the 1790s at Springfield, Mass., and Harpers Ferry, Va. (now W. Va.), to manufacture and store small arms and related supplies. They were to provide a dependable source of military weapons for the U.S. government and render it independent of other nations in this regard. During the early 1800s Frankford arsenal was established at Philadelphia, Watertown arsenal near Boston and Watervliet arsenal in upper New York state. At the same time, storage arsenals or depots were built at strategic points for the supply of the army, and gun factories were built for the navy. Rock Island arsenal was established in 1863 on an island in the Mississippi river, and later Picatinny arsenal in New Jersey was added as a powder factory. Of the U.S. manufacturing arsenals that continued in active service into the 20th century, each specialized in the development and manufacture of one or more classes of ordnance such as artillery, small arms or ammunition. Because of the great demand for armoured vehicles in World War II a new tank arsenal was created at Detroit, Mich.

After the war, Redstone arsenal in Alabama became the U.S. army's chief rocket and guided missile centre. (H. C. T.)

ARSENIC, a chemical element that has both gray and yellow crystalline forms. White arsenic (arsenious oxide), the common commercial form of the element, is usually prepared as a by-product of the roasting of various ores. The highly toxic nature of many arsenic compounds has led to their extensive use in insecticides and weed killers.

Arsenic is designated by the chemical symbol As. Its atomic number is 33 and its atomic weight is 74.9216.

History and Occurrence.—Of the compounds of arsenic, the sulfides are the earliest mentioned. In the 4th century B.C. Aristotle referred to a substance, probably realgar, which he designated as sandarach; Pedanios Dioscorides and Pliny the Elder in the 1st century refer to auripigmentum, which was probably orpiment. Both observed the change in colour and properties of the sulfide on calcining it. Albertus Magnus in the 13th century noted the appearance of a metallike substance on heating arsenicum (arsenious sulfide) with soap. Later writers considered arsenic to be a semimetal. In 1733 A. Brandt showed that white arsenic is an oxide of arsenic and in 1817 Jöns Jakob Berzelius established the weight relations of arsenic to the other elements.

Arsenic is widely distributed. It appears at low concentration in volcanic gas, sea water and spring water, and traces are present in many chemicals, metals and foodstuffs. Mineral deposits of native arsenic usually occur in metalliferous veins in association with ores of antimony, silver, etc. Some of the naturally occurring compounds of arsenic are shown in Table I. Of these, arsenopyrite or mispickel is the most abundant. (H. Te.)

Table I.—*Mineral Compounds of Arsenic*

Type	Mineral name	Formula
Oxide	arsenolite	As_2O_3
Metal oxyarsenic compounds	mimetite	$Pb_5Cl(AsO_4)_3$
	olivenite	Cu_2OHAsO_4
	scorodite	$FeAsO_4.2H_2O$
Arsenic sulfides	realgar	AsS
	orpiment	As_2S_3
Metal arsenides	smaltite	$CoAs_2$
	löllingite	$FeAs_2$
Metal-sulfarsenic compounds	arsenopyrite	$FeAsS$
	cobaltite	$CoAsS$
	tennantite	$Cu_3As_2S_7$
	enargite	Cu_3AsS_4
	proustite	Ag_3AsS_3

Production and Application.—White arsenic, As_2O_3, is the principal form of arsenic in commerce. The United States and Sweden are the leading producers, followed by Mexico, France, Germany, Italy and Japan.

Practically all of the white arsenic is produced as a by-product from the roasting of copper, lead, and other ores, although it can be produced by roasting arsenopyrite and arsenic sulfide ores. In general, arsenic is regarded as a troublesome impurity. The large amounts of arsenic oxide obtained as a by-product sometimes exceed the market demands, creating a disposal problem. At one time a Swedish plant placed its excess arsenic oxide in large concrete cylinders which were towed out and sunk in the ocean.

When ores containing arsenic are roasted the volatile oxide collects in the flue dusts. These dusts are roasted again and a crude product containing about 90% white arsenic is collected in condensing chambers. Refining of the crude oxide by volatilization yields a white crystalline product of over 99% white arsenic.

Metallic arsenic is produced by reducing arsenic trioxide with charcoal in a retort furnace of the horizontal type. The volatilized metallic arsenic is deposited on the walls of a water cooled condenser. Metallic arsenic was made in the United States during World War I and World War II, but in the early 1960s all needs were met by importations, mainly from Sweden.

The major uses of arsenic compounds are as insecticides, weed killers, in the manufacture of glass and in wood preservatives. The principal insecticides are lead arsenate, calcium arsenate, and Paris green (copper acetoarsenite); the use of arsenicals for this purpose has been reduced by the adoption of organic chemical compounds. Sodium arsenite is used as a weed killer; arsenic trioxide is used as a decolorizer in the glass industry; and sodium arsenate is used as a wood preservative.

The most important metallurgical use of arsenic is in arsenical copper, where it increases the corrosion and erosion resistance and raises the annealing temperature. Arsenical copper alloys are used in making automobile radiators and other objects assembled by soldering. Metallic arsenic is also added to lead for making shot in order to obtain more perfect spheres; in lead-tin-antimony-bearing alloys to obtain better strength at elevated temperatures; and as a partial replacement for antimony as a hardening agent in lead storage battery plates. (A. W. S.)

Physiological Effect and Therapeutic Uses.—The most common toxic forms of the arsenic compound are those of trivalent arsenic. The toxicity depends on the availability of the oxy-ions, and is greatly diminished if the solubility of the compound is low or if the arsenic is incorporated in other stable complexes. The principal effects produced by arsenic in the system are degeneration of the lining of the digestive tract and of the tissues of other internal organs, and probably also a direct attack on nerve tissue. Nausea, vomiting, diarrhea, headache, muscular pains, weak pulse and coma are symptoms observed in arsenic poisoning. (*See also* Poison: *Characteristics of Different Poisons: Irritant Poisons*).

Some inhabitants of Styria, Tyrol and other regions believe that arsenic compounds exert a tonic effect and the habit of arsenic eating is prevalent in these regions. Inorganic arsenic preparations have been prescribed for anemia, leukemia, nervous disorders, rheumatism, malaria, trypanosome infections and syphilis. Organic preparations are, however, less capricious and less dangerous and have supplanted inorganic compounds in many applications. For example, arsphenamine hydrochloride (salvarsan) and related derivatives have been used in the treatment of syphilis; and sodium arsanilate (atoxyl) has been used with success in the treatment of some forms of sleeping sickness.

CHEMISTRY OF ARSENIC AND ITS COMPOUNDS

Physical Properties and Structure of Elementary Arsenic.—Arsenic is placed in the main Group V of the periodic classification, below phosphorous and above antimony. The trend from nonmetallic to metallic characteristics as the atomic number in the group increases reveals itself in the appearance of metallic properties in some of the forms of elementary arsenic, but in terms of chemical properties, this element is best classified as a nonmetal. Some of the important properties of arsenic atoms are the following:

Electron configuration	$3s^2, 3p^6, 3d^{10}, 4s^2, 4p^3$
Ionizing potential of gaseous atom	10.5 v.
Radius of As^{+++} in crystals	0.69 Å
Mass numbers of isotopes	range from 68 to 80; only the natural isotope, 75, is stable.

Elementary arsenic exists at room temperature in two well-defined crystalline forms: metallic or gray arsenic, the common stable form, and yellow arsenic, which is unstable for all conditions with respect to transformation to other forms. Their physical properties are outlined in Table II.

Yellow arsenic is deposited when arsenic vapour is cooled suddenly below 0° C. It appears as well-formed crystals on evaporation of solvent from the solution in carbon disulfide. The transformation of yellow arsenic to stabler forms is accelerated by heat, by light and by certain substances, iodine and bromine being two which are thus catalytically active.

Other forms of elementary arsenic have been reported. If arsenic is sublimed, the characteristics of the deposits which appear depend on the temperature of deposition. At about 200° C., a black shiny deposit of density 4.7 g. per cubic centimeter collects. While the deposits at other temperatures differ in density and appearance, all are similar in that they are brittle, show conchoidal fracture, and none are obviously crystalline. Above about 280° C. only the gray form exists.

The crystal structure of elementary arsenic has been determined by X-ray methods. The crystals of the gray form are composed of double layers of atoms. Within a given double layer consisting of two planes of atoms, an atom of arsenic in one of the

TABLE II.—*Physical Properties of Arsenic*

Property	Gray arsenic	Yellow arsenic
Appearance	steel gray; opaque, metallic lustre	yellow; transparent
Crystalline system	hexagonal	cubic
Melting point	814° C. at 36 atm. press.	transforms below melting point
Specific heat	0.0772 at 28° C.	
Density	5.73 g./c.c.	2.03 g./c.c. at 18° C.
Electrical resistivity	35×10^{-6} ohm-cm./cm.^{3} at 20° C.	
Specific magnetic susceptibility	0.31×10^{-6}	
Linear coefficient of expansion	5.59×10^{-6} at 40° C.	
Cubic compressibility	4.5×10^{-6}/atm. at 20° C.	
Mechanical properties	brittle; hardness 3.5 on Mohs' scale	softer than gray form
Vapour pressure	1 atm. at 604° C.	more volatile than gray form
Heat of sublimation	580 kg.cal./g. atom	
Solubility	not appreciable in common solvents	8 g./100 c.c. CS_2 at 20° C.; slightly in C_6H_6 and glycerine

planes has as closest neighbours three equidistant atoms in the adjacent plane at a distance of 2.51 Å. The next closest neighbours are three equidistant atoms of an adjacent double layer, and are 3.15 Å removed. The yellow form of arsenic probably contains tetrahedrally shaped molecules As_4. This conclusion is reasonable since the molecular weight of yellow arsenic in carbon disulfide corresponds to the formula As_4, and in the analogous case of white phosphorus, the tetra-atomic molecules persist in the solid state.

Arsenic vapour at temperatures below 800° C. exists as As_4 molecules but at higher temperatures measurable decomposition into smaller molecules occurs. Thus, at 1,700° C. and ordinary pressure, the average molecular constitution of the gas corresponds to the formula As_2.

General Chemical Properties.—In common with the other main Group V elements, arsenic exhibits the range of valence states from 3− to 5+ in its compounds. These extremes, together with the 3+ state, embrace the principal compounds of the element. The enhanced electropositive character of arsenic as compared with phosphorus can be correlated with the following facts: AsH_3 is less stable than is PH_3, is a more powerful reducing agent and is less basic; the oxidation of As to the positive ion $As(OH)_2^+$ can be achieved by a weaker oxidizing agent than would be required for the corresponding hypothetical change with phosphorus; the hydroxide $As(OH)_3$, but not the hydroxide $P(OH)_3$, can be converted to a positive ion by strong acid. While the arsenic atom is larger than that of phosphorus, the usual co-ordination number to oxygen is still only four. The similarity in size and shape of arsenate and phosphate ions is indicated by the isomorphism of many metal arsenates and phosphates. In their chemical behaviour, however, phosphates and arsenates show important differences, the arsenates being in general much more labile. Thus, arsenates oxidize (*see* OXIDATION AND REDUCTION) much more rapidly than do phosphates, and equilibrium between *ortho* and condensed forms of arsenic acids is established much more rapidly than is the case with the phosphoric acids. Antimonates and arsenates are dissimilar in structure and in many properties, since the co-ordination number of antimony to oxygen in antimonates is six.

Analysis and Detection.—In a common scheme for qualitative analysis, arsenic is precipitated as the trisulfide, together with the sulfides of mercury, copper, antimony, tin, etc., by passing hydrogen sulfide into an acid solution containing these as ions. Iodide ion may be added to the solution to facilitate the reduction of arsenate, if present, to the 3+ valence state. Arsenious sulfide together with the sulfides of antimony and tin are separated from those of mercury, copper, etc., by treating the precipitates with an alkaline solution containing sulfide ion. In this operation, As_2S_3 is converted to AsS_2^-, and the antimony and tin sulfides to similar sulfo-anions. On making the resulting solution strongly acid, only arsenious sulfide precipitates. This can be filtered off and the presence of arsenic confirmed by a convenient one of the methods of detection described below.

Quantitative determination of arsenic can be based on the precipitation of magnesium ammonium arsenate. This solid is filtered off and dissolved in hydrochloric acid solution; the arsenic is then precipitated as As_2S_5, which is filtered off, washed, dried and weighed.

The detection of arsenic even in traces is important because of the toxic nature of many arsenic compounds. The Reinsch test utilizes the fact that arsenites in acid solution are reduced by copper. A piece of clean copper is inserted into the solution to be tested. If an arsenite is present a black deposit forms on the copper, and the deposit on heating in oxygen is converted to the white volatile oxide which collects on the walls of the tube. In other tests, the arsenite is reduced to the volatile substance arsine which is carried along by a stream of hydrogen. In the Fleitmann test, silver nitrate test paper is exposed to the vapour, a black deposit indicating the presence of arsine. In the Marsh test, the gas is passed through a heated tube, and if arsine is present, a shiny black mirror of arsenic is deposited. The similar mirror of antimony is not removed by a solution containing hypochlorite ion, but that of arsenic is. In the Gutzeit test, a mercuric chloride test paper is exposed to the gas stream, and develops a black stain if arsine is present. In each case, hydrogen sulfide is removed by generating the gas in an alkaline solution, or by passing it through a solution of lead acetate.

Chemical Properties of Elementary Arsenic.—Elementary arsenic can function both as an oxidizing agent and as a reducing agent. The half-reactions describing these modes of action, and their potentials relative to the normal hydrogen electrode as zero, are:

$$AsH_3 = As + 3H^+ + 3e^- \qquad E^\circ = 0.54$$
$$3H_2O + As = As(OH)_3\,aq. + 3H^+ + 3e^- \qquad E^\circ = -0.248$$

As is to be expected from the value of the potential for the reduction of elementary arsenic, only powerful reducing agents can accomplish this process. It does take place when arsenic is present at the cathode during electrolysis of an alkaline solution. A large variety of oxidizing agents oxidize elementary arsenic to higher valence states in the presence of water. Chlorine, bromine, concentrated nitric acid and potassium permanganate are examples.

In contrast to phosphorus, arsenic does not disproportionate to the 3+ and 3− valence states when it is treated with alkali. Fusion with alkali does result in the production of arsenite, but presumably hydroxide ion or oxygen functions as the oxidizing agent in the change.

In the dry state, arsenic can be oxidized by oxygen, fluorine, chlorine, bromine, iodine and sulfur as well as by other powerful oxidizing agents, such as KNO_3 or $KClO_3$. The products of interaction for the elementary oxidizing agents listed are: As_4O_6, AsF_3 or AsF_5, $AsCl_3$, $AsBr_3$, AsI_3 and As_2S_3 or As_2S_5. The changes take place readily in all cases, and in fact with O_2, F_2 and Cl_2 they can proceed as combustion reactions. Arsenic can be reduced in the dry state by the direct action of alkali metals and other active metals.

Valence State 3− and Compounds with Metals.—Arsine, AsH_3, is a colourless, extremely poisonous gas. The melting point and normal boiling point of the substance are −119° C. and −55° C. respectively. The solubility in water is low, much less than that of ammonia, but the solubility in less polar solvents such as fats and turpentine is quite high.

Arsine cannot be prepared by the direct combination of the elements. Two methods of preparation have been used: (1) the reduction of arsenious acid or arsenates by powerful reducing agents in a strongly acid or, for some metals, strongly alkaline medium, and (2) the interaction of water or a mineral acid with the arsenide of an active metal. The mineral acid commonly used is hydrochloric acid. Equations describing typical preparations are:

$$3Zn + 6H^+ + As(OH)_3 = 3Zn^{2+} + AsH_3 + 3H_2O$$
$$Zn_3As_2 + 6H^+ = 3Zn^{2+} + 2AsH_3$$

The second method of preparation yields a purer product.

Arsine is unstable with respect to decomposition into the constituent elements. This decomposition proceeds slowly under ordinary conditions but less rapidly if the gas is thoroughly dried

or if the surface area is decreased. The reaction is accelerated on the absorption of light and by an increase in temperature, and can proceed explosively if the gas is suitably detonated.

Arsine is a powerful reducing agent, being oxidized by even fairly weak oxidizing agents. It reduces soluble silver, mercury and gold salts, sulfurous acid and the more powerful oxidizing agents such as chromates, permanganates and the halogens. Arsine can act also as an oxidizing agent but only powerful reducing agents are affected; sodium and potassium react with it, reducing it to hydrogen and forming the corresponding arsenide.

Double decomposition reactions, involving the interaction of arsine with a metal salt to produce a metal arsenide and an acid, are not well defined. It seems likely that this type of change takes place when arsine is passed into a solution of a cupric salt, and the formation of a metal arsenide may be an intermediate stage in the net reduction by arsine of heavy metal ions.

The Compounds of Arsenic with Alkali, Alkaline Earth and several other metals are also examples of compounds containing arsenic in the 3− valence state. Specific examples are: Na_3As, Ca_3As_2, Zn_3As_2 and AlAs. Substances of this type can be prepared by the direct union of the elements or by heating the metals with arsenious oxide and carbon.

Other compounds of arsenic with metals, some of which are more complex than those of the previous class, are known. Many of these compounds occur naturally and some can be made by the methods used above. As the metals become increasingly noble, it is observed that the compounds depart more and more from the rather saltlike character of the alkali metal arsenides, and begin to assume metallic physical properties. The reaction with acid to form arsine does not take place for the more noble metal arsenic compounds and in these compounds the assignment of a negative valence state to arsenic has little significance.

The 3+ Valence State (in Solution).—Arsenic in the 3+ valence state can exist in water solution as a positive ion, as the hydroxide, as a negative oxy-ion and as a negative sulfarsenite ion.

A solution of the hydroxide, arsenious acid, is formed by bringing arsenious oxide in contact with water. The exact formula of the acid in water solution has not been established. However, it has been shown that the hydroxide contains only one arsenic atom per molecule and on this basis the formulation of the substance as $As(OH)_3$ or H_3AsO_3 seems reasonable. Arsenious acid is a weak monobasic acid; the value for the dissociation constant at 25° C. is about 6×10^{-10}.

There are a number of important association reactions involving the oxyarsenite species. Arsenious acid reacts with strong bases to give a solution containing the arsenite ion, $H_2AsO_3^-$. There is evidence that in solutions containing both arsenious acid and arsenite ion, substantial concentrations of a complex which has two arsenic atoms in each unit exists. Since most arsenites, with the exception of the alkali metal and ammonium arsenites are only sparingly soluble in water, precipitates are formed when solutions containing arsenites and many metal salts are mixed. The metal arsenites resulting are of various types. In some of the products, Ag_3AsO_3 and $Pb_3(AsO_3)_2$ for example, complete replacement of the hydrogen ions of the acid by metal ions has taken place. Other compounds, $Ca_3As_4O_9$ and $Ca_2As_2O_5$, for example, may contain polyarsenite ions. In some cases, association of metal and arsenite ions to form complex ions appears to take place. Thus, although copper arsenite is sparingly soluble in water, a precipitate does not form when a solution of a copper salt and an excess of an alkaline solution containing arsenite are at room temperature. In strongly acid solution, arsenious hydroxide is converted to a positive ion, which can be represented by the formula $As(OH)_2^+$. The constant governing the equilibrium, $As(OH)_3 = As(OH)_2^+ + OH^-$, is about 5×10^{-15}. When hydrogen sulfide is passed into a solution containing arsenious acid, arsenious sulfide is formed. If the concentration of ions in the solution is low, the sulfide persists for long periods of time as a colloidal suspension. In the presence of an electrolyte such as HCl, however, arsenious sulfide separates as a yellow precipitate.

Arsenious acid and arsenites are fairly strong and, in most cases, rapid reducing agents. Thus, chlorine, bromine and iodine, concentrated nitric acid, potassium permanganate, etc., rapidly transform arsenites to arsenates. With iodine, the oxidation is substantially complete only in neutral or alkaline solutions. In solutions of intermediate acidity, the equilibrium, $H_3AsO_4 + 2H^+ + 2I^- = As(OH)_3 + I_2 + H_2O$, is measurable.

The reduction of arsenites by powerful reducing agents has been discussed in connection with the chemistry of arsine.

A solution containing sulfarsenite ion can be prepared by dissolving arsenious sulfide in a solution containing sulfide ion. The sulfarsenite ion is commonly represented by the formula AsS_2^-. In the presence of acid the reaction, $2AsS_2^- + 2H^+ \rightarrow As_2S_3 + H_2S$, takes place.

Many metal sulfarsenites, of formulas analogous to arsenites, are formed on adding soluble metal salts to solutions of sulfarsenites. Examples are $Ba_3(AsS_3)_2$ and $Ba_2As_2S_5$.

Compounds in the 3+ Valence State.—*Arsenious oxide*, As_2O_3, the substance referred to as white arsenic and often simply as arsenic, exists in several forms as shown in Table III.

TABLE III.—*Physical Properties of Arsenious Oxide*

Property	Arsenolite	Claudetite	Amorphous
Crystalline system	cubic	monoclinic	amorphous
Colour	white	white	colourless
Density, g./c.c.	3.65 at 12.5° C.	4.05	3.68 at 12.5° C.
Melting point	275° C.	*c.* 315° C.	*c.* 200° C.
Solubility, g./100 g H_2O	2.04 at 25° C.		*c.* 4 at 13° C.
Vapour pressure	6 mm. at 240° C.	6 mm. at 240° C	
Hardness	1.5	2.5	

Cubic white arsenic is the common form. The so-called amorphous variety is unstable with respect to the other forms at room temperature and changes over fairly rapidly to the cubic form in the presence of water. It is formed on slow condensation of arsenious oxide vapour.

In the vapour state arsenious oxide exists as molecules As_4O_6 up to temperatures well in excess of 1,000° C. At sufficiently high temperature, dissociation to smaller molecules does take place. In solution in nitrobenzene the substance also exists as As_4O_6 molecules, and X-ray studies have shown As_4O_6 molecules to be present in the cubic modification. As_4O_6 molecules have arsenic atoms in a tetrahedral configuration, with oxygen atoms bridging them along the tetrahedron edges. The As—O separation is 1.80±0.02Å, the As—O—As angle is 126±3° and the O—As—O angle is 100±1.5°.

The reactions of arsenious oxide in water are included in the chemistry of arsenious acid. It is of interest to note that the rate of solution of arsenious oxide in water is accelerated by mineral acid, presumably because As—O bonds must be hydrolyzed in the process.

Arsenious Halides.—The halides can be formed by direct union of the elements or by treating arsenious acid with the corresponding hydrogen halide. With the latter method of preparation, the fluorine, chlorine and bromine compounds can be distilled off from the reaction mixtures while the iodine compound separates as crystals.

TABLE IV.—*Physical Properties of Arsenious Halides*

Property	AsF_3	$AsCl_3$	$AsBr_3$	AsI_3
Colour	colourless	colourless	colourless	red
Melting point	−8.5° C.	−18° C.	31° C.	146° C.
Boiling point	64° C.	130° C.	221° C.	*c.* 400° C
Density, g./c.c.	2.67 at 0° C.	2.18 at 20° C.	3.66 at 15° C	4.39 at 15° C
Dielectric constant		12.4 at 21° C.	8.33 at 35° C.	7.0 at 150° C
Heat of formation		71.4 kg cal.	45.6 kg.cal.	13.5 kg cal
Molecular shape	pyramidal	pyramidal	pyramidal	pyramidal
As X distance	1.72 Å	2.16 Å	2.31 Å	2.51 Å
X-As-X angle		103 ± 3°	101.5°	102.5°

As may be seen from their physical properties, and the observation that the dissociation in the liquid state or in solvents is very slight, the arsenic halides are not saltlike. In water solution they are rapidly hydrolyzed to arsenious acid and the hydrogen

halide.

Arsenious sulfide occurs naturally as orpiment. It can be made by heating arsenic and sulfur in equivalent amounts. An amorphous, or cryptocrystalline, form is deposited when hydrogen sulfide and arsenious acid interact in water solution.

The solubility of arsenious sulfide in water is very low. Even concentrated hydrochloric acid, if cold, does not affect it, but it is transformed by sulfide ion to sulfarsenite ion, by concentrated alkali to sulfarsenite and arsenite ion and by oxidizing agents to arsenates and sulfur.

The Valence State 5+ (in Solution).—The principal forms to consider for the 5+ valence state in water solution are arsenic acid, its ions and the sulfarsenate ion. Only the *ortho* form of arsenic acid exists in water solution in reasonable concentrations.

Arsenic acid functions as a tribasic acid. The dissociation constants for the successive dissociations are 4.8×10^{-3}, 4.8×10^{-7} and 4.8×10^{-13}. Most arsenate salts except ammonium and alkali metal salts are only sparingly soluble in water, and can be precipitated by mixing solutions of arsenates and the appropriate metal salts. The products obtained from water solution are almost always the *ortho*-arsenates.

Arsenic acid is a sufficiently powerful oxidizing agent to oxidize stannous salts, iodides in acid solution and sulfurous acid. The reaction with hydrogen sulfide can proceed either as the double decomposition reaction, $2H_3AsO_4+5H_2S=As_2S_5+8H_2O$, or as the oxidation-reduction reaction, $2H_3AsO_4+5H_2S=As_2S_3+2S+8H_2O$. Both changes proceed slowly but are accelerated by an increase in hydrogen ion concentration and of temperature. An increase in concentration of arsenic acid favours its reduction relative to precipitation of arsenic pentasulfide.

Sulfarsenate ion in solution is represented by the formula AsS_4^{3-}. It is formed when arsenic pentasulfide is treated with a solution containing sulfide ion, or arsenious sulfide with polysulfide ion. The acid corresponding to the ion is unstable and decomposes to arsenious sulfide and hydrogen sulfide. As a class the sulfarsenates are more soluble than the arsenates but precipitates of heavy metal sulfarsenates can be formed from water solutions. *Ortho*-sulfarsenates, $Cu_3(AsS_4)_2$, etc., and *pyro*-sulfarsenates, $Co_2As_2S_7$, etc., are known.

Compounds in the 5+ Valence State.—When a solution of arsenic acid, made for example by oxidizing arsenious oxide with concentrated nitric acid, is evaporated, the solid hydrate $2H_3AsO_4.H_2O$ separates. On further dehydration, crystals of *pyro*-arsenic acid $H_4As_2O_7$ are formed. Continued heating produces a glassy mass of simplest formula $HAsO_3$ and on complete dehydration arsenic pentoxide, of simplest formula As_2O_5, results.

Arsenic pentoxide formed on the dehydration is white and appears noncrystalline on examination under a microscope. At a sufficiently high temperature it melts and on cooling forms a glassy solid. In the vapour state at high temperature it dissociates to arsenious oxide and oxygen. As_2O_5, $HAsO_3$ and $H_4As_2O_7$ all absorb water rapidly and are transformed to *ortho*-arsenic acid.

Arsenic pentafluoride has been prepared by the spontaneous interaction of arsenic trifluoride and fluorine, and by heating a mixture of arsenic trifluoride, antimony pentafluoride and bromine. The boiling point of arsenic pentafluoride is $-53°$ C. and its melting point $-80°$ C. It has been suggested that arsenic pentachloride is formed when arsenic trichloride and chlorine react at low temperature. The substance if it exists is unstable above $-30°$ C.

Arsenic pentasulfide, As_2S_5, can be prepared by heating the elements in the proportions required by the formula. It is yellow in colour, and only sparingly soluble in water. At high temperatures, it decomposes to arsenious sulfide and sulfur.

Organic Derivatives of Arsenic.—Most of the organic derivatives of arsenic can be considered in two series:

Series I, R_3As, R_2AsX, $RAsX_2$, AsX_3
Series II, R_3AsX_2, R_2AsX_3, $RAsX_4$, AsX_5

In the general formulas above, R represents hydrogen atoms and aliphatic or aromatic organic radicals and X represents an electronegative atom or radical (F, Cl, Br, I, OH, $\frac{1}{2}SO_4$, etc.). The least oxidized members of each series appear at the left in each list, the increasingly more oxidized members to the right arising by progressive replacement of organic radicals by electronegative atoms or radicals. Arsenious and arsenic acids are examples of the most oxidized members for series I and II, respectively.

Series I.—In the lowest stage of oxidation for the first series, compounds of the type RH_2As, R_2HAs and R_3As are known. None of the substances in the class above has pronounced basic character to H^+, although they do show a strong affinity for some metal ions such as Pt(II), Pd(II). Arsenic trimethyl, $(CH_3)_3As$ can be prepared by the reaction of arsenic trichloride with zinc dimethyl. By the action of an alkyl iodide on compounds of the type R_3As, tetra-alkylarsonium compounds are formed. The tetra-alkylarsonium compounds such as R_4AsCl are saltlike, little hydrolyzed and are completely dissociated into ions in water. R_4AsOH is a strong base.

In the second stage of oxidation, the cacodyl derivatives, $(CH_3)_2As—X$, have received particular attention. Cacodyl oxide, $(CH_3)_2As—O—As(CH_3)_2$, is prepared by distilling a mixture of potassium acetate and arsenious acid. On treatment of cacodyl oxide with HCl, cacodyl chloride, $(CH_3)_2AsCl$, is obtained. The halogen is readily replaced by other electronegative groups. By reduction of cacodyl oxide, free cacodyl, $(CH_3)_2As—As(CH_3)_2$, analogous to hydrazine in structure, is formed.

In the third stage of oxidation, RAsO rather than $RAs(OH)_2$ is formed when a substance of the type $RAsCl_2$ is treated with a base. Compounds of the type $RAsCl_2$ can be prepared by the action of chlorine on $RAsH_2$.

Examples of organic derivatives of the final stage of oxidation in the first series are esters of arsenous acid. The ester $As(OC_2H_5)_3$ is prepared by the reaction of arsenic trichloride and ethyl alcohol.

Series II.—Trimethyl arsine oxide, $(CH_3)_3AsO$, an example of the lowest oxidation state for the second series of arsenic organic derivatives, results when $(CH_3)_3As$ is exposed to air. Compounds of the type R_3AsCl_2 can be prepared by treating R_3As with chlorine.

An important compound in the second stage of oxidation for the second series is dimethyl arsenic (or cacodylic) acid, $(CH_3)_2AsO$ OH. It can be obtained by oxidizing cacodylic oxide with mercuric oxide in the presence of water. It is a weaker acid than is arsenic acid, its dissociation constant being 6.4×10^{-7}.

Methyl arsinic acid, $CH_3AsO(OH)_2$, is a representative of the third stage of oxidation. Sodium methyl arsenate is formed when sodium arsenite and methyl iodide are left in contact in dilute alcoholic solution for several days.

In addition to the organic compounds described thus far, there are others in which As—As bonds are retained. They include cacodyl, mentioned above, arsenobenzene ($C_6H_5As—AsC_6H_5$) and its derivatives, and arsenomethane $(CH_3As)_n$.

The latter two present interesting structural features; arsenobenzene because a multiple As—As bond is presumably involved, and arsenomethane because of the problem of the skeletal arrangement.

See also Index references under "Arsenic" in the Index volume.

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ARSENIUS AUTORIANUS (d. A.D. 1273), patriarch of Constantinople, whose deposition caused a schism in the Byzantine Church, was born in Constantinople. Baptized George, he took the name Gennadius on becoming a monk and Arsenius on being appointed patriarch in 1255 by Theodore II Lascaris, to whose son John IV Lascaris he later became guardian. Arsenius retired to a monastery when Michael VIII Palaeologus usurped the throne from John IV, but was persuaded to return to office after Constantinople had been won back from the Latins in 1261. When Michael blinded John, Arsenius excommunicated him and

as a result was deposed (1265). He died in exile on Proconnesus (Marmora) in 1273.

Arsenius wrote a testament that is an important document for contemporary history, and he may be the author of an anacreontic poem on Easter. He did not write the three Kanons that have been ascribed to him but are the work of another Arsenius. Similarly he is not the author of the *Synopsis canonum* extant under the name Arsenius. After Arsenius' deposition the empire was split into two factions known as the Arsenites and the Josephists (called after Joseph, Arsenius' second successor). The Zealot party took the side of the Arsenites, who strongly opposed the pro-Latin policy of the emperor, which culminated in the Council of Lyons (1274), when papal supremacy was accepted by the Byzantine legates. The Arsenite schism, which continued after this decision had been rejected by the Byzantine people and officially abandoned as imperial policy, was not healed until 1310 when the body of Arsenius was buried in Hagia Sophia by the patriarch Niphon.

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ARSENOPYRITE, a mineral consisting of iron sulfarsenide, contains 46% of arsenic and is of importance as an ore of this element. The mineral was known to Georgius Agricola, the "father of mineralogy," in 1546 under the name *mistpuckel* (Eng., mispickel).

Arsenopyrite is the most abundant and widespread arsenic mineral. It occurs with ores of tin, copper, gold, etc., in metalliferous veins and contact metamorphic sulfide deposits. It is also found, sparingly disseminated, in pegmatites, crystalline limestones and schists. Arsenopyrite is the principal source of arsenious acid, the "white arsenic" of commerce (*see* Arsenic). The chief supplies are from Boliden in Sweden, the United States and Mexico. Finely crystallized specimens have been obtained at Freiberg and Munzig, Ger.; Mitterberg near Mühlbach, Aus.; and Reichenstein, Silesia.

The crystals are monoclinic. They are often prismatic in habit and are usually terminated by faces of an obtuse dome. The colour is silver white to steel gray, with a metallic lustre; the streak is grayish black. The hardness is 5.5 to 6, and the specific gravity 6.1.

Arsenopyrite generally is formed at relatively high temperatures. Some varieties of the mineral contain cobalt in solid solution, and a series exists from arsenopyrite, FeAsS, to the mineral glaucodot, (Co,Fe)AsS. (Cl. F.)

ARSES, king of Persia, the youngest son of Artaxerxes III, was raised to the throne in 338 B.C. by Bagoas (*q.v.*), who had murdered Arses' father and all his brothers.

But when the young king tried to make himself independent, Bagoas killed him too, with all his children, in the third year of his reign (336 B.C.).

ARSINOE, the name of four queens of the Ptolemaic dynasty in Egypt (*see* Ptolemies). The name was also that of the mother of Ptolemy I, founder of the dynasty. The queens are listed below.

Arsinoe (I) (fl. early 3rd century B.C.), daughter of Lysimachus, king of Thrace, was the first wife of Ptolemy II, whom she married not later than 281 B.C. and to whom she bore three children, the future king Ptolemy III, Lysimachus and Berenice. About 278, accused of having conspired with two courtiers against her husband's life, she was banished to Coptos in upper Egypt. The truth of the charge is doubtful; possibly she was a victim of the intrigues of Arsinoe (II), her sister-in-law and stepmother.

Arsinoe (II) (*c.* 316–270 B.C.), daughter of Ptolemy I and Berenice, married Lysimachus, king of Thrace, as his third wife *c.* 298. Energetic, ambitious and ruthless, she gained much influence with her aged husband, who renamed Ephesus after her and delivered to her as personal domains Heraclea, Tios, Amastris (all on the Black sea) and Cassandria (in Chalcidice). She bore him three sons, Ptolemaeus, Lysimachus and Philip. To assist their prospects she is said to have persuaded Lysimachus to execute his eldest son and heir, Agathocles, on a false charge of treason. This caused opinion to move in favour of Seleucus, who then invaded the territory of Lysimachus in Asia Minor. When Lysimachus was defeated and killed at Corupedium in Lydia (281), Arsinoe escaped from Ephesus to Cassandria. Her half-brother Ptolemy Ceraunus murdered Seleucus and took possession of Thrace and Macedonia; he then tricked Arsinoe into marrying him, seized Cassandria and murdered her two younger sons. The eldest escaped; so too did Arsinoe, first to Samothrace, then to Egypt (279). Some time after her arrival there she married her full brother Ptolemy II, so displacing Arsinoe (I). This marriage of brother and sister corresponded to Egyptian custom but was an innovation for Greek rulers.

Arsinoe now exercised an even greater influence in state affairs than she had done in Lysimachus' kingdom, and many of Egypt's military and political successes in the following years were due to her. She was in the fullest sense a co-ruler: her head figured on the coinage, either alone or with the king's; she wore the diadem; in the native ritual she possessed a throne name (not customary in the case of a queen); and even before her death (270) she was the object of a widespread cult both in Egypt and overseas. The Greeks worshiped her as Thea Philadelphos ("goddess who loves her brother"). In several instances her cult takes precedence over her husband's—a further proof that she was the dominant partner. No other queen in the Hellenistic world received so many honours; a number of cities in Lycia, Cilicia, Aetolia, Libya, Syria, Cyprus and Egypt took her name, either before or after her death, and many dedications to her are found in the Aegean area, in Cyprus and in Egypt itself. After death her memory was kept alive; an Athenian inscription praises Ptolemy for following his dead wife's policy; in Egypt a great shrine, the Arsinoeion, was consecrated at Alexandria and a colossal obelisk of granite erected there; and similar memorials were consecrated in other parts of Egypt and at Samothrace. She became the guardian goddess of the province lying about Lake Moeris in the Faiyum (upper Egypt), known henceforth as the Arsinoite nome.

Arsinoe (III) (late 3rd century B.C.), daughter of Ptolemy III and Berenice, married her full brother Ptolemy IV Philopator and was present with him at the battle of Raphia (Rafa on the frontier of Egypt and Palestine) in 217 B.C., where she gave encouragement to the troops. Her marriage to the king probably took place after the battle. In 210 she gave birth to the future Ptolemy V. Her efforts to detach her husband from debauchery were unavailing and she was eventually killed by the courtiers Sosibius and Philammon. This crime, of uncertain date, first became known with the news of the king's own death, which was also kept secret until late in 203. The queen had been held in high esteem by her subjects, and the news of her death and the suspicion of foul play led to an outbreak in Alexandria against the assassins.

Arsinoe (IV) (d. 41 B.C.), youngest daughter of Ptolemy Auletes, was the younger sister of the famous Cleopatra. At the outset of the Alexandrine War (48–47 B.C.) she was for a time recognized as queen by the Alexandrian populace. Captured at the end of the war, she was sent to Rome to appear in Julius Caesar's triumph (46). Subsequently she was set free and returned to the east, but in 41, at Cleopatra's instigation, Antony put her to death.

See G. H. Macurdy, *Hellenistic Queens* (1932). (R. H. St.)

ARS NOVA, the title of a musical treatise by Philippe de Vitry (1291–1361), written in 1320, probably in Paris, outlining the technical innovations used by Vitry, particularly the introduction of more accidentals and duple rhythms, which were indicated by notes in red ink. The new style may already have been in use in southern France and Italy, since a bull of Pope John XXII, dated 1324–25 from Avignon, condemns the mannerisms of "the pupils of a new school." The treatise reflects the struggle between an older and younger generation of composers, which ended *c.* 1330. By that time the achievements of those using the new techniques were generally recognized. Recent musicologists have used the term "Ars Nova" in a wider sense for a period opposed to the preceding "Ars Antiqua" (*q.v.*) and covering the work of Vitry and Guillaume de Machaut (*q.v.*), that is, the

greater part of the 14th century.

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(E. J. Wz.)

ARSON, a common-law crime defined as the malicious and voluntary burning of the dwelling house of another, has in modern times, both in England and the United States, been greatly expanded in scope by statute Common-law arson is often termed a "crime against the habitation" rather than a "crime against property" in recognition of the fact that its prohibition is aimed more at protecting people from the danger of injury or death by fire than at protecting their property from damage. Modern arson statutes encompass the latter aim as well.

Common-Law Arson.—At common law, arson, a felony originally punishable by death, consists of four separate elements, three physical, the fourth mental: (1) "Burning": The house need not be entirely, or even in large part, consumed by fire; the burning of any small portion of the house, such as a part of the floor or wall or door, is enough. But, though the wood of the house need not be set ablaze, there must be a charring, the destruction of the fibre of the wood; a mere discoloration will not suffice. (2) "Dwelling house": A building is a dwelling house if people customarily sleep there, though it is not necessary that someone actually be in the house at the time of the fire. An abandoned dwelling is no longer a dwelling house, but a house is still a dwelling house though the inhabitants close it for the summer, intending to return. Weekend cabins, modern trailers, buildings used partly for living and partly for business (as a building with a store on the first floor, living quarters on the second floor) have all been held to be dwelling houses. On the other hand, unfinished structures, designed for dwelling purposes but not yet occupied, are generally held not to be dwelling houses. In England common-law arson encompasses the burning of outbuildings, such as barns and stables, which are part and parcel of the dwelling house because they are "within the curtilage" of the house, *i.e.*, enclosed within a common wall, hedge or fence. In more spacious America, where such enclosures are less common, outbuildings have been included for arson purposes, though not so enclosed, where the building is used in connection with the house and not situated too far away. (3) "Of another". At common law it is not arson to burn one's own house (*e.g.*, to defraud the insurance company). (It is a common-law misdemeanour—not the felony of arson—intentionally to burn one's own house where other houses are close by; but if in fact another house is thereby burned, such conduct constitutes arson.) The term "of another," however, refers to the right to possession rather than to ownership. Thus a landlord is guilty of arson who burns the house he has leased to his tenant; but a tenant is not guilty of arson who burns the leased premises. The owner of a house who leases a part of it to a tenant is guilty of arson, however, if he sets his house afire. (4) "Malicious and voluntary": The act of burning another's dwelling house, to constitute arson, must be accompanied by a "malicious and voluntary" state of mind. "Malice" in the literal sense of hatred, spite or ill will is not required. An intention to burn the building, unaccompanied by any such hatred, will suffice. It is probably true also that a reckless burning (*i.e.*, conduct which the actor realizes creates a high degree of risk of causing a burning, though he does not desire it) will do for arson, though mere negligence or accident clearly will not suffice. Probably criminal conduct which causes an unintended and nonreckless burning—as where a candlelight burglar in the course of the burglary carelessly leaves his candle too close to the curtains, thus causing the burglarized house to burn—will not qualify for arson.

Statutory Arson.—Modern statutes, in England and the United States, have enlarged the scope of arson by altering two of its four common-law elements. First, other types of property, other than dwelling houses, have commonly been made the subject of arson: unfinished dwellings, various types of buildings other than dwellings (*e.g.*, stores, warehouses, factories, churches), automobiles, railroad cars, ships, bridges, fences, trees and stacks of hay or grain. Second, it is commonly made arson for one to burn his own property, real or personal, if done to defraud the insurance company. (But modern statutes generally still require a "burning" in the sense of charring, rather than mere discoloration, and "malicious and voluntary" burning in the sense of intentional and perhaps reckless burning, rather than merely negligent or accidental burning.) Generally accompanying these new additions to arson has been a division of arson into two or more degrees, with heavier punishments assigned to what was common-law arson, with its emphasis on danger to human life, and lighter punishments to the new types of statutory arson, which involve primarily a danger to property.

Insanity as a Defense.—Criminal insanity in the generally accepted sense of mental disease which prevents knowing right from wrong constitutes a defense to arson as to other crimes. About 15 of the states of the United States accept the "irresistible impulse" test for insanity in addition to the "right and wrong" test; in such states pyromania (a mental disease causing the sufferer to possess an irresistible urge to set fires) affords a defense to arson, though the pyromaniac should be held for psychiatric treatment of his dangerous disease before being released.

Motives for Arson.—The principal motives for intentionally burning property are (1) to collect fire insurance; (2) to conceal the existence of some other crime (as where a murderer burns the building containing the corpse to conceal the fact of murder); (3) to obtain revenge upon the owner; (4) to punish the owner, generally a merchant, for failure to pay demanded extortion money; and (5) to experience the excitement of watching the blaze. Motive, as distinguished from intent, is generally irrelevant to guilt or innocence of crime; but in statutory arson to defraud the insurance company the particular motive to defraud is required; and in states which accept the "irresistible impulse" test of insanity, the existence of pyromania constitutes a defense.

Arson-Murder.—An arson which actually produces a death—as where the fire kills the occupant of the burned dwelling house or a fireman fighting the blaze—constitutes common-law murder, and generally statutory murder, even though the arsonist does not intend to kill anyone, at least where the death is the foreseeable consequence of the arsonist's act of setting the fire. England abolished this form of "constructive" murder in 1957.

See also CRIMINAL LAW. (A. W. ST.)

ARSUF, an ancient town on the coast of Palestine, situated 9 mi. N.N.E. of the modern Tel Aviv in Israel and famous for the victory won there in 1191 by the English king Richard I during the third crusade (*see* CRUSADES). Richard, having taken Acre in July 1191, was marching on Joppa (Jaffa) in preparation for an attack on Jerusalem, but the Muslim army under Saladin slowed down the crusaders' progress when they advanced from Caesarea, which they left on Sept. 1. Richard marched his forces in strict formation, dividing the cavalry into three bodies, which advanced with the infantry protecting their flanks. On Sept. 7, after the crusaders had left Arsuf, the Muslim attacks became more intensive and were concentrated against the Hospitallers, Richard's rearguard, whom Richard forbade to counterattack until the evening. He then ordered the infantry to open ranks and launched a general charge that overwhelmed Saladin's army and inflicted heavy losses on the forces attacking to the rear. Seven hundred crusaders and several thousand Muslims were killed.

The victory at Arsuf enabled the crusaders to occupy Joppa but was not a crushing blow to the Muslims, as has been asserted. Saladin was able to regroup his forces, which the crusaders had not pursued for fear of ambushes. From Sept. 9 onward the Muslims renewed their harassing tactics and Richard did not dare to push on to Jerusalem.

See C. W. C. Oman, *History of the Art of War in the Middle Ages*, vol. i (1924); R. C. Smail, *Crusading Warfare 1097–1193* (1956).

(J. B. R.)

ART (ARTICLES ON). In this article, art is taken to mean the visual, plastic, and graphic arts. For articles on the other arts, *see* articles such as MUSIC (ARTICLES ON); LITERATURE (ARTICLES ON); THEATRE (ARTICLES ON).

The artist may attempt to communicate a sense of beauty or he

may react to his impulses and attempt to express them in various mediums; finally, he may accept a commission for a specific work and execute it to the best of his capability. These basic attitudes are discussed in ART, which includes a review of the history of art and a discussion of trends in art in terms of western and oriental approaches. Attempts to define the nature of beauty and to fit the concept into a philosophical and psychological framework are described in AESTHETICS and AESTHETICS, HISTORY OF.

Articles in which the history of European art is summarized along general lines include (in approximately chronological order): GREEK ART; ROMAN ART; EARLY CHRISTIAN ART; BYZANTINE ART; ROMANESQUE ART; GOTHIC ART; RENAISSANCE ART; BAROQUE ART; NEOCLASSICAL ART; NINETEENTH-CENTURY ART; MODERN ART. These articles are supplemented by others on distinctive phases, as: ABSTRACT ART; BARBIZON SCHOOL; EXPRESSIONISM; FAUVISM; FUTURISM; IMPRESSIONISM; POSTIMPRESSIONISM; SURREALISM. Also, there are articles on DESIGN, 19TH-CENTURY; and DESIGN, 20TH-CENTURY.

Articles on the characteristic art of various regions include: ARMENIAN ART; CHINESE PAINTING; INDIAN ART; INDONESIAN ARCHAEOLOGY AND ART; ISLAMIC ART; JAPANESE PAINTING AND PRINTS; PERSIAN ART; RUSSIAN ART; TIBETAN ART; etc.

The rise of the great European schools of painting under the influence of Christianity and their evolution in various countries is described in PAINTING, which is accompanied by many illustrative plates. The major types of subject matter are treated in STILL-LIFE PAINTING; PORTRAIT PAINTING; and LANDSCAPE PAINTING. Articles devoted to painting mediums include ENCAUSTIC PAINTING; GOUACHE; OIL PAINTING, TECHNIQUE OF; PASTEL; TEMPERA; and WATER-COLOUR PAINTING.

Articles dealing with engraving processes include DRY POINT; ETCHING; ENGRAVING, LINE; LITHOGRAPH; MEZZOTINT; STIPPLE AND CRAYON ENGRAVING; and WOODCUT AND WOOD ENGRAVING.

Various technical procedures in the arts are discussed in many other articles, for example: CRAYON DRAWING; DESIGN; DRAWING (TECHNIQUES OF); MINIATURE PAINTING; MURAL PAINTING; PENCIL DRAWING; PEN DRAWING; PERSPECTIVE; and POSTER.

Certain themes in the tradition of art are traced in DANCE OF DEATH; CARICATURE AND CARTOON; MOTION PICTURES (including animated cartoons).

SCULPTURE surveys the history of this art in western civilization in postclassical times; it is supplemented by SCULPTURE TECHNIQUES. Greek sculpture is discussed in GREEK ART, Roman sculpture in ROMAN ART. Separate articles are devoted to CHINESE SCULPTURE and JAPANESE SCULPTURE. Articles on special phases include SCULPTURE, SEPULCHRAL; IVORY CARVING; JADE AND OTHER HARD STONE CARVINGS; RELIEF; TERRA COTTA; WOOD CARVING; WAX FIGURES; etc.

FINE ARTS gives a general survey of the arts in which material functions and values become mediums for the expression of aesthetic ones. The subject of architecture is surveyed in ARCHITECTURE, and among the many articles on related arts are: INTERIOR DECORATION; INTERIOR DECORATION, HISTORY OF; IRONWORK; LANDSCAPE ARCHITECTURE; LEADWORK; and WOODWORK, DECORATIVE. A more detailed listing is given in ARCHITECTURE (ARTICLES ON).

A key article on applied arts is INDUSTRIAL DESIGN. The story of the struggle of British artists to win aesthetic recognition for various applied arts is summed up in ARTS AND CRAFTS MOVEMENT.

Articles on the fine and applied arts include, besides those mentioned above: BOOKPLATE; COSTUME DESIGN, THEATRICAL; DRESS; ENAMEL; FRAME DESIGN; FURNITURE DESIGN; GEM (for gem engraving); GLASS; ILLUMINATED MANUSCRIPTS; JEWELRY; LACE; LACQUER; LAMP; METALWORK, DECORATIVE; NUMISMATICS; POTTERY AND PORCELAIN; SILVER AND GOLD WORK; TEXTILES; EMBROIDERY; etc.

The processes of evolution and revolution by which the major philosophies of art were developed are discussed in ART, SOCIETIES OF and MUSEUMS AND GALLERIES. The influence of these processes on the economics of art is described in ART SELLING.

Trends in the teaching of art appreciation and of art as a profession are discussed in ART EDUCATION.

Primitive and preclassical forms of artistic expression are examined in PRIMITIVE ART; ARCHAEOLOGY; in the section of ANTHROPOLOGY captioned *Archaeology and the Cultural Record*; in the anthropological sections of articles on continents and many other geographical sections of articles on continents and geographical areas; and in articles on specific archaeological sites, such as ALTAMIRA CAVE; CARNAC; TROY; etc.

ART, in its most basic meaning, signifies a skill or ability. This definition holds true for its Latin antecedent, *ars*, as well as its German equivalent, *Kunst* (derived from *können*, "to be able"). One who has acquired a skill may be designated an artisan or artist according to whether his abilities are directed principally toward a utilitarian or an aesthetic purpose. While art continues to be associated with basic skills (*e.g.*, the art of gardening, the art of warfare), the term more generally carries the connotation of nonutilitarian activities: the art of painting, the art of poetry and the art of music.

A further distinction occurs in the traditional differentiation of the liberal arts and fine arts (*q.v.*). The former include those practical pursuits that facilitate freedom of expression in language (grammar), speech (rhetoric) and reasoning (logic and mathematics), as well as the studies that lead to an understanding of man's physical, social and cultural environment. The fine arts, on the other hand, are those that are cultivated more for their own sake and for the intrinsic pleasure they afford the minds and emotions of those who experience them.

The term fine arts is a translation of the French *beaux-arts*, meaning the arts concerned only with the beautiful. Because of the bureaucratic structure of the French academies, the term came to be associated primarily with sculpture and painting, the concern of the Academie des Beaux Arts. Architecture, partly owing to its semiutilitarian character, and letters and music were artifically excluded because they came under the jurisdiction of other academies. The fine arts, in any rational view, however, must be broadened to include any aesthetically directed expression in visual, verbal or auditory images and symbols. The fine arts thus would include architecture, sculpture, painting and the various related visual, plastic and graphic arts; literature in its various poetic, prosaic and dramatic forms; as well as the dance and music.

This article, however, by force of tradition, after a review of some of the broader principles that underly all the arts, will be focused primarily on the visual arts. It is organized as follows:

I. PRINCIPLES OF ART

1. Art v. Science.—While both art and science are concerned ultimately with the pursuit of truth, the processes and methods employed by the artist, on the one hand, and by the scientist, on the other, vary to a considerable degree. The scientist, whether physical or social, is concerned principally with the problem of analyzing materials or events, while the method of the artist is primarily synthesizing. The scientist isolates, breaks things down and separates matter into its constituent parts for purposes of analysis; the artist selects his materials, assembles, composes (in the literal sense of putting things together) and builds. The scientist has to concern himself with the objective world of facts and phenomena; the artist deals more with the subjective world of imagery and feeling. The sciences attempt to evolve general laws that are applicable in all cases; the arts and letters explore individual reactions and revel in the unique qualities of experience. Scientists, by increasing concern with particular fields, tend to become specialists; artists strive to give form and substance to a world view. The social scientist, with his case histories and statistical compilations, attempts to comprehend the dynamics of human behaviour and to analyze political movements. But, as Romain Rolland put it: "The political life of a nation is only a superficial part of its being; in order to learn its inner life—the source of its actions—we must penetrate to its very soul by way of its literature, its philosophy, and its art, where the ideas, the passions and the dreams of its people are reflected" (Romain Rolland, *Some Musicians of Former Days*, 4th ed., Routledge & Kegan Paul, Ltd., London).

A scientific theory once formulated is at best tentative, since the premises on which it is based are destined to be disproved or superseded by subsequent research and discovery. A work of art once completed, however, stands as a final statement for all time. Fashions and critical evaluations may change rapidly, and the work of one artist may be eclipsed by that of another and greater artist, but a particular building, statue or painting endures. It may be destroyed, to be sure, but not disproved. Out of the artist's subjectively built world he projects a moment in the world of objective values, a fragment of infinity.

The artist thus does something to make the moment last, to give permanence to the present. The artist, then, is the only victor in man's struggle against time, and the work of art is the crystallization of a moment, a link between past and future, a bridge between individual and universal experience. The broader and wider the artist builds his bridge into the infinity of the objective world, the more universal will be the values he expresses and hence the greater and more lasting his work of art.

2. Imagination and Imagery.—The wellspring of all creativity is the imagination, which manifests itself in the projection of images. One of the profoundest insights into the creative process is contained in Gen. i, 26–27: "Then God said, 'Let us make man in our image, after our likeness; . . .' So God created man in his own image, in the image of God he created him." The Godlike principle, then, can be interpreted as creativity. If God is conceived as the creative force, and man is fashioned in his image, it follows that man also possesses creative powers in his own right and in turn creates his gods in his own image. From the theoretical void, the man-artist conceives an image; from nothingness he gives birth to being; from chaos he achieves order, which is to say that by selection he conceives relationships. The development of art skills then becomes necessary in order to transmit his ideas from mind to mind. Art thus becomes a language in images and symbols by which man communicates his conceptions of order in perceptual more than conceptual terms. The role of the artist is thus to clarify, intensify, dramatize and interpret the world about him in all its physical, social and spiritual aspects.

Art as a creative process involves the activities of both artist and audience—directly in the case of the visual arts and books, and with the mediation of reader, narrator, actor or performer in the case of poetry, drama and music. The process of creativity is thus threefold with the artist as the prime mover, communicating his ideas through the performer, as his interpreter, to his audience. Each participates in the creative process, the difference being in the intensity of the stimulus and response and in the concentrated creative thought each brings to bear on the situation.

Art works are by no means confined to the products of professional artists. In such daily activities as speaking, dressing, working or playing, all participate in the projection of images. Consciously or unconsciously, everyone is involved in the process of projecting a psychological and social image of himself. Furthermore, when participating in a work of art, whether as reader, observer or listener, a person is not a mere passive receiver of images and impressions, but an active agent in the creative process. By experiencing the work of art, he must conjure up a corresponding set of images, perceptions and impressions in his own mind and imagination. The intensity of the activity, to be sure, may be less than that of the artist who produced the work, but the reader, observer or listener is nevertheless involved in the dynamic activity of responding. Through education the development of a disciplined imagination makes it possible for the eye, ear and mind to acquire perceptive vocabularies and to develop the critical faculties so that some of the finer nuances of sight and sound are distinguishable.

Mental images, aroused as they are by sensations, assume certain perceptive and symbolic forms associated with sight (*i.e.*, visual imagery), sound (auditory), taste (gustatory), smell (olfactory), touch (tactile) and muscular motion (kinaesthetic). Art expression is based principally on the so-called higher senses of sight and sound, with the other senses playing more or less indirect roles. While no fine art, for instance, is based exclusively on taste or smell, gustatory and olfactory imagery nonetheless often is used in poetry and prose to awaken corresponding sensations in the minds of readers and to intensify the vividness of description. Tactile imagery, while not the basis of an art in its own right, nevertheless is important in distinguishing the feeling for hard or soft, rough or smooth textures in architecture, sculpture and painting. Likewise kinaesthetic imagery is important in conveying the feeling of motion, either implied as in the visual arts or actual as in the dance and music.

Sensitivity to certain types of imagery predisposes the artist, as well as any other person, to one rather than another type of expression. It seems clear that a person deficient in visual imagery would not be inclined to the visual arts except perhaps as a psychological compensation for that deficiency; and that one who is insensitive to auditory imagery would not be predisposed to music. Fortunately these various types of imagery are not mutually exclusive, and most persons experience several types, with one or another dominant. A writer or reader, for instance, would tend to be primarily visual minded, and the auditory imagery of the sounds of words would play a secondary role in his experience; a musician or listener would be primarily auditory minded, visual and kinaesthetic perceptions being of less importance to him.

In some cases synaesthesia—that is, a fusion of sensations by which the experience of one sense impression conjures up that of another type—is present. Sounds, for instance, often evoke visual images such as colours. The descriptive vocabulary used in connection with the arts is evidence of the common experience of such synaesthetic perception. Painters speak of the "tone" of certain colours. Titian and Veronese have been contrasted by some critics on the basis of their preference for gold and silver "tonalities"; the tactile analogy of "warm" and "cool" colours is also used. Musicians distinguish the timbres of various instruments according to their tone "colour." Richard Strauss wrote "tone poems," or musical compositions with narrative or pictorial content, while Debussy called one of his piano pieces *Sounds and Perfumes on the Evening Air*. Synaesthesia, in which perfumes, colours, tones and textures echo each other, was rather thoroughly explored by the Symbolist poets. "There are perfumes fresh as children's flesh," wrote Baudelaire, "Soft as oboes, green as meadows . . ." (*Selected Poems From Flowers of Evil*, trans. by Geoffery Wagner, New Directions, Norfolk, Conn., 1946).

3. Creative Drive.—Man as an experiencing individual is ceaselessly seeking to bring his experience to articulate expression.

The past experience of the individual may be said to have present existence in so far as there is a mental image of it and to the degree that it is recreated by the mind. Through images of this experience he reveals his conception of his relationship to the world about him. Through these images he asks questions of life, seeks to clarify his confused impressions and to give unity and meaning to many-sided and seemingly unrelated events. Through this process of externalization the human being seeks to understand himself and to make himself understood to others.

Since the experiences of life are never finished, but flow and change constantly, no one projected image can be sufficient and final, and hence one witnesses an inexhaustible number of expressive manifestations of the human being about himself, about other human beings and about the world around him. He tries to discard the unessential and to unite and preserve the essential elements in his experience, and by creating images of certain conceptions of life he endeavours to create a coherence and a unity to life itself.

Imagination is the prime source of creative expression, and the capacity to discipline the imagination and give form and substance to its products is one of the distinguishing characteristics of a successful creative artist or an intelligent and sensitive observer or listener. The imaginational experience of a writer occurs in the shape of figures of speech, that of the visual artist in pictures, that of the composer in musical forms, that of the engineer in inventions. Free imagination usually is fanciful and undirected, while constructive imagination represents a conscious effort to create an imaginary product with a view to letting others see, hear or feel the sensations and images the artist himself experiences.

The artistic imagination thus is concerned with the creation of fictitious characters, events, scenes, situations and moods in such a way as to recreate the artist's experience in the minds and imaginations of those who come in contact with his work. In order to bridge the gap between minds, the artist must fashion some vehicle—poem, building, statue, mural, symphony—that will convey his ideas to his readers, viewers and listeners and thus make his intuitions and emotions readable, visible and audible to others.

The creative act, then, results in the concrete forms known as works of art, and it is here that the question of classification, the choice of medium and the problem of technical facility are encountered.

4. Major and Minor Arts.—The arts, for the sake of convenience, customarily have been divided on the basis of various practical, critical, aesthetic or philosophical principles. Reference has been made above to the separation of the higher and lower sense arts. Another widely found distinction is the division into major and minor categories. Architecture, sculpture, painting, literature and music are classified thus as major arts; while ceramics, furniture, tapestry, gem carving, gold and silver smithing, coin and cameo work comprise minor categories. Similar is the classification of the fine as opposed to the applied arts.

Modern thought, however, tends to reduce the distinction between arts and crafts, form and function. An equestrian statue or a monumental fountain is, to be sure, a major achievement; but a beautiful chair, despite its practicality, is also a form of sculpture and a work of art. A cathedral and a suspension bridge once were thought to be miles apart on the aesthetic scale, but in the contemporary view engineering is the alter ego of architecture in the building craft. On a more philosophical plane, the arts have been separated on the basis of their relative concreteness and abstractness, their degree of materiality and spirituality, their aspirations toward the beautiful or sublime, or their existence in space or time.

5. Analysis and Synthesis.—Once a work of art has left the hands of the artist, it obtains an existence of its own. The completed work is both an organized whole and a historical fact. As a composition—that is, a system of related parts—it can be analyzed; as a product of a definite time and place, it can be synthesized. Analysis, by breaking the work of art down into its component parts, by examining how the parts are related to the whole and how the unity in the manifold is achieved, by examining the materials the artist used in its composition, by studying the techniques the artist used to achieve his effects, can be very revealing. But while each work of art is essentially unique, it also can be placed alongside others of a similar kind, together with those originating at the same time and place, so that by comparison a pattern of development eventually may be found. The process of synthesis, then, by placing the work of art in its social and historical frame of reference, by relating the particular work to that of other contemporary artists, by viewing the work in the light of broader cultural developments and the general stream of events in its decade, century and style period, is likewise an invaluable aid to the understanding.

6. Approaches.—All in all there are essentially but three ways of approaching art: (1) theory, which includes the factors of evaluation, the setting up of critical standards, aesthetics (*q.v.*) and the philosophy of art dealing with speculation on ultimate objectives and meanings; (2) the practice of art, which has to do with the choice of mediums, the techniques employed by the artist in the performance of his craft; and (3) history, which involves placing art in its temporal context, investigating streams of influence and relating particular works to the spirit of the time in which they were produced as well as to the history of ideas in general. The remainder of this article will deal with the techniques and with the history of the visual arts.

II. TECHNIQUES OF ART

The practice of art in any given time and place cannot be divorced from historical and geographical circumstances. When, for instance, the rebuilding of the Acropolis temples in the Athens of the 5th century B.C. was contemplated, the visions of Pericles and Phidias would, of necessity, have taken an entirely different turn had it not been for the presence of the vast and fruitful marble quarries at Mt. Pentelicus only a few miles away; otherwise stone had to be transported by ship from Ionia across the Aegean sea. Likewise the sculptural genius of Michelangelo could not have developed in the direction it did, had it not been for the easy availability of marble from Carrara and elsewhere in Italy. Similarly, a young painter of talent born in 16th-century Venice could hardly have become a great fresco painter if he wished to remain and work in his native city, the damp climate of which made fresco work unfeasible and hence favoured the development of oil painting; the wealth and splendor of Venice, consequently was mirrored best in the rich, deep, warm colours of oil pigments. A pictorial artist working in the middle ages naturally would have favoured the dominant two-dimensional mode of representation in his mosaics or miniature manuscript illuminations, while his Renaissance counterpart just as naturally would have thought in terms of the three-dimensional techniques of linear and atmospheric perspective as the normal way to describe space.

An artist, then, must choose the medium in which he is to work—whether it be sculpture or painting, architecture or music, etching or engraving, water colour or oil pigments—as well as the materials, tools and methods suitable to that medium. It is also necessary for him to develop the proper skills and disciplines necessary to manipulate his materials according to his will and imagination, and to allow him to arrive at a personal solution for the expression of his ideas. In addition, he must take certain external considerations into account, such as the nature of his commission and the source of his patronage. Is his work to be seen in sacred or secular surroundings? Is his audience to be the general populace of a city like Athens or Florence, or a sophisticated aristocracy such as the court of Louis XIV? Thus inevitably, the artist's medium, materials and techniques will reflect the tastes of his time, as well as the dominant ideas and stylistic trends of his period.

An artist's personal style thus is determined quite as much by the current practice and the historical tradition of his time as by the nature of his skill, craftsmanship and technique. Fresco painting, for instance, dates back to ancient times, and while modes of representation have varied, the basic methods and procedures of fresco have changed very little since Greco-Roman

times; certain skills, on the contrary (such as encaustic painting; *q.v.*), that were widely practised in pre-Christian art eventually become obsolete, while other disciplines (such as mosaic making), after falling into disuse for a number of centuries, are revived and flourish again.

After initial experimentation new mediums and tools come into use and are quickly absorbed into contemporary practice. Thus masonite has become accepted as a surface for painting along with canvas, wood panels and other surfaces. With the increased use of metals for sculpture, the welding torch as well as the chisel is used by the sculptor. And the strength of ferro-concrete as building material has made it possible for modern architects to add the structural device of the cantilever to the more venerable systems of the post and lintel and the arch and vault.

A. Architecture

Architecture seems to be the logical starting point for any study of the visual arts because of man's necessity to shelter himself and to devise a framework for his domestic, religious and social activities. In its broadest sense architecture also includes town, city and regional planning (*see* City Planning) as well as landscape architecture (*q.v.*).

The building art, furthermore, is perhaps the best example of the partnership and basic identity of a fine and useful art, beauty and utility, form and function. A building—whether a temple, church, exhibition hall or domestic dwelling—must demonstrate the solution of the practical problems associated with its purpose.

The primary concern of the builder is the definition and articulation of exterior space and the spanning and enclosure of interior space. The moment a square or circle has been described on the ground, one area has been separated from another and the architectural process has begun. As the architect spans his space—on the ground as with a wall or road or in the air as with an arch or bridge—he encounters not only the complex technical problems of his craft but aesthetic factors as well. He must mold his materials with an eye for the proportion of masses and voids; for the qualities, textures, colours and capacities of materials; for the harmonious relationship of open windows and doors to closed wall space; for the control and flow of lighting; and above all for architecture in action—that is, for the movement of the people who will be living, working and carrying on their various activities within his building.

The history of architecture may be read in the progressive changes in the solution of structural problems. The transition from the most primitive shed roof and simple truss construction to the vertical posts, or columns, supporting horizontal beams, or lintels, covers the period from the beginning of civilization through the ancient Egyptian and Greek cultures. The Romans exploited the arch, vault and dome and made broader use of the load-bearing wall of mass masonry; and in the late medieval period the pointed arch, ribbing and pier systems gradually emerged. At this point all the problems of brick and stone masonry construction had been solved, and little innovation except in decoration was achieved until the Industrial Revolution. Not until the 19th century, with the advent of cast iron and steel construction, did a new architectural age dawn and higher, broader and lighter buildings become possible. With the advances of 20th-century technology, new structural methods such as cantilevering received more extensive use.

Building materials evolved in much the same way from the primitive grass, thatch, stick frame, wattle and daub, to clay, adobe, brick, stone and cement. The modern use of reinforced and prestressed ferro-concrete, of various metals including steel, copper and aluminum as well as of glass, has led not only to more daring structural innovations but also to greater beauty through the realization of the inherent qualities of such materials and their use in novel decorative schemes.

Thus architecture as a fine art and engineering as a practical science, after being artificially separated since the Renaissance, have again been reunited in the 20th century.

See also Architecture.

B. Sculpture

Sculpture, like architecture, is concerned with three-dimensional space; but unlike architecture it is representational in that it depicts human, animal and plant as well as abstract forms. Sculpture and architecture exist in an intimate relationship, since most exterior and interior architectural embellishment is conceived in terms of moldings, friezes, statues in niches and the like.

Sculpture can be subdivided into two categories: (1) relief (*q.v.*) sculpture, in which the figures are attached to a background and seen against a plane; and (2) free-standing sculpture, in which the figures are detached and appear in the round. Modern sculpture goes a step further in the pieces called "mobiles" and achieves a freedom of movement, part against part, by being suspended in the air. Motion itself thereby becomes the subject matter, whereas previously it could be suggested only by illusion and incipient tendency.

1. Materials.—Any material with the capacity for being shaped and retaining that shape is potential material of sculpture. Tradition has favoured wood, clay, stone, and metal as the usual choices for plastic expression. In ceramics clays of various kinds are first shaped, either by hand or with a potter's wheel, then hardened by baking. Wood carving (*q.v.*) and stone carving are also among the simplest and oldest techniques of the plastic arts, while metalwork in copper, silver and gold, as well as bronze casting, requires far more complicated processing. Modern sculptors have employed other metals, such as aluminum, iron and steel, together with such foundry techniques as welding. Their preoccupation with new materials as well as their forthright and rugged treatment of them has led to modern abstract sculpture whereby the formed material becomes its own subject matter. They likewise have experimented with industrial components such as pieces of steel with rough and jagged surfaces that are often shaped into anthropomorphic forms suggesting the intimate relationship of man and machine. Modern sculptors also have taken cognizance of the opposition of solids and voids, sometimes termed positive and negative volumes, by perforating their works. Often the masses are merely suggested by outlines of wire or planes defined by bent sheets of plastic or metal.

2. Techniques.—Sculptural techniques can be separated into two major classifications, additive and subtractive. By addition the sculptor usually works with clay, wax, plaster or some other soft material building up the work from a central nucleus, shaping and molding his three-dimensional composition from the inside out. The image then can be hardened by baking, as with terra cotta (*q.v.*), or transferred by casting into a metal such as silver or bronze. Many modern sculptors work additively by assembling pieces of wood, stone, plastic, metal or wire. In the subtractive technique a sculptor works with a block of wood or marble and carves and cuts away toward the interior, working from the outside in. Material thus is removed, and what remains becomes the final product.

Besides lines, planes, masses and plastic forms, the sculptor also must be concerned with the texture and colour of his materials as well as with the play of light and shade about them. Tactile values play an important role in the art, as is indicated by the necessity of placing "Do not touch" signs near sculptural works. Lighting also must be taken into account, and the sculptor must consider whether his finished work will be placed indoors or out, in bright light or dim, in natural or artificial light; whether the light will fall from above or be reflected upward from below; and whether it will be viewed from eye level or at a considerable height. Because of such factors as these, wrong impressions may occur when a work of sculpture is taken from its original setting and placed in a museum. The pedimental sculptures of the Parthenon, for instance, were intended to be viewed at a height of approximately 35 ft., but in the British museum they are seen at eye level. Similarly the cella frieze was designed for lighting reflected from below, but in the British museum the light falls from above. (*See* also Sculpture.)

3. Minor Three-Dimensional Arts.—A jeweler quite as much as a bronze caster works with metal. His more precious materials can be molded and are also malleable (that is, capable of

being hammered or beaten into various shapes). For ornament a design can be added by engraving or chasing or by beating a metal sheet against a mold so as to leave a relief pattern on one side, a technique called *repoussé*. Inlaying (or damascening) with other metals, plating one metal with another, and enameling (cloisonné) are also employed (*see* METALWORK, DECORATIVE; ENAMEL). In addition to such decorative arts as silver and gold work, bone and ivory carving (*q.v.*), cameo portraits, gem carving (*see* GEM) and coin making (*see* NUMISMATICS), there are the arts that combine utility with decoration, among them pottery, glass blowing, cabinetmaking, furniture designing, basket weaving, leatherwork and the modern machine arts and industrial design. *See* POTTERY AND PORCELAIN; GLASS; FURNITURE DESIGN; SILVER AND GOLD WORK; BASKET; and INDUSTRIAL DESIGN.

C. PAINTING

The image in painting, as in all the other pictorial arts (mosaic, tapestry, textiles, stained glass, engraving, etching and the like), is fictitious; that is to say, it has no physical three-dimensional existence. Since the artist works only on a surface or picture plane, he must employ certain conventional devices if he wishes to symbolize objects in space. These methods include perspective, modeling in light and shade, and the use of colour. Linear perspective takes advantage of the apparent reduction in the size of objects as they recede from the eye; atmospheric perspective suggests the haziness, softening of outlines and loss of detail as the eye looks into the distance; chiaroscuro, or the gradations between light and dark as reflected from objects, produces the effect of modeling, a term borrowed from the sculptor's vocabulary; colour perspective is based on the principle that warm colours such as red and yellow seem to project forward and cool colours such as blue and green create the illusion of recession.

1. Materials and Techniques.—The materials of which painting is composed and the techniques that organize the materials are closely related. The three materials of painting are (1) the surface, also called the ground; (2) the pigments employed to make the colours; and (3) the tools used to spread the paint on the surface.

The term medium in painting has a special meaning, referring to the vehicle in which the powdered colours, or pigments, are suspended and which binds the pigments to the surface. One medium is pastel (*q.v.*), in which the powdered colours are compressed into pencillike sticks, or crayons, and then spread directly onto the paper; in order to assure permanence, a fixative must be sprayed on the work when it is finished. Another is water colour, in which the pigments are suspended and their tone controlled by the proportion of water; the usual surface is paper or silk (*see* WATER-COLOUR PAINTING). In the technique known as *gouache* (*q.v.*), the addition to the water colours of an opaque filler such as zinc white makes certain textured and bright-hued effects possible.

Fresco (*see* FRESCO PAINTING) means painting with water colours on a wet lime-plaster ground, usually a wall or ceiling surface; the paints and plaster combine chemically to dry into a permanent surface and become part of the wall itself. With tempera (*q.v.*) the binding medium is egg yolk, or some other viscous substance; remarkably permanent and capable of brilliant colour effects and precise detail, tempera can be used not only for mural painting but also can be applied to wooden panels, parchment and the like. Casein, a milk-based vehicle, has found favour as a tempera type of painting.

Oil is perhaps the most flexible of all vehicles (*see* OIL PAINTING, TECHNIQUE OF). Slow in drying, it allows the painter time to consider and correct his work until the desired quality is achieved. Oil paints, unlike the more opaque tempera, are translucent and thus allow light to be refracted; luminous surfaces and certain shimmering effects thus are obtainable.

Experiments have been made with synthetic lacquers and pyroxilins such as Duco as mediums for painting. Mexican muralists have employed such mediums, often spraying them on a ground of Portland cement.

2. Application of Pigment.—The painter ordinarily spreads his pigments on the surface with brushes of various sizes and with bristles of varying textures. Flexible palette knives, spatulas, the handle of the brush, and the fingers sometimes have been used by artists to achieve certain textures and qualities. Some even pour the paint directly on the canvas; others use an airbrush, run by compressed air from a pump, to spray paint on the surface in a fine mist.

Although painting is a two-dimensional art, an artist occasionally will employ certain techniques that add a third dimension to the picture plane. The texture of the canvas itself may be used, or the gesso sizing can be thick in texture. The painter then builds up his picture with thick pigments, called impasto, or he may smear lighter-coloured paints over darker ones with a "dry" brush to vary the texture in the technique called scumbling. Painters also have experimented with adding sand, pebbles and other materials to their pigments to give thicker-textured and three-dimensional effects. They also may desire the opposite effect and paint layer after layer of thin transparent pigments over each other permitting colours to shine through each other. This technique, called glazing, permits delicate and subtle colour modulation, thin textures and precise delineation of detail.

In most oil painting the mixing of colours is done as little as possible on the palette, since it renders them muddy and dull; rather, the mixing is done on the picture surface itself, thus permitting the colours to fuse and blend more directly. Or the artist may not mix his colours at all, but place, for example, his yellows and blues side by side in small dots or splotches, allowing the eye of the beholder to blend the hues and give the effect of a lively green. Such techniques, called optical mixing and pointillism, were used extensively by the Impressionists to suggest the vibrant nature of sunlight.

Though many other arts use colour in their expression, in no art is colour so fundamental as it is in painting.

See also PAINTING.

3. Allied Arts.—Parenthetical mention should be made of allied types of mural decoration (*see* MURAL PAINTING) such as mosaics, textile wall hangings and glass painting. The technique of mosaic (*q.v.*) requires the placement of many small, flat, variously-tinted pieces of stone or glass, called tesserae, into a mortar ground, which is then bound with cement. A rich and sparkling surface is produced, and though pictorial effects such as light and shade as well as perspective can be suggested, the nature of the medium is best realized in two-dimensional patterns of a semi-abstract or abstract style. This is also the case with stained glass (*q.v.*) as well as with the textile arts, tapestry and embroidery. Cloth and tapestry weaving (*see* TAPESTRY) calls for the coloured threads to become a part of the cloth—the warp, as it were, worked into the woof to make the resulting design or image a part of the fabric itself. Embroidery, by contrast, uses the technique of superimposing the design by stitching it onto a plain fabric background. The artist can also make his designs by stamping or painting them on a plain piece of cloth, a process much favoured in modern, machine-manufactured fabrics. *See* EMBROIDERY; TEXTILES.

D. DRAWING AND THE GRAPHIC ARTS

Drawing (*q.v.*) is an art in itself and an indispensable technique for other arts. Architects, sculptors and painters usually set their first ideas down as quick sketches. As the artist's ideas crystallize, a series of preparatory studies may pave the way for the final work, or the drawing itself may eventually become the finished work. There exist many fine drawings by almost all the great western masters, as well as vast numbers of drawings of great sublety from Chinese and Japanese artists. A fairly wide range of drawing tools and materials has been traditionally available to the artist; the surface has usually been paper, though many oriental drawings are done with brush and ink on silk, which in turn is mounted on paper. Besides the common pencil, pen and ink, chalk and charcoal sticks, the artist also may use crayon of various types, or silverpoint, a somewhat more complex technique in which the artist uses a paper prepared with a fine abrasive coating that retains bits of metal scratched off the sharp

silverpoint stylus as it moves across the surface. (*See* also PENCIL DRAWING; PEN DRAWING; CRAYON DRAWING.)

An artist may be drawn to the graphic arts partly because they place at his command a wide range of effects not available in any other medium, and also because through mechanical reproduction many copies may be made from a single plate, enabling him to reach a larger public. The end of the graphic process is a print—an inked impression, usually on paper, made from a previously prepared plate. The two principal methods for making the plate are relief and intaglio. The relief technique is employed, as in the case of wood and linoleum cuts, when the lines the artist has cut are not inked, but only the remaining smooth surface is inked and transferred to the paper. With intaglio the process is reversed, and the lines cut into the copper, zinc or steel plate are inked, while the remaining surface is wiped clean and becomes blank on the paper.

The chief methods of working the surfaces of metal plates are engraving, etching and dry point. With engraving (*see* ENGRAVING, LINE) a steel graver, or burin, is pushed over the plate with sufficient pressure to cut lines in the metal. In dry point (*q.v.*) the stylus is pulled as with a pen. The burr, or raised edge, is usually scraped off so as to leave a clear precise line. Sometimes, as in the case of dry point, it is left on the plate in order to give the line a soft, fuzzy edge. In etching (*q.v.*) the plate is first coated with a wax or varnish through which the artist scratches his lines with an etching needle. The plate is then dipped into a corrosive acid, which etches, or bites, into the exposed parts of the metal. Upon removal of the surface coating, the remaining lines are inked and the plate is ready for printing. The etcher has the advantage of working with soft wax material, which makes greater subtleties of line, tone and shadow effects possible. In the technique known as aquatint (*q.v.*), not only lines but tones, shadows or large areas of various grays may first be etched into the plate by carefully sprinkling the wax on the plate rather than by coating it completely. Or in mezzotint (*q.v.*), the burr may be raised on the metal plate mechanically rather than chemically by the use of a rocker, or tool that roughs a larger surface at one time.

Other techniques common to the graphic arts are lithography, aquatone and serigraphy, as well as photography. Lithography (*see* LITHOGRAPH), as the name implies, entails drawing on a special kind of polished stone, though metal plates also are used. Subtleties of shading, tone and line are more readily available in lithography than in other graphic mediums because the artist has the greater freedom of drawing directly on the plate with grease crayons or brushes with special inks. In serigraphy, or the art of silk screen (*see* SILK SCREEN PRINTING), paints are squeezed through a special cloth masked with a stencil so that only certain areas permit the colours to pass through to the surface of the paper beneath. Invented in the 19th century, the methods and techniques of silk screen have been raised to the status of an important art form. Photography (*see* PHOTOGRAPHIC ART) is basically a simple process of exposing light-sensitive, chemically treated materials to light-reflecting objects, which are then recorded on a plate of film. The processes, materials and equipment employed by photographers have become extremely complex, flexible and sensitive. The most varied and subtle effects can be achieved by this graphic method, which takes modern chemistry and optics into account.

E. CONTENT

1. Traditional Categories.—Traditionally the subject matter of the pictorial arts is divided into various categories. (1) In historical scenes, including mythological and religious events, the artist usually is concerned with epical subjects and many figures placed in large-scale settings. (2) Genre (*q.v.*) pictures, by contrast, include casual, everyday situations such as a family at supper or a group playing cards. Such subjects are not the epic stuff of history, but lend themselves to informal, genial, sometimes humorous treatment, usually tempered with the warmth of human sympathy. (3) Portraiture (*see* PORTRAIT PAINTING) and figure painting, including academic studies of the nude, constitute still another branch of traditional subject matter. (4) Landscapes (*see* LANDSCAPE PAINTING), including seascapes and cityscapes, are pictures in which scenery assumes major interest. When human or animal figures are included they are of secondary importance. (5) Then, if landscape represents the larger aspects of man's environment, still life (*q.v.*) becomes the smaller, interior and more detailed view. Still-life pictures usually are composed of static arrangements of fruit and flowers, or a thoughtful grouping of inanimate objects on a table.

2. Abstract and Imaginary Art.—While these categories are still valid for traditional art, the 20th century has witnessed a break with the past, so sharp that it becomes necessary to add still another division for abstract and imaginary art. In the one case the picture does not describe or refer to the world outside itself, but rather, by an abstract play of lines, shapes and colours, the picture is self-identifying and its own referent. In the other, by conjuring up phantasms from the inner psychological world of emotion and imagination, the picture becomes a revelation of the artist's unconscious reactions.

In the various movements—cubism, nonobjectivism, expressionism, surrealism, fantastic art, to name a few—contemporary artists attempt to see the world with new eyes, to distill the essence of things rather than represent their external appearance, and to construct a subjective reality out of their own imaginations. This can mean anything from the distortion of natural shapes to the invention of new forms independent of those found in nature. In abstract design, the artist tries arbitrarily to free line, colour and form from nature and to emphasize the essential order of things as he understands them. Fantastic art and surrealism, on the other hand, look inward toward an introspective dream world of emotions and psychological states. Salvador Dali has called his pictures "hand-painted dream photographs," and the surrealist André Breton declared such art to be "pure psychic automatism."

3. Modifications in Sculpture and Graphic Arts.—Some modification of these categories must be made for sculpture and the graphic arts. Sculpture, like painting, has always dealt with historical subjects (both religious and secular), as well as with genre and portraiture, and, in the 20th century, with abstract and imaginary plastic forms. Landscape and still life, however, play only an incidental part in sculptural expression. Such devices as a tree trunk, the shape or texture of a rock, the element of water as with fountain groups serve to suggest the placement of figures amid natural surroundings; or a sculpture composition may include an arrangement of flowers, fruits or other still-life components.

While the pictorial ingredients of the graphic arts can include all those of painting, a subtle relationship between form and content and between the limitations of a medium and the choice of subject is involved. Shakespeare, for instance, casts his tragedies in the monumental mold of poetic drama, but for more tender and lyrical expressions he chooses the sonnet. Similarly, a visual artist must take the nature of his medium into account. If the theme is of heroic proportions, a fresco mural or large canvas is in order, but casual and intimate subjects find themselves more at home in the dimensions of an etching or lithograph.

F. CONCERTS OF ARTS

In addition to the relatively independent arts, there are composite arts—such as religious monuments, the theatre arts and opera—that result from collaboration of artists from many fields. More than the work of stonemasons, sculptors and glass painters are those collective outbursts of medieval creative energy known as cathedrals. Here the constellations of breathtaking vaults, proliferation of sculptured forms, mysterious colour harmonies of stained glass, merge with choral chant and the sacred liturgy to form one grand architectonic design. Similarly, a theatre or opera production entails the setting of a theatre building, scenic architecture, sculptured properties, costumes, dramatic movement of human figures, plot and dialogue, dance interludes or ballet, spoken or sung melody, solo, choral and instrumental music, and an incidental or full score.

These concerts of the arts apparently had their origin in pri-

mordial religious rites that eventually took the shape of the more stylized sacred liturgies and such art forms as the Greek drama. Medieval mystery, miracle, morality and passion plays, as well as the popular forms of minstrelsy, combined elements of dramatic action, spoken dialogue, poetry, solo and choral chant and pantomime. Renaissance Florence witnessed such elaborate pageants as the *canti carnascialeschi*, or carnival songs of the pre-Lenten celebrations, and the *Calendimaggio*, or May-season entertainments, that included outdoor singing and dancing by masked merrymakers, mimicry, tableaux and torchlight processions with elaborately designed floats and chariots representing mythological or historical events. Lorenzo de' Medici himself wrote some of these so-called triumphs, and the foremost visual artists of the time—Ghirlandajo, Verrocchio, Leonardo da Vinci and Andrea del Sarto—did not disdain to design the scenes and machines for them.

History records some notable examples of these composite artistic ventures of the past. The poet Angelo Politian collaborated with the composer Germi on an *Orfeo* at Mantua in 1474. The presentation was modeled on the sacred representations and pastoral plays of the period, which included dialogue, solo and choral song, instrumental interludes, ballets, pantomime, plot and scenic spectacle. In Renaissance Rome, Pope Leo X, son of Lorenzo the Magnificent, in 1518 patronized a production of a poetic comedy by Ariosto that included dancing, instrumental music and scenery painted by Raphael. The English court masque was a combination of these Italian triumphs and the French court ballet. For the *Masque of Blackness*, performed in 1605 at the court of James I, Shakespeare's junior contemporary Ben Jonson wrote the text and the architect Inigo Jones designed the scenery, which involved nothing less than the invention of movable stage sets. Nor is the 20th century wanting in this respect. Sergei Diaghilev assembled in Paris for his Russian ballet productions such leading lights as the composers Debussy, Ravel and Stravinsky; the scenic designers Bakst, Derain, Matisse and Picasso; the choreographers Fokine and Massine; and the dancers Karsavina and Nijinsky.

III. HISTORY

Ultimately what matters in art, as Lionel Venturi pointed out in the case of painting, "is not the canvas, the hue of oil or tempera, the anatomical structure, and all the other measurable items, but its contribution to our life, its suggestions to our sensations, feeling and imagination." (Lionel Venturi, *Painting and Painters*, p. 10, Charles Scribner's Sons, New York, 1945). The history of art reflects the conflicts of social forces, the rivalries of cities and states, the ambitions of priests and rulers, the competition among public and private patrons. The human urge to create order and build, decorate and depict, impress and express are the constants of art history, while the dynamics of society, the momentum of particular art movements, the fluctuation of shapes and forms, the evolution of techniques and the vagaries of group and individual tastes are its variables.

When a centre of population attains a degree of civilization, develops a prosperous economy, fosters an adequate educational system and produces a number of talented persons, a cultural climax may occur. Usually this happens because some person of powerful and persuasive convictions reacts strongly enough to the challenge of his age to reach a position of prominence and influence. Various arguments have been advanced, such as the "great man" theory, according to which outstanding persons stamp their image upon their age, and genius is the primary causal influence on history. Social realists, on the other hand, contend that environmental forces shape the personality and product of the individual. The truth probably lies somewhere between these extremes of nature and nurture; the interplay between powerful personalities and the stimulus of their times brings about the explosion commonly described as genius.

Such a cultural climax may be instigated or encouraged by a single or collective patron with energy and discernment. The patron might be an individual ruler with the vision and means possessed by Pericles, who built the Acropolis temples and fostered the poetry and drama that combined to produce the aesthetic climax of ancient Athens. Or it might be a family of merchant princes such as the Medici who brought Renaissance Florence to its high point of development. In the 20th century the Commonwealth of India became the patron of Le Corbusier, whose commission was nothing less than the construction of an entirely new city, complete with every public and private architectural facility. Modern industrialists have contributed to New York city such cultural complexes as Rockefeller centre, and have joined with the city planning commission as well as other public and private contributors to erect the Lincoln Square "Acropolis" that embraces an opera house, several concert halls, a repertory theatre, a library and educational centre, as well as co-operative housing units.

Taken as a whole the arts of a given time and period usually demonstrate a certain unity of direction. Yet this unity does not lie in the separate objects or techniques of production; its focus is found in minds capable of perception and understanding. A search for the common idea that animates and motivates human activities often can reduce to basic simplicity what appears on the surface to be a confusing multiplicity of actions and directions. And since the arts usually are not experienced separately but simultaneously, comprehension may be sought multidirectionally.

If a common idea or configuration of ideas can be found, then elements that previously were not understood begin to fall into place and to acquire significance. Techniques of production, of course, are and always will remain private problems to the particular craftsman, but the idea of composition, used here in its basic sense of putting things together, is common to all. An architect puts bricks together, a poet words, a musician tones, but they do not do so in a vacuum of abstractions; they do so rather for purposes of expression and communication of thought, free fantasy, social comment, satirical observation, self-revelation, construction of new orders and the like. Highly important is the fact that the artist's viewpoint has been coloured and shaped by a social and historical environment, and his works are addressed to some segment of the contemporary order. Whether the artist accepts or rejects, endorses or protests, constructs or destroys, his taking-off point must be his own period. Some artists function largely within their own time, having little to say to posterity and hence passing eventually into oblivion. Others speak in broader humanistic terms so that they transcend their own times, and their works are consequently significant enough to ensure their survival.

Through its artists, society can see, hear and feel aspects of its world that it never experienced before. Similarly, by training his perceptions and sensitizing his eyes and ears to sight and sound the individual observer, reader or listener may discover a new and richer world. The insight of the artist thus can help to create a larger world outlook; through the arts it is possible to participate in the intellectual and emotional currents of the past and present. The visual arts can present the visage of an age through historical painting, portraiture, scenes from daily life; while poetry and music, by revealing emotion, can yield deeper understanding of present as well as past life. Song and lyric poetry reflect the joys and sorrows of the people who sang them. Dances reveal the inner rhythms as well as the outer gestures and steps of the individuals and groups who have performed them. The drama and lyric stage, including opera, is a rich source of social commentary, replete with conceptions of order, manners and characteristic attitudes of a given time. The music of a period tells not only of its harmonies but also of its conflicts: in periods of oppression it represents the passionate outpouring of the human heart; during religious revivals, it sings out with resounding declarations of faith; in an age of reason, it bespeaks the logical processes of well-ordered minds; and during social upheaval, it rings out with revolutionary anthems.

It is the artist, then, who most poignantly expresses the spirit of his age. The poet, as leader, establishes goals and ends for human living. He opens up new areas of potential experience and gives structure to that experience by creating images of order. He can convince the individual that life is not an incoherent sequence of events but a force that has a definite direction, unity and meaning in which particular events are subordinated to a

larger whole. A work of art is always a reflection of both the personality of the artist and the age in which it was produced. Paintings, for instance, often speak more eloquently than do historical treatises and other documentary evidence. Titian in a portrait of Charles V has contributed some vital substance that allows the viewer to visualize the qualities of a living human being as he appeared to one of the subtlest and most alert minds of his age. In art the past continues to exist as a living process; its arbitrary separation from present and future disappears. True understanding of human life and history can come only by relating one event to another and eventually to the entire stream of universal life from which each derives its significance; in achieving such a relation art plays the vital role.

A. Prehistoric and Early Near Eastern Styles

The origins of art in preliterate times can be discerned dimly in the caves of the nomadic hunter-artists of the Paleolithic Age (*c.* 25,000–10,000 B.C.) and in the lake dwellings and agricultural settlements of their Neolithic Age (*c.* 10,000–4,000 B.C.) successors. Various theories about the important and vital place of art expression in the activities of early man have been formulated: some feel that art is the expression of an affirmative attitude and the joy of life; others see fear as an impetus to artistic creation. Primitive man seems to have enjoyed ornamenting his clothing, tools and weapons and decorating his baskets and pottery; but he likewise fashioned idols and fetishes, presumably in order to propitiate hostile spirits in magic ceremonies and thus to bring the more mysterious forces of the universe under his control. To some students primitive art represents the delight in exercising the play instinct during leisure time; to others it is a by-product of the struggle for existence, the psychological need to assert the self in the face of an overwhelmingly hostile and brutal world. Some see early man's art as originating in the desire to cover blank surfaces with lines, shapes and patterns; others feel that it is based on deeper spiritual aspirations and the worship of superpersonal beings.

1. Early Man.—Already manifest in these early times is the polarity between a naturalistic recording of observed phenomena and the tendency to symbolize unseen forces in formal patterns and abstract designs. The Paleolithic artist covered the surfaces of caves and rocks with richly coloured, lifelike bisons and mammoths. With amazing accuracy and keen powers of observation, the cave artists saw and recorded details of animal anatomy, its musculature at rest and in action. Unconcerned with tradition or convention, Paleolithic art was the reflection of a highly individualistic attitude toward life.

The shift from hunting to agricultural life brought about corresponding changes in art, and art of the Neolithic period shows a trend to severe geometrical design. Instead of merely representing the visible world, Neolithic man appears to have been concerned with the invisible forces that controlled his destiny. Natural observation and recording gave way to stylized signs and symbols that stood perhaps for the unseen forces and hidden inner substances. In an agricultural world that alternated between plenty and scarcity, man's livelihood and destiny depended upon such capricious factors as the fertility of domestic animals, the alternation of sunshine and rain, threats of drought and flood, storm and wind. Such forces do not lend themselves to realistic treatment, and hence must be represented by signs and symbols or personified by masks or totems. Neolithic geometrism bespoke a more integrated social organization, uniformity of social attitudes and acceptance of conventions. (*See* Primitive Art.)

2. Egypt, Mesopotamia and the Aegean.—With the coming of the city cultures of the great river valleys—the Tigris, Euphrates, Indus and Nile—concentration of population allowed for a more varied life as well as for a greater stratification of social levels. In both the near and far east, art expression, with occasional exceptions, was essentially a continuation and refinement of the formal geometrical style of Neolithic times. The ceremonial and courtly arts that developed in Mesopotamia and Egypt reflected the splendour and magnificence of a superindividual, aloof ruling class, whose life was inexorably regulated by a rigid etiquette and conformity to convention. All individuality was suppressed under a veneer of stereotypes and archetypes. This art was the product of temple and palace workshops in which generations of anonymous artisans and craftsmen laboured and in which the personality of the artist-designer invariably was concealed. It was an art created not to be admired and enjoyed but to impress potential enemies with the rulers' power or to preserve their bodies and souls for eternity. Hence its remains are found not only in public places, but also in remote temple sanctuaries and in tombs.

Neither the conservative aristocracy nor the priestly caste desired change in the social structure. Consequently those masterly solids, the ziggurat (*q.v.*) towers and pyramids (*q.v.*), that practically negated interior space, the pylon-faced temples with their forests of painted columns, the immense palaces, the obelisks, the stylized friezes of solemn and stately processions, winged lions and sphinxes, are massively static and endlessly repetitive. Because prince and priest had to adhere to rigid convention in order to proclaim and maintain their worldly position, only subhuman creatures could become emotionally expressive; hence representations of animals became the most human aspect of art.

Two exceptions to these stylized, hieratic expressions were a brief interlude that coincided with the reign of Ikhnaton (*q.v.*) in Egypt, and the longer-lived culture of Crete and Mycenae. Ikhnaton broke with the past not only in his adoption of monotheism but also in his conscious innovations in art. Portraits of him and his queen, Nefertiti, as well as the informal scenes depicting his court, reveal truly individual personalities with real human warmth. The animated, lively Minoan style of Crete, afterward continued on the mainland at Mycenae, mirrored a gay, chivalrous, luxurious courtly life (*see* Aegean Civilization). Difference rather than sameness, diversity rather than uniformity, spontaneity rather than study, flexible forms rather than strict symmetry characterized this colourful and imaginative art.

See also Egyptian Architecture; Jewish Art; Persian Art; Pre-hellenic Architecture.

B. Classical Styles

It remained for the Greeks to synthesize these opposing tendencies in Mediterranean art. After a slow germination during the Archaic period, the abstract geometrism of the near east and the spontaneous naturalism of the Minoan-Mycenaean culture, the decorative elegance of the Ionian merchant cities and the solid strength of the Dorian agricultural communities—east and west, in short—met and merged and eventually flowered into the classical art of antiquity. Throughout the successive periods of Hellenic, Hellenistic and Roman domination (roughly the millennium spanning the five centuries before and after Christ), and despite the social evolution from city-state and kingdom to world empire, this balance between the extremes of naturalistic uniqueness and stylized convention was maintained. Though the scales could tip at any time in one direction or the other, the precarious balance between democratic individualism and aristocratic traditionalism, the actual and the ideal, the changing world of appearances and the permanent realm of abiding principles, spontaneity and self-restraint, emotional and intellectual elements somehow was maintained. Classical art was never wholly one or the other, but in the work of various generations, geographical centres and schools of artists now one aspect was predominant, now another.

The declared principle of Greek aesthetics was the imitation, or representation, of nature. Taken at face value this would be a straightforward naturalism, and to some extent it was; Myron's bronze "Heifer" on the Acropolis at Athens, for example, was so lifelike that cows were said to low at it as they passed by. But the desire to idealize, to perfect, to create types, to work out canons of proportion and rational concepts of order invariably asserted itself.

The history of art knows no event more momentous than the aesthetic revolution brought about by the Greeks. Art emerged from the tomb and from dim temple sanctuaries into the light of day, where it could be seen and admired by all. No longer was art a form of propaganda; it became a free pursuit of creative truth

and a method of interpreting reality. Ponderous pyramids, with their overwhelming weight and size, yielded to perfectly proportioned temples conceived as dwelling places for benign deities. No longer were the gods conceived as mighty monsters but as perfect human beings endowed with attributes of physical beauty. No longer was art the work of anonymous craftsmen; artists now acquired individual reputations, and their works exhibit personal style. Beauty in the Greek conception was equated with truth and goodness in a trinity of eternal verities, and aesthetic activity was raised to the level of intellectual and moral pursuits. Physical or visible beauty could lead the mind of the beholder to thoughts of the divine, and through the contemplation of eternal beauty man could obtain glimpses of the moral order of the universe.

Such lofty ideas, however, still allowed ample scope for personal expression. Individual differences were explored along with the establishment of types and archetypes; sensuous and intellectual pleasures were found not to be mutually exclusive; capricious differences could coexist with accepted conventions; personal hero worship in portraiture and biography found a place beside admiration for abstract ideals; architects concerned themselves with city planning and domestic dwellings as well as with temples and shrines; utilitarianism in engineering projects such as aqueducts and bridges was not incompatible with concepts of beauty; and painters depicted casual genre scenes as well as vast mythological and historical subjects.

Above all, perhaps, the Greeks established the ideal of man as the measure of all things, a concept that has illuminated all succeeding phases of classicism in western art. To the Greeks art was an adjunct to the good life, the material embodiment of spiritual attributes, the harmonious reconciliation of man and his environment. Nature was humanized by personification; even in such fanciful creatures as the goat-footed Pan and the centaurs, the human body was always the point of departure. Classical architecture, furthermore, humanized the experience of space by imposing special limitations that rendered it intelligible to the eye as well as the mind. The Greeks defined space in terms of lines and planes and banished mystery from the building process by making all parts of their temples clear and self-explanatory. The Romans went a step farther in expanding and developing interior space and in learning to control and manipulate it as a sculptor molds his materials.

In all cases the point of reference was man, his activities and movements. The anthropomorphic idea of the gods gave impetus to the perfection and idealization of the human body, and sculptors evolved canons of proportion—*i.e.*, systems of measurements in modules—by which each part of the body in a particular statue is logically and integrally related to the whole. Classical art with its criteria of moderation, balance, order and clarity has stood as a model and inspiration to all subsequent generations. Across the centuries, it has been an ideal to be studied and emulated, a standard for critical comparisons, a basis for judgment.

See also Greek Architecture; Greek Art; Roman Architecture; Roman Art.

C. Oriental Parallels

By the end of the classical era both occident and orient had arrived at critical principles and criteria of judgment. The line of thought in the west runs from Aristotle's *Poetics* and the Neo-Platonists, through the ancient treatises on rhetoric, poetry, music and the visual arts, to the commentaries of St. Augustine and Boethius. The basic tenets of oriental art were formulated in China by Hsieh Ho about the 5th century. His *Six Canons of Painting*, which have constituted the basis of oriental art criticism ever since, are arranged in the order of their importance: (1) life rhythm engendered by spiritual harmony; (2) correct use of the brush in delineating structure and anatomy; (3) rendering of forms in keeping with the objects; (4) application of colours appropriate to the kinds; (5) spacing based on proper planning; and (6) emulating classic pictures in order to preserve tradition.

To be recognized as a masterpiece, a work must qualify on all six points. It will also be noted that first and foremost an artist must concern himself more with interpretation than with representation, more with the spirit than with the semblance of his subject. The other five rules have to do with technical considerations—the lines and brush strokes, or skeleton that supports the spirit; the forms and colours, or flesh and skin that enclose it; the spacing or arrangement of the design; and copying that transmits the principles established by the old masters. The brush strokes by which the oriental artist puts his conception into execution are never static entities but the invocation of living motion, the nerve system of his composition. Sketching from nature and colouring likewise are dynamic processes that included training the artist's perception by observation, grasping the spirit inherent in objects, pondering on the mystery of animate and inanimate objects and identifying himself with his subjects. In painting a plant or tree, furthermore, the oriental artist follows the natural order of growth, drawing the roots first and proceeding upward.

Rules of composition based on Hsieh Ho's canons have been amplified at various times. The order and relationship of principal and subordinate parts are carefully distinguished, with the former as the major portion of the design and the latter as its adjunct. The principal is the focal centre of attention, larger in size and more abundant in detail; the subordinate is smaller in proportion, supporting, complementing and balancing the principal. In a portrait of an emperor, for instance, the personality is the principal, and the palace, furniture and garden are the subordinate accessories. The artist must always be conscious of the dominant characteristics, attributes and ideals of his subjects—in human subjects, the dignity of a ruler, the courage of a warrior, the refinement of a lady, the rusticity of a farmer; in animals, the plumage of a peacock, the beak and talons of an eagle, the horns of a deer. In figure drawing the oriental canon prescribes that the head should be twice the size of the open palm of the subject's hand; when standing, the height of the figure should be seven times the size of the head, when seated only three times.

Oriental conventions for representing perspective differ from occidental. The picture is built in three planes, one above the other, with the nearest objects in the lowest plane. The tones of ink or colour are graded accordingly, with the darkest tones in the foreground, medium in the middle and lightest in the background. Likewise the degree of representing detail is arranged accordingly, with distant objects being less distinct. This does not imply that such details are absent; they merely appear as if they were not present. The total effect thus amounts to aerial rather than linear perspective, and the artist must decide how to suggest spatial and temporal relationships within a restricted area. This involves grasping the essential attributes of a subject, then rendering them with the utmost economy of means. Every extraneous detail must be omitted, and what is left out of a picture is often more important than what is included. One of the most felicitous aspects of oriental painting is precisely this uncluttered appearance, allowing the observer's imagination free play.

Copying, as part of rule six, was probably not intended to be taken literally, but rather in the sense of interpreting and preserving traditions, acknowledging that the past is inevitably a part of the present, and recognizing that art parts company with the past as its own peril. Reverence for tradition and the habit of looking to the past for inspiration, however, is deeply ingrained in the oriental artist. Time-tested techniques and hallowed treatment of subject matter plays a far greater part in eastern than in western art. Schools of mannerism, by which artists seek models in the work of other painters rather than from nature, abound in oriental art. Stylization (*i.e.*, using conventional devices and accepted modes of representation rather than seeking new solutions to technical problems) leads to a certain repetitiousness both of subjects and their treatment.

For cross references to numerous articles on the arts of China and Japan, *see* Chinese Art and Japanese Art. *See* also Indian Architecture; Indian Art; Indonesian Archaeology and Art; Tibetan Art.

D. Medieval Styles

After the fall of Rome and the dissolution of the Pax Romana,

the situation in the western world was one of disunity and confusion. The middle ages comprise, in time, roughly the millennium between the 5th and 15th centuries; *i.e.*, from the early Roman and Byzantine Christian periods, through the barbarian invasions and the successive European dynasties, to the emergence of the Romanesque and the climax of the Gothic styles. Geographically the middle ages may be said to have covered the Mediterranean world and all of Europe. Thus multiplicity and variety are more characteristic of the medieval styles than unity, and a diverse rather than a homogeneous culture prevailed.

As Christianity came to maturity in the final phases of the Roman empire, the arts were drawn into the orbit of the church, which was extending its influence over all aspects of political, social, intellectual and cultural life. There was a reorientation from a physical to a metaphysical view of life, a turning away from the natural world toward the supernatural, from the visible to the invisible.

Johannes Scotus Erigena, a 9th-century theologian, expressed the patristic viewpoint in his fear that sacred pictures, if beautiful, might lead the faithful toward an appreciation of the seen rather than the unseen world, toward false rather than true beauty. According to Scotus, God created the world of appearances in order to reveal himself in visible form to those who could not see the invisible. The fall of Adam came about when he took delight in the tangible aspects of creation before he had arrived at the perfect state of wisdom in which he would have praised the Creator before the things created. Hence the lesson of the Fall was to learn the nature of God first, then to contemplate beauty in its sensible forms and praise the Creator. It is therefore possible to enjoy beauty only on condition that it is seen as the revelation of the glory of God and not as a gratification of sensuous desire. Scotus thus left one door open to aesthetic expression.

Knowledge of the criteria of classical art is not particularly helpful in understanding medieval styles. While late Roman building methods and modes of representation continued in modified form, such criteria as canons of proportion, correct use of classical architectural orders and symmetrical design do not apply. Medieval architecture, sculpture and painting actually emphasized the irregular, asymmetry and eccentricity. The walls of Romanesque buildings often are not parallel; the angles of the vaulting sometimes are askew; the arches in arcades frequently are not of uniform height; and Romanesque and Gothic sculptors delighted in apocalyptic grotesqueries.

This metaphysical orientation could not be expected to find its models in nature. Objective observation yielded to subjective feeling. The open, exterior colonnades of Greco-Roman temples were succeeded by the enclosed interior arcades of Christian basilicas, and the earthbound horizontality of classical architecture was replaced by aspiring Romanesque and Gothic verticality. In sculpture and the pictorial arts the three dimensions of classical space yielded to two-dimensional illusionism. To depict the infinitely remote and unfathomably mysterious realm of the spirit, medieval artists had to devise an elaborate system of symbols. God the Father, for instance, became a hand pointing downward from above; the Son was represented by the chrismon (an abbreviation of Christ formed by a combination of the Greek letters Chi and Rho); and the Holy Spirit was a dove.

Evolution of church forms is most characteristic of the changing medieval styles. Romanesque abbey churches were designed for monastic communities, while Gothic cathedrals had to take the needs of growing city populations into account. The isolation of Romanesque monasteries contrasted with the greater accessibility of city churches, and during festival periods a cathedral might need to accommodate an entire town's population in addition to a contingent of pilgrims. The cathedral choir and presbytery evolved, for example, to provide space for a large participating clergy. Porches and portals at the ends of transepts, often more elaborate than those of the west façades, had to be developed to allow for entrance and egress of large crowds. In the abbey church, where many services took place at night, the need for interior light was minimized, while a cathedral's congregation, assembling by day, required larger windows and an increased use of glass. And while the embellishments of abbey churches were concentrated on the interior, Gothic cathedrals, facing as they did toward market places and city squares, called for interesting and significant exteriors. In the sculptures that graced such façades and porches all contemporary knowledge was recorded in a symbolic language of stone.

Through the medium of stained glass, the ultimate in the etherealization of interior space was achieved. Light itself became a building material that the architect, with the collaboration of the glazier, could manipulate at will. Through his glass-curtain walls, exteriors and interiors became unified, and the architect was in complete control of the flow of light. Physical light was transmuted into metaphysical illumination, and interiors seemed to be lighted not by the outer rays of the sun but by the inner radiance of the spirit. The loftiest expression of the middle ages is thus found in these miracles of soaring stone and gleaming glass, the Gothic cathedrals, which were the end result of an amazing co-ordination of community effort in concert with a spirit of religious exaltation.

Reflected in Gothic art are many of the social, political and intellectual dissonances that affirm the vigour and vitality of the period. The struggles between town and country, feudal lords and monarch, kingdom and empire, church and state, monastic and secular clergy, sacred and secular aspects of life, knowledge and faith, reason and feeling were either at or just beneath the surface. By bold thinking and intellectual adroitness the mind attempted to reconcile these irreconcilables. Remarkably, the period was able to effect a balance, however temporary, between such sharp divergencies. Some of the ingenious solutions are found in the monarchy that divided powers between king and feudal lord; in the code of chivalry that effected a balance between strong and weak; the courts of love that upheld ideal love against both marriages of convenience and gratification of the senses; in the art of counterpoint that harmonized note against note, consonance and dissonance, in two or more divergent musical lines; and in the building system that solved the problem of gravitational pull by its equipoise of attraction and revulsion, and by its equilibrium of thrusts and counterthrusts.

See also Byzantine Architecture; Byzantine Art; Early Christian Art; Gothic Architecture; Gothic Art; Islamic Architecture; Romanesque Architecture; Romanesque Art; Russian Architecture; Russian Art.

E. Renaissance, Baroque and Neoclassical Styles

1. Renaissance.—The widely accepted historical view that the Renaissance represented a rediscovery of the beauties of nature and the joys of this world, a rejection of medieval religious authoritarianism in favour of a secular spirit of free scientific inquiry, and a rebirth of classical humanism needs critical reappraisal. More accurately, the movement appears to have been more an evolution than a revolution, more a continuation and intensification of certain trends apparent in late Gothic thought than an abrupt break with the immediate past.

In regard to nature, no more eloquent tribute than St. Francis' "Canticle of the Creatures" (*c.* 1225) or the descriptive passages in Dante's *Divine Comedy* have ever been penned. The acute observation and accurate representation of flora and fauna in late Gothic sculpture, tapestries and manuscript illuminations reveal a de-emphasis of allegory and symbolism and point to a recognition of the realities and beauties of the visible world. The paintings of Duccio and Giotto are evidence of renewed interest in spatial perspective and the presentation of visual data as the eye sees them. Naturalism was thus already highly developed in Gothic art. The Renaissance extended this and gave it a special scientific character.

The Renaissance, in fact, witnessed a partnership between art and science in which sculptors and painters became leaders in seeking a more exact understanding of the physical world. Curiosity about natural phenomena drove artist and savant alike to experimentation and investigation. In order to depict the musculature of the human body more accurately, artists dissected cadavers and made significant strides in anatomy. By applying Euclid's

theorems to diverging and converging lines, artists worked out the principles of spatial representation, perspective drawing and foreshortening. Speculation on optics and the dynamics of light led painters to the discovery of atmospheric perspective and the modeling of figures in light and shadow so as to create the illusion of three-dimensionality. Renaissance man thus was pictured in well-proportioned interior settings that had depth as well as height and breadth. Outdoors, in the midst of living landscape, Renaissance man could gaze about and behold a world created for his delight and enjoyment. Nothing, in short, was too large or small to claim the attention of the inquiring Renaissance mind, and Leonardo da Vinci's notebooks bear witness to the scientific speculation and progress that took place.

During the middle ages the spirit of classical humanism had been kept alive in isolated monastic centres and universities; in Renaissance times it began to flourish once more. God, according to Pico della Mirandola, made man at the close of creation to know the laws of the universe, to love its beauty, to admire its greatness. Man once again became the measure of all things, and nothing human was foreign to the Renaissance artist or his art. Medieval man had thought of himself in such larger contexts as class, family, party or corporation, but Renaissance man became an individual in his own right. In late medieval times Petrarch wrote sonnets to his Laura, and Simone Martini painted her portrait, but Laura was still partially an abstract ideal from the age of chivalry. With Renaissance writers and painters, the subjects of biographies and portraits became flesh and blood. Artists became active competitors for personal recognition. Their patrons likewise sought renown by sponsoring works that bore their names as, for example, the chapels created by Brunelleschi, Masaccio and Michelangelo for the Pazzi, Brancacci and Medici families, respectively.

To enjoy, said Leonardo, is to love a thing for its own sake and for no other reason. The Renaissance artist looked more for the intrinsic value of objects than for their symbolic or allegorical significance. In contrast to his medieval counterpart, the Renaissance artist thought more in terms of the purely aesthetic aspects of his work and less in terms of moral lessons and visual narrative techniques. He was more concerned with modes of presentation and pictorial mechanics than with subject matter as such. He was also more conscious of his mission to create works of art, while his medieval predecessor was content to produce functional objects in which artistic implications were more a by-product than a direct concern.

2. Classicism.—Greco-Roman ideas recur in every century, and it is illuminating to compare Renaissance conceptions of classical art with those of the Baroque and Neoclassical periods. The models each generation chooses from antiquity, the way each century adapts and modifies ancient forms and handles decorative details, the manner in which each period absorbs the classical vocabulary into its expressive language become critical indices to the understanding of each style.

Interest in the antique world during the Renaissance had been limited to certain restricted circles of intellectuals and artists: the Florentine academy, the group around Lorenzo de' Medici and the courts of certain of the popes. Baroque classicism, as exemplified at the court of Louis XIV, was the plaything of an aristocratic class who pictured themselves as Olympian deities with all their mythological trappings and capricious moral behaviour. The Neoclassicism of the revolutionary period had a broad popular base in the solid citizenry of an educated middle class who saw Greece and Rome as the birthplaces of liberty and freedom. Lorenzo the Magnificent, as the head of a small city-state, could envisage himself as the philosopher-king of Plato's *Republic;* Louis XIV, who viewed the antique world through the eyes of an absolute monarch, found his model in Alexander the Great; and the leaders of the American and French Revolutions found precedents for their new governments in the parliamentary forms of the Roman republic.

The extent of knowledge about antiquity varied considerably. During the Renaissance an occasional antique statue was unearthed and caused a stir. In Italy, however, the heritage of antiquity could be seen on all sides, in the extant monuments as well as in the Roman bridges, roads and buildings that were still in use. Not until the late 18th century and the discovery of the ruins of Herculaneum and Pompeii, however, were large-scale excavations undertaken. The Neoclassical period, therefore, had a far more exact knowledge about all aspects of ancient life than was available during the Renaissance or Baroque periods. Speculation about antiquity during the Renaissance was largely an individual affair. During the Baroque, however, the French academies were set up to codify classical principles, uphold canons of proportion and order and enforce rules of symmetry and clarity. In this way the academies acted as a restraining influence on Baroque exuberance and to a certain extent curbed Baroque decorative extravagance. By Neoclassical times, classical archaeology had come to be regarded as a science, and faithful adherence to authentic models was required.

Renaissance and Baroque artists, furthermore, knew antiquity only through Roman eyes, while the Neoclassicists had the advantage of more authentic information about Greek originals. Until the late 18th century, original Greek architecture and sculpture had remained unknown to western artists. At that time Stuart and Revett described and measured the antiquities of Athens; Winckelmann drew a clear distinction between Greek and Roman sculpture; and Lord Elgin brought back his collection of ancient Athenian sculptures to London.

In the Renaissance Botticelli occupied himself with mythological subjects and allegories; Poussin, his Baroque counterpart, evoked nostalgic and elegiac moods with his serene figures strolling through Arcadian landscapes; while the Neoclassicist David desired all aspects of his canvases to be so faithful to antiquity that if a Roman of ancient times should suddenly come to life he would feel at home. In sculpture the Italian Renaissance reaffirmed the expressive power of the nude, revived Roman techniques of bronze casting and created original works animated by the spirit of antiquity. Baroque statuary created new variations on old mythological themes. The Neoclassical sculptors saw living flesh through the marble eyes of antique statuary, and with their pointing machines produced works that adhered closely to classical models. In landscape architecture the gardens of the Italian Renaissance with their fountains, grottoes and statuary, had a dignified formality. Baroque classicism sought to master nature, force it into geometrical patterns and harmonize it with a rational concept of the cosmic order. Neoclassical gardens, however, became highly picturesque with artificially constructed ruins and picturesque accents.

In the early Renaissance Brunelleschi sought the inspiration of ancient Rome in Vitruvius' treatises and in such monuments as the Pantheon. When, however, he built the dome of the Florentine cathedral, he reverted to Gothic vaulting methods. By using Roman decorative detail, his Pazzi chapel achieved a crisp, clear-cut geometrical definition that marked a distinct departure from the medieval concept of infinite space. Baroque architects thought in terms of the correct use of the classical orders, the mathematical proportions of their buildings and the judicious use of antique decorative detail. The Neoclassicists, however, were concerned with the problems of archaeological correctness. Baroque rationalism could never have countenanced the reconstruction of classical buildings for contemporary use. Baroque architects were content to design their "modern" buildings and adorn them with ancient porticoes and Roman decorative motives. The archaeological enthusiasm of the Neoclassicists, however, led to the construction of "ancient" buildings for modern use, and this antiquarianism often resembled a cult of ruins.

See also Renaissance Architecture; Renaissance Art; Baroque and Post-Baroque Architecture; Baroque Art; Neoclassical Art.

F. Romantic and Modern Styles

Though in the late 18th and early 19th centuries Neoclassicism had the full force of officialdom and the academies behind it in France and was still the accepted style in Georgian England and the American Federal period and early republic, it represented

but one tendency of the arts of this time. While Neoclassicism was riding the crest of the popular wave, the Gothic revival was enlisting its partisans; the German "storm and stress" outbursts were reverberating in dramatic, literary and musical circles; the tender emotions were being aroused by the "sensibility" movement in bourgeois novels, plays and genre pictures; interest in the near and far east was adding an exotic dimension to the imagination; and bucolic novels and landscape paintings pointed to the "back to nature" movement. In this battle of styles the pious medieval knight, the noble savage, the idyllic shepherd, the poor but proud peasant competed for popular favour with the dignified Greek and stalwart Roman. Together these new images of man heralded the dawn of romanticism with its repertory of escape mechanisms and its longings for any place but here and any time but now.

In approaching the arts and ideas of the modern world, it is well to keep in mind that at present, as in the past, there are two possible world views. The subjective view is coloured by personal involvement and an accent on emotionalism. The objective view bespeaks logical organization and a cool, detached intellectuality. The subjective side reveals itself in the various facets of expressionism, in which the emotions gain the upper hand, the inner world of neuroses and psychoses is explored and protests against existing conditions in the external world are made. Objectivity in contemporary art finds its outlet in various forms of constructivism such as cubism, futurism, the mechanical style in painting and sculpture and the international style in architecture.

The exponents of expressionism and its variants are little concerned with the world of appearances. Reactions to physical, psychological and spiritual events can be revealed only by looking inward and beholding soul states through the mind's eye. The images on the canvas are altered and distorted according to the intensity of emotion and violence of feeling through which they are viewed. The visual vocabulary used to express such flights of the imagination, neuroses and psychoses includes psychological symbolism, violent visual distortions, conflicting linear directions, clashing colour dissonances and a variety of shock techniques.

From the Renaissance until the end of the 19th century, the pictorial artist was expected to portray the three-dimensional physical world and to describe the objects in it more or less completely from one point of view, that of the spectator. Pictures through their subject matter, literary allusions and narrative content made constant reference to the world outside the picture. In abstract design, natural appearances, as the eye beholds them, play little part; it is a type of analytical vision in which a landscape or still-life composition is simplified to a system of angles, shapes and patches of colour on a two-dimensional surface. Abstract art had its inception in Cézanne's pictorial studies in which he saw nature in terms of such forms as the cylinder, the sphere and the cone. The geometry of the cubists, futurists and practitioners of the mechanical style, based as it is on a dynamic image of the world, is considerably more complex. Vision, in their theory, is a fast-moving, fleeting experience in which the observer sees objects not from a single point of view but simultaneously from many. A picture, therefore, should be presented as a constellation of multivisual viewpoints and in multifocus perspective. In a process of disintegration and reintegration, fission and fusion, the cubists and their successors analyzed, broke up and fragmented their pictorial content, then reassembled it in a new unity, one that lies not in the subject represented but in the picture itself. The nonobjectivists went a step farther in banishing all recognizable objects derived from the external world. They manipulated their abstract lines, swirls of colour and free forms, and the picture becomes both an independent entity and its own referent. *See* also ABSTRACT ART; CUBISM; DADAISM; EXPRESSIONISM; FAUVISM; FUTURISM; IMPRESSIONISM; MANNERISM; POSTIMPRESSIONISM; SURREALISM.

In seeking an understanding of contemporary art, the observer must remember that modern society presents an unusually complex picture, that extraordinary technological advances have invited artists to experiment in many new mediums and that detailed knowledge about the products of past centuries have opened up wider historical horizons than those beheld by any previous period. While formerly an artist lived and worked within a small geographical centre and executed commissions for a few patrons, his modern counterpart addresses his work to a vast, inchoate public, with all its international connotations and multiplicity of social levels. Contemporary artists as well as observers are, to a greater extent than ever before, the heirs of all the ages. Access to vast stores of information can lead either to a stultifying eclecticism in artistic productivity and public taste, or can become a challenge to new creative activity. In one case the dead arts are in danger of burying the living; in the other, the present, without denying its heritage, can assert itself in the face of the past and evolve new mediums and expressive forms.

Since each cultural epoch, century, generation and individual views the world with different eyes, no one concept or image is ever final. All works of art exist in the present, and since new ideas of art are constantly appearing, all such works become links in the chain of evolution of new forms. *See* MODERN ARCHITECTURE; MODERN ART; NINETEENTH-CENTURY ART; *see* also references under "Art" in the Index. (WM. F.)

ART, SOCIETIES OF. The earliest societies of art consisted solely of practising artists and existed chiefly for their mutual protection and to a lesser extent for their social betterment. They had their origins in medieval "lodges," which were groups of craftsmen working together on ecclesiastical building projects; but early in the 14th century painters and sculptors began to secede from the lodges and to attach themselves to guilds. In Florence the appropriate guild came to be the surgeon apothecaries', and a special branch for artists was formed in 1360 with compulsory membership. Earlier, the Florentine Compagnia di San Luca (Guild of Saint Luke) had arisen (*c.* 1339) as a voluntary religious company of artists, but with mainly charitable aims, for its rules (1386) do not mention the practice of art. St. Luke had been chosen as its patron saint in accordance with the 6th-century legend that the Apostle painted the Blessed Virgin's portrait. A similarly named guild also flourished at Antwerp; its earliest surviving records are of 1453.

The guild organization, with its restrictive rules and carefully observed hierarchy, became increasingly irksome to more independently minded artists, particularly when the church ceased to be the unchallenged patron of the arts and when painting came to be regarded more as one of the liberal arts than as a craft—with all the enhanced social status thus implied. The old master-apprentice relationship was slowly replaced by one of professor-student, with the emphasis upon the teaching of knowledge rather than of manual skill. Symptomatic of this change was Lorenzo the Magnificent's "garden school" (or academy) at Florence, founded in 1490 with the sculptor Bertoldo at its head and Michelangelo as its most distinguished student. There the instruction was informal and uncircumscribed by guild rules. Leonardo da Vinci's academy (*c.* 1498), by contrast, was not a teaching establishment, but seems to have been a group of amateurs—a social gathering of men meeting to discuss the theory and practice of art. Similar academies were formed by Baccio Bandinelli at Rome (1531) and at Florence (1550). Nevertheless, the old Florentine guild of surgeon apothecaries and Guild of Saint Luke were only finally vanquished by the advent of Giorgio Vasari's Accademia del Disegno in Jan. 1563, under the patronage of Grand Duke Cosimo de' Medici, who shared with Michelangelo the honour of *capo* (master)—a significant development of the artist's social position. Vasari's *accademia* became the society of leading Florentine artists and the chief centre of instruction for students. But its organization soon began to crack, and in about 1575–78 Federico Zuccaro unsuccessfully attempted to reform it. His ideas were later carried out at Rome when he and Cardinal St. Carlo Borromeo founded the Accademia di San Luca in Nov. 1593. This was the prototype for the modern academy: education took priority with the election of 12 visiting tutors; there were departments of drawing from casts, the antique and the life; prizes were offered, and the members and the president (Zuccaro) were required to present works of their own. Lectures on mathematics and physics were planned but never delivered. After several vicissitudes the Accademia di San Luca became firmly

established by 1635.

The history of academies then became inextricably interwoven with that of art societies: then, too, were sown the seeds of confusion between the definitions of learned society and society of art; for once painting, sculpture and architecture were regarded as the equals of, for example, mathematics, astronomy, rhetoric and poetry, it became necessary to indicate how each branch of knowledge again divided off into separate compartments by the time the highly specialized 20th century was reached. Thus the Accademia della Virtù, Rome (*c.* 1538), was the first archaeological society and the indirect ancestor of such societies as the (British) Society for the Promotion of Hellenic Studies. Societies of this kind obviously have an artistic as well as scientific appeal, but their membership is comprised of enlightened amateurs or professional scholars with few, if any, practising artists.

In the 16th and 17th centuries there appeared in Italy a number of informal, and sometimes semisecret, societies of artists, intended to provide corporate lodgings, studio and life-model facilities, and even mutual physical protection. Some of these clubs or cabals were formed by foreign artists working in Italy. A notorious example was the "Cabal of Naples" organized in the 1630s by Jusepe Ribera and others to persecute north Italian artists who had obtained contracts in the city.

During the 17th century Italy gradually lost the initiative in artistic matters to France. In Paris the Académie Royale de Peinture et de Sculpture, due largely to Cardinal Mazarin's efforts, merged with the old guild organization, the Académie de St. Luc, in Aug. 1651. Ten years later Jean Baptiste Colbert was elected director and in 1666 the Académie de France was founded at Rome. The four-year studentship, "Prix de Rome," followed, and French supremacy in Rome was achieved when the French artist Charles Errard was elected *principe* of the Accademia di San Luca in 1672. An important new development of the academy as an exhibiting society took place in 1667 when an exhibition of students' prize drawings and members' work was held at the Paris Académie. From this was evolved the annual salon of succeeding centuries, which in turn formed the pattern followed throughout Europe during the latter half of the 18th century and after.

In northern Europe the most important academy after that of Paris was Berlin's. Founded by Frederick I of Prussia in 1697 it was part of an ambitious cultural program which included the formation of the University of Halle and the Akademie der Wissenschaften. Both the Berlin academy and that at Vienna (1705, reformed 1725 and 1770) were based on the French pattern. By contrast with those in the wealthy, highly systematized royal states, Flemish and Dutch artists remained within loosely knit guild organizations which hardly interfered in their affairs except to gather annual taxes. In Holland no direct state patronage existed, and the artist had complete freedom of expression. But this meant that he had to paint for an unknown clientele, and so gradually specialized in a particular genre, disposing of his work through a new class of intermediaries—dealers. The old regulating mechanism of guild and state patronage disappeared, and the markets became oversupplied. Most Dutch artists chose to have a second breadwinning occupation. This was the first symptom of an evil that bedeviled 20th-century painting, and one which helped to stimulate the rapid increase in exhibiting societies after about 1880.

The 18th Century.—Paris, Rome, Florence and Bologna were among the most active of 19 academies flourishing in 1720; by 1790 over 100 academies and public schools of art had been formed. Most German princely states possessed private academies, closely followed by Italy; in France provincial academies were subservient to Paris; Spain, Scandinavia, Belgium, the Netherlands and the U.S. also opened new academies. This rapid rise accorded well with the changing taste of the age of reason, an age also characterized by revived interest in antiquity, classical ruins and literature. Equally important was the practical value of these schools as stimulants to overseas commerce resulting from their raising of the general standard of a nation's products. A few exceptions to this revived mercantilism were Rome, Florence, London, Madrid, Turin and Düsseldorf. Rome and Florence had a strong ancient tradition; in England art education remained in private hands and was generally conservative. Even the (now Royal) Society of Arts for the Encouragement of Arts, Manufactures, and Commerce in Great Britain (1754) did not provide an art school, and it had been anticipated by the Dublin society for "improving husbandry, manufactures and the useful arts and sciences" (1731) and the Foulis academy, Glasgow (1753).

Sir Godfrey Kneller's academy held its first meeting on St. Luke's day, Oct. 18, 1711, and soon after Kneller's death in 1723 this private art school was continued by Sir James Thornhill, who was himself succeeded by his son-in-law William Hogarth in 1734. Hogarth then fused the old St. Martin's Lane academy (begun 1720) with Thornhill's property and by 1750 it had become the chief English academy. But life drawing was its only function, and a more general artistic demand was satisfied after the foundation in 1734 of the Society of Dilletanti by a group of gentlemen travelers and amateur *cognoscenti*. In 1768 the Royal academy (*see* ACADEMY, ROYAL) came into being, and a special feature of it was the great importance attached to annual exhibitions. Experience had shown that its precursor, the Society of Artists of Great Britain (founded 1760, granted royal charter 1765), found such exhibitions a sure and cumulative source of income; so also did the academy, which soon became financially (and therefore politically) independent of royal patronage.

By 1790 the chief function of most academies was as art schools, whereas formerly they had been select groups of especially competent men. An interesting reversion to the function of the Medicean and Vasarian academies had taken place, for academies were educational rather than social institutions. Just as they had spread rapidly across Europe during the second half of the 18th century so also did they gather a small but vociferous opposition. Jean Jacques Rousseau, Edward Young, Goethe and J. G. von Herder led the Romantic school in philosophy and letters, J. L. David and A. J. Carstens in painting. Their chief attack was made against the universal rules prescribed by academicians for the comprehension and instruction of creative genius. Academies were regarded as sickly things only capable of perpetuating the mediocre, a view also held by Voltaire and the Encyclopaedists. But Jacques Louis David, in his struggle against the Académie Royale, failed to change any part of its fundamental structure. Although in 1793 he broke with it and replaced it with a Commune des Arts which abolished all rival organizations, its successor, the Societé Populaire des Arts, renewed contact with surviving members of the old Académie Royale, reopening in 1795 as the École des Beaux-Arts (for art instruction) which left social functions to the fine arts section of the Institut de France. This latter was named the Académie des Beaux-Arts by Louis XVIII in 1816.

Nineteenth and Twentieth Centuries.—After about 1805 there was a bewildering proliferation of art societies, the majority of which were, originally at least, antiacademic in intention. This rapid growth also reflects 20th-century anarchy and increasing specialization in the figurative arts.

At first, the most effective antiacademic movement centred around the German painters Johann Friedrich Overbeck, Franz Pforr, Peter von Cornelius and Friedrich Wilhelm von Schadow who formed a Brotherhood (later "Order") of St. Luke, about 1807–08, afterward traveling to Rome where they lived and worked in the deserted monastery of S. Isidoro. The Nazarenes (as they were nicknamed) believed that the defects of an academy —mechanical routine and slick drawing formulas—could be avoided by a return to the more intimate teacher-pupil relationship characteristic of a medieval workshop. Cornelius returned to Germany in 1819 to direct the Düsseldorf academy, but both there and at Munich, where he moved in 1824, he proved a poor organizer and it was left to his successor, Schadow, to introduce teaching reforms in 1826. The most important of these derived from an idea already practised in France by David; *i.e.*, one professor, instead of 12 visiting teachers, to supervise 30 or 40 pupils drawing and painting from casts and life.

Patronage began to undergo radical changes: fewer works were commissioned directly from the artist, and by the middle of the century it had become increasingly important for artists to find

exhibition space in order to attract buyers. Academies could supply this need only partially and were therefore highly selective; since quality was not always the sole basis of selection their enemies had further cause for complaint.

In England the Free Society of Artists held exhibitions from 1761 to 1783, and the (now Royal) Society of British Artists was founded in 1823 as a revival of the old Royal Society of Artists of Great Britain (1760–91). Between 1850 and 1860 the National Institute of Fine Arts catered for many minor painters who seldom exhibited elsewhere. More specialized institutions were the (now Royal) Society of Painters in Water Colours (1804), the Royal Institute of Oil Painters (1883), the Royal Society of British Sculptors (1904), the Royal Society of Painter-Etchers and Engravers (1880) and the Pastel society (1898). The foundation of the New English Art club in 1885 marked a major secession from the Royal academy, only partially healed after several leading members were later readmitted. A second upheaval followed the first Postimpressionist exhibition at the Grafton gallery when the London group (at first called the Camden Town group) was founded (1912). Other independent groups were the Society of Twelve (1904–15), which included Charles Conder, William Orpen, Alphonse Legros and D. Y. Cameron; the short-lived Young Painters' society (1930); the Allied Artists' association (1908–20), which held annual salons at the Royal Albert hall; and the Seven and Five society (1920), which later comprised the nucleus of English abstract painters, some of whom, however, subsequently seceded to Unit One. Indicative of the fierce sectarianism of the 1900s was the formation of the Modern Society of Portrait Painters (1908) and the National Portrait society (1912–21) in rivalry with the older Royal Society of Portrait Painters (1891). Similarly, the Society of Graver-Painters (1910), the Senefelder club (1910) for lithographers and the Society of Graphic Art (1921) supplemented the conservative Royal Society of Painter-Etchers and the (now defunct) International Society of Painters and Engravers (1898). The terms "international" and "national" usually denoted independence and catholicity of outlook: such was the declared policy of the National Society of Painters, Sculptors, Engravers and Potters (1930), of the Artists' International association (*c.* 1943) and the Women's International Art club. The East London group begun in 1929 later became the East End academy, accepting work from amateurs and professionals resident locally. The increased popularity of art, at first largely due to John Ruskin's teaching and facilitated by the increased leisure now more widely enjoyed, was emphasized by the countless amateur art societies active throughout England and Wales. Ireland and Scotland each have their own royal academies (founded 1823 and 1826 respectively) besides numerous independent organizations for professionals and laymen. The state-aided Arts Council of Great Britain (formerly the wartime Council for the Encouragement of Music and the Arts), formed in 1946, must also be mentioned for the help and encouragement it extends to all the arts. In 1950, for example, it sponsored an exhibition of the revived Society of Mural Painters.

The Paris salon was attacked in 1790, and the following year works by all artists (whether academicians or not) were admitted. But it suffered its most serious rebuff in 1863 from the Salon des Refusés, where works by the avant-gardes Edouard Manet, Camille Pissarro, J. A. M. Whistler and Paul Cézanne were shown. The École des Beaux-Arts was reorganized the same year. In 1874 the Impressionists exhibited together as a "Societe anonyme des artistes peintres, sculpteurs, graveurs, . . . etc." Their eighth and last group show was in 1886, two years after the formation of the Société des Artistes Indépendants, which had held its first salon unrestricted by a selection jury. Then in 1890 the official salon suffered schism, and from it grew two separate organizations: Société Nationale des Beaux-Arts and Société des Artistes Français. The latter began to admit the decorative arts on a small scale, but the Salon d'Automne, founded in 1903, especially favoured them. In 1898 the lithographers banded together as the Société des Peintres Lithographes.

Toward the end of the century artists tended to form into small independent groups, united by common ideals but indifferent to the setting up of rigid constitutional machinery. In Paris for example, the *Nabis* ("prophets" or "leaders") used to assemble once a month for dinner at the Restaurant de l'Os à Moelle (Nov. 1888 onward) and soon after met regularly each Saturday at the studio of Paul Ranson. They exhibited together at a private gallery (Le Barc de Boutteville) from 1891 until 1896, as well as sending to the Salon des Indépendants.

Similarly, in 1908 the Cubists banded together as La Groupe du Bateau-Lavoir (13 rue Ravignan, Montmartre); although in 1911 a second group of Cubist painters met at Jacques Villon's studio and founded the Salon de la Section d'Or in an attic (rue Trouchet). The Salon des Surindépendants (founded 1927, and unconnected with the Indépendants), the Salon des Tuileries (1923) and the Salon de Mai afford a cross section of modern French painting. Many young artists of all nationalities and tendencies working in Paris exhibited after 1950 at the annual Salon de la Jeune Peinture held at the Musée d'Art Moderne.

Much the same process of revolt occurred in Germany, Austria, the Netherlands and Belgium. The German school of Impressionists led by Max Liebermann and Max Slevogt organized the Munich Sezession ("secession") in 1894, an example soon copied at Berlin. In Vienna, the Sezession was in 1897 and constituted a landmark in the history of the international *art nouveau* style. In 1905 a group of German painters working in Dresden exhibited together until 1913 as *Die Brücke* ("The Bridge"), which became the centre of the Expressionist school. Cubist doctrine quickly spread from France, and at Munich in 1911, Wassily Kandinsky, Paul Klee and Franz Marc formed *Der Blaue Reiter* ("The Blue Rider") group of German abstract painters; in this year also Piet Mondrian left the Amsterdam St. Lucas group to help found the Moderne Kunstring ("modern art circle") of Dutch abstract artists. Two years later the Erster Deutscher Herbstsalon ("first German Autumn salon") was held in Berlin, and its title betrays its French origin. After World War II the supreme German professional artists' organization was the Bund Deutscher Landesberufsverbände Bildender Künstler. Belgium also had its independent societies such as Les Vingt (1884) and the Salon de la Libre Esthétique, which held its first exhibition in 1896. Le Cercle des Indépendants, Brussels, organized the first Cubist exhibition in Belgium in 1911.

In Italy, the first Venice Biennale was held in 1895 as an international review of current artistic trends, and a similar series of *biennali* at Rome were begun in 1921. Nothing could be more violently antiacademic than the group of Futurist painters whose manifesto was proclaimed at Turin in March 1910. The Fronte nuovo delle arti (1946) led by Renato Birolli and Renato Guttuso was intended as a counterblast to the reactionary Novecento group.

Even as this revolt against academies was taking place, a new awareness of the need for the fine arts to be linked with industrial design steadily increased and the perils of the doctrine "art for art's sake" was realized. In England this movement produced the Art Workers' guild (1884) and the Arts and Crafts Exhibition society (1888, now defunct), from which sprang the Council for Industrial Design and the Rural Industries' bureau. Nevertheless, the Germans were the first to realize the full significance of William Morris' ideas of workshop training for artists and initiated reforms in their industrial schools of art. The Deutscher Werkbund was founded in 1907 as a society of enlightened architects, designers and industrialists, and this prepared the way for Walter Gropius' famous Weimar Bauhaus (1919). There the tradition of the medieval craft guilds was ingeniously fused with modern school instruction and industrial manufacturing processes. In nearly all the chief European countries industrial design organizations developed, usually government-financed and in varying degrees state-controlled.

Direct state control of the arts obtains in both the U.S.S.R. and China. The Mir Iskusstva ("The World of Art," from a magazine so entitled, 1899–1904) group of St. Petersburg centring around Sergei Diaghilev, Léon Bakst, Alexander Benois and K. Somov was discredited after 1917; so also were the Constructivist V. Tatlin and the Suprematists K. Malevich, A. Rodchenko and D. P. Sterenberg, who led the Russian school of abstract paint-

ing until about 1925. The October society which succeeded the Constructivists was denounced as "formalist" (*i.e.*, not "social realist") and was contrasted with the Association of Artists of the Revolution. In 1927 a State Committee for Art Affairs was appointed by the Soviet government to decide and implement the official artistic policy. Soon afterward the Artists' co-operative (Khudozhnik) was formed with a central and branch councils. The co-operative acts as agent; it supplies painting materials, etc., and living accommodations, besides buying, exhibiting or selling work on commission in its chain of galleries throughout the U.S.S.R. These exhibitions are controlled by politico-artistic selection juries. The Moscow Union of Soviet Artists (Moskovsky Soyuz Sovietskikh Khudozhnikov or MOSSKh) is the largest of several provincial groups. The All-China Artists' association was formed about 1950 with headquarters in Peking; its membership consists of artists, critics and art historians. It is divided into four commissions: (1) creative; (2) national artists' research; (3) popularization of art; (4) exhibitions (5 branches). Like its Russian counterpart it makes recommendations about public building decorations, and fixes suitable scales of payment.

Societies for Popular Encouragement and Preservation.—These are largely a 20th-century development, but the British institution (1806–67) acted as both patron and meeting place for artists and connoisseurs, and a similar function was performed by the Burlington Fine Arts club, London (1880–1939). In 1903 the National Art-Collections fund was founded to help national museums acquire art treasures in face of increasing financial competition from wealthy foreign collectors, and in 1910 the Contemporary Art society began similar work for the acquisition of works by modern artists; both have headquarters in London. The Institute of Contemporary Arts, London (1947), also acts as a discussion and exhibition centre for the avant-garde.

Most large European continental museums have organized groups of interested laymen to aid them—for example, the Société des Amis du Louvre, Paris (1897); the Société des Amis des Musées Royaux de l'Etat, Brussels (1907); the Verein des Museumfreunde, Vienna; and the Sociedad Española de Amigos del Arte, Madrid.

Among the British societies of preservation and special study may be listed the National Trust for Places of Historic Interest or Natural Beauty (1895), the Georgian group (1937) for 18th-century architecture and the Society for the Protection of Ancient Buildings, established under William Morris' leadership. Many local preservation societies were formed after 1935 to meet the threat of heavy industrialization and rapid urban development.

(D. L. Fr.)

THE UNITED STATES

The oldest permanent art association in the United States is the Pennsylvania Academy of the Fine Arts, established in Philadelphia in 1805 to provide instruction in the fine arts, exhibit works of contemporary artists and maintain a permanent collection and gallery. Although an Academy of Sciences and Fine Arts had been formed in Richmond, Va., in 1786, the project languished and finally was dropped.

The New York Academy of the Fine Arts was organized in 1802; it existed until 1841 and is said to have provided almost the only art influence in New York for nearly a quarter of a century. In 1825, however, a number of its students formed the New York Drawing association, an independent society presided over by the painter-inventor Samuel F. B. Morse, which in 1828 was incorporated as the National Academy of Design.

The development of interest in art in the United States has been progressive—for the first 100 years undoubtedly slow, but thereafter more rapid, and as the years passed, surprisingly so. It may well be noted that the art movement was largely fostered by laymen. In 1909 the American Federation of Arts was formed to furnish a channel for the expression of public opinion in matters pertaining to art, to maintain a central clearinghouse for art organizations and to undertake educational work for which only a national organization could qualify; with national headquarters in New York city, the nonprofit organization had about 400 chapters in the latter 1950s. Associated with the American Federation of Arts were all of the chief interests in art—practising artists, teachers and art departments in schools and universities, various associations, dealers and private collectors, museums and laymen. To have a central organization, art associations in some states were federated.

Professional Organizations.—Chartered in 1857, the American Institute of Architects, Washington, D.C., held annual conventions from 1867; its membership of more than 10,000 in the mid-1950s was entirely professional. Other architectural organizations include the American group of the Société des Architects Diplômés par le Gouvernement Français (1899) and various local societies. The Archaeological Institute of America (1879) was intended to increase knowledge and disseminate information in its field.

The National Academy of Design, already mentioned, elects to membership painters, sculptors and architects who have attained distinction, holds one exhibition a season and maintains a permanent collection of works by members. It opened its own building in New York city in 1942. (A number of other art societies established headquarters in the building.) The Sculptors' guild (1937), comprising in its membership those of progressive tendencies, holds annual popular outdoor exhibitions. The American Water Color society, New York city (incorporated in 1903), holds annual exhibitions at the National Academy of Design building; the New York Water Color club was amalgamated with that society in 1941. Also important is the Philadelphia Water Color club (1900). In Boston, Baltimore, Washington and other cities water-colour clubs were also established. The American Society of Miniature Painters, New York city (1899), exhibits regularly and similar societies became active elsewhere.

In relatively recent years etching, lithography and wood-block printing had a renaissance in the United States. Of notable importance is the Society of American Graphic Artists, Inc. Organized in 1915 as the Brooklyn Society of Etchers (later called Society of American Etchers and in 1947 named the Society of American Etchers, Gravers, Lithographers and Woodcutters), the organization adopted its present name in 1951. It holds annual exhibitions and promotes international exchanges. Other societies of like nature include the print clubs in Philadelphia (1914), Cleveland (1919) and other cities, which hold frequent exhibitions and sponsor lectures and demonstrations.

To further literature and the fine arts, the American Social Science association organized in 1898 a National Institute of Arts and Letters, New York city, which was incorporated by act of congress in 1913. It comprises, by election, 250 writers, painters, sculptors, etchers, etc. In 1904 it organized, along lines similar to the French academy, an American Academy of Arts and Letters, limited to 50 members.

An organization to advance the artist as well as his art is the Guild of Boston Artists (1914), with artist and associate lay members co-operating in sustaining a gallery for exhibition and sale of members' works. Somewhat similar, the Grand Central Art Galleries, New York city (1923), with the purpose of marketing works of American artists, maintains a continuous exhibition of works of members and also sends out traveling exhibitions. The Society of Medalists, established in 1930 to stimulate interest in medallic sculpture, issues to its approximately 600 members two bronze medals each year.

The alumni associations of the leading art schools are closely allied with the professional art organizations.

Groups Associated With Museums.—The members of the Metropolitan Museum of Art, New York city, numbered approximately 12,000 in the mid-1950s. The Museum of Fine Arts, Boston, formed in the same year (1870) as the Metropolitan museum, likewise relied a great deal on funds from supporting members (2,300). The Art Institute of Chicago (1879), with a membership of about 17,200, depended to a greater extent on wide popular support. The Toledo Museum of Art (1901) was long supported by an associate membership; the Buffalo Fine Arts academy (1862) was the parent of the Albright Art gallery; the Cincinnati Museum association (1881) acquired a gallery through gifts in

1887 and thereafter the art museum was supported by private contributions. The Art Association of Indianapolis (1883) acquired a gallery, now the John Herron Art institute; the museum was dedicated in 1906 and remodelled in 1941. The Minneapolis Society of Fine Arts (1883) opened the Minneapolis Institute of Arts building in 1915 and made additions in 1927. The Friends of the Institute (1922) co-operate in building up its collections and broadening its influence. Various "Friends of Art" groups were formed in relatively recent years.

Art museum heads organized the Association of Art Museum Directors, established in 1916, and the Western Association of Museum Directors (1921). The American Association of Museums, with headquarters at the Smithsonian institution, Washington, D.C., was established in 1906 and incorporated in 1920. *See* also MUSEUMS AND GALLERIES.

Art and Industry.—Probably the first organization in the United States to recognize the need of relating art to industry was Cooper union (*q.v.*), in New York city (1859). The handicrafts have largely been fostered by societies especially organized for that purpose, such as the Society of Arts and Crafts of Boston (1897), which set a high standard of endeavour and has maintained a salesroom successfully for many years in Boston and New York city; the society became a member of the Massachusetts Association of Handicraft Groups, established in 1945. The Detroit Society of Arts and Crafts (1906), with lay and professional members, brought to the United States notable works by foreign craftsmen.

More intimately associated with industrial art are such organizations as the Art Directors' club, New York city (1920). Members of businessmen's art clubs of Chicago and other cities turned to art for recreation rather than as a vocation.

Civic Associations.—The American Planning and Civic association (1904), a national organization with headquarters at Washington, D.C., and several hundred affiliated organizations throughout the country, embraces city planning, village improvement, protection of scenic beauty and safeguarding of highways in its objectives. Somewhat akin in purpose is the American Society of Landscape Architects (1899), with headquarters in Boston, Mass., whose chief aim is the support of professional ideals in the practice of landscape architecture as an art, and whose concern is mostly that of design in city and regional planning and the design of private and institutional parks and grounds. There are also numerous art commissions, for example, the National Commission of Fine Arts, Washington, D.C. (established by an act of congress in 1910), appointed by the president with the consent of congress and comprising an advisory body of experts, serving without pay, to which are referred designs for public buildings, monuments, improvements of public lands, etc.; and the Art Commission of Philadelphia (formerly the Art Jury, 1907), intended to safeguard municipal authorities against artistic blunders and secure maximum civic beauty. The Municipal Art Society of New York city was established in 1892 as a private organization for the development of civic art.

School Organizations.—School art teachers organized the Eastern Arts association (established in 1910), the Western Arts association (1893) and the Southeastern Arts association (1930). The National Art Education association was organized as a department of the National Education association in 1933. The College Art Association of America (1912) is made up of teachers of art in colleges. The School Art League of New York city (established in 1909), composed of laymen, art teachers and pupils, fosters art education in the public schools of that city. The Chicago Public School Art society (1894), chiefly occupied with placing fine prints and paintings by American artists in Chicago schools, also was instrumental in securing better design for school buildings and decoration for schoolrooms.

See also ACADEMIES.

See Dorothy B. Gilbert (ed.), *American Art Directory* (1958), which contains a complete list of art societies and similar organizations in the United States and a report on each; Nikolaus Pevsner, *Academies of Art* (1940). (L. ME.; X.)

ARTA, capital of Arta *nomos* (department) of Greece in the region of Epirus, on the site of the ancient Ambracia (*q.v.*), stands on the left bank of the Arachthus (Arta or Arakhthos) river, and is surrounded with orchards of orange, lemon and citron. Pop. (1961): town, 16,899; *nomos* (1961) 82,630. Arta came into existence after the destruction of the nearby Roman city of Nicopolis Actia by the Bulgars in the 11th century and became a provincial city and bishopric of the Byzantine empire. In 1083 it was seized by the Normans; and after the fourth crusade (1204) it became the capital of the Greek despots of Epirus, from whom it passed to the Orsini family of Cephalonia in 1318. Subsequently it was under Serbian, Albanian and again Italian rule, before falling to the Turks in 1449 who called it Narda. In the 16th and 17th centuries it was noted for its Greek schools. In 1688 it was taken by the Venetians, and in 1798 by Ali Pasha of Iannina. It was several times fought over during and after the Greek War of Independence; but in 1881 it was ceded to the Greeks, and after the Balkan War of 1912 was incorporated with southern Epirus in the kingdom of Greece. It was occupied by German troops from 1941 to 1944.

There are remains of a Byzantine fortress on the ancient acropolis, several churches and monasteries dating from the period of the despotate (13th century), notably the church of the Panagia Parigoritissa (Our Lady of Consolation), and a 17th-century hump-backed bridge over the river, which forms the theme of a well-known Greek folk song. Arta is now the seat of a metropolitan bishop. Woolens, cottons and embroidery are manufactured; and there is trade in cattle, wine and spirits, tobacco, fruit, hides and grain. (D. M. N.)

ARTA, GULF OF (AMBRACIAN GULF; GULF OF AMVRAKIA or mod. Gr. AMVRAKIKOS KOLPOS), an inlet 20 mi. long and 12 mi. wide, is on the west coast of Greece, where the *nomos* (department) of Arta meets that of Aetolia. It is terminated to the west by the composite limestone peninsulas of Preveza on the north and Aktion on the south. The gap between the two, the straits of Preveza, provides its only outlet to the sea. These straits, little more than half a mile wide, are floored with very shallow flats of sand and gravel. On their north side is the small port of Preveza. The north shore of the gulf is formed by the combined delta of the Louros and Arakhthos rivers, and is a mosquito-ridden tract of marshes and lagoons; the south shore is traced by broad bays alternating with wooded rocky headlands. The arterial road from Arta to Agrinion skirts the eastern shore of the gulf. (WM. C. B.)

ARTABANUS ("protector of right"), an Iranian name the later form of which is Ardaban. It was borne by a number of Persian princes and nobles and by Parthian kings. The following are the most important:

1. ARTABANUS (6th–5th century B.C.), the brother of the Persian king Darius I and, according to Herodotus, the trusted adviser of his nephew Xerxes. Herodotus states that he warned Darius not to attack the Scythians and predicted to Xerxes his defeat by the Greeks. Xerxes sent him back to govern the empire during his Greek campaign.

2. ARTABANUS (d. 465 or 464 B.C.), minister of Xerxes, whom he murdered in 465 B.C. According to Aristotle, he had previously killed Xerxes' son Darius and feared that the father would avenge him; according to Ctesias, he killed Xerxes first and then pretended that Darius had murdered him and instigated his brother Artaxerxes I to avenge the parricide. Artabanus was in control of the Persian state for seven months and was recognized as king by Egypt, but was then defeated and killed by Artaxerxes.

3. ARTABANUS (fl. 465 B.C.), satrap of Bactria, who revolted against Artaxerxes I, by whom he was defeated in two battles.

4. ARTABANUS I (reigned *c.* 211–191 B.C.), king of Parthia, also known as Arsaces II, knowledge of his personal name depending on a single source. In 209 he was attacked by the Seleucid king Antiochus III of Syria, who took Hecatompylos and Syrinx in Hyrcania, but finally concluded a treaty with Artabanus. After 206 the latter lost much territory to Euthydemus of Bactria.

5. ARTABANUS II (reigned *c.* 128–124/123 B.C.), king of Parthia, successor of his nephew Phraates II. Saka invaders then occupied much of Parthia's eastern territories, and Artabanus died of a wound received fighting the "Tochari" in the region of Bactria.

6. Artabanus III (reigned *c.* A.D. 12–*c.* 38), king of Parthia, an Arsacid through his mother, with family links with the Dahae. King of Atropatene, he made a first bid for the Parthian throne in A.D. 9 or 10, against the romanized Vonones, and was proclaimed king in Ctesiphon *c.* A.D. 12. Vonones fled to Armenia, where he secured the throne, but was forced to abdicate through pressure from Artabanus in A.D. 15 or 16. The Roman emperor Tiberius set Zeno, son of the king of Pontus, on the Armenian throne in A.D. 18. During the first part of Artabanus' reign there was peace with Rome, and there is therefore little information for this period. He was apparently a strong king, faced with internal unrest. Two Jewish rebel barons in northern Babylonia are known from Josephus to have been recognized by him as vassal kings. A letter of his to the magistrates of Susa (A.D. 21) survives in an inscription there.

On the death of Artaxias III (Zeno) of Armenia (A.D. 34), Artabanus set his son, known only as Arsaces, on the Armenian throne. Two Parthian nobles, restless apparently at Artabanus' assertion of central authority, applied at this time to Tiberius for a king from among the descendants of Phraates IV. Tiridates III arrived in Syria in A.D. 35 and was set on the Parthian throne, by use of arms and bribery, by the Roman general L. Vitellius. Arsaces of Armenia was assassinated at the beginning of the campaign, and was succeeded by a Roman nominee, Mithradates of Iberia. Artabanus withdrew to Hyrcania, but, summoned by the anti-Roman party, returned within a year, with support from the Dahae and the Saka, and recovered his throne. He made a treaty with Vitellius in A.D. 37. The struggle had evidently weakened Parthia internally, and at this time large areas and some of the great commercial centres appear virtually independent of the crown. Discontent almost at once drove Artabanus into flight again. He took refuge with his vassal, Izates II of Adiabene, while a certain Cinnamus occupied the Parthian throne. Artabanus was restored by negotiation, but died *c.* 38.

7. Artabanus IV (fl. A.D. 80), a pretender to the Parthian throne, who gave shelter to a pseudo-Nero in Parthia in A.D. 79 and who struck coins at the Seleucia mint in A.D. 80–81. He failed to maintain himself against Pacorus II.

8. Artabanus V (reigned *c.* A.D. 213–224), the last Parthian king. The younger son of Vologaeses IV, who died in 207 or 208, he was ruler of Media when he rebelled against his brother, Vologaeses V, *c.* 213. By 216 he had apparently extended his power over Mesopotamia, although Vologaeses continued to strike coins at the Seleucia mint till 222 or 223. The Roman emperor Caracalla, who claimed to have engendered these disputes to weaken Parthia, attacked in 216, ravaging much of Media and desecrating the Parthian royal tombs at Arbela. In 217 Artabanus counterattacked; Caracalla was assassinated, and his successor Macrinus, defeated at Nisibis, made peace with heavy indemnities. Meanwhile, however, Ardashir the Sasanian, who had begun his rule as petty king in the province of Persis in 208, had been steadily extending his domains and winning Iranian allies against Parthian overlordship. Revolt became general and led to the death of Artabanus in battle against Ardashir in 224. *See* Parthia; Persian History. (Ed. M.; Ma. B.)

ARTAXERXES, the Greek form of Old Persian Artakhshathra, the name borne by three kings of the Achaemenid dynasty of Persia. For Sasanian kings who bore a later form of the same name *see* Ardashir.

Artaxerxes I, surnamed in Greek Macrocheir, "Longhand" (in Latin Longimanus), reigned from 465 to 424 B.C. A younger son of Xerxes, he was raised to the throne by the commander of the guard, Artabanus, the murderer of his father. A few months later he slew Artabanus in a hand-to-hand fight in the palace. The authentic account of his cupbearer Nehemiah shows him as kind and good-natured, but he had a vein of weakness and was much under the baneful influence of his mother Amestris. His reign, though on the whole peaceful, was disturbed by several insurrections. It began with the revolt of his brother, the satrap of Bactria, quickly suppressed. More dangerous was the rebellion of Egypt under Inaros, who received assistance from the Athenians. Persian rule was restored by Megabyzus, satrap of Syria, after a prolonged struggle (460–454). Megabyzus guaranteed Inaros' life and when Artaxerxes yielded to the importunity of Amestris and permitted the execution of Inaros, Megabyzus himself rebelled. In 448 the war with Athens was ended by the "peace of Callias," by which Persia renounced its claims on the Greek cities of Asia Minor which were under Athenian rule, while Athens bound itself not to attack Persian territories. In the Samian and Peloponnesian wars, Artaxerxes remained neutral. Toward the Jews he pursued a tolerant policy, permitting Ezra to return to Jerusalem in 458 and appointing Nehemiah as governor of Judaea in 445. His building inscriptions at Persepolis record the completion of the throne hall of Xerxes. A number of alabaster vases from Egypt, plausibly attributed to his reign, bear his name in Egyptian hieroglyphs, in addition to a trilingual cuneiform legend (Old Persian, Elamite, Akkadian). Many tablets dated to his reign have been found at Nippur and a few others elsewhere in Babylonia.

Artaxerxes II, surnamed in Greek Mnemon, "the Mindful," the son of Darius II, reigned from 404 to 359 or 358 B.C. Although personally courageous, his acts reveal him as weak, faithless to his friends and dependent on his favourites and harem, especially his mother Parysatis. When he mounted the throne, the power of Athens had been broken in the Peloponnesian War (*q.v.; and see* Greece: *History*), and the Greek towns of Asia Minor were again subjects of the Persian empire. In 404, however, Artaxerxes lost Egypt as the result of the revolt of Amyrtaeus, and in the following year his brother Cyrus (*q.v.*), secretly favoured by Parysatis and by Sparta, began preparations for his rebellion. Although Cyrus was defeated and killed at Cunaxa (401) this rebellion had dangerous repercussions, for it not only demonstrated afresh the superiority of the Greek hoplites but it made the Greeks feel that Persia was accessible. Greek mercenaries became indispensable both to the king and to the satraps, who thereby gained the means for attempting successful rebellions, into which they were provoked by the king's weakness and by the continuous intrigues between the Persian magnates.

In 400 B.C. Sparta broke openly with Persia and sent aid to the Ionian cities. During the next five years Spartan armies achieved considerable military success in Asia Minor. A naval counterstroke, however, was being prepared by Pharnabazus, satrap of Hellespontine Phrygia, who, with the help of Evagoras of Salamis in Cyprus and the Athenian admiral Conon, destroyed the Spartan navy at Cnidus (394) and thereby gave the Persians mastery of the Aegean. This victory enabled the Greek allies of Persia (Thebes, Athens, Argos, Corinth) to carry on the Corinthian war against Sparta, which was forced to withdraw from Asia Minor. It soon became evident, however, that the only people to gain by the war were the Athenians, who began to revive their old imperial policy (*see* Delian League) and to ally themselves with the Greek cities in Asia, with Egypt and with Evagoras who, in defiance of Persia, sought to seize the whole of Cyprus. In consequence, when Antalcidas went to Susa in 388, Artaxerxes was ready to conclude peace with Sparta. In 386 Athens was compelled to accept the settlement known as the "King's peace" or the "peace of Antalcidas." By this Artaxerxes decreed that all the Asiatic mainland and Cyprus were his; Lemnos, Imbros and Scyros were to remain Athenian dependencies; all the other Greek states were to receive autonomy; and the terms of the peace would be enforced by Persia. After the peace Evagoras was deprived of his conquests but recognized as king of Salamis (380).

Elsewhere Artaxerxes met with less success. Two expeditions against Egypt (385–383 and 373 B.C.) ended in complete failure and in the same period there were continuous rebellions in Asia Minor. Pisidia, Paphlagonia, Bithynia and Lycia threw off the Persian yoke and Caria became virtually independent. There were also wars against the mountain tribes of Armenia and Iran, especially against the Cadusians on the Caspian sea.

By the "King's peace," Persia had become the arbiter of Greece and in the following wars all parties, Spartans, Athenians, Thebans and Argives, continually applied to Persia for a decision in their favour. After the Theban victory of Leuctra (371 B.C.), Pelopidas went to Susa in 367 and restored the old alliance between Persia and Thebes. Persian supremacy, however, was based on

Greek discord. Shortly after the edict by which Artaxerxes proclaimed his alliance with Thebes and the conditions of the general peace which he intended to impose upon Greece, his weakness became apparent. From *c.* 366 all the satraps of Asia Minor were in revolt, in close alliance with Athens, Sparta and Egypt, and the king could do little against them. The satraps, however, were divided by mutual distrust, and the rebellion was finally put down by a series of treacheries, though some of the rebels retained their provinces. When the long reign of Artaxerxes came to an end in 359 or early in 358, Persian authority had been restored over most of the empire, but Artaxerxes himself had done little to obtain this result.

Under Artaxerxes an important change took place in the Persian religion. Berossus states that the Persians did not worship images of the gods until Artaxerxes II set up the image of Anahita in Babylon, Susa, Ecbatana, Persepolis, Bactra, Damascus and Sardis; and whereas all former kings name only Ahura Mazda, inscriptions of Artaxerxes from Susa and Ecbatana also invoke Anahita and Mithra. These two latter deities belonged to the old popular religion of the Iranians, but had been neglected by the true Zoroastrians till Artaxerxes introduced them into the official worship.

Artaxerxes III came to the throne between Nov. 359 and April 358 and died in 338 or 337 B.C. The son of Artaxerxes II, he was called Ochus before he succeeded his father. The chronographers generally retain the name Ochus for him, and in the Babylonian inscriptions he is cited as "Umasu, who is called Artakshatsu." He was a cruel but energetic ruler. To secure his throne he put to death most of his relatives. In 356 he ordered all the satraps to dismiss their mercenaries. Most of them obeyed; Artabazus of Phrygia, who tried to resist and was supported by his brothers-in-law, Mentor and Memnon of Rhodes, was defeated and fled to Macedonia. Athens, whose general Chares had supported Artabazus, was forced by threats to conclude peace and to acknowledge the independence of its rebellious allies (355).

Artaxerxes then attempted to subjugate Egypt, which had remained independent since 404. The first attempt failed (351 B.C.) whereupon the Phoenician towns and the princes of Cyprus rebelled. At the beginning of 345 the king collected a great army in Babylon and marched against Sidon, which the local king, Tennes, betrayed to him. Sidon was burned and Tennes put to death, but Mentor of Rhodes, who had also helped in the betrayal of Sidon, rose high in the king's favour and entered into a close understanding with the eunuch Bagoas, the king's favourite. Artaxerxes then advanced on Egypt with a great land and naval force and, at Pelusium, defeated the pharaoh Nectanebo, who fled to the south (343). A Persian satrap was placed over Egypt; the walls of its cities were destroyed; its temples were plundered; and Artaxerxes is said to have killed the sacred Apis bull with his own hand.

After the king's return to Susa, Bagoas ruled the court and the upper satrapies, while Mentor restored the authority of the empire throughout the west. He deposed or killed many Greek dynasts, among them Aristotle's patron Hermias of Atarneus, who had friendly relations with Philip of Macedonia (341 B.C.). When Philip attacked Perinthus and Byzantium (340) Artaxerxes sent support to those cities, enabling them to withstand the Macedonians. In 338 or 337 Artaxerxes, with his elder sons, was killed by Bagoas, who raised the king's youngest son Arses to the throne. See Persian History. (Ed. M.; J. M. M.-R.)

ART EDUCATION, referring to the visual arts, may be defined in two ways: as the training of potential or actual professional artists; and as the instruction given to school children, students and adults, the purpose being enjoyment, enrichment of life or psychological benefit. Instruction in art is given in the public and private schools, from the pre-elementary through the secondary level; in most colleges and universities; in private academies or schools of art, representing almost all levels of skill; in art galleries and museums; by professional artists giving individual lessons to single pupils; and privately or semipublicly by numerous organizations such as labour unions, youth clubs, fraternal organizations, and so forth.

Until the 17th century artists, like other craftsmen, learned their craft by apprenticing themselves to practising professional artists. Then in France were founded the Académie Royale de Peinture et Sculpture and the École Nationale des Beaux-Arts (*see* Beaux-Arts, École des). The former established the form of art education in Europe for many generations. Italian academies of art were established before the 17th century. The movement for art training in general education was largely a product of the 19th century. (X.)

UNITED STATES

History and Development

Early History.—From the 17th century through the early 19th, the visual arts had little place in American public schools and universities. The student who sought to be an artist learned by assisting an older artist, by taking private lessons or by going to Europe for academic training. A Philadelphia private school, established in 1791, became in 1805 the Pennsylvania Academy of Fine Arts. Drawing was introduced into the public schools of Boston, Philadelphia and Baltimore in the 1840s. In a few eastern colleges, professors of Latin and Greek were showing their classes pictures of classical sculpture and architectural ruins.

From such beginnings, U.S. art education expanded during the 20th century along the following lines: (1) academies and courses for the practice of the arts, sometimes called "creative art" or "studio courses," dealing with the technical use of materials and instruments such as paints and brushes, clay and looms; (2) courses in the appreciation of the arts—in perception, understanding, criticism and evaluation; (3) aesthetics—theories and principles of art; (4) courses in the history of the arts, arranged chronologically; (5) courses in art education—the training of prospective teachers of the arts.

Practice of Art.—The first of these, devoted to practice, is most extensive in the lower grades, for young children from the nursery school on. By the early years of the 20th century it was generally recognized that all young children should have an opportunity to use their hands and minds in manipulating art materials. There were lingering prejudices against art education for boys as a useless, effeminate frill, and for girls as dangerously Bohemian; but these attitudes disappeared as art became a flourishing, respected and occasionally well-paid field.

Art Appreciation.—Art appreciation won a place in the curriculum more slowly. Many practical-minded school administrators assumed that anyone could appreciate art simply by looking at it. The public was slow to realize the difficulty of perceiving and understanding the subtle, complex forms and detailed interrelations within a great work of art. On the college and university level, there were educators who derided the study of appreciation on the ground that "good taste" was something inborn, which could not be taught. They preferred rather to stress historical facts in college courses on the arts. The aim in teaching art appreciation shifted gradually away from urging students to admire certain things and toward developing their powers of perception and evaluation. The new emphasis in art itself on form and design, as opposed to storytelling and sentiment, led to a similar emphasis on form and design in the appreciation and evaluation of art. It was recognized that art appreciation also involved the ability to understand meanings, such as those of symbolic images in medieval painting, sculpture and architecture, as well as the ability to criticize and evaluate. The young child cannot be expected to like and enjoy the same kinds of art as an adult connoisseur, but even in the lowest grades children can discuss their likes and dislikes open-mindedly.

History of Art.—It was not until 1874 that art history was systematically taught in an American college. The place was Harvard and the teacher was Charles Eliot Norton, whose aim was to inspire his students "with love of things that make life beautiful and generous." His staff gradually was increased and (after 1895) aided by the resources of the Fogg museum. Allan Marquand went to Princeton in 1882, founded its department of art and archaeology, and lectured with slides and photographs on Italian art. Other pioneers in the teaching of art history were Charles R. Morey, Frank J. Mather, A. Kingsley Porter, Howard C. Butler

and Paul J. Sachs. By 1880 the Chautauqua Literary and Scientific circle in Chautauqua, N.Y., was teaching art history and appreciation through lectures and correspondence. The Metropolitan Museum of Art in New York began giving lectures in 1872, and in 1907 appointed Henry W. Kent as the first museum instructor. During the next few years, the art museums of Boston, Chicago, Cleveland, Toledo, Detroit, St. Louis and Baltimore were outstanding for their teaching of art history in galleries and lecture halls. By mid-20th century about 900 courses on art history were being taught in U.S. colleges and universities.

Colleges offer introductory courses on general history of art, followed by specialized courses on particular periods. The earliest courses were limited to the Egyptian, Classic, Gothic and Renaissance art of the occident. Modern textbooks and college catalogues show a great increase in the range of nations and periods covered, and much interest is shown in the interconnections of periods and styles within the general flow of cultural history, and in relations between art and other phases of cultural history.

Aesthetics.—The systematic study of aesthetics, including the philosophy, psychology and sociology of art, was still later in developing. Ralph Waldo Emerson made New England philosophically conscious of art and beauty, and G. L. Raymond published an important series of books on comparative aesthetics in the 1890s. A concerted and rapidly expanding movement to establish it as a college subject and a field of scholarship began in 1941 with the founding of the *Journal of Aesthetics and Art Criticism*, followed by the establishment of the American Society for Aesthetics a year later.

The emphasis in aesthetics has shifted from abstract discussions of beauty and value toward an empirical, inductive study of the arts and related modes of experience. Aesthetics tends to assume more and more the aims and methods of a psychological and social science, drawing its data and hypotheses in large part from these older sciences; in part from the direct observation, analysis and comparison of works of art themselves to discover the nature and varieties of form and style. Advanced systematic studies of the history and theory of art are carried on principally in large universities and graduate schools, but they have had a profound influence on the training of teachers of art and hence indirectly on the teaching of art in the lower grades. (*See* also AESTHETICS, HISTORY OF.)

Later Trends in Art Instruction.—Policies in art instruction have been deeply influenced by events in the visual arts. From the Impressionist movement of the 1870s onward there was a growing trend toward nonrealistic styles in painting and sculpture. Postimpressionist movements introduced more alteration of natural shapes, proportions and colours; realistic perspective was altered and the natural shapes of things were freely varied in the interest of design or emotional expressiveness.

These trends were violently attacked by conservatives, but by the second quarter of the 20th century the right of the artist to represent nature with such independent alterations had been fairly generally conceded. These trends in art were influenced also by the late-19th century discovery and revival of many exotic and primitive styles, such as those of African sculpture and prehistoric cave drawing.

There was also a trend toward specialized experiment in the arts; *e.g.*, toward exploring the effects of divided colour in Impressionism or pure, flat, contrasting areas of colour in some of the Postimpressionists; toward geometrical form in Cubism; and toward suggestions of movement and temporal sequence in Futurism. Abstract or nonrepresentational painting was widely taught and produced. The art of children was discovered and admired as something possessing independent value both for the child and for the mature admirer. Child art, when not much influenced by adults, was found to have a spontaneous charm often lacking in the work of older students and also to possess educational value in helping the child to think out and consciously express his inner life and his experience of the visible environment.

Philosophical trends in U.S. thought also influenced art education, notably the pragmatism, instrumentalism and empiricism of such leaders as William James and John Dewey. The trend was toward a greater respect for the practical and the tangible in art and life and toward a technological spirit in the arts.

Prosperity before and after the depression of the 1930s turned a stream of U.S. wealth into art institutions. It also helped to develop many new careers in the arts for young people, who could choose among hundreds of related design occupations in industry and commerce or find work in magazine and book publication, photography, motion pictures, radio, stage designing and television, art museums, journalistic art criticism and teaching—all within the general field of visual arts.

Art education itself broadened to include preparation for these new careers. Academies introduced courses in industrial and commercial design. Some colleges established courses in television and stage production, drawing upon painters for stage design and costume sketches. The great increase in numbers of persons actively practising careers in the arts led to the establishment, in the early 20th century, of many national professional organizations such as the National Art Education association, the College Art association, the American Association of Museums, the American Society for Aesthetics and the Committee on Art Education. These helped to raise standards and to advance discussion and planning. Some co-operated with international organizations such as the United Nations Educational, Scientific and Cultural organization.

CONTEMPORARY LIFE

Elementary and Secondary Schools.—In public and private schools there was a tremendous rise during the early 20th century in the number of courses on art offered at all age levels. In the lower grades there is less departmentalization, and the classroom teachers commonly handle all subjects including the arts, sometimes with the aid of an occasional visit from a supervisor or special teacher. An increasing number of states require all prospective elementary schoolteachers to take some courses in art, but the amount thus required is so small that highly qualified art instruction is not always to be found in the elementary schools. Much is left to the individual teacher's taste and initiative. What the elementary art lesson lacks in technical skill, however, it may gain through better integration with other subjects. In the higher grades, in junior and senior high schools, the curriculum in both public and private schools is more departmentalized, and a given school may or may not teach art; an individual student may or may not elect to take it.

Because of new distracting interests, including college and vocational requirements, more and more students drop the subject of art as they advance in school. Colleges are slow to grant entrance credit for secondary school work in the arts, partly because of the difficulty in evaluating it. In large cities special secondary schools commonly are set up for those interested in manual or technical training in the arts, and the high schools that specialize in college entrance preparation are more likely to offer courses in art history and appreciation.

A serious fault in U.S. art teaching is lack of continuity from grade to grade. There is little agreement or common practice on the sequence of steps from the fundamentals to higher levels. After a good start, a student may abandon all art study for three or four years, then have to begin all over again. Teachers cannot take it for granted that his previous courses in art covered any particular set of facts, skills or experiences.

There also is doubt and disagreement as to goals and standards of value. Some teachers hold to the value of a sound foundation in drawing from life or from sculptural casts, in realistic modeling of anatomy and in accurate perspective. Others, claiming to express the modern age, consider such traditional training worthless, calling for complete freedom for every student and artist to express himself and paint as he wishes. The basic issue is between academic and free expression methods, between strict discipline and the newer, progressive education. The decline in prestige of the academic method has been a result not only of theoretical argument but also of the undermining of the academic method in practice, through the great success of many contemporary artists who had no academic training or formal art educa-

tion, or who completely abandoned traditional styles.

The conflict between extremists gradually has been giving way, however, to a moderate educational philosophy, which seeks to preserve the best features of both. Free expression and progressivism achieve their greatest success on the lowest levels of schooling, where it generally is considered best for young children to play freely with materials and to express their impulses spontaneously. Art education in the lower grades has been much influenced by the psychology of child development; it is widely felt that the spontaneous art activity of children should be used as an instrument for their general personality development. In early adolescence it becomes harder to preserve the interest in spontaneous play and self-expression. Educational methods become more systematic, with definite requirements of knowledge and skill. Many older children lose interest in the arts at this period; others, if they are to continue in art at all, want more techniques. They become self-critical and impatient with fumbling; they want to learn how to do a thing correctly. In drawing and painting, many want to know how to represent the figure in action with an illusion of realism. In history and theory, they want definite information and methods of research. The urgent problem of art teachers in junior and senior high schools is to keep alive the continued growth of the child's abilities by providing him with interesting, usable materials and experiences in the practice, appreciation and understanding of art.

In a few metropolitan communities the public-school system has developed an educational museum or audio-visual lending agency, which distributes materials for the study of the arts, including lantern slides and films in colour, together with machines for projecting them. In a few school systems, the use of these materials is correlated with radio lessons. At a given time, an art teacher in the central radio studio may broadcast a lesson on art appreciation while the classroom teachers show slides in the schools. Television also is used for similar purposes. Art museums in the larger cities have taken the lead, because of their wealth of illustrative material and large, nearby television audiences, but a few metropolitan school systems also operate closed television circuits with the assistance of local cultural institutions, providing programs of drama and music as well as demonstrations of artistic techniques and talks on art appreciation. Occasionally programs are telecast from museum galleries.

Colleges and Universities.—Throughout the early 20th century there was much discussion of the place of the visual arts in higher liberal education. What should be their status, aims and methods? Classical education was disappearing rapidly, being replaced by a more practical, vocational emphasis and by a new emphasis on realistic, sociological study of contemporary civilization as a part of the liberal arts curriculum. Humanists deplored the loss of aesthetic, intellectual and other spiritual values in the new college curriculum; they called for a revival of such values, especially through increased attention to world literature, cultural history, the visual arts and the appreciation of music and theatre.

From 1918 onward orientation courses in humanities were established in an increasing number of colleges, especially for freshmen and sophomores. Some were historical in approach and some gave a cross section of the civilization of the present or of some other period. Nearly all incorporated some attempt at a survey of the visual arts, including an analysis of their materials, aims and principal current styles. College and university facilities for studio work in the practice of the arts were increased, and studio work sometimes was correlated with history. Every liberal arts college developed a collection of lantern slides, at first in black and white, later in full colour, and some began to collect educational films. Many college art instructors show comparatively little interest in educational psychology and methods, holding that these are unnecessary on the college level. But college art instruction often is too specialized and factual in approach, though in some colleges attempts have been made to integrate the practice of the arts with general studies.

Art Schools and Academies.—Independent art schools are under pressure to devote all the student's time to technical training, thus neglecting general education. Students in specialized art academies often are unwilling to study languages, literature, and other subjects desirable for general education, arguing that the pressure of competition in an art career requires intensive studio work and, moreover, that no one knows how much general education, aesthetic theory or art history is needed by a successful artist.

Art academies that are independent of either university or museum control tend to stress techniques, usually of a somewhat conservative type, though slowly following recent trends in art. Many teachers follow the trend toward radical distortion, abstraction and nonobjective form in painting, as is shown in annual exhibitions of work by students and teachers in the leading professional schools. The widespread disagreement about values in art causes many art teachers to be somewhat vague and timid in directing and criticizing students' work. They no longer feel confident of the rules they learned as students and have not found any definite substitutes. They show the student how to use various materials and techniques but say little about what he should do with them or what they believe makes a work of art good or bad. Many are uncertain about how much history of art they should know.

In teaching crafts, the art academies are somewhat more assured. They feel the need of definite instruction in materials and techniques, together with the use of simple machinery, as in weaving, ceramics and jewel cutting. The industrial arts, such as the design of household appliances, demand greater precision and clearly thought-out, functional planning than do the fine arts, in which the artist is freer to indulge his own subjective tastes and impulses. The spirit of self-confidence is strong in art students, and many of them feel little need to learn either from living teachers or from the works of old masters.

Art Museums.—Art museums and similar agencies, multiplying during the early 20th century, have provided an extensive sampling of the great styles of art. The rise of the art museum as an educational institution in the 20th century strengthened the international, cosmopolitan approach to world culture. The U.S. art museum, more than its European counterpart, brings together a selection from all arts and periods. A number of art museums have their own educational staffs, which work in collaboration with the art departments of schools, colleges and art academies in the vicinity. Such museum staffs, if sufficiently large, can specialize in presenting the same great works of art to persons of various ages, types and interests. Museum educational work has been diversified along many lines, including gallery guidance and organized courses on history and appreciation. It includes some studio work and drawing in the gallery, especially for children. During the week, it stresses co-operation with nearby schools and colleges, whereby museum visits are scheduled during the year at appropriate points in the school curriculum.

Teacher Training.—The training of prospective teachers of art has been making steady progress toward a synthesis of the necessary elements in the art teacher's education. A capable teacher of the arts needs much intellectual and pedagogical preparation, whereas an artist may get along with less. The teacher should have: (1) a fairly wide range of skills in the fine and applied arts; (2) knowledge of the history and theory of the visual arts; (3) some knowledge of the philosophy, psychology and classroom procedures of education; (4) a fairly wide general education, so that he can present the subject not in isolation but as an integral part of a liberal education. In short, he should be a well-educated person outside his field as well as in it. The difficulty lies in how to achieve this broad and diversified education together with excellence in a few artistic techniques, and to do so within the limits of a short course of study. (T. M.)

GREAT BRITAIN

Training of Artists.—The teaching of professional artists began in Britain in the 18th century with the organization of private academies by well-known artists. Free tuition for suitable candidates was given in the Royal Academy schools started in 1768, and full-time courses of instruction came into being in 1837 with the inauguration of the Government School of Design in

Somerset house. Its foundation was part of the new official policy in the recognition of "the need for extending a knowledge of the arts and the principles of design among the people" and to encourage "the direct application of the arts to industry."

With this same object, local art schools were started in 1842. By 1852 there were 17 of these and at the beginning of the new century about 200. In 1857 the Government school moved to be near to the newly opened South Kensington (later Victoria and Albert) museum; in 1897 it became the Royal College of Art.

These consistent attempts to enlarge the contribution of art to industry and among the people, however, were not successful. Industrialists gave them scant encouragement; local authorities, on whom the support of local art schools depended, were apathetic. The type of instruction given by the graduates of these schools was devoid of the lively quality that practical manufacturing experience gives. It was generally ineffectual in any creative sense, as teaching was repetitive, based on copying past styles of art.

In consequence of manufacturers' continual complaints that they could not find designers, few of whom found their way into industry, the Royal College schools of painting and sculpture were compounded with the Government School of Design at the turn of the century, in order to give fresh life to the application of design in industry. Despite the achievement of some renown by its departments of fine art, however, the school of design still continued its decline into mediocrity.

The school of English painting, which had made an inspiring contribution to European art in the 18th and early 19th centuries, tended to adopt a servile acquiescence to the primarily literary and sentimental bias and to the vulgar tendencies of its age. This attitude was more and more reflected in teachings, and the ordinary citizen found little or no room for the cultivation and exercise of his visual sensibility in the kind of academicism that pervaded all aspects of artistic activity.

Although the development of the great national collections of art and design produced distinguished scholars of art and a heightened understanding within a comparatively small circle of well-educated people, this influence did not extend far or deeply. The academic approach of the "expert," which dictated their sustained attempts to infuse art into the community from the top down, appeared in practice to set up at the same time a barrier between the comprehension of art and the ordinary citizen or to canalize his innate feeling into a merely passive "arty-crafty" sentimentalization of it. Art and design were at their lowest ebb by the end of the century, owing to the stubborn adherence to the fallacy that art was a one-way process.

20th Century.—Before the beginning of the new century the valiant struggles of a few individual groups of artists helped to free visual art from predominantly false standards, and new live conceptions, returning rather belatedly from the European continent, began to invade art teaching. In its last decade the Slade School of Art, as an independent school attached to the University of London, took a decisive lead in focusing these ideas and in relating its practice of drawing and painting and observation of first-hand experience to a close study of the content of great art. Under two famous professors, Fred Brown and Henry Tonks, the distinguished artists this school produced began to challenge the lifeless domination of official art. With others of the same mind they founded the New English Art club independently of the Royal academy and did much to reinstate a worthier school of British painting. At the same time they helped to bring a new focus into all levels of art teaching.

By the end of the first half of the century the indeterminate nature of professional art school courses in the Royal college and in local art schools had given way to a more closely coordinated structure, and the quality of teaching, with a greater percentage of experienced practising artists teaching part-time, had been improved. Art schools offer a four-year course, qualifying their pupils after examination for the national diploma of design. After another concentrated year's course those who matriculate, under the government scheme, may obtain a teacher's diploma, giving them degree status as teachers. Higher qualification is given by the Royal College of Art (associate) and the Slade school (London university diploma).

In 1936 Lord Hambledon's committee gave clear advice that the Royal college's preoccupation with the fine arts should yield to the overriding purpose of studying "applied art in all its forms with particular reference to Industry." Although this purpose was delayed by World War II, the college's scope thereafter was widened to provide a highly professional and imaginative standard of instruction in design, and through its influence with many other schools, as for example the London County council's historic School of Art and Craft, invaded and stimulated the world of industrial design. The Bray report of 1948 allowed each school to share in the assessment of its candidates' abilities; an advisory committee on art examination was set up in 1949. The admirable principle that art schools should be adapted to serve the particular needs of their own areas was established. It resulted in the formation of regional schemes in which schools comprehensively serve the needs of the area.

Professional teaching of artists based firmly on the experience of the past thus is adequately assured, but there still remains an almost complete void between this provision and the wider general need of the public for art and for the expression of its own vital experiences by this means. Further, despite the achievement by teachers in art schools in broadening their pupils' experience, their main work inevitably is concentrated on producing in the shortest time professionally competent and highly qualified artists, securing for them immediate financial security. This paramount duty scarcely enables the art schools to foster direct contact with the keener artistic observation and with the experience of life outside the school that is so valuable in the early formation of a creative artist. Art schools still tend to be isolated from the community rather than a part of it. They cannot be directly concerned with the creation of a living art in society which will surely interpret its common moods. Something also is required to ensure the return of art as a source of ideas, inspiring the life of the people and creating once more a dynamic expression of civilization.

Art Teaching in General Education.—Art teaching in general education, which has largely developed separately from that in professional schools of art, came to life in the second half of the 19th century with new experiments stimulated by the ferment of ideas emanating from John Ruskin and William Morris. A strong indigenous approach to the subject arose when a number of independent minds began to discover, empirically from experience, that children were capable of lively expression through drawing and painting and that this was not dependent on prior acquisition of a taught adult technique. The child had his own technique, found through practice.

The most significant contribution to these as yet vaguely understood facts was that of T. R. Ablett, who provided new methods for stimulating children's essential creative ability. He propounded the real aim of such activity in children as "drawing for delight," founding in 1888 the Royal Drawing society, which held its first exhibition of children's art in 1890. The results were generally acknowledged to be remarkable; the society's influence was great and has spread ever since.

At the turn of the century, at Birmingham, R. Catterson Smith's teaching was equally interesting. He fired his pupils' natural ability "through the cultivation of the power of mental imagery," fed by the continual drawing of remembered observation." His success re-established the importance of prior digestion by the artist of the details and fundamental form of observed facts before he is able to interpret them vividly as a summary in drawing.

More important still were the results of Smith's teaching as practised by his pupils Marian Richardson and Marian Duffield. Miss Richardson found and perfected new methods and mediums, as in her development of Ablett's "writing patterns," so that for the first time the child had suitable means, matching his own eloquent sense of design, colour and drawing, to express his emotional and imaginative conceptions. Through the work of her disciples, working in many schools, she showed how such expression could enhance the child's whole personality. She was influenced by the great Austrian pioneer, Franz Cizek, but Cizek confined his teaching to the few and gifted, while Miss Richardson

was able to show that eloquence in emotional expression among children was in fact a general gift, requiring only the opportunity and a relationship akin to love between teacher and child to bring it to fruition. Miss Richardson crystallized much individual experiment in teaching, giving a clear basis and point for the development of teaching method at all ages. Further, her work directly influenced the general attitude and practice of teachers in all aspects of the education of the younger child.

Acceptance of the conception that the creative instinct in the arts was also a very general one at the adolescent age, however, was very much more difficult to obtain. All long-standing educational tradition seemed against it. "Childish" intuition and emotional expression often were thought to be a hindrance to the clear development of an "adult" logical faculty, which at adolescence should be universally applied and which could prove adequate, it was thought, in all realms of human thinking. In the late 1920s and early 1930s a group of young teachers from the Slade school advanced the idea that much of the instability of youth and incompleteness of adult personality and character were due to this concentration on the development of only one side of the mind. This approach worked to the exclusion and consequent destruction in adolescence of the qualities of emotional inspiration, courage and individual discovery that are fundamental to this period of development and to the maturing of deeper spiritual and intellectual perceptions. The group at the Slade school believed that their experience in teaching children proved, in a practical realizable sense, that "there is not a special kind of person called an artist, but that each person is a special kind of artist." A paramount aim of education, therefore, should be to discover and develop the artist in every man. Only so would art again become a vital force, creating a language for the exchange of those social, spiritual and common ideas for which scientific analysis and the language of words proved inadequate or altogether impotent. Such self-discovery could also control the artist's developing emotional instincts and help the realization of a self-discipline on which the acquisition of a mature, balanced adult personality largely depended. With a few notable exceptions—such as Sir Michael Sadler and R. R. Tomlinson, whose books on child art have long been an influence in many countries—these ideas seemed unconvincing both to official art teaching and in general education.

This group of teachers started a society, the New Society of Art Teachers, to prove these truths; later, in amalgamation with the Art Teachers' guild it became the Society for Education Through Art. Before World War II it initiated a number of activities to establish these beliefs, such as that for the regular supply of examples and reproductions of art in schools, and a journal called *Athene*. Through exhibitions of school art, in its wide variety, they tried to find how a finer, not a less adult, technique was brought into being as an intrinsic part of live expression, not in separation from it; each language having its own unique kind of drawing, design and use of colour to interpret experience.

Although World War II delayed many projects, such as that for an institute of research into the nature of the growing faculty of intuitive imaginative expression, it produced one noteworthy result in the publication of the classical work on the subject by Sir Herbert Read, *Education Through Art* (1943). The findings of this book, relating the understanding of the discoveries made by art teachers to contemporary psychological discovery, established a reasoned unity to propositions arising out of these achievements which have been described as the most outstanding educational discovery of the 20th century.

After the war the Society for Education Through Art attempted to link painting in schools much more securely to contemporary art in its yearly "pictures for schools exhibitions," showing works of contemporary artists that could be bought by schools. Certain local education authorities, such as those of Leicester, Derby, London and South Wales, initiated notable schemes for providing schools with a regular flow of works of art. International co-operation was sought through UNESCO and supported by the ministry of education. As a result an international seminar was held in Bristol in 1951 with the subsequent formation of the International Society for Education Through Art (*see* below, *International Co-operation*). Co-operation among the different arts and between art and science teaching in education was initiated, leading to the formation of the Joint Council of Education Through Art. Similar expression among groups of adult nonprofessional artists showed the ability of many ordinary people to translate, through individual and quite separate ways, their own experience into painting. Work of great interest, in adjusting the problems of the mind, has been achieved through art both for those ill in mind and body and for educationally subnormal persons.

In 1957 the London County council in a very large exhibition held a review of the different ranges of visual art, growing through all its stages to maturity. The exhibition also demonstrated not only the result of one gifted pupil's work but many different achievements of the pupils in one class, each painting a given subject with his own particular interpretation of experience. In the growth of "comprehensive schools" and their regular teams of art instructors, the fuller realization of a live art pervading a whole school community and producing its own expression and decoration has been made possible. By the 1960s it was hoped that local centres would come into being, where teams of nonprofessional artists leaving schools could carry their expression and interpretation of contemporary experience into contemporary life. Increasingly it was being considered how an art of the people, inspired by the life of the community, could arise and, together with the art of the professional artist, reveal a greater art epitomizing the age and inspiring a richer conception of civilization in the future. Such an event, however, would seem to require a more objective view of the nature and function of art than that which still tended to confine much professional teaching.

(A. B.-Ru.)

EUROPE

The technical term "art education" is used, except in France and Spain, only with reference to academies of art and art schools that also include a section for the training of art teachers, and to pedagogic academies; in other educational establishments different terms can be found for the various activities connected with fine arts. In the curricula of primary and secondary schools the word "drawing" is used, alone or in connection with "handicrafts." In Switzerland (Bern) painting and modeling, in Spain studio work and needlework, are added instead of handicrafts. In the Federal Republic of Germany the subject is called "art and handicrafts" in primary schools, "fine arts" in secondary schools. Other official terms are "art lessons" in Greece and "art courses" in Hungary.

The number of hours assigned to the subject in secondary schools varies according to the type and character of the school, oscillating between 1 and 3 hours weekly, and exceptionally rising to 9 or 11 hours in secondary schools for girls in the Netherlands. Restrictions are common in the upper forms (grades). Many countries do not demand a definite arrangement of the lessons among the youngest age groups. Art education is part of the entire instruction. In any case—explicitly mentioned or not—it is compulsory in the primary schools, with a very few exceptions for the upper forms. This compulsion is based on the knowledge that children are able to express themselves better through art than through words and that art thus fosters their mental growth. In most secondary schools on the European continent art education is compulsory during the first four forms, becomes an optional subject in the upper forms and very often disappears from the curriculum of the last form.

All continental countries acknowledge the educational value of art education and agree that it fosters self-possession, concentration, attentiveness, discipline, self-reliance and responsibility. Most of the continental curricula, without any difference in the primary and secondary levels, emphasize the training of observation, imagination and aesthetic feeling. The abilities achieved through art education are sometimes deemed an important help in the mastering of other subjects. Some countries are more interested in the acquisition of techniques in art education, yet they stress that techniques are not to be an end but a means to an end.

It is known, of course, that art education contributes, as does

no other subject, to an understanding of the child's psychological disposition and thus gives the teacher necessary insight. However, continental European countries refuse to let the children work only to serve psychological interpretation, as this would result in the loss of educational purpose. In special schools art education is used for observation and development of retarded children. Besides general aims, particular goals are: training of manual ability, memory and intellect, and development of critical analysis, power of judgment, sense of quality, interest in works of art and awareness of their backgrounds.

Drawing appears first among the activities of art education. Painting gradually develops from it to form a special branch. Drawings develop from the observation of nature and out of imagination and memory. Besides these, graphic techniques and the so-called intermediary graphic procedures are practised, together with calligraphy and illuminated writing. Handicrafts such as bookbinding, wood carving and metal and leather manufacturing are added. Puppets are made everywhere.

Art appreciation generally is assigned to the secondary level. It is very often built up on a historical basis or on criticism of styles. Boys and girls get instruction equally, but adaptations for their tastes are made, being specially worked out for different mental abilities. The aim of art education ultimately is understanding of the nature of creative process and apprehension of the values of life as realized through works of art. The awakening and development of creativity, which should help the child to understand his own personality and to discover his own way of expression, is achieved by a program that examines the various possible ways of creating form. Contemplation of a work of art fosters creative work as well as understanding of the art object itself; at the same time it helps to develop the faculty of independent judgment.

The many kinds of materials and tools that are of importance in art education are sometimes provided free of charge to children of primary-school age. Materials used for art appreciation, such as reproductions and art books, are owned by the schools; slides and films are lent out by official centres. The study of original works of art is favoured, and visits to exhibitions and art galleries, in addition to exhibitions of the work of outstanding artists in the schools, contribute to the art program.

In all continental primary schools art education is given by the form master, who first receives teacher training at secondary schools, pedagogic academies and teachers' training schools. In some countries artistic activity is emphasized in such schools. Teachers specialized in art teach the subject in the upper forms of the primary level, most of these having attended official or nonofficial art courses. All teachers are given the opportunity to broaden their learning in continuation classes arranged by educational authorities or art teachers' associations. It is taken for granted that the secondary-school art teacher is an artist, because only as an artist can he possess the sensibility, vitality and strength necessary for his task. Secondary art teachers are trained at academies of fine arts or applied arts, in art schools or in special art centres as in Poland and Rumania; training lasts between two and five years and stress is often laid on the artistic side rather than on the pedagogic. Secondary-school art teachers, except in Italy and Switzerland, hold the same position as teachers of other subjects, but in most countries art teachers give more lessons than other teachers do. They are advised by art inspectors. In France and Norway art teachers are able to consult the museum staffs. Art teachers' associations exist in most European countries. Their members are mainly teachers of the secondary schools but also include primary school teachers, very rarely teachers of academies.

Nearly all countries publish technical journals and organize meetings and congresses. Adult colleges have the same aim in art education as primary and secondary schools, without the possibility of achieving the same successes. Their courses are directed by art teachers, artists and handicraftsmen. In the Federal Republic of Germany, Sweden and France the handicraft art schools are of special significance.

Art education for young people attending vocational schools is not yet fully exploited or its value realized. In a review of the situation on the continent of Europe it must be said that, in spite of the progress mentioned above, the estimation of art education has shown retrogression during the 20th century. (R. Cu.)

INTERNATIONAL CO-OPERATION

At the close of World War II, internationally minded art teachers in many countries looked forward to a period of active co-operation through the newly established United Nations Educational, Scientific and Cultural organization (UNESCO). At UNESCO headquarters in Paris, special sections of the staff were formed to facilitate co-operation in the visual arts, art education and museum work. Arrangements were made to work with professional societies in several member countries in the visual arts, drama, dance and music. In 1947 and 1949 international committees of experts met under the chairmanship of Thomas Munro (U.S.) and Sir Herbert Read (Great Britain) to plan a program for developing the arts in general education. UNESCO was to act as a world clearinghouse for the exchange of information, exhibitions, plans for international art festivals, and professional conferences. Supporting panels of artists and teachers met in Paris, London, Washington and New York. Under the leadership of Trevor Thomas (Great Britain), then a member of the UNESCO staff, a magazine on art education was published in English and French. With C. D. Gaitskell (Canada) as director an international seminar on the visual arts in general education was held in Bristol, Eng., in 1951, followed by one in Tokyo.

Some important further steps were taken: (1) As a sequel to the Bristol seminar, a volume entitled *Education and Art* was edited by Edwin Ziegfeld (Paris, 1953) with articles by 45 art educators from North and South America, Europe, the near and far east, and with many illustrations in colour of children's art work. (2) The International Society for Education Through Art (INSEA) was organized, with headquarters in Paris; Edwin Ziegfeld (U.S.) was its first president. (3) An assembly of the society, devoted to "Art Education and Adolescence," was held at The Hague in Aug. 1957. (4) Technical advisers on arts and crafts were sent to Afghanistan and other countries requesting them. (5) A series of large books of colour reproductions of paintings from Egypt, India, Italy and elsewhere was issued under the direction of Peter Bellew of the art section of UNESCO, together with catalogues of colour reproductions available for purchase elsewhere. (6) Through the museums section, steps were taken to aid in the preservation and restoration of great monuments of art throughout the world.

Through other agencies, especially the U.S. state department and various private foundations, many artists, art students, teachers and museum workers from the United States and foreign countries have been given travel grants for study abroad. Although not all countries of the world participate, the ideal of cultural interchange in the arts and in methods of creative education is gaining wide support.

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ARTEMIDORUS. (1) A geographer of the ancient Greek city of Ephesus who, in about 100 B.C., compiled a systematic geography in 11 books, using both his own itineraries in the

Mediterranean and the records of others. His work is known only from references in Strabo, who made much use of it, from fragments preserved by later authors and from the surviving part of an abridgement, attributed to Marcianus of Heraclea (possibly early 5th century), of his periplus (coastal guide) of the Mediterranean and Euxine. (2) A soothsayer of Ephesus who flourished during the 2nd century A.D. His *Oneirocritica*, or interpretation of dreams, in four books, is extant and affords a valuable insight into ancient superstitions. It is mainly a compilation from the works of earlier authors. Artemidorus was called A. Daldianus, either after his mother's home, Daldis in Lydia, or because he was an initiate of Apollo Daldiaios. (Wm. C. B.)

ARTEMIS, the Greek goddess of wild animals and vegetation, of chastity, childbirth and the hunt, identified by the Romans with Diana (*q.v.*), was the most popular of all goddesses with the ordinary worshiper. Her character and function vary greatly from place to place; the many-breasted Artemis of Ephesus and the Artemis *Lochia*, who aided women in labour, contrast strangely with the virginal huntress familiar from Euripides' *Hippolytus*. Yet apparently behind all forms lies the goddess of wild nature, who dances, usually accompanied by nymphs, in mountains, forests and marshes.

Artemis' worship probably flourished in Crete or on the Greek mainland before the Hellenic immigration during the 2nd millennium B.C. The Minoan Cretan pantheon included a Mistress of Animals who supervised wild nature and the hunt, and who was closely related to the goddess of the tree cult. The Mistress of Animals likewise appears on artifacts of the Mycenaean Greek culture of the later 2nd millennium, and their form closely resembles 7th-century Greek representations of Artemis. The name Artemis defies successful derivation from Greek or any Indo-European tongue and may well be of Minoan origin. Scholars have claimed that her name appears on a Mycenaean tablet, and though the decipherment of Mycenaean Greek is still uncertain, continuity of functions and artistic type render Artemis' transmission through the Mycenaeans from Minoan beginnings reasonably certain.

Many of Artemis' local cults preserve traces of other deities, often with Greek names, suggesting that, upon adopting her, the Greeks identified Artemis with nature divinities of their own. Even where such syncretism is not discernible, non-Minoan influences may be seen: phallic dances and symbols, of which the Minoan religion shows little or no trace; the sibling relationship between Artemis and Apollo (*q.v.*; he immigrated from Asia Minor after the early Hellenic settlement of Greece) and the consequent belief that she too was the daughter of Zeus and Leto; and her occasional encroachments upon Apollo's domain, such as her assistance in healing Aeneas in the *Iliad*.

The Mycenaean princes encountered wild nature rarely except while hunting, so that to Homer, who so often reflects their values, Artemis is essentially the huntress; Hera contemptuously confines her to this role in book 21 of the *Iliad*. From it stem her epithets "arrow-shedder" and "noisy" (probably referring to the din of the boar hunt). Embodying as she does the sportsman's ideal, besides killing game she protects it, especially the young; such is the Homeric significance of the title "mistress of animals." Because she is the bow-carrying goddess, it is she who sends sudden death to women (once to a man, Orion the hunter, in the *Odyssey*) through the "gentle darts" whose effect is specifically contrasted with death by long illness in book 11 of the *Odyssey*. Her archer brother Apollo is responsible for the sudden deaths, off the battlefield, of men; he slays the sons, she the daughters of Niobe (*q.v.*). Somewhat surprisingly, Artemis appears alongside Aphrodite in the *Odyssey* as the paradigm of female beauty; her stature especially is praised.

Since Artemis belongs to the rural populace rather than the urban court, Homer understandably displays little interest in her. Later poets, too, tended to favour other Olympians, perhaps because they had difficulty establishing for Artemis an extensive cosmological role. Chastity, the hunt, and the out-of-doors are not spheres of human concern comparable in importance to love, war, or moral and intellectual excellence; and even virginity is often regarded as the denial of Aphrodite rather than the affirmation of Artemis. Details such as Artemis' connection with the dance and the nymphs were drawn not from poetic imagination but from cult.

Dances of maidens representing nymphs are especially common in Artemis' worship as goddess of the tree cult, a role probably deriving from Minoan religion and especially popular in the Peloponnesus. At Caryae, for instance, dances of maidens symbolizing dryads (the usual term for tree nymphs) honoured Artemis *Caryatis*; they and the nut-tree nymph, Carya, were once changed into trees. Elsewhere are Artemis *Cedreatis* (goddess of the cedar) and Artemis *Apanchomene* ("hanging"), whose image was presumably suspended from a tree and who may have developed from the dying vegetation-goddess of the Minoans.

THE MANSELL COLLECTION

THE ARTEMIS OF GABII. IN THE LOUVRE, PARIS

The tree cult is one form of the worship of Artemis as goddess of wild vegetation. Throughout the Peloponnesus, bearing such epithets as *Limnaea* and *Limnatis* ("lady of the lake"), she supervised waters and lush wild growth, attended by nymphs of wells and springs (ordinarily called naiads). In parts of the peninsula her dances were wild, lascivious and often phallic, accompanied by timpani and reed flutes. To such musical origins was bucolic poetry anciently traced; Caryae vied with shrines in Dorian Sicily for the honour of having been its birthplace. In a sanctuary east of Sparta, Artemis bore the unexplained epithet *Orthia*, perhaps once an independent divine name. Her worshipers there included masked dancers, and there exists a lyric by Alcman which rival choruses of maidens probably sang in her honour one morning before dawn. If, as the ancient commentary suggests, these girls dedicated a plow to the goddess, it is one of the few indications that Artemis extended her activities to cultivated vegetation. Plant life of some kind she certainly supervised there: she was called *Lugodesma* ("withybound," referring in part to the condition of her statue), and sickles were offered her. Later the cult became famous for a mysterious ritual, the scourging of youths at her altar.

Outside the Peloponnesus, Artemis' most familiar form is the mistress of animals. Poets and artists usually pictured her with the stag or hunting dog, but the cults show considerable variety. In Phocis and elsewhere, Artemis *Laphria* (meaning unknown) received the sacrifice of a large number of living animals of all sorts, heaped upon a funeral pyre and burned. Artemis *Agrotera* ("of the wild") received every year from the Athenians 500 goats as a thank-offering for her help at Marathon. At Brauron in Attica, maidens called "bears" dressed in tawny cloaks and danced for Artemis; the bear may also be a theriomorph of Artemis *Calliste* ("fairest") in Arcadia. The Tauropolia festival at Halae Araphenides, also in Attica, honoured Artemis *Tauropolos* ("bull-goddess"), who received a few drops of blood drawn by sword from a man's neck. It may have been partly this obvious surrogate for human sacrifice which led Euripides (in *Iphigenia in Tauris*) to derive the cult (together with the Brauronian) from the Crimean Taurians, among whom Iphigenia, in one version of the legend, immolated strangers to Artemis. Iphigenia herself was nearly sacrificed to Artemis by her father, Agamemnon; the goddess rescued her, substituting a bear or stag, a change of sacrificial object which must very nearly reflect historical truth. In most versions of the myth Iphigenia is actually killed, an act which the poets ex-

plain variously; according to Aeschylus (in *Agamemnon*), Artemis is angrily determined to make the leader of the Trojan expedition pay dearly for honouring the code of blood revenge for the rape of Helen. All these cases of human sacrifice honoured the mistress of animals and are likely to be early, though not necessarily Minoan. In a few cults, especially where the deer-festival Elaphebolia was celebrated, Artemis was worshiped as a huntress, but such rites are relatively rare, the concept belonging mainly to aristocratic private cult and to poetry and sculpture.

Many scholars have held that Artemis was originally a mother-goddess, descended from a Cretan Mother of the Mountains similar to the Asian Magna Mater (*see* GREAT MOTHER OF THE GODS). A familiar artistic type of the Minoan Mistress of Animals, showing the goddess standing on a heap of stones (mountain?), in a flounced skirt with rod (spear?) in hand and flanked by lions, is highly reminiscent of the Magna Mater and certainly shows eastern influence. But derived artistic types do not necessarily impose the religious interpretations of their originals; motherhood is not an obvious feature of the design, and the Minoan language cannot be read. Attempts to discover in the later Greek mistress of animals (Artemis herself) traces of a mountain-mother have not been conspicuously successful. Mountain shrines, whose neighbourhood she wandered, presumably accompanied by orestiads (mountain nymphs, also called oreads), were indeed hers; perhaps here she carried the torches which she bears on vase paintings and which have hopefully but unconvincingly been called marriage torches. The many-breasted Ephesian Artemis, whose temple was one of the seven wonders of the world, was a mother, in fact a form of the Magna Mater. But she was distinctly different from Artemis in Greece; the Greeks doubtless made the identification because both were mistresses of animals, but there the resemblance ceases. Goddess of childbirth Artemis was, often identified with Eileithyia; on occasion she was offered the clothes of women who died in childbirth. She was sometimes called *Kourotrophos* ("nurse"). But midwife and nurse are not mother, and lovemaking and probably conception, too, are Aphrodite's concern. The chorus in *Oedipus Rex,* for instance, invokes Artemis on behalf of the Theban women, who are not barren, but are unable to "surmount their shrieking pangs by births." In later times she was identified with Hecate (*q.v.*) and with the moon, whose monthly cycle was early connected with woman's, but efforts to see Artemis as a moon-goddess in early cult are unconvincing. Premarital ceremonies were occasionally held in her honour, especially in Locris and Boeotia in the cult of Artemis *Eucleia* ("renown"; Eucleia was probably once an independent divinity), but they do not seem to have aimed at fecundity. Only very indirectly, where Artemis was the goddess of woman's life in general, did motherhood become her sphere.

The frequent stories of the love affairs of Artemis' nymphs are supposed by some to have originally been told of the goddess herself, presumably as mother-goddess. Thus Callisto ("Fairest"), who bore Arcas, progenitor of the Arcadians, to Zeus, is supposed to be Artemis; she may indeed be related to Artemis *Calliste,* but it cannot be said whether her seduction was invented while she was identified with Artemis (if she was) or later. Often the nymph escaped her amorous pursuer; Britomartis, who was once a Cretan goddess and probably related to Artemis, remained chaste. It is unreasonable to identify Artemis only with those nymphs who succumbed.

The poets after Homer stress Artemis' chastity: Homeric hymn 5 attributes her immunity to Aphrodite to her delight in the hunt, dancing and music, shadowy groves and the cities of just men. The reference to city life is unusual; sole jurisdiction over 30 towns, promised her by Zeus (Callimachus, *Hymn to Artemis*), was apparently never her portion; few writers mention the role, though market-place temples occasionally are mentioned. But that the goddess of the unconquered wilderness should be free of sexual desire, a taming and subduing force, seems altogether natural. This thought paved the way for the archetype of the virgin huntress, whose possibilities as a symbol of human aspiration were fully exploited by Euripides in the *Hippolytus* (*q.v.*). Its hero in consecrating himself to Artemis rejects not only Aphrodite but mankind itself, which is subject to Aphrodite; Artemis' wild haunts represent an ultimately impossible escape from the human condition.

The wrath of Artemis is proverbial, for to it myth attributed wild nature's hostility to man. In sending the Calydonian boar against Oeneus, Artemis demonstrates the costliness of his failure to remember nature's power (*see* MELEAGER; ATALANTA). The hunter above all cannot afford such forgetfulness; Actaeon (*q.v.*), for carelessly surprising the naked Artemis, is changed from hunter to hunted, to a stag who is devoured by his own hounds. Yet Greek sculpture avoided Artemis' unpitying anger as a motif; the goddess herself did not in fact become popular as a subject in the great sculptural schools until the relatively gentle 4th-century spirit prevailed. The rather scant remains reflect such thoughtful pride as may be found on the Vienna statuette or the girlish charm of the Gabii huntress, both perhaps spiritual children of Praxiteles' lost work.

See also references under "Artemis" in the Index.

See Martin P. Nilsson, *Geschichte der griechischen Religion,* vol. 1, 2nd ed. (1955), with sufficiently full bibliography of earlier material.
(W. M. SE.)

ARTEMISIA, daughter of Lygdamis, was queen of Halicarnassus and Cos about 480 B.C. She took part in the expedition of Xerxes against the Greeks, and fitted out five ships, with which she distinguished herself in the sea fight near Salamis (480). According to Herodotus it was her advice which decided Xerxes not to risk another battle, but to retire at once from Greece.

ARTEMISIA, the sister and wife of Mausolus (or Maussollus), king of Caria, was sole ruler *c.* 353–350 B.C. She built for her husband, in Halicarnassus, the magnificent mausoleum, which was one of the seven wonders of the world. Artemisia was also known as a botanist and medical researcher. She discovered and named several herbs; *Artemisia* is named after her.

See HALICARNASSUS.

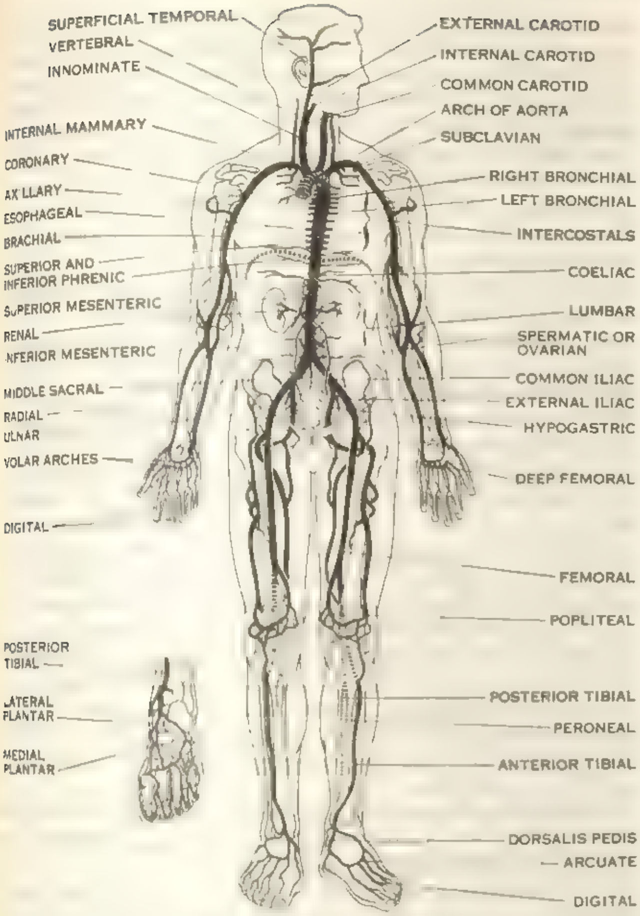
See Pliny, *Natural History,* vol. xxv, p. 73, vol. xxxvi, pp. 30 *et seq.*

ARTEMISIA, a large genus of aromatic, bitter-juiced herbs or shrubs of the family Compositae, comprising about 100 species, most abundant in arid regions, notably in the western United States, the Asiatic steppes, South Africa and South America. They often have much divided leaves and inconspicuous flowers borne in very numerous small heads. Several are grown for ornamental and medicinal purposes. Four species are found in Great Britain; 40 or more occur in the United States and Canada, chiefly from the Great Plains westward, and several old world species have become widely naturalized, such as the southernwood (*A. abrotanum*), the wormwood (*A. absinthium*) and tarragon (*A. dracunculus*). The beach wormwood and mugwort (*qq.v.*) are less aromatic, and are weedy escapes from cultivation in eastern North America. The well-known sagebrush (*q.v.*) of western North America is a silvery shrub, four to six feet high (occasionally more), and covers many thousands of square miles.

The dried flower heads of several Asiatic species are used for the extraction of santonin, a drug used to expel roundworms from the gastrointestinal tract. Two of the chief sources of santonin are *A. cina* of Iran and Turkistan and *A. maritima,* found from England to Mongolia. Closely related, the products of either are commercially known as Levant wormseed. Both are woody perennials or subshrubs, bearing numerous tiny yellowish flower heads, usually gathered in July. (N. TR.)

ARTEMOVSK (formerly BAKHMUT), a town of Donetsk *oblast* of the Ukrainian Soviet Socialist Republic, U.S.S.R., lies on the Bakhmut river, a tributary of the Donets, about 40 mi. N.N.E. of Donetsk. Pop. (1959) 60,626. It is connected by railway to the coal-mining town of Gorlovka and to Kharkov. The largest salt mines in the U.S.S.R., worked since the 17th century, are at Artemovsk. There are also alabaster and glass works, food and light industries. Near the town is the Mironovskaya electric plant. (R. A. F.)

ARTERIES, in anatomy, are the muscular and elastic tubes that carry the blood away from the heart to the tissues. Since after death, the arteries are always found empty, the older anatomists believed that they contained air, and to this belief they



FROM MILLARD, KING AND SHOWERS, "HUMAN ANATOMY AND PHYSIOLOGY," 4TH ED., SAUNDERS (1956)

FIG. 1.—DIAGRAM OF THE ARTERIAL SYSTEM

owe the name, which was originally given to the windpipe. Two great trunks, the aorta and pulmonary artery, leave the heart and divide again and again until they become minute vessels to which the name arterioles is given.

The larger trunks are fairly constant in position and receive definite names, but there is an increasing inconstancy in the position of the smaller branches. Many arteries are tortuous, especially when they supply movable parts such as the face or scalp, but when one or two sharp bends are found they are generally due to the artery's going out of its way to give off a constant and important branch.

Small arteries unite (*i.e.*, anastomose) with others near them very freely, so that when even a large artery is obliterated a collateral circulation is carried on by the rapid increase in size of the communications between the branches coming off above and below the point of obstruction. Some branches, however, such as those going to the basal ganglia of the brain and to the kidney, are known as end arteries, and these do not anastomose with their neighbours at all; thus, if one is blocked, arterial blood fails to reach the area normally supplied. As a rule, there is little arterial anastomosis across the middle line of the body near the surface, although the scalp, lips and thyroid gland are exceptions.

The following account refers to the vessels as they occur in man.

Aorta.—The aorta lies in the cavities of the chest and abdomen and arises from the base of the left ventricle of the heart. It ascends forward, upward and to the right as far as the level of the second right costal cartilage, then runs backward and to the left to reach the left side of the body of the fourth thoracic vertebra, and then descends almost vertically. It thus forms the aortic arch, which has attached to its concave surface a fibrous cord, the ligamentum arteriosum, which connects it with the left branch of the pulmonary artery. The aorta continues downward close to the bodies of the thoracic vertebrae, then passes through an opening in the diaphragm (*q.v.*), enters the abdomen and descends in front of the bodies of the lumbar vertebrae as low as the fourth, where it usually divides into two terminal branches, the common iliac arteries. Above and behind the angle of bifurcation, however, a long slender artery, called the middle sacral, is prolonged downward in front of the sacrum to the end of the coccyx. It is really the terminal aorta, shifted in position.

Carotid System.—The branches for the head, neck and upper limbs arise as three large arteries from the arch of the aorta; they are named innominate (or brachiocephalic), left common carotid and left subclavian. The innominate artery is the largest and passes upward and to the right to the root of the neck, where it divides into the right common carotid and the right subclavian. The carotid arteries supply the two sides of the head and neck; the subclavian arteries supply the two upper extremities. Each common carotid artery runs up the neck by the side of the windpipe, and on a level with the upper border of the thyroid cartilage divides into an internal and external carotid artery.

Each internal carotid artery ascends through the carotid canal in the temporal bone into the cranial cavity. It gives off an ophthalmic branch to the eyeball and other contents of the orbit, and then divides into the anterior and middle cerebral arteries. The middle cerebral artery extends outward into the lateral (Sylvian) fissure of the brain, and supplies the insula (of Reil), the orbital part and the outer face of the frontal lobe, the parietal lobe and the temporal lobe; it also gives a chorioid branch to the chorioid plexus of the anterior medullary velum. The anterior cerebral artery supplies the inner face of the hemisphere from the anterior end of the frontal lobe as far back as the internal parieto-occipital fissure.

At the base of the brain not only do the two internal carotids anastomose with each other through the anterior communicating artery, which passes between their anterior cerebral branches, but also the internal carotid on each side anastomoses with the posterior cerebral branch of the basilar, by a posterior communicating artery. In this manner a vascular circle, the arterial circle (of Willis), is formed, which permits freedom of circulation between the arteries on opposite sides of the mesial plane. The vertebral and internal carotid arteries, which are the arteries of primary supply for the brain, are distinguished by lying at some depth from the surface in their course to the organ, by having curves or twists in their course and by the absence of large collateral branches.

The external carotid artery ascends through the upper part of the side of the neck, and behind the lower jaw into the parotid gland, where it divides into various branches. The external carotid artery gives off the following branches: (1) superior thyroid to the larynx and thyroid gland; (2) lingual to the tongue and sublingual gland; (3) facial to the face, palate, tonsil and submaxillary gland; (4) occipital to the sternomastoid muscle and back of the scalp; (5) posterior auricular to the back of the ear and the adjacent part of the scalp; (6) superficial temporal to the scalp in front of the ear, and by its transverse facial branch to the back part of the face; (7) maxillary, giving muscular branches to the muscles of mastication, meningeal to the dura

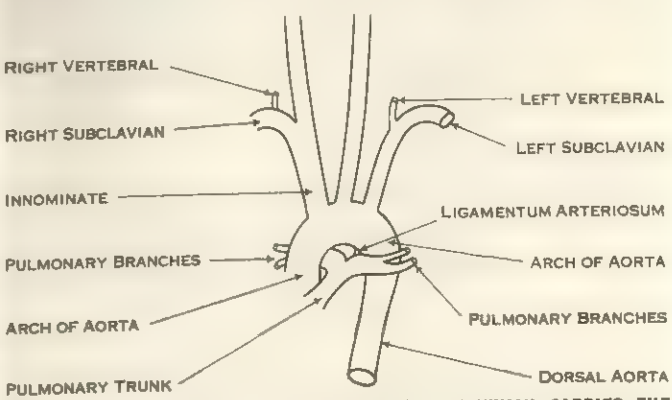


FIG. 2.—THE HUMAN AORTA, THE GREAT ARTERY WHICH CARRIES THE BLOOD FROM THE HEART TO ALL PARTS OF THE BODY EXCEPT THE LUNGS, AND ITS MAIN BRANCHES

mater, dental to the teeth and other branches to the nose, palate and tympanum; (8) ascending pharyngeal, which supplies the pharynx, palate, tonsils and dura mater.

Subclavian System.—The subclavian artery is the commencement of the great arterial trunk for the upper limb. It passes across the root of the neck and behind the clavicle, where it enters the armpit, and becomes the axillary artery; by that name it extends as far as the posterior fold of the armpit, where it enters the upper arm, takes the name of brachial and courses as far as the bend of the elbow; there it bifurcates into the radial and ulnar arteries. From the subclavian part of the trunk the following branches arise: (1) Vertebral, which enters the foramen at the root of the transverse process of the sixth cervical vertebra, ascends through the corresponding foramina in the vertebrae above, lies in a groove on the arch of the atlas and enters the skull through the foramen magnum, where it joins its fellow to form the basilar artery; it gives off numerous branches in its course. The basilar artery extends from the lower to the upper border of the pons Varolii; it gives off pontine, labyrinthine and inferior cerebellar branches and breaks up into four terminal branches, viz., two superior cerebellar and two posterior cerebral. (2) Thyrocervical trunk, which immediately divides into the inferior thyroid, the suprascapular and the transverse cervical branches. (3) Internal thoracic (or internal mammary), which supplies the anterior surface of the walls of the chest and abdomen and the upper surface of the diaphragm. (4) Costocervical trunk, which supplies the first intercostal space, and by its deep cervical branch the deep muscles of the back of the neck.

The axillary artery supplies thoracic branches to the wall of the chest, the pectoral muscles and the fat and glands of the armpit; a thoracoacromial to the parts about the acromion; anterior and posterior circumflex branches to the shoulder joint and deltoid muscle; a subscapular branch to the muscles of the posterior fold of the armpit.

The brachial artery supplies muscular branches to the muscles of the upper arm; a nutrient branch to the humerus; profunda or deep branches and ulnar collaterals to the muscles of the upper arm and the region of the elbow joint.

The ulnar artery extends down the ulnar side of the front of the forearm to the palm of the hand, where it curves outward toward the thumb and anastomoses with the superficial palmar or other branch of the radial artery to form the superficial palmar arch. In the forearm the ulnar gives off the interosseous arteries, which supply the muscles of the forearm and give nutrient branches to the bones; two recurrent branches to the region of the elbow; and carpal branches to the wrist joint. In the hand it gives a deep branch to the deep muscles of the hand, and from the superficial arch arise digital branches to the sides of the little, ring and middle fingers and the ulnar border of the index finger.

The radial artery extends down the radial side of the front of the forearm, turns around the outer side of the wrist to the back of the hand, passes between the first and second metacarpal bones to the palm, where it joins the deep branch of the ulnar, and forms the deep palmar arch. In the forearm it gives off a recurrent branch to the elbow joint; carpal branches to the wrist joint; and muscular branches, one of which, named superficial palmar, supplies the muscle of the thumb and joins the ulnar artery. In the hand it gives off a branch to the thumb and one to the radial side of the index, metacarpal branches to the interosseous muscles, perforating branches to the back of the hand and recurrent branches to the wrist.

Visceral Branches.—The branches of the aorta that supply the viscera of the thorax are the coronary, the esophageal, the bronchial and the pericardiac. The coronary arteries, two in number, are the first branches of the aorta, and arise opposite the anterior and left posterior semilunar valves, from the wall of the aorta, where it dilates into the aortic sinuses (of Valsalva). They supply the tissue of the heart.

The esophageal, bronchial and pericardiac branches are sufficiently described by their names.

The branches of the aorta that supply the viscera of the abdomen arise either singly or in pairs. The single arteries are the coeliac trunk, the superior mesenteric and the inferior mesenteric, which arise from the front of the aorta; the pairs are the suprarenal, the two renal and the two testicular or ovarian, which arise from its sides. The single arteries supply viscera that are either completely or almost completely invested by the peritoneum (see COELOM AND SEROUS MEMBRANES), and the veins corresponding to them are the roots of the vena portae.

The pairs of arteries supply viscera developed behind the peritoneum, and the veins corresponding to them are rootlets of the inferior vena cava.

The coeliac trunk is a thick, short artery that almost immediately divides into the gastric, hepatic and splenic branches.

The superior mesenteric artery gives off an inferior pancreaticoduodenal branch to the pancreas and duodenum; about 12 intestinal branches to the small intestine, which form in the substance of the mesentery a series of arches before they end in the wall of the intestines; an ileocolic branch to the end of the ileum, the caecum and beginning of the colon; a right colic branch to the ascending colon; and a middle colic branch to the transverse colon.

The inferior mesenteric gives off a left colic branch to the descending colon, a sigmoid branch to the iliac and pelvic colon, and ends in the superior rectal artery, which supplies the rectum.

The suprarenal arteries, small in size, run outward from the aorta to end in the suprarenal capsules. The renal arteries pass one to each kidney. Additional renal arteries are fairly common.

The testicular arteries are two long slender arteries that descend, one in each spermatic cord, into the scrotum to supply the testicle. The corresponding ovarian arteries in the female do not leave the abdomen.

Parietal Branches.—The branches of the aorta that supply the walls of the chest, abdomen and pelvis are the intercostal, the lumbar, the phrenic and the middle sacral.

The intercostal arteries arise from the back of the thoracic aorta, and are usually nine pairs. They run around the sides of the vertebral bodies as far as the commencement of the intercostal spaces, where each divides into a dorsal and a ventral intercostal branch. The dorsal branch passes to the back of the thorax to supply the deep muscles of the spine; the ventral branch runs outward in the intercostal space to supply its muscles, and the lower pairs of intercostals also give branches to the diaphragm and wall of the abdomen. Below the last rib a subcostal artery runs, with similar relations.

The lumbar arteries arise from the back of the abdominal aorta, and are usually four pairs. They run around the sides of the lumbar vertebrae, and divide into a dorsal branch which supplies the deep muscles of the back of the loins and an abdominal branch which runs outward to supply the wall of the abdomen. The distribution of the lumbar and intercostal arteries exhibits a transversely segmented arrangement of the vascular system, like the transversely segmented arrangement of the bones, muscles and nerves met with in these localities, but more especially in the thoracic region. Anastomoses of their ventral tips produce the internal thoracic (or internal mammary) arteries.

The two phrenic arteries supply the undersurface of the diaphragm.

The middle sacral artery, as it runs down the front of the

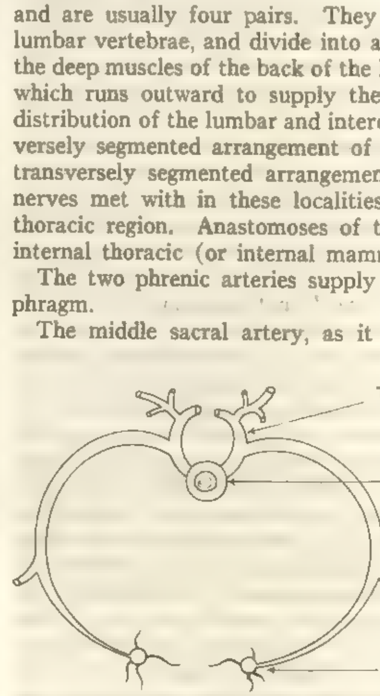


FIG. 3.—A PAIR OF INTERCOSTAL ARTERIES AND THEIR BRANCHES

sacrum, gives branches to the back of the pelvic wall.

The arteries to the pelvis and legs begin at the level where the aorta bifurcates into the two common iliacs.

Iliac System.—The common iliac artery, after a short course, divides into the internal and external iliac arteries. The internal iliac enters the pelvis and divides into branches for the supply of the pelvic walls and viscera, including the organs of generation, and for the great muscles of the buttock. The external iliac descends behind the inguinal ligament into the thigh, where it takes the name of femoral artery. The femoral descends along the front and inner surface of the thigh, gives off a profunda branch, which, by its circumflex and perforating branches, supplies the numerous muscles of the thigh; most of these extend to the back of the limb to carry blood to the muscles situated there. The femoral artery then runs to the back of the limb in the ham, where it is called the popliteal artery. The popliteal divides into two branches, of which one, called anterior tibial, passes between the bones to the front of the leg and then downward to the upper surface of the foot; the other, posterior tibial, continues down the back of the leg to the sole of the foot and divides into the medial and lateral plantar arteries; branches proceed from the lateral plantar artery to the sides of the toes, and constitute the digital arteries. From the large arterial trunks in the leg many branches proceed, to carry blood to the different structures in the limb. (F. G. P.; L. B. Ay.)

Pulmonary Trunk.—This stem is a short vessel that arises from the right ventricle and, extending upward and backward, passes first in front of the ascending aorta and then to its left. Reaching the concavity of the aortic arch, it divides into right and left pulmonary arteries.

The longer and larger right pulmonary artery runs horizontally to the root of the right lung, and there divides into two branches; the larger one supplies the middle and lower lobes of the right lung; the smaller enters the upper lobe. The left pulmonary artery also runs horizontally and, at the root of the left lung, sends a branch to each lobe. Unlike all other adult arteries, these vessels carry impure blood.

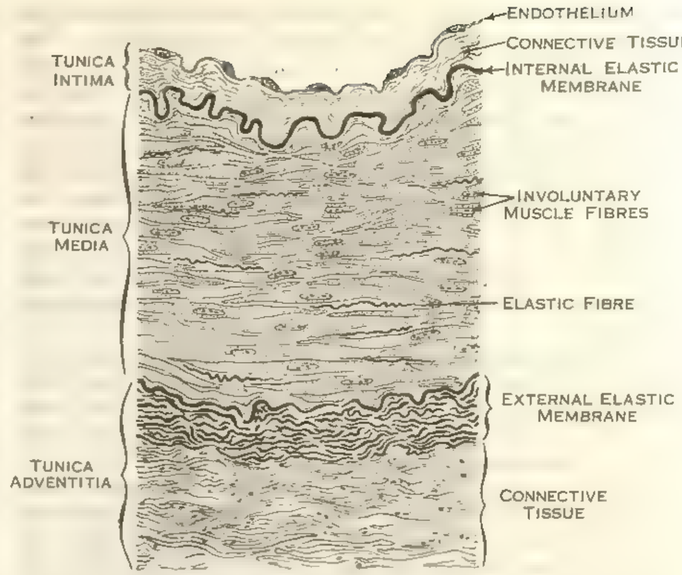
Structure of Arteries.—The wall of a typical artery consists of three coats. The outermost is the tunica adventitia, composed of fibrous tissue; its inner layers commonly form a zone of elastic fibres, the so-called external elastic membrane. The middle coat, the tunica media, is the thickest of the three. It contains unstriped (involuntary) muscle fibres, arranged in a circular manner, and a varying amount of elastic tissue (lacking in arterioles; largely replacing the muscle in the aorta and its largest main branches). The innermost coat is the tunica intima. Passing through this coat toward the lumen of the vessel come first an internal elastic membrane, then a varying amount of connective tissue and finally a layer of endothelium; the latter is a sheet of single-layered, flat epithelial cells that provide the free surface over which blood flows.

The smallest arteries (those about the thickness of a thread) are called arterioles. The tiniest arterioles are invested with only a scattering of muscle fibres and connective-tissue elements instead of complete coats; such intermediates between arterioles and capillaries are called precapillary arterioles.

In general, arteries are less variable structurally than veins; yet they do specialize in adapting themselves to particular locations and duties.

From a structural standpoint, arteries can be divided into elastic and muscular types, in agreement with the preponderant tissue in their walls. Thus the aorta and its largest main branches are often called elastic arteries; with reference to function these vessels are also termed conducting arteries because they serve chiefly to pipe the blood to the various branches. All other arteries are known as muscular arteries because of their high muscle content; a functional term is distributing arteries, because they not only distribute blood to the various organs and parts but also control systemic blood pressure and the amount of local blood flow.

Vasomotor nerves terminate in the muscular coat of arteries. All but the smallest are nourished in part by minute vessels, the



ADAPTED FROM MAXIMOW AND BLOOM, "TEXTBOOK OF HISTOLOGY"

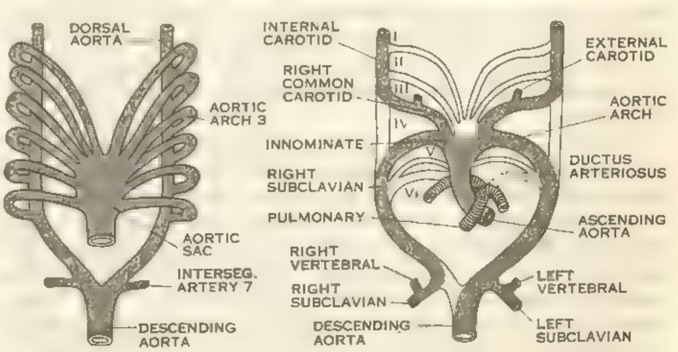
FIG. 4.—TRANSVERSE SECTION OF A MUSCULAR ARTERY

vasa vasorum, which, however, are confined mostly to the adventitial coat.

Embryology.—Human embryos about four weeks old (five millimetres long) have the rudiments of an arterial system, but these parts still have to undergo considerable change before attaining the final arrangement. A single trunk leaves the heart and breaks into a series of paired loops (aortic arches) that pass upward around the sides of the pharynx and join paired dorsal aortas above that organ.

Elsewhere the originally paired dorsal aortas have fused throughout much of their length into a descending aorta, and this vessel bears serially arranged dorsal, lateral and ventral branches. (*See* also CIRCULATION OF BLOOD.)

Transformation of the Aortic Arches.—The aortic arches of the human embryo are equivalent to the vessels that supply the gills of certain larval and adult vertebrates, but these vessels undergo marked changes before the final pattern is attained. This transformation reflects adaptations pursuant to the acquisition of lungs. Mammals and man have six pairs of arches, although the fifth is inconstant and rudimentary. The first and second pairs disappear soon after their formation and contribute only slightly to the



FROM AREY, "DEVELOPMENTAL ANATOMY," SAUNDERS (1954)

FIG. 5.—TRANSFORMATION OF THE HUMAN AORTIC ARCHES, ILLUSTRATED IN VENTRAL VIEWS

(A) Model of the full set of aortic arches before transformation begins. (B) Scheme, with the dorsal vessels spread lateral, showing persisting vessels (gray), discontinued vessels (white) and atrophic vessels (stipple)

permanent arterial plan. The dorsal aortas drop out between the third and fourth arches, and this leaves the third arches and the dorsal aortas, continuing into the head, as the internal carotid pathway; when presently an external carotid buds out of each third arch, the internal and external vessels gain a common stem thereafter known as the common carotid. The left fourth aortic

arch persists as the arch of the aorta, and blood from it reaches the descending aorta through the dorsal aorta of that side. The right fourth arch also persists, but serves merely as the stem to a vessel (right subclavian artery) carrying blood to the arm when the right dorsal aorta loses connection with the descending aorta; the left subclavian is a simple branch off the left dorsal aorta. The fifth arches have no derivatives. From each sixth arch a pulmonary artery grows to the corresponding lung. On the right side, the connection with the dorsal aorta involutes; on the left, it continues throughout fetal life as a shunt that permits blood largely to bypass the lungs and reach the aorta; after birth this ductus arteriosus fibroses into the ligamentum arteriosum.

While these changes have been going on, the single truncus from the heart divides into an ascending aorta, connecting with the permanent arch of the aorta on the left, and the right subclavian artery on the right, and into a pulmonary trunk that connects with the paired pulmonary arteries.

Aortic Branches.—The seven highest vessels of the paired series of dorsal branches of the aorta link into a vascular chain known as vertebral arteries; these continue by a single basilar artery and join the internal carotids through the arterial circle beneath the brain. In the thoracic and lumbar regions these vessels become intercostal and lumbar arteries.

Certain lateral branches off the aorta are retained and supply the diaphragm, suprarenal glands, kidneys and sex glands.

The primitive ventral branches disappear, except those that become the unpaired coeliac, superior mesenteric and inferior mesenteric arteries and the paired iliac arteries.

Arteries of the Extremities.—In the arm, the original main line of vessels is the subclavian—brachial—interosseous. The median, ulnar and radial arteries are secondary acquisitions in the order named. Similarly, in the leg, the stem vessel is known as the sciatic artery. Then the external iliac, femoral and anterior and posterior tibials progressively make their appearance. The primitive sciatic becomes interrupted at two levels, leaving the inferior gluteal, popliteal and the peroneal as the sole permanent derivatives. The hand and foot regions are supplied at first by plexuses that are annexed by different vessels in turn.

Comparative Anatomy.—The arterial system of protovertebrates was undoubtedly segmental, but little of this arrangement remains in adult, living vertebrates. These latter animals, in general, tend to send arterial trunks to the various regions of the body rather than supply many small vessels. The arterial plan is relatively stable throughout the several vertebrate classes, and this contrasts with the greater variation in venous patterns. Most striking are the changes in the set of aortic arches; these transformations accompanied the shift from gills to lungs. The arterial system is conveniently considered in three distinctive regions: (1) head and neck; (2) aortic arches (and lungs); and (3) trunk (and limbs).

Head and Neck.—All vertebrates have carotid arteries to the head and brain. In elasmobranch fishes and urodeles (tailed amphibians) these vessels retain a portion of the gill system, but in all higher vertebrates there are paired common carotids, each of which bifurcates into an external and internal branch; the common stems are derivatives of the third aortic arches. The common carotids may pass directly off the fourth arches, may arise by a single stem or may share an innominate origin with the subclavian.

Aortic Arches.—Primitively there were six pairs of aortic arches connecting ventral and dorsal aortas through intermediary gills. This number became reduced progressively, as gills were replaced by lungs, until birds and mammals retain a single complete arch, and on one side only. In fishes the series of vascular arches supplies functional gills, but with the advent of lungs the gills became lost in all but one adult amphibian group. The pattern in other amphibians and in still higher classes of vertebrates relates the third arches to the carotid system, the fourth arches to paired, permanent aortic arches (amphibians and reptiles) or to a single, permanent arch (birds on the right; mammals on the left). The sixth arches give rise to the pulmonary arteries. In urodeles each pulmonary arch continues past the pulmonary artery to the aorta as an open vessel, thus giving rise, beyond the origin of the pulmonary artery, to a ductus arteriosus; a similar condition occurs in one adult reptile only. Birds retain both arterial ducts until after hatching, whereas mammals retain only the left duct during fetal life as a bypass of the lungs.

Trunk.—The aorta proper is single in all vertebrates. It continues into the tail of vertebrates as the caudal artery; in tailless forms this vessel is vestigial, as in man, where it is represented by the so-called middle sacral artery. The arterial branches off the aorta show an essential uniformity of plan in all classes of vertebrates. Small, paired segmental arteries supply the spinal cord, skin and muscles of the trunk. Lateral branches pass to the gonads and kidneys; in lower vertebrates these arteries are more numerous than in higher forms. Unpaired arteries to the visceral organs occur in all vertebrates. In tailward order they are, typically: coeliac trunk, to the stomach-duodenum region superior mesenteric artery, to much of the intestinal tract; inferior mesenteric artery, to the caudal intestine.

All vertebrates possessing pectoral fins or forelimbs have subclavian arteries extending into them. These vessels leave the aorta near the base of the aortic arches in lower vertebrates, but they move up on the functional aortic arches (or arch) as the neck lengthens and the heart moves caudad in higher vertebrates. Paired iliac arteries pass from the aorta into the pelvic fins or hind limbs.

See Blood Vessels, Surgery of; Circulatory System; Heart Anatomy of; Heart, Comparative Physiology of; Respiratory System, Anatomy of; Veins; *see* also Index references under "Arteries" in the Index volume.

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ARTERIES, DISEASES OF. Diseases of the arteries are the most important medical entities in the western world. They cause more disability and death than any other group of troubles. Anatomical evidence of their prevalence has been found in archaeological studies of the earliest human remains.

The commonest form of arterial disease is called atherosclerosis (an early stage of hardening of the arteries, or arteriosclerosis). This consists of a deposition of fatty material in the wall of the artery just below its inner surface. Later, calcium may be deposited in a way that makes the vessel less elastic and unable to dilate when the physiological need arises. The location in the arterial tree and the size of the deposit largely determine the effect on the health of the individual. If the disturbance is present in one or more of the blood vessels supplying the heart muscle with blood (the coronary arteries), it may lead to symptoms that are called angina pectoris (*q.v.*), coronary insufficiency or coronary occlusion. The chief symptom is pain in the chest, often excruciating, and frequently radiating to one or both arms or to the neck.

If the difficulty is chiefly in the arteries supplying the brain, it may lead to paralysis of a part or all of one side of the body (familiarly called a stroke [*q.v.*] or apoplexy), by virtue of the fact that the weakened wall ruptures and causes a hemorrhage into the brain; or a clot (thrombus) may form on the roughened inner surface of the vessel. Much more rarely, this form of arterial disease brings about an insufficient blood supply to the kidneys, with resulting retention of waste products. When it occurs in the arteries supplying the extremities, and particularly the legs, it may result in pain on walking or in the death of tissue (gangrene), requiring amputation.

A great deal of laboratory and clinical research was being devoted in the early 1960s to the study of this form of hardening of the arteries. Researchers believed that it should be regarded as

a disease rather than the inevitable consequence of aging; that it could be forestalled, if not prevented; and that it might even be reversible under certain circumstances. The main lines of attack included dietary studies, with emphasis on the fat and particularly the cholesterol content of the intake of food; the relation of various hormones to the development of the disorder; and other factors too numerous to mention, including the stress and strain of modern life.

High blood pressure (hypertensive vascular disease) eventually results in an organic change in the walls of the smaller arteries. It, too, can be the precursor of coronary, cerebral or renal insufficiency. Its cause is not known in the majority of cases. In certain instances it can be ascribed to various kinds of kidney disease, particularly nephritis. Patients may survive for many years with the commonest form of high blood pressure. One form, however, runs a more fulminating course and results in death in a comparatively short time.

An important, but fortunately decreasing, arterial disease is syphilis of the aorta. Syphilis affects the aorta in one of, or a combination of, three ways: (1) it may weaken the wall of the vessel until it dilates and becomes an aneurysm (*q.v.*); (2) it may weaken it at the valvular ring in a way that produces aortic valvular insufficiency; or (3) it may cause inflammation at the mouths of the coronary arteries in a way that interferes with the circulation of blood to the heart itself. Early and effective treatment of the initial infection will prevent it. It can be arrested by proper treatment at any stage.

When a clot forms some place in the body and travels to another place it is called an embolus. The original clot may be in the systemic veins or in the right side of the heart and travel to a branch of the pulmonary arteries; or it may be originally in the left side of the heart and travel to some branch of the aorta. When it travels to the pulmonary artery, it causes the death of a part of the lung, with resulting pain, cough and the expectoration of blood. When it travels in the systemic arterial tree, it causes symptoms related to the branch in which it lodges. If it goes to the brain, it may cause a stroke. If it goes to the kidney, it may result in pain and the passage of blood in the urine. If it goes to the spleen, it may cause pain in the upper left part of the abdomen. If it goes to an extremity, the limb becomes cold and pulseless, and gangrene may result if it is not treated properly. Very prompt surgery, involving the removal of the freshly deposited clot, is successful in those areas in which it can be performed.

The newest development in this category is the successful surgical substitution of grafts for diseased portions of arteries. These grafts may be arteries properly stored after autopsies or synthetic plastics. The commonest diseases for which they are used are dilatation (aneurysm) or obliteration of the channel by various causes. These may be life-saving measures.

Rarer conditions involving the arteries include inflammation of the walls; hemorrhage into the wall from the little blood vessels that supply the arterial muscles; a specific disease called periarteritis nodosa; and a form of arteriosclerosis involving, primarily, the pulmonary artery (Ayerza's disease). Rheumatic fever affects the arteries more often than is commonly recognized, but since its main scars are left in the heart itself, its arterial manifestations are relatively unimportant. Other rare entities that affect the arterial tree include primary amyloidosis, disseminated lupus erythematosus, scleroderma and dermatomyositis.

See Blood Vessels, Surgery of; Blood Pressure; Thrombosis and Embolism; Tobacco: *Tobacco and Disease*.

(E. B. By.)

ARTERIOSCLEROSIS, or hardening of the arteries, a condition of the arteries in which normal elasticity is lost and the vessel walls become hardened and thickened. *See* Arteries, Diseases of.

ARTESIAN WELL: *see* Well.

ARTEVELDE, JACOB VAN (*c.* 1287–1345), Flemish statesman who formed a federation of Flemish towns and ruled it for the first seven years of the Hundred Years' War (*q.v.*), was born at Ghent of one of the wealthy commercial families of the city. His brother Jan, a rich cloth merchant, took a leading part in public affairs during the first decades of the 14th century. Jacob, who according to tradition was a brewer, spent three years in quietly amassing an extensive fortune. He was twice married, the second time to Catherine de Coster, whose family was of considerable influence in Ghent. Not till 1337, when the imminence of hostilities between France and England threatened serious injury to the industrial welfare of his native town, did he make his first appearance as a political leader. As the Flemish cities depended upon England for the supply of wool for their staple industry of weaving, he boldly came forward as a tribune of the people and, in 1338, at a great meeting at the monastery of Biloke, unfolded his scheme for an alliance of the Flemish towns with those of Brabant, Holland and Hainaut to maintain an armed neutrality in the dynastic struggle. His efforts were successful.

Bruges, Ypres and other towns formed a league with Ghent, in which town Artevelde, with the title of captain general, henceforth until his death exercised almost dictatorial authority. His first step was to bring about the conclusion of a commercial treaty with England. Louis of Nevers, count of Flanders, tried to overthrow Artevelde's power by force of arms but failed completely and was compelled at Bruges to sign a treaty (June 21, 1338) sanctioning the federation of Ghent, Bruges and Ypres, henceforth known as the "three members of Flanders." This was followed, during the year 1339–40 by more treaties which gradually brought into the federation many of the towns and provinces of the Netherlands. The policy of neutrality, however, proved impracticable, and the Flemish towns, under Artevelde, openly took the side of the English, with whom a close alliance was concluded (Jan. 26, 1340). Artevelde now reached the height of his power, concluding alliances with kings and publicly associating with them on equal terms. Under his able administration trade flourished, and Ghent rose rapidly in wealth and importance.

Artevelde's well-nigh despotic rule eventually provoked his compatriots to jealousy and resentment. His proposal to disown the sovereignty of the count of Flanders and to recognize in its place that of Edward, prince of Wales (the Black Prince), gave rise to violent dissatisfaction. A popular insurrection broke out in Ghent, and Artevelde fell into the hands of the crowd and was murdered on July 24, 1345.

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ARTEVELDE, PHILIP VAN (1340–1382), Flemish patriot, was the youngest son of Jacob van Artevelde (*q.v.*) and godson of Queen Philippa of England, who held him at his baptism. After living in England, where he had been knighted, until 1360, he returned to Ghent and, in 1382, though he had neither military nor political experience, was offered the supreme command by the people of Ghent when they rose in revolt against the count of Flanders, Louis of Male. His name aroused great enthusiasm and his efforts were at first successful. He defeated Louis outside Bruges on May 2, 1382, entered that city in triumph and was soon master of all Flanders. But France took up the cause of the count, and a French army was led across the frontier by the young king, Charles VI, in person. Artevelde advanced to meet the enemy at the head of a burgher army. In the battle of Roosebeke, near Courtrai, on Nov. 27, 1382, the Flemings were routed with terrible loss and Artevelde himself was killed. The brief but stirring career of this popular leader is treated in Sir Henry Taylor's drama, *Philip van Artevelde*.

See P. Rogghé, *Filips van Artevelde* (1947).

ART FORGERY, an object of art by means of which a purchaser is defrauded or the public deceived. The work may have been created for purposes of fraud or it may have been incorrectly attributed as a result of ignorance or expectation of gain. Neoclassical art is deliberately created in imitation of the style or technique of ancient works that the artist believes to be perfect; such neoclassical imitations may later be mistaken for originals or be fraudulently sold as such. In Roman antiquity, for

instance, many imitations or copies of earlier Greek sculptures were produced; some of them were subsequently unearthed by inexperienced antiquarians who could not distinguish a Roman copy from a Greek original. Since the middle of the 18th century, knowledge of the styles, technology and materials of the various periods of classical antiquity slowly improved until such errors of attribution have become relatively rare. Moreover, the particular qualities of neoclassical imitations have come to be appreciated too.

Throughout the middle ages and the Renaissance, imitations of the arts and crafts of classical antiquity were produced in the neoclassical spirit with varying skill and often in new materials. Neoclassical art of the Carolingian renaissance or of the Sicilian court of the emperor Frederick II Hohenstaufen, for example, generally fails to achieve a style pure enough to deceive. Imitations are often marred or embellished by unconscious memories of the styles of intervening periods, especially by Byzantine characteristics that give them a peculiar quality of their own.

Neoclassical imitations of the arts and crafts of earlier periods were produced in great numbers in the far east, especially in China under the Sung dynasty and in Japan in the 18th century. Chinese craftsmen of the Sung, Ming and Ch'ing periods sought to reproduce as exactly as possible, presumably for religious reasons, bronze ritual vessels of the Chou and Shang periods a thousand or more years earlier. A careful analysis of style, technique, qualities of bronze, casting devices and patina, however, usually determines the later bronzes.

Decorative Arts.—It is not as easy as it might seem to detect, by scientific means, frauds or falsifications in the decorative arts or minor antiquities and curiosities, fields in which frauds have always been plentiful. Since the middle of the 19th century frauds of this kind have been offered in great quantities to tourists all over the world. In France, Italy, Germany and England industries were established to cater to the expanding demand for souvenirs; sometimes the wares were even exported to the alleged countries of origin. Nearly all antique-style coffee spoons bearing on their handles the crests of cities throughout the world were manufactured in the German city of Pforzheim; "scarabs" sold in Egypt are often modern products of Bohemia. In some underdeveloped countries native craftsmen still produce pottery of the same materials and according to the same general techniques as those of antiquity, but generally with only a vague understanding of style. However cheap the labour of such craftsmen, in Tunisia, Egypt or Mexico, their modern imitations are often more expensive than the genuine pieces recovered in large quantities in excavations. Modern copies can generally be recognized because of errors of style or materials. The faking of antiquities has spread far and wide, even in fields of primitive art, African, American Indian, Polynesian and others.

In the field of European porcelain, more pieces of false Sèvres are known to exist than the Sèvres factory can have produced. Meissen and Capo-di-Monte ware have likewise been copied in massive quantities, often with little knowledge or skill. Shortly before World War II, U.S. and South American stores were flooded with cheap Japanese imitations of English Wedgewood ware. Far eastern porcelains have also been widely imitated or copied with the intention of defrauding, both in Asia and in Europe. Customs regulations requiring that the country of origin of all modern wares be clearly marked on them have done much to reduce this traffic, which is also threatened by legislation for the protection of trademarks, original designs and models. Many imitations, however, are already antiques which have a recognized artistic or commercial value of their own. Several museums own collections of antique "fakes" which illustrate the history of taste, including various misconceptions of styles and techniques. Instructive in this respect are 18th-century European imitations of far eastern porcelain, such as the earliest pieces of Meissen ware, the French second empire imitations of 18th-century Sèvres and the very lush imitations of rococo wares produced in the latter part of the 19th century for the court of Ludwig II of Bavaria.

Faked antique furniture has been produced extensively and profitably. Fragments of genuine old pieces together with timber, nails or marble salvaged from wrecked houses can be made relatively convincing antiques. Many of these pieces [illegible] ever be treaks it genuine, since they were manufactured [illegible] the tastes and requirements of an age different from th[illegible] they are attributed. In the 18th century, for instance, [illegible] tables were not in use, yet thousands have been put together of old bits and pieces and sold as genuine antiques. Many [illegible] early 19th-century desks are likewise doctored pianofortes. [illegible] French manufacturer of faked antiques has boasted in his [illegible] of his ability to produce forgeries convincingly defaced by [illegible] wormholes or excrements of flies. (*See* also ANTIQUE.)

Fine Arts.—Unsigned drawings in the general manner of a well-known old master are frequently attributed to the master himself and then offered on the market as such, though they [illegible] well be works of his minor contemporaries or pupils or even late copies of originals. Genuine old drawings by students who have carefully copied an authentic original or a print are sometimes mistaken for lost originals; many experts are therefore suspicious of all "finds" that have an obscure history and cannot be traced to their attributed source.

From the 16th century until the latter part of the 19th century European painters and sculptors spent much time, especially in their youth, carefully copying works of older masters. Géricault's early drawings and paintings include many studies after Rubens or Caravaggio; one such Géricault study, in a provincial French museum, was erroneously attributed to Rembrandt.

Many museums have inherited, especially from 19th-century collectors, legacies in which a majority of the attributions have been proved to be incorrect. In some cases, a work is proved to be that of another master; more often, old copies, once mistaken for originals, are weeded out. A famous work attributed to Murillo in the Vatican collections, a gift of the Spanish royal family, was proved by an X-ray examination to be painted over a work of a later period than that in which Murillo lived. Sometimes, however, an old copy turns out to be the only record of a lost [illegible] particularly in the case of masterpieces of very early [illegible] painting.

The attributions in most 19th-century collections of [illegible] and sculptures of the Italian Renaissance were, on the [illegible] erratic. Through the work of such connoisseurs as Bernard Berenson experts in this difficult field have become far more [illegible] in their attributions, though even Berenson, in later years, [illegible] the honesty and courage to correct a great number of his [illegible] attributions.

In spite of great progress during the 20th century [illegible] attributions of unsigned works of old masters remain [illegible] The working habits of some masters made the task of [illegible] tribution particularly complex. It has been remarked [illegible] were more paintings by Camille Corot in U.S. coll[illegible] than Corot had ever painted. Corot was, however, a prolific [illegible] often producing several exquisite small oils in a single day [illegible] sides he was at one time surrounded by numerous a[illegible] whose works he frequently corrected with a few bro[illegible] his own, he sometimes playfully added his own sign[illegible] an impecunious student might sell it. It was the pr[illegible] earlier masters, such as Rubens, to allow their students to [illegible] the background and draperies of a major commiss[illegible] the master contributed only the final touches to an e[illegible] of one of his original sketches.

A brisk trade has developed in works of minor French [illegible] painters fraudulently attributed to major masters. The [illegible] on an early riverbank scene by Maximilien Luce [illegible] removed to make the picture look like an unsigned [illegible] Gauguin's signature is also known to have been added [illegible] of unsigned works by his friends, associates and [illegible] Pont Aven art colony. In Rome, in 1958, what was th[illegible] a major work by Amedeo Modigliani, at the Galleria Nazionale d'Arte Moderna, which had paid a high price for it, was [illegible] to be most probably the work of Modigliani's friend M[illegible] an excellent artist who, at one time, used the same [illegible] Modigliani and often painted in almost the same style [illegible] of real intrinsic quality, false attributions can be corrected [illegible]

…; may be reduced in current market value. In the case of …tored works, another problem arises: many badly dam… inferior originals have been brilliantly restored to look … of far greater artistic and commercial value. Only X-ray examination of such masterpieces of the restorer's … allows the detection of what was originally there (*see* … CONSERVATION OF).

…ts of some famous "cases," such as the false Vermeers … Hans van Meegeren, the doubtful Leonardo da Vinci …" in the former Berlin museum, the almost legendary … in the Paris Louvre, the sculptures by Alceo and even the Cardiff giant in upper New York state, may … works of real historic, artistic, technical and even commer… Often they have been produced by an unrecognized … crank or a practical joker of genius, however misguided … Because of the great skill they required and the … they caused, they not only reveal much about human na… also contribute valuable elements to the science of de… fakes.

…detection of minor artistic frauds is made much easier by … and X-ray equipment, chemical analysis of materials and Geiger counters and other scientific devices. The expert, … assistance of laboratory scientists, can detect, for instance, …ials that could not possibly have been at the disposal of the …leged author. Analysis of style, if conducted objectively …ut excessive reliance on intuition, has also become far …ble. In the Van Meegeren imitations of Vermeer the … of the faces and the gestures of the hands reveal a quality of pathos utterly alien to Vermeer and suggestive …ligious art of the 19th-century English Pre-Raphaelite or … Nazarene painters. In the turmoil of World War II a … analysis of style was barely possible in an occupied coun… Holland. According to a dictum of Max Friedländer's, …generation is able to recognize the errors of attribution of the … one.

…tunately greater factual and scientific knowledge is also … to the forgers. Fraudulent old-master drawings are no …drawn on paper with the wrong watermarks; bronzes are not … the wrong alloys; and pictures are seldom painted in re… invented synthetic colours. Reference works such as … monumental historical catalogue of watermarks have … an essential tool of the expert's and of the forger's trade.

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ARTHRITIS, from the Greek *arthron*, "joint," and *-itis*, a … medically to mean inflammation, refers to any disease … in which there is inflammation in a joint. Obviously, … a single disease entity but can have many different … Frequently the expression "rheumatism" is used as synon… arthritis but, strictly speaking, it is a more general …ing to pain and inflammation not only in the joints …ulations) but also in nonarticular connective tissues either in … areas or throughout the body. A third term, "rheumatic …" is widely used, especially by physicians, to include all … and also a group of usually serious disorders of con… that bear the designation "collagen diseases." In …at article the subject matter to be included is that of the … diseases rather than the more circumscribed one of … alone.

…tion to the anatomy and function of connective tis… joints is essential for an understanding of diseases … structures. The connective tissues comprise the …lages, ligaments, tendons and muscles that form the … tissues of the body and permit motion. Each joint … the articular ends of the bones concerned; the articular … which provide glassy-smooth coverings over the bony … capsule, which forms a strong envelope about … and the synovial membrane, a soft lining tissue that … surface of the capsule. In addition, each joint … nerves and blood vessels, tendons and muscles that pro…vide motive power and a small amount of viscous synovial fluid that lubricates the gliding surfaces. Many articulations, such as those of the fingers and the knee, are typical hinge joints in that they permit motion in one plane only. At the other extreme of joint action are the shoulders, hips, wrists and ankles, all constructed on the principle of the ball and socket, which permit motion in all directions. Between these types are various modifications such as the elbows, which permit rotation, and the temporomandibular joints of the jaw, which permit side to side motion in addition to hinge action. Another type of articulation is that illustrated by the sacroiliac joints of the pelvis; these merely connect bones and allow little or no motion between them. Nevertheless, these synarthrodial articulations may be the site of arthritis. The various ways the different forms of rheumatic diseases affect the articular tissues are discussed below in the descriptions of the individual diseases.

The length of time that man and other creatures have been plagued by illnesses is largely speculative in most instances. In the case of at least one form of arthritis, however, it can be stated with assurance that the ravages of illness have been felt for at least 100,000,000 years, for unmistakable evidence of osteoarthritis has been found not only in the skeleton of a Neanderthal man dating from about 40,000 B.C. but also in dinosaurs of the Mesozoic period.

Of far greater practical significance, however, is the importance of arthritis and rheumatism today. Since physicians are not required to report these diseases to public health statistical collection agencies, exact data as to their incidence are not available. Nevertheless estimates have been attempted. A survey published in 1938 under the auspices of the U.S. public health service led to the conclusion that more than 6,500,000 people in the U.S. were then victims of some form of rheumatic disease. This figure was larger than similar estimates for heart diseases, cancer, tuberculosis, and nervous and mental disease combined. A public health service survey published in 1952 raised the estimated number of people over the age of 14 suffering from these diseases to more than 10,000,000, and unquestionably this figure rises as the population increases. Data from the 1938 survey indicated that arthritis and rheumatism caused more than 97,000,000 days of time lost to gainful occupation—an economic loss to the nation greater than that from strikes and walkouts combined over the same period of time. When one adds the wages lost by the patient and individual and public funds spent for care, the cost must be reckoned in excess of $1,500,000,000 annually in the U.S. alone. Even this figure, however, takes no account of the still more serious toll exacted by these diseases in terms of human suffering and broken lives.

In the succeeding paragraphs individual rheumatic diseases will be briefly considered under the following headings:

1. Arthritis caused by known microorganisms
2. Rheumatic fever
3. Rheumatoid arthritis
4. Ankylosing spondylitis
5. Arthritis accompanying psoriasis
6. Arthritis accompanying ulcerative colitis
7. Arthritis accompanying foreign protein reactions
8. Degenerative joint disease
9. Gout
10. Traumatic arthritis
11. Neurogenic arthritis
12. Neoplasms of joints
13. Collagen diseases
14. Nonarticular rheumatism
15. Miscellaneous forms of joint diseases

Arthritis Caused by Known Microorganisms.—Prior to the introduction of sulfonamides and penicillin, arthritis caused by the invasion of bacteria into the joints was a serious problem. The pyogenic (pus-forming) cocci were the usual bacterial agents responsible, of which the most common were the gonococcus, pneumococcus, hemolytic streptococcus and staphylococcus. The pus produced in response to infection by these cocci has the property of eroding articular cartilages. Since the latter have almost no

capacity to regenerate after sustaining damage, such infections usually caused serious and permanent harm. Other intra-articular tissues were damaged also and the joint was ultimately left with injury varying from moderate disability to complete bony fusion (ankylosis), depending on the severity of the infection. Happily this formerly serious problem has become comparatively minor since the introduction of modern antibiotics, for the infections can be controlled in most instances before permanent damage has been caused.

Arthritis caused by a particular microorganism, the tubercle bacillus, deserves special mention. This germ causes a less acute and less rapidly destructive type of articular infection than do the pyogenic cocci, but one that is extremely stubborn. Antibiotic therapy may be insufficient in tuberculous arthritis, and surgical procedures designed to fuse the joint and thus give complete rest may be required as well.

Rheumatic Fever.—Rheumatic fever causes an extremely acute and painful type of arthritis that usually affects multiple joints and is referred to as migratory because it tends to move from one joint to another. The inflammation persists only a few days or weeks in any one joint and invariably subsides without leaving residual damage since it affects primarily the synovial membrane and does not injure the articular cartilage nor lead to scarring around the joint. Unfortunately, however, the disease often results in serious and permanent damage to the heart. Hence, although the arthritis is extremely painful, this manifestation is of relatively minor importance in the total disease picture. It has been generally well established that rheumatic fever does not occur without a preceding hemolytic streptococcal infection of the throat but the exact mechanism of causation is not known. Aspirin and other salicylates as well as the powerful corticosteroid drugs cause prompt and complete relief of the arthritis. Unfortunately, however, they appear to have very little beneficial effect on the lesions in the heart, and involvement of this vital organ demands rest in bed for weeks or months until cardiac inflammation has subsided. Fortunately, the disease can be prevented from recurring in patients who have once had it by preventing further hemolytic streptococcal infections through the continual administration of penicillin or sulfonamides over periods of years.

Rheumatoid Arthritis.—Rheumatoid arthritis is a chronic, generally progressive disease involving multiple joints and frequently associated also with mild or moderate fever, general debility and other manifestations such as nodules under the skin and inflammation of the eyes. Synonyms for rheumatoid arthritis no longer used are: chronic infectious arthritis, atrophic arthritis and arthritis deformans. Of all the rheumatic diseases this is the one that causes the most severe crippling. Among approximately 10,000,000 patients in the U.S. with rheumatic diseases in the 1950s, an estimated 25% of that total had rheumatoid arthritis. Yet because of the many years the average rheumatoid arthritis case persists and the severe disability it causes, these patients probably accounted for a very large proportion of the total "man days" lost as result of all types of joint diseases.

As the name implies, rheumatoid arthritis resembles rheumatic fever in some respects. Indeed when its onset is particularly acute it cannot be easily distinguished from the latter disease except by observing the course of illness for several weeks. However, the average attack of rheumatoid arthritis is not acute, and the joint involvement customarily persists for months and years instead of subsiding in a few days or weeks as does that of rheumatic fever. The heart may be involved in rheumatoid arthritis but in contrast to rheumatic fever this is a rare and usually not serious manifestation.

Damage to Joint.—The disease process within the joints apparently begins as inflammation of the synovial membrane. This sometimes may be fairly acute, but characteristically the onset is insidious and the disease moderate in intensity and chronic from the outset. In either case there is an increase in the amount of synovial fluid, which becomes less viscous. The involved joints are tender and the range of motion is limited by pain. Swelling is contributed to by the increased fluid, thickening of the synovial membrane and frequently by inflammation of the capsule and surrounding tissues. If the disease subsides at this stage the [illegible] can return to an essentially normal state, and this often [illegible] after a period of weeks or months during the first few [illegible]. Eventually, however, and commonly from the outset, the [illegible]mation becomes one of a continuous, chronic type with considerable proliferation of the synovial membrane. A feature of the [illegible] is the growth of thin sheets of inflammatory tissue over the surfaces of the articular cartilages from their periphery toward the center. This tissue has the capacity to erode articular [illegible] in the fashion previously described for the action of pus. When this occurs, irreparable damage begins. The amount of ultimate articular disability that will remain after the pain of inflammation has subsided depends largely on the amount of injury sustained by the cartilages. If it is slight, articular function can return almost to normal. If injury is severe, large areas of the articular bony surfaces may be denuded of cartilage. This leads to the formation between the ends of the bones of adhesions and scar tissue, which in turn can be transformed into bone with resultant complete immobility of the joint. In other instances loss of cartilage and the erosion of bone margins coupled with destruction of ligaments can result in instability and dislocation of bones within the articular capsule.

Other Diagnostic Features.—Several other very characteristic features of rheumatoid arthritis help establish the diagnosis. The two most important are subcutaneous nodules and the so-called rheumatoid factor. The nodules are firm connective tissue masses about the size of almonds that occur in approximately 20% of patients at some stage of the disease. They usually are just distal to the elbow on the extensor surface of the arm. They do no harm although they often indicate a rather severe type of disease. The rheumatoid factor, a component of the gamma globulin fraction of the blood, can be detected by certain agglutination tests and occurs almost exclusively in patients with rheumatoid arthritis. Hence it has great diagnostic value. Other diagnostic features are the great tendency for joint involvement to be symmetr[illegible] the two sides of the body and the "early morning stiffness" that patients experience on first waking, which may persist for [illegible] hours after rising.

Rheumatoid arthritis occurs in women more frequently than in men in a ratio of two or three to one. The onset is [illegible] between the ages of 18 and 50, but it also occurs in chil[illegible] is not rare among those of advanced years. It apparently occurs in all climates and affects all races.

The cause of rheumatoid arthritis has not yet been d[illegible]. Attempts to isolate bacteria and viruses from the blood [illegible] fluid or tissues have been unsuccessful. Dietary factors [illegible] shown to play no causative role. When the important [illegible] was made in 1949 that cortisone, a hormone of the adrena[illegible] greatly benefits the pain and disability of the disease, [illegible] thought that rheumatoid arthritis might be due to an a[illegible] of adrenal cortical function. Subsequent research, howe[illegible] not bear this out.

Treatment.—In view of the lack of knowledge as to the cause of rheumatoid arthritis, it is not surprising that no treatment has been found that will effectively control the disease. Neve[illegible] much can be done to make the patient more comfo[illegible] to minimize ultimate crippling. Of chief importance in [illegible] trol of pain and disability are the salicylates, such as [illegible] which may be taken in far larger doses than ordinar[illegible] headache. If salicylates alone are not sufficient, [illegible] of the corticosteroids may be added. These hormones [illegible] most powerful anti-inflammatory agents yet discovered [illegible] acute, potentially fatal diseases of short duration, doses [illegible] large to control symptoms must be used. However, [illegible] costeroids are themselves potentially dangerous and the[illegible] used sparingly in a nonfatal disease like rheumatoid a[illegible] which it can be expected that treatment must be conti[illegible] months or years.

Of no less importance in treatment are corrective exercises designed to minimize muscular atrophy and to prevent [illegible] velopment of deformities. These measures are undra[illegible] tedious for the patient, but if adhered to faithfully they ca[illegible]

... ultimate benefit. Even in patients who have already ... crippling deformities, these corrective exercises can ... ded, although sometimes they must be coupled ... orthopedic measures or operations in the case of the ... disabilities.

... In 1897 an English physician, G. F. Still, called ... crippling disease in children that was subsequently ... It was later shown to be rheumatoid arthritis ... children and since that time has been more accurately ... juvenile rheumatoid arthritis.

Ankylosing Spondylitis.—This is a form of chronic arthritis ... the sacroiliac joints and the spine primarily, although ... shoulders are also frequently involved and other ... joints less often. Synonyms are: Marie-Strümpel ... von Bechterew's disease, spondylitis ankylopoietica and ... spondylitis. As the latter term indicates, it has been ... be rheumatoid arthritis of the spine by many physi... United States. By the early 1960s, however, there ... accumulation of evidence supporting the European ... the disease as one distinct from rheumatoid arthritis. ... reasons for this change in concept were the lack of ... factor in the blood of these patients and the fact that ... rheumatoid arthritis affects women more often than men, ... spondylitis occurs approximately 11 times more frequently ... in women. The cause of the disease is not known. ... is similar to that of rheumatoid arthritis.

Arthritis Accompanying Psoriasis.—Some patients with the ... psoriasis develop a form of arthritis that was long ... merely rheumatoid arthritis occurring because of an ... tendency for psoriasis to predispose the patient to it. ... of ankylosing spondylitis, however, the lack of ... factor in these patients and certain differences in the ... gradually led to its acceptance as a distinct dis... frequently the skin lesions precede the arthritis by ... months, occasionally they appear at the same time and in ... the arthritis precedes skin changes. A special fea... approximately two-thirds of the patients is involvement ... joints of the fingers and toes, which are rarely af... rheumatoid arthritis. Treatment is essentially the same ... rheumatoid arthritis combined with measures for the ... of the skin disease.

Arthritis Accompanying Ulcerative Colitis.—Another ... disease often considered to be rheumatoid arthritis ... occurs in approximately 15% of patients with ulcera... serious disease of the large intestine. In roughly ... of the cases the joint disease is clinically indistinguish... ankylosing spondylitis, while in the other three-fourths ... of the extremities are affected. These patients ... rheumatoid factor and the peripheral joint involve... from that of rheumatoid arthritis in usually being ... The arthritis tends to improve as the colitis improves ... corticosteroid therapy.

Arthritis Accompanying Foreign Protein Reactions.— ... days of serum therapy it has been observed that a ... portion of patients receiving antiserums prepared ... developed urticaria (hives) and transient but pain... Antiserums are now much less commonly used, but ... occasionally have similar reactions following the use of ... such as penicillin or insulin. These reactions ... with corticosteroids and are usually of little ... except for the fact that henceforth those patients ... given the offending agent.

Degenerative Joint Disease.—This disease is also called ... degenerative joint disease is the preferred term ... the underlying process. Other synonyms no... hypertrophic and senescent arthritis. In contrast ... arthritis, which is an inflammatory disease starting ... membrane, osteoarthritis is primarily a degenera... beginning in the articular cartilage. Microscopic ... the cartilage occurs in many people in the third ... However, symptoms rarely occur before the age ... and many people experience no significant disability even after the age of 70. When degeneration of cartilage becomes advanced, large areas of the articular bony surface may become denuded of cartilage. In addition, bony projections (osteophytes) grow out from the margins of the bones and may cause mechanical interference with motion. There is no doubt that wear and tear of daily life plays a part in this disease but it is not the sole causative factor.

The reasons for the various degenerative changes in the body that occur with advancing age are poorly understood. In the case of articular cartilage, however, at least two factors are apparent. First, the arrangement by which these structures are nourished is less efficient than that of most tissues since they have no blood supply and must absorb their required metabolic materials from the synovial fluid that bathes them. Second, as has been noted previously, articular cartilage has very limited capacity to regenerate. Another factor of importance in some types of degenerative joint disease is that of heredity. This is especially notable in the case of the so-called Heberden's nodes involving the terminal joints of the fingers.

The name primary osteoarthritis is sometimes given to the form of the disease that appears, usually quite benignly, in multiple joints with advancing age. When only one or two joints are involved, the osteoarthritic process usually is a secondary one occurring in a joint made more susceptible to wear and tear by some structural abnormality, previous injury from an accident or an inflammatory type of arthritis. Most people who have osteoarthritis have few or no symptoms; the articular changes are often discovered incidentally in X-rays ordered because of other conditions. Among persons who have symptoms the disability is mild in most, moderate in some, crippling in very few. Some affected joints are often painful for a while but later are painless. Few if any constitutional reactions accompany the disease, which is essentially limited to joints and does not affect other tissues or body systems except for some associated transitory stiffness of musculotendinous structures. The condition should be regarded in most instances merely as one of the annoying but minor disabilities of advancing years.

Because in osteoarthritis synovial membranes are not inflamed, no permanent stiffness or fixation (ankylosis) occurs. Thus, a chief remedy is reassurance for the patient that he does not have one of the progressive, crippling forms of arthritis or one likely to cause serious disability. Moderation in the use of affected joints, their protection from undue irritation (including that from excessive weight bearing in obesity) and the philosophic acceptance by the patient of a somewhat lowered level of physical activity are sometimes the only measures required to obtain comfort. Application of heat, other physical remedies and the use of mild analgesic drugs such as aspirin often are helpful. Only in the case of hip involvement is osteoarthritis apt to be significantly disabling. In the few patients in whom crippling is severe, much benefit often can be obtained from various surgical procedures.

Gout.—Gout is a disease of abnormal uric acid metabolism characterized by acute episodes of arthritis and, in later stages, by urate deposits (tophi) around bones and joints. In spite of its known relationship to uric acid, the exact nature of the metabolic defect is not understood. Men are more subject to gout than are women in a ratio of approximately 19 to 1, and hereditary influences are important. Persons with gout habitually have more uric acid in their blood than do unaffected people, and a significant number of their blood relatives do also even though they are free of symptoms. The involved joints are exquisitely painful and tender, and are swollen and red. The disease has especial predilection for the basal joint of the great toe, but this joint is by no means always involved.

During the early years of a patient's history of gout, the attacks occur suddenly, last a few days to weeks and subside without leaving any disability. After a number of years of repeated acute attacks the disease passes gradually into the chronic or tophaceous stage during which the deposition of urate crystals produces defects in articular cartilages and bones. From this time on, the disability remaining after each attack increases, and severe crippling can ultimately occur if the disease is unchecked.

Fortunately the acute attacks can be effectively controlled by colchicine, derived from the plant colchicum, and by the anti-inflammatory drugs; and the ravages of chronic gout can be prevented by so-called uricosuric drugs that increase the urinary excretion of uric acid. Special diets low in foods that produce uric acid formerly were an important part of the therapeutic regimen, but it is no longer considered necessary for most patients to adhere to them rigidly.

Traumatic Arthritis.—Trauma to joints can produce injuries ranging from simple sprains—small tears in ligaments and tendons caused by violent overstretching—to serious mechanical derangements of intra-articular structures and fractures of bones extending within the joint capsule. Milder lesions require no more than adhesive strapping or the application of plaster casts to insure local rest and protection against further injuries during healing. More severe disabilities may require operations for the repair or removal of damaged structures such as ligaments and cartilages, or for the pinning of broken bones.

Neurogenic Arthritis.—A very destructive disorder of joints can result from diseases or injuries of the tracts in the spinal cord and peripheral nerves that carry sensory stimuli from the extremities. Probably these disruptive lesions represent an exaggerated form of combined degenerative joint disease and traumatic arthritis occurring in joints made prone to repeated injury by lack of pain sense, and awkwardly used because of absent tactile and position sense.

Neoplasms of Joints.—Neoplasms of joints may be benign and produce symptoms merely by their local encroachment on space, or they may be malignant and capable of sending cancerous metastases to other parts of the body. Neither type is common. Benign tumours may or may not require removal depending on their size, location and significance of symptoms. Malignant tumours always demand prompt surgical opinion as to the best means of treating them.

Collagen Diseases.—The so-called collagen diseases comprise a group of usually serious illnesses involving connective tissues in blood vessels widely spread throughout the body in synovial membrane, skin and internal organs. Included in the collagen diseases are systemic lupus erythematosus, polyarteritis (periarteritis) nodosa, dermatomyositis and scleroderma. Rheumatoid arthritis and rheumatic fever also are commonly considered to belong to this group. Transient or more chronic arthritis is common, and many patients show features that overlap those of rheumatoid arthritis. In the past these diseases were thought to be usually fatal, but it is now recognized that they may frequently run a relatively benign course and that even in severe cases many patients show great improvement, especially since the introduction of corticosteroid drugs.

Nonarticular Rheumatism.—This important group of disorders comprises a wide variety of complaints in which pain is felt in ligaments, tendons, bursas, muscles and other connective tissues outside the joints. Such pain does not necessarily reflect inflammation within those structures but may represent pain referred to them by sensory nerves that supply them and are irritated at a higher level. This diversified group of disorders is represented in the largest segment of patients with rheumatic diseases. Fortunately, however, these disorders ordinarily persist in severe form only a few days or weeks and hence are seldom permanently disabling although they may force a change of occupation.

When the complaints can be traced to painful tissues they take their name from the structure involved—tendinitis, bursitis and myositis (inflammation of muscle). When complaints are widespread the descriptive term fibrositis is often used to indicate generalized pain in fibrous connective tissue without designating a particular location. Little is known about the appearance of the lesions in the tissues or about the causes. The bursas, which are flattened, balloonlike structures containing small amounts of viscous fluid, are situated deep in the soft tissues overlying bony prominences and act as cushions. Inflammation in the bursas usually is secondary to inflammation in the tendons that underlie them.

A very common cause of referred pain to muscles of the shoulders and arms is degeneration of the intervertebral discs that act as cushions between the individual vertebrae of the spinal column in the neck. Secondary to this, bony outgrowths develop from the margins of the vertebrae. As a result, the large sensory nerves that leave the spinal cord between each pair of vertebrae may become irritated and cause pain in the structures they supply. Similar changes in the lower spine can cause pain referred to the buttocks and thighs, or throughout the entire distribution of the sciatic nerve, causing the syndrome of sciatica.

There is some evidence that vague painful states in fibrous tissue and muscles can result, in susceptible individuals, from stimuli arising from the brain due to anxiety and other emotional problems. Such painful states are called psychogenic rheumatism, but the mechanism is not understood nor, indeed, is it certain that such a mechanism exists.

Most forms of nonarticular rheumatism respond well to aspirin or corticosteroids and are benefited by local warmth, massage and exercise.

Miscellaneous Forms of Joint Diseases.—The foregoing types of diseases that affect the joints include those of greatest importance, but there are many others, including the following: hemophilic arthritis, which results from repeated bleeding into the joints of hemophiliac patients (bleeders); various degenerative disorders of unknown cause occurring in young individuals of which osteochondritis dissecans is an example; aseptic necrosis of bone, which results from obstruction to the blood supply such as may occur in caisson disease because of air bubbles in the blood stream; Reiter's disease, a form of arthritis of unknown cause associated with inflammation of the urethra and eyes and often also with diarrhea and skin lesions; and intermittent hydrarthrosis, a disease of obscure cause characterized by periodic episodes of effusions of fluid into the joints.

See JOINTS AND LIGAMENTS, DISEASES AND DISABILITIES OF; CORTISONE; GOUT; STEROIDS; *see* also references under "Arthritis" in the Index.

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ARTHRODIRE, fishes common about 300,000,000 years ago but extinct for the last 230,000,000 years. The head and thorax were covered by a bony shield; the rest of the body was naked. *See* PLACODERM.

ARTHROPODA, the largest phylum of the animal kingdom, forming about three-quarters of the known species of animals. In size arthropods range from the tiny parasitic mite *Demodex*, less than 0.1 mm. in length, to the giant Japanese crab *Macrocheira*, which has a leg span of 11 ft. Fossil Eurypterida, aquatic in habit, reached a body length of nearly six feet.

Arthropods occur in every conceivable habitat, from the deepest seas (crustaceans and pycnogonids) to an elevation of 22,000 ft. on Mt. Everest (spiders), from north polar waters to far in the antarctic continent (Collembola) and as external and internal parasites on other animals.

The phylum includes: the insects (class Insecta); spiders, mites, scorpions, etc. (Arachnida); crustaceans (Crustacea); centipedes (Chilopoda); millipedes (Diplopoda); and other less familiar groups—Symphyla, Pauropoda, Onychophora, Merostomata (which includes the Xiphosura and Eurypterida).

The insects (*q.v.*), which dominate the land, are of economic importance both as pests and as beneficial pollinators of crop plants; they alone among invertebrates are capable of flight, by one or two pairs of wings. Spiders, mites, scorpions and other arachnids (*q.v.*) also live on land and are found in many millions per acre of arable country; they comprise the majority of the invertebrate carnivores and are therefore of great importance to other animals. Crustaceans (*see* CRUSTACEA) are abundant in salt and fresh waters; they are of great economic importance in marine food supplies and serve as food for other invertebrates, fishes and whales. Centipedes, millipedes, symphylids, pauropods and onychophorans are all land dwellers restricted to damp habitats; they are of little economic importance (*see* CENTIPEDE; MILLI-

Tardigrade, or water bear, cl[illegible] Tardigrada, a free-living form found on vegetation, in sand, fresh water and even [illegible] sea. The largest are not much more than 1 mm. in length; most of them are mu[illegible]ler

Red centipede (*Otocrypt*[illegible] *sp*[illegible]*nosus*), class Chilopoda, a land-dwelling arthropod found throughout the world in damp locations. Feeding on live prey, it poisons victims with venom from glands in its first pair of legs, which serve as jaws. Centipedes range in length from 3 mm. to almost 1 ft.

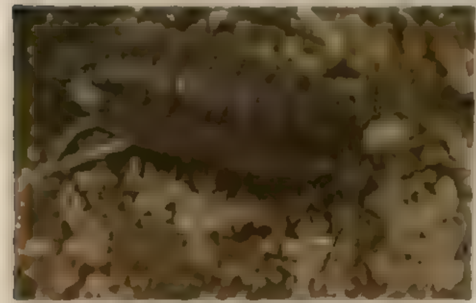
Millipede (*Narceus americanus*), class Diplopoda. Like the centipede, it lives in moist places; during the dry season it is found at considerable depths in the soil. It feeds primarily on decaying plants. Millipedes vary in length from about 2 mm. to 1 ft.

Wolf spider (*Dolomedes sexpunctatus*), class Arachnida, feeding on a minnow captured by diving below the surface

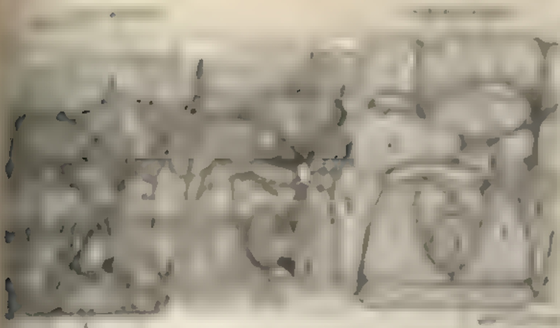
Horseshoe crab (*Limulus polyphemus*), class Merostomata, a marine arthropod that lives in shallow water and feeds on worms and mollusks. Extremely ancient in origin, horseshoe crabs often are called "living fossils." Their maximum size is about 2 ft.

REPRESENTATIVES OF ARTHROPOD CLASSES

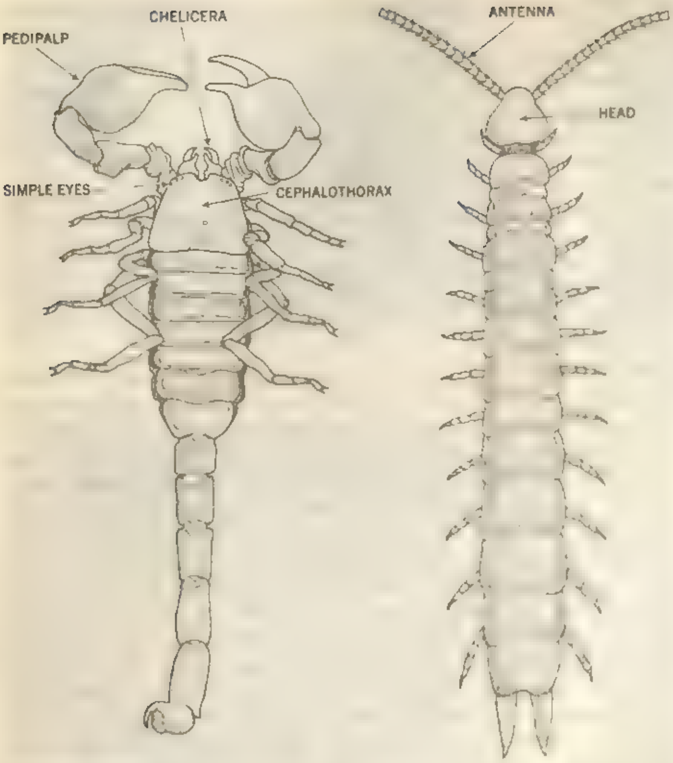
PHOTOGRAPHS (TOP LEFT) DR. ROMAN VISHNIAC—PUBLIX, (OTHERS) JOHN H. GERARD



REPRESENTATIVES OF ARTHROPOD CLASSES



Movement. The movements of arthropod bodies, limbs and wings ...



AFTER S. M. MANTON

FIG. 3.—EXTERNAL FEATURES OF THE CLASSES ARACHNIDA AND SYMPHYLA

(Left) Scorpion (class Arachnida) showing preoral chelicerae and united cephalothorax bearing eyes and legs (length 100 mm.); (right) *Scutigerella immaculata* (class Symphyla) showing preoral antennae and defined head. Each trunk segment bears a pair of legs (length 4 mm.)

As in vertebrates, the skeletal muscles of arthropods are "striped." The fine structure and the properties of the striped muscles vary; some contract slowly, but the flight muscles of a fly can twitch 330 times per second. If the movements caused by a muscle are rapid and large, they cannot also be strong. Much of the complex anatomy of arthropods meets one or the other of these two incompatibles, depending on the different ways of living. Slow rhythmical movements of the alimentary canal are mediated, as in vertebrates, by "unstriped" muscle.

Organ Systems and Function.—Besides possession of an exoskeleton, another outstanding characteristic of the Arthropoda, one not primarily associated with the metameric segmentation just described, is the form of the blood system. No fine vessels, such as the capillary nets of worms and vertebrates, are present. A dorsally situated heart discharges its blood into main arteries, most of which lead ultimately into large vascular spaces (collectively, the haemocoel) that bathe the organs. These vascular spaces replace the coelomic body cavity of vertebrates and worms. Blood returns to the heart via a pericardial blood space and enters by paired ostia, which open to receive blood and then close while the heart is contracting and forcing blood into the arteries. Arthropod blood may be red, green, blue or colourless, according to the presence and nature of respiratory pigments. These pigments, comparable with the red hemoglobin of human blood, increase the carrying or the storage capacity of the blood for oxygen.

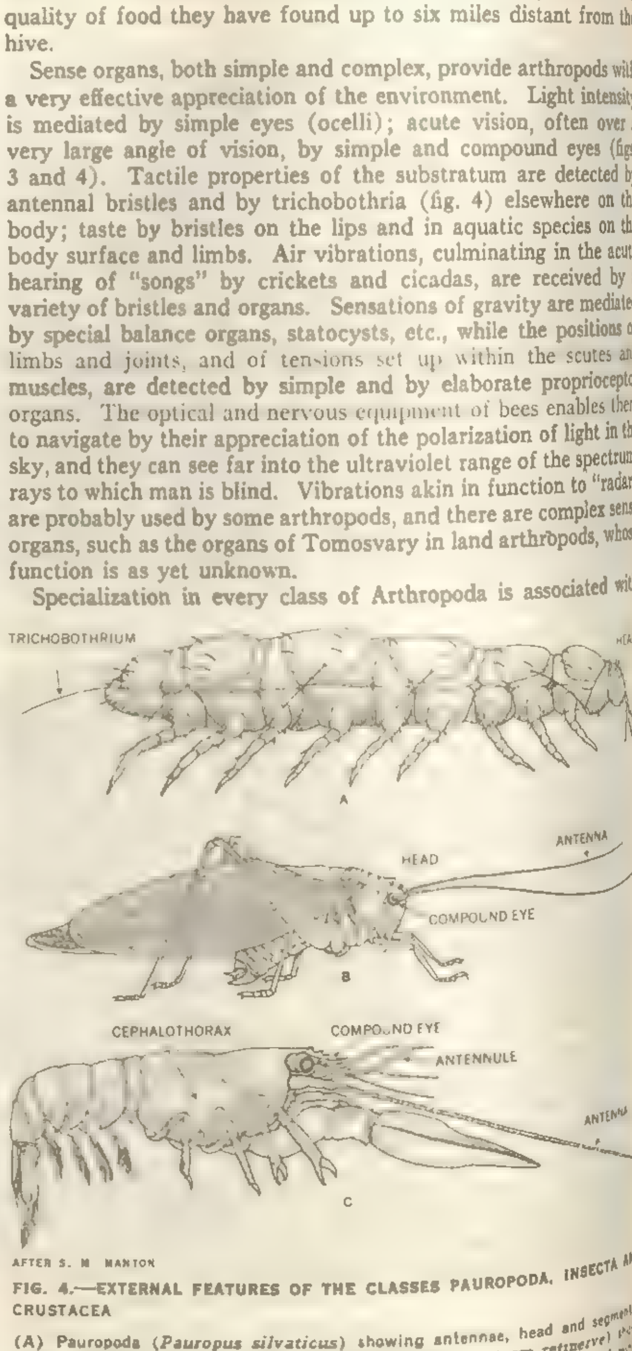
The alimentary and nervous systems are not unlike those of other segmented invertebrates, but both systems may be more elaborate and specialized for various purposes. The mouth leads into an ectodermal pharynx that may be armoured and very elaborate. The mid-gut that follows is usually the seat of digestion and absorption of food. The hind-gut, also ectodermal, may be long or short and usually absorbs water, so consolidating the feces. In terrestrial arthropods Malpighian tubules, often present at the junction of hind- and mid-gut, absorb waste material from the blood spaces that bathe them. The tubules discharge (often crystalline uric acid in the insects) to the hind-gut, thus reducing water loss. There may be special devices for drawing in fluid food, for internal-chewing (trituration) and for the production of digestive juice.

The nervous system, as in annelid worms (*see* ANNELIDA), consists of paired ventral nerve cords with paired ganglionic swellings in each segment. From the ganglionic swellings segmental nerves pass out to the limbs and organs. Anteriorly, a dorsal supra-esophageal "brain," which innervates the eyes, is united by circum-esophageal commissures with a subesophageal ganglionic mass often representing the fused ganglia of the immediately postoral segments. The antennal ganglia are primarily postoral, but more often become preoral and associated with the supra-esophageal brain during embryonic development.

The great range of arthropodan sense organs exceeds those of all other invertebrates and makes possible varied and precise responses. The considerable powers of transmission of information by some arthropods resides in the acuity of their sense organs and in their nervous equipment. For example, bees can transmit information to other bees in a hive as to the direction, distance and quality of food they have found up to six miles distant from the hive.

Sense organs, both simple and complex, provide arthropods with a very effective appreciation of the environment. Light intensity is mediated by simple eyes (ocelli); acute vision, often over a very large angle of vision, by simple and compound eyes (figs. 3 and 4). Tactile properties of the substratum are detected by antennal bristles and by trichobothria (fig. 4) elsewhere on the body; taste by bristles on the lips and in aquatic species on the body surface and limbs. Air vibrations, culminating in the acute hearing of "songs" by crickets and cicadas, are received by a variety of bristles and organs. Sensations of gravity are mediated by special balance organs, statocysts, etc., while the positions of limbs and joints, and of tensions set up within the scutes and muscles, are detected by simple and by elaborate proprioceptor organs. The optical and nervous equipment of bees enables them to navigate by their appreciation of the polarization of light in the sky, and they can see far into the ultraviolet range of the spectrum, rays to which man is blind. Vibrations akin in function to "radar" are probably used by some arthropods, and there are complex sense organs, such as the organs of Tomosvary in land arthropods, whose function is as yet unknown.

Specialization in every class of Arthropoda is associated with



AFTER S. M. MANTON

FIG. 4.—EXTERNAL FEATURES OF THE CLASSES PAUROPODA, INSECTA AND CRUSTACEA

(A) Pauropoda (*Pauropus silvaticus*) showing antennae, head and segmented trunk (length 1 mm.); (B) Insecta, katydid (*Microcentrum retinerve*) showing antennae, head, thorax bearing three pairs of legs and two pairs of wings and abdomen; (C) Crustacea, lobster (*Homarus vulgaris*) showing antennules, antennae, united cephalothorax and abdomen with limbs

elongation of limbs and a reduction in their number on the hinder body segments. Along with this specialization there is a tendency toward concentration of the primitive ladderlike trunk nervous system.

The sclerotization of the surface of many arthropods restricts the access of air to the tissues by direct diffusion. Aquatic arthropods, except the smallest, usually respire by means of gills, thin-walled projections from the body containing a copious blood circulation. Wood lice and scorpions, for example, breathe by means of air-filled chambers, the walls or processes of which are vascular; the majority of land species, however, utilize tracheae, fine air-filled tubes opening on the body surface and ending within tissue cells. In tracheate arthropods blood does not transport the respiratory gases as it does in the majority of animals. Tracheae differ in structure from class to class and have doubtless been evolved independently several times during arthropodan adaptation toward land life. Carbon dioxide is eliminated from the general body surface, gills and tracheae, and nitrogenous waste matter is excreted by segmental excretory organs (some of which are converted to salivary glands), by Malpighian tubules and even by the mid-gut (*Peripatus*).

The sexes are usually separate, but there are many cases of hermaphroditism. Reproductive organs and accessory glands may be very complex, but there is generally a single external genital opening or one pair of openings. Copulation is usual but not invariable, the eggs being fertilized in the female genital tract or externally just as they are laid. Great egg production (fecundity) characterizes many arthropods, particularly some crustaceans and insects. Enormous numbers of lightly yolked eggs may be produced that quickly hatch into larvae; these larvae feed, grow, molt many times and eventually assume the adult form. In some arthropods a few heavily yolked eggs are laid; these eggs, protected by a good shell or by parental care, may hatch as miniature adults. The time interval between one generation and the next may be three days or less in some insects and small crustaceans, so that one pair, or one parthenogenetic female (reproducing without fertilization) may give rise to several millions of descendants in a few weeks. By contrast, well-armoured large arthropods, such as the lobster, become sexually mature at the age of four years and breed only every other year.

The form of the mouth-parts (segmental head appendages) and trunk limbs of arthropods is enormously diverse, serving many different ways of feeding, running and swimming. In aquatic forms many ways of filtering food from the water exist, performed by head limbs alone or by trunk limbs in addition. Limbs also provide offensive, defensive and copulatory aids and may bear the respiratory surfaces. A limb that is basically two-branched (biramous) occurs in the Crustacea, Trilobita and Merostomata, while unbranched (uniramous) limb characterizes the Onychophora, Diplopoda, Chilopoda, Pauropoda, Symphyla and Insecta.

Evolutionary History.—The past history of the arthropods and the relation of one class to another can only be deduced from comparative anatomy, embryology and functional studies since recognizable fossils are not sufficiently ancient. The terrestrial arthropods, that is, the Onychophora, Pauropoda, Diplopoda, Chilopoda, Symphyla and the various hexapod groups (Apterygota and Pterygota insects) appear to be a related series of classes. Basic similarities shared among these classes contrast with the characteristics of Trilobita, Merostomata, Arachnida and Crustacea.

A differentiation of habits in very similar environments appears to have been of paramount importance in the evolutionary differentiation of the former series of terrestrial groups: the Onychophora retain a soft body wall, unstriated muscle, etc., in association with an extraordinary power of deforming the body and of squeezing through cracks impassable to predators; the centipedes have evolved the carnivorous habit and a body form that allows fast running; the millipede construction enables these forms to burrow by the motive force of their legs; the Symphyla gain cover in the leaf mold and decaying wood by twisting and turning their delicate bodies in narrow spaces, but not by pushing, and their anatomy serves this purpose.

A reduction in the number of legs and an increase in leg length brings many mechanical advantages and, like the compound eye, has been independently acquired many times by different groups of arthropods. There is little doubt that the Merostomata and Arachnida are related; they are often grouped together as the Chelicerata because they share the chelicerate nature of the first pair of legs (fig. 3) in contrast to the pair of sensory antennae seen in terrestrial groups mentioned above. The relationships of the Crustacea, with two pairs of antennae, and of the Trilobita with, as far as is known, one pair of antennules and postantennulary cephalic limbs basically resembling those of the trunk, are problematical.

CLASSIFICATION

The following scheme, except in a few sections (see *Disputed Relationships* below) is generally accepted by students of the Arthropoda.

Class Crustacea (fig. 4).—Head composed of unsegmented acron fused with preoral preantennulary, antennulary and antennal somites, the last two bearing paired antennule and antenna; and postoral somites bearing paired mandible, maxilla 1 and maxilla 2; thorax comprises a series of leg-bearing segments, some of which may be fused with the head, their limbs becoming feeding organs (maxillipedes); the abdomen may or may not bear limbs, and terminates in a telson. Legs may be biramous.

Class Trilobita.—Paleozoic, body molded longitudinally into three lobes; one pair of antennules; a head shield bearing eyes is followed by movable trunk segments, the hindermost being immovably united to form a pygidium; postantennulary cephalic limbs and trunk limbs of a common type with two rami.

Chelicerata.—Anterior limbs a pair of chelate chelicerae used in feeding.

Class Merostomata.—Prosoma bearing preoral chelicerae, five pairs of postoral walking legs and chilaria or metastoma; opisthosoma of 9–12 somites bearing genital operculum and five pairs of branchiate limbs or branchiae, the terminal telson forming a spine.

Class Arachnida (fig. 3).—Prosoma with embryonic precheliceral somite, preoral chelicerae and postoral pedipalps and four pairs of walking legs; mesosoma bearing lung books or tracheae; limbless metasoma present or absent.

Monognatha.—One pair of gnathal limbs (jaws) behind the mouth.

Class Onychophora.—Besides the unsegmented acron possessed by all Arthropoda, the head comprises the preoral antennal somite and the postoral jaw and slime papilla somites, all bearing limbs; soft integument; a long series of trunk somites with short paired legs.

Dignatha.—Two pairs of gnathal limbs behind the mouth.

Class Pauropoda (fig. 4).—Minute; head comprising acron and preantennal, antennal and premandibular somites in front of the mouth, only the antennal somite carries limbs (antennae) and postoral mandibular and maxillary somites with their limbs; trunk with 9 or 10 limb-bearing somites; a reduction in every other tergite providing stability for the type of gaits employed.

Class Diplopoda.—Head, as far as is known, is as in the Pauropoda, with postoral mandibles and gnathochilarium; typically specialized herbivores burrowing by the motive force of their legs, large numbers (up to some 130 pairs) of which are obtained by the formation of diplosegments along most of the trunk, each bearing two pairs of legs.

Trignatha.—Three pairs of gnathal limbs behind the mouth.

Class Chilopoda.—Preoral head much as in Pauropoda, bearing antennae; postoral mandibles, maxilla 1 and maxilla 2; first trunk segment bears poison claws; followed by a variable number (15–177) of trunk somites bearing paired walking limbs.

Class Symphyla (fig. 3).—Preoral head much as in Pauropoda, bearing antenna; postoral mandible, maxilla 1 and maxilla 2; trunk composed of 14 somites the anterior 12 bearing running legs. A duplication of tergites on segments 4, 6 and 8 enhances body flexibility.

Class Collembola.—Head segmentation much as in Symphyla, bering antenna, but postoral entognathous mandible and maxilla 1; maxilla 2 present; trunk with nine somites, the first three bearing thoracic legs; typically the abdomen bears hamula and furcula used in jumping.

Class Insecta.—Head segmentation, antenna and mouth-parts much as in Symphyla but with important differences in detail; trunk of 14 somites, the first 3 bearing thoracic legs and 2 pairs of wings.

Disputed Relationships.—The Apterygota, lacking wings (the Thysanura and the entognathous Diplura, and Protura) are usually regarded as outside the main line of descent of the winged insects, the Diplura and Protura showing resemblances to the Collembola. Whether the Pycnogonida represent a separate class, or a section of the Arachnida, is uncertain. The minute Tardigrada are usually regarded as aberrant arthropods. Although some authorities consider the horseshoe crabs as a subclass (Xiphosura) of Merostomata, others regard them as a separate class. The Collembola is sometimes given ordinal rank under the class Insecta.

See also references under "Arthropoda" in the Index volume.

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ARTHUR, a legendary British king, the sovereign of the knights of the Round Table (*q.v.*) in a famous cycle of medieval romances. Whether the legends concerning Arthur had a historical basis and how and where (in Wales or in those parts of northern Britain inhabited by Brythonic—Welsh-speaking—Celts) these legends originated, scholars are not agreed. In the *Historia Britonum* of Nennius, a 9th-century compilation, a section describes Arthur's 12 battles against the Saxons, culminating in the victory of Mt. Badon. The *Annales Cambriae* (*c.* 950–1000) record the battle of Camlann (537), "in which Arthur and Medraut fell," and also Arthur's victory at Badon (516). Badon is mentioned in Gildas' *De excidio et conquestu Britanniae* (*c.* 547) as having occurred in the year of Gildas' birth (*c.* 500) but here the battle is not connected with Arthur. The assumption that there was a historical Arthur who led the Welsh resistance to the West Saxon advance from the middle Thames rests on an unwarranted conflation of Gildas, Nennius and the *Annales Cambriae*. R. G. Collingwood's picturesque variant of this view is speculative: according to his *Roman Britain and the English Settlements* (1936) Arthur, described by Nennius as *dux bellorum*, was a professional soldier, serving the British kings, who had a cavalry force trained on Roman lines which he switched from place to place to meet the Saxon threat.

It is difficult to assess the historical value of these early chronicles: Nennius, for example, is a compilation and the "Arthuriana" section is from an undetermined source, possibly a poetic text. The long Welsh poem *Y Gododdin* (*Book of Aneirin*, original version *c.* 600) alludes to Arthur as a great warrior but it is not known when this allusion entered the text.

If Nennius is comparatively sober, the references to Arthur in early Welsh literature (*q.v.*) make him into a king of wonders and marvels. He is sometimes referred to in 13th-century manuscripts in terms appropriate to heroic poetry—as the *guledig* ("ruler"—*Book of Taliesin* xv) and the *ameraudur* ("emperor"—*Black Book of Carmarthen* xxii)—but elsewhere appears surrounded by a mythological aura. In the strange and allusive poem "Preiddeu Annwfn" (*Taliesin* xxx) he undertakes a disastrous expedition against certain miraculous fortresses, which some scholars have located in the underworld. He also slays strange monsters (*Black Book* xxi) and hunts the boar Trwyth (*Mirabilia* and the 12th-century prose romance *Culhwch and Olwen*). He is associated with other heroes—no doubt originally independent—and this conception of a heroic band of which Arthur is chief led to the idea of Arthur's court (*Culhwch and Olwen*). Arthur, Bedwyr (Bedivere), and Cai (Kay) seem early to have formed a group. The *Mirabilia*, a late addition to Nennius (*c.* 1000), connects the hunting of Trwyth, as well as Arthur's dog Cabal and Arthur's son Amr, with the topography of south Wales. In *Culhwch and Olwen*, Arthur's role is somewhat passive (according to Sir Ifor Williams, his sole personal exploit was the efficient slaughter of one old woman), the work being essentially a love story based on a whole mass of romanticized folk material centred on the young hero and heroine rather than on Arthur who assists them. This conception of Arthur's role is very similar to that in the later French romances of Chrétien de Troyes (*q.v.*).

From the beginning of the 12th century, Arthurian stories were in circulation in France and other countries in the French cultural sphere. The existence of such tales is vouched for by William of Malmesbury and, more doubtfully, by Wace (*q.v.*). Little is known about the way they reached the French-speaking world. The notion that Arthur (like Charlemagne and Frederick Barbarossa) had never died was at this time widely current, to judge from such evidence as that provided by Herman de Tournai (*c.* 1140), a line in the "Stanzas of the Graves" (*Black Book* xix) which has been taken as denying that Arthur has a grave, and the strongly classicized story of Arthur's departure to Avalon (*q.v.*) in Geoffrey of Monmouth's *Historia regum Britanniae* (*c.* 1135). There is probably genuine Celtic tradition behind the story of the abduction of Guinevere by Melwas in Caradoc of Llancarfan's *Vita Gildae*. Stories such as those of Arthur and his warriors sleeping in Mt. Etna or of Arthur leading the wild hunt are probably just examples of the association of a well-known name with common folklore themes. Similarly, the representation of Arthur riding a goat in an Otranto mosaic may be just a fanciful caricature.

The appearance of the *Historia* of Geoffrey of Monmouth (*q.v.*), which asserts that Caerleon (*q.v.*), sometimes identified with Camelot, was the place of Arthur's coronation, marks a decisive stage in the development of Arthur's literary fortunes: the Arthurian legend, as the middle ages knew it, is essentially the creation of this one book.

See Arthurian Legend.

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ARTHUR I (1187–1203), duke of Brittany, famous in history and literature as the nephew and victim of King John (*q.v.*), was born at Nantes on March 29, 1187, the posthumous son of Geoffrey, son of Henry II of England, and of Constance, heiress of Brittany. Richard I (*q.v.*) of England recognized Arthur as his heir presumptive in Oct. 1190, and in March 1191 the king of France, Philip II, agreed that Arthur should do homage to Richard as duke of Normandy. Richard's crusade and subsequent captivity prevented him from arranging effectively for Arthur's future, but in April 1196 he demanded custody of the young duke. The Bretons refused and delivered him instead to Philip, who brought him up in his own household. Richard therefore designated his brother John as his heir, and after Richard's unexpected death on April 6, 1199, John was accepted as ruler by most of the prelates and barons of England and Normandy. But Arthur's claim to Brittany and Anjou was recognized by Philip, although a year later the treaty of Le Goulet (May 1200) arranged that he should do homage to John for Brittany. After John was condemned to forfeiture (1202) by the court of the king of France, Arthur's further claims to Aquitaine and Maine were provisionally recognized by Philip, who had already betrothed him to his daughter Mary.

In the ensuing warfare Arthur was captured by John on Aug. 1, 1202, at Mirabeau, and was imprisoned first at Falaise and then at Rouen. Although his precise fate is uncertain, there can be no doubt that he was dead before 1204 and there is a tradition that he was murdered about April 3, 1203, at Rouen or at Cherbourg, either by John himself or at his command.

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ARTHUR III (1393–1458), duke of Brittany from 1457 to 1458 but known for most of his life as earl of Richmond (in French, comte de Richemont) or as the constable de Richemont (when he was constable of France), was the third son of John IV, duke of Brittany, and Joan of Navarre (afterward wife of Henry IV of England). His brother, John V of Brittany, gave him his

English title earl of Richmond in 1399. From 1410 to 1414 he served on the side of the Armagnacs in the French civil wars and became the intimate friend of Charles VI's son, the dauphin Louis. Wounded and captured in the battle of Agincourt (1415), he was a prisoner in England till 1420. Released on parole, he supported the English policy for several years, persuading John V of Brittany to sign the treaty of Troyes and being rewarded by Henry V of England with the countship of Ivry.

In 1423 Richmond married Margaret of Burgundy, widow of the dauphin Louis, and thus became brother-in-law (1) of Philip the Good, duke of Burgundy; (2) of the English regent in France, the duke of Bedford; and (3) of Charles duc de Bourbon. Offended by Bedford's refusal to give him a high command, he broke with the English and, in March 1425, was made constable of France by Charles VII.

Richmond now threw himself with ardour into the French cause and persuaded his brother, John of Brittany, to conclude the treaty of Saumur (Oct. 7, 1425) with Charles VII. In battle, however, he was several times defeated; and at court, where his rough and overbearing manners made him disliked, his influence was overshadowed by that of incompetent favourites, especially Georges de la Trémoïlle. The peace concluded between the duke of Brittany and the English (Sept. 1427) led to Richmond's expulsion from the French court. Joining Joan of Arc at Orléans in June 1429, he fought victoriously under her banner in several battles (for example, at Patay). After La Trémoïlle's disgrace, thanks to the king's mother-in-law Yolande of Aragon and to the queen Mary of Anjou (1433), Richmond was allowed to return to court. On Sept. 20, 1435, mainly as a result of his diplomacy, the treaty of Arras was signed between Charles VII and the duke of Burgundy. This turned the course of the Hundred Years' War in France's favour.

In April 1436, Richmond took Paris from the English; but it was not till May 1444 that the armistice of Tours gave him leisure to participate in the reorganization of the army. This reform had its effect in the struggles that followed. In alliance with his nephew, Peter II of Brittany, Richmond reconquered during Sept. and Oct. 1449 nearly all the Cotentin. It was moreover his rapid intervention, with 800 Breton knights, that won the battle of Formigny for the French (April 15, 1450). On Peter II's death (Sept. 22, 1457), he became duke of Brittany. He reigned little more than a year and died on Dec. 26, 1458. He left no legitimate children, though he was remarried twice: first to Jeanne, daughter of Charles d'Albret; then to Catherine, daughter of Pierre de Luxembourg, comte de Saint-Pol.

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ARTHUR, CHESTER ALAN (1830–1886), 21st president of the United States, was born in Fairfield, Vt., on Oct. 5, 1830. His father, William Arthur (1797–1875), when 18 years of age, emigrated from County Antrim, Ire., and, after teaching in various places in Vermont and lower Canada, became a Baptist minister. William Arthur had married Malvina Stone, an American girl who lived in Canada at the time of the marriage, and the numerous changes of the family residence afforded a basis for allegations in 1880 that the son Chester was born not in Vermont but in Canada, and was therefore ineligible for the presidency. Chester entered Union college, Schenectady, N.Y., as a sophomore and graduated with honour in 1848. He then became a schoolmaster, at the same time studying law. In 1853 he entered a law office in New York city and in the following year was admitted to the bar. His reputation as a lawyer began with his connection with the famous "Lemmon slave case" in which, as one of the special counsel for the state, he secured a decision from the highest state courts that slaves brought into New York while in transit between two slave states were *ipso facto* free. In another noted case, in 1855, he obtained a decision that Negroes were entitled to the same accommodations as whites on the street railways of New York city.

In 1859 he was married to Ellen Lewis Herndon (1837–80), daughter of a Virginia naval officer and explorer of the Amazon.

A Whig and abolitionist family background prepared him for entry into the new Republican party and he attended the Anti-Nebraska convention at Saratoga, Aug. 16, 1854. He participated in local politics in New York city and joined the state militia. When the American Civil War began he held a political appointment as engineer-in-chief on Gov. Edwin D. Morgan's staff. Soon he became successively assistant quartermaster general, inspector general, and quartermaster general of the state troops. He displayed exceptional administrative ability under trying circumstances and retired with Governor Morgan on Jan. 1, 1863. He resumed the practice of his profession, specializing in war damage claims, but continued his activities in local politics.

In Nov. 1871, he was appointed by President Grant collector of customs for the port of New York. The customhouse had long been conspicuous for the most flagrant abuses of the spoils system but Arthur, although an important figure in Sen. Roscoe Conkling's machine, combined experimental civil service examinations with patronage considerations in making appointments and made few removals for political reasons. His management did not satisfy the reform convictions of President Hayes, and a nonpartisan commission appointed by Secretary of the Treasury John Sherman recommended sweeping changes. The president asked for the resignation of Arthur and his two principal subordinates, Alonzo B. Cornell and George H. Sharpe. Arthur refused to retire under fire and his cause was espoused by Senator Conkling, for a time successfully; but on July 11, 1878, during a recess of the senate, the collector was removed, and in Jan. 1879, after another severe struggle, the senate approved. Arthur's business conduct of the office was not impugned, but he was regarded as too involved in machine politics to carry out a reform program. However, in defense of his management he insisted that he had already instituted every reform authorized by the treasury and that the recommendations of the investigating commission largely repeated his own previous proposals for improving the system.

In 1880 he was a delegate-at-large to the Republican national convention. In common with the rest of the "Stalwarts" under Conkling's leadership, he worked hard for the nomination of U. S. Grant for a third term. Upon the triumph of James A. Garfield, the necessity of conciliating the defeated faction led to the offer to the New York delegation of second place on the ticket. When Levi P. Morton declined, Arthur was offered the nomination and accepted the honour over Conkling's angry protests. His nomination was coldly received by the public; and when, after his election and accession, he actively engaged on behalf of Conkling in the great conflict with Garfield over the New York patronage, the impression was widespread that he was unworthy of his position. Upon the death of President Garfield, Sept. 19, 1881, Arthur took the oath as his successor. Coming at a period of intense factional controversy and following the assassination of Garfield, which had profoundly shocked the public mind, the accession of Arthur to the presidency created apprehensions. The widespread expressions of dismay in the press at the probable outcome of an administration in the hands of so confirmed a factionist and spoilsman as he was reputed to be are said to have deeply wounded Arthur. But his accession address was clear, judicious and reassuring, and his expressed purpose, from which he never measurably deviated, to administer his office in a spirit devoid of factional animosity, established the confidence of the nation and won for him the approval

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ARTHUR, PHOTOGRAPHED IN 1882

of many of his severest critics. Contrary to the general expectation, his appointments as a rule were unexceptionable, and he earnestly supported the Pendleton law, passed in 1883, for the reform of the civil service. His use of the veto in 1882 in the cases of a Chinese immigration bill (prohibiting immigration of the Chinese for 20 years in contravention of the treaty of 1880) and a river and harbour bill (appropriating over $18,000,000, some of which was to be expended on insignificant streams), confirmed the favourable impression that had been made.

Other important events of his administration were the passage of the high protective tariff act of 1883—which disregarded both the report of a tariff commission and his own recommendations—the enactment of the Edmunds law prohibiting polygamy in the territories, and the completion of three great continental railroads.

Arthur was much concerned about national defense and secured increased appropriations for the navy, including funds for the construction of the first steel cruisers. One of his last official acts was the appointment of U. S. Grant as general, a special bill creating this rank having been passed in 1885. In 1884 he permitted his name to be presented for renomination at the Republican national convention but he was defeated by James G. Blaine on the 4th ballot. Although a close friend of Conkling, long an implacable political enemy of Blaine, he supported the latter in the ensuing presidential campaign. At the end of his term he returned to New York city, where he died on Nov. 18, 1886.

In appearance Arthur was an imposing figure, tall, handsome, always immaculately dressed, dignified but sociable and gracious to everyone. A widower, he depended upon his sister, Mrs. John McElroy, to act as his hostess in the White House.

See George F. Howe, *Chester A. Arthur* (1934); Herbert J. Clancy, *The Presidential Election of 1880* (1958). (E. H. Ro.)

ARTHUR, JOSEPH CHARLES (1850–1942), U.S. botanist who discovered basic facts about the life history of rusts (parasitic fungi) during research on plant diseases. He was born at Lowville, N.Y., on Jan. 11, 1850, graduated at Iowa State college, Ames, in 1872 and received the degree of doctor of science at Cornell university, Ithaca, N.Y., in 1886. In 1887 he was made professor of botany in Purdue university, Lafayette, Ind., where he served until 1915. During his professorship at Purdue he was also professor of vegetable physiology and pathology in the Indiana agricultural experiment station, and it was during this period that he made his chief contributions regarding the life history of rusts. From 1882 to 1900 he was an editor of the *Botanical Gazette*. Arthur wrote numerous botanical articles and published a *Handbook of Plant Dissection*, with Charles R. Barnes and John M. Coulter (1886), *Living Plants and Their Properties*, with Daniel T. MacDougal (1898), and *Manual of the Rusts in United States and Canada* (1934). He died April 30, 1942.

ARTHURIAN LEGEND, the body of stories concerning King Arthur (*q.v.*), themes and incidents from which were variously treated by medieval writers in most western European languages. They describe the birth of Arthur, the establishment of the knightly fellowship of the Round Table (*q.v.*), his own exploits and those of his knights, and finally relate how the adultery of Lancelot and Guinevere and the quest for the Grail (*q.v.*) led to the destruction of that fellowship and Arthur's kingdom and to the death of Arthur himself.

The Legendary History of Britain.—Although stories about King Arthur and his court were extremely popular in Wales before the 11th century, the Arthurian legend as known today is almost wholly the creation of the French middle ages. Arthur first achieved European fame through the *Historia regum Britanniae* (*c.* 1135) of Geoffrey of Monmouth (*q.v.*), a reckless forger who created, partly from Celtic tradition but still more from classical and biblical reminiscences, the fictional history of a Britain which had received undying lustre from the glorious rule of Arthur. The basic conception of a great warrior who triumphantly defeats the Saxons is taken from Nennius' *Historia Britonum* (*c.* 800): but Geoffrey's Arthur, not content with repelling the Saxons, subjects Scotland, Norway and France to his rule and, after refusing to pay tribute to Rome, defeats a Roman army in eastern France. At this moment of his highest glory he is summoned home to put down a rebellion led by his nephew Mordred (Modred), who has been left in Britain as regent and has seized Arthur's crown and wife. In a last battle on the river Camel, Mordred is defeated but Arthur, mortally wounded, disappears to Avalon (*q.v.*).

Some features of this story are obviously complete fabrications when applied to Arthur; for example, the account of how Uther Pendragon, aided by Merlin, took the shape of Gorlois, duke of Cornwall, and in this shape begot Arthur on Igerne (Igraine), Gorlois' wife, is a blatant adaptation of the classical story of Zeus and the wife of Amphitryon. Even apparently genuine Celtic features (*e.g.*, the sword Excalibur and the journey to Avalon) are given a strong classical colouring, while Kay and Bedivere, Arthur's closest companions in the Celtic tradition, are transformed into feudal barons. The theme of Arthur the world-conqueror is obviously patterned upon the exploits of such worthies as Charlemagne and Alexander the Great, while Arthur's disastrous fall at the height of his prosperity conforms to the accepted medieval idea of tragedy. Wace's *Roman de Brut* (1155), an Anglo-Norman adaptation of Geoffrey, and Layamon's much expanded early Middle English version of Wace, the *Brut* (*c.* 1200), both contain material lacking in Geoffrey, especially in connection with the Round Table and Avalon. (*See* also WACE and LAYAMON).

The Medieval Romances.—Five romances (*c.* 1160–80) by Chrétien de Troyes (*q.v.*) make Arthur the somewhat passive ruler of a realm of marvels, although he is permitted to retain the imperial status given him by Geoffrey. But Chrétien's works are basically adventure romances with a strong love interest, in which a high-born young knight and his lady-love play the leading roles. The obvious Celtic analogue is *Culhwch and Olwen*. Very little is known about Chrétien's presumed Celtic sources, although his *Lancelot* (*Le Chevalier de la charette*) has analogies with the story of the abduction of Guinevere by Melwas in the *Vita Gildae*. Chrétien's *Le Conte del Graal* (*c.* 1180) introduces the theme of the Grail into the Arthurian story; the origin of the Grail—it is the dish of the Last Supper given by Christ to Joseph of Arimathea—and its early history was related in Robert de Borron's non-Arthurian romance *Joseph d'Arimathie* (*c.* 1200?).

Glastonbury became connected with both the Grail legend and the story of Arthur, and the monks began to exploit its fame from the mid-12th century on: in 1191 a fraudulent exhumation of Arthur's remains took place there.

The Arthurian prose romances of the 13th century are built round two main themes: the winning of the Grail and the love story of Lancelot and Guinevere. Robert de Borron in his *Merlin* (*post* 1200) had established links between the Round Table, Merlin and the Grail hero Perceval (Parsifal). There seems to have existed an early prose romance of Lancelot which related Lancelot's successful wooing of Guinevere, Arthur's wife, and his friendship with Galehaut, the high prince. This romance formed the kernel of a cyclic work which is now known either as the prose *Lancelot* or the "Vulgate cycle" (*c.* 1225). The Vulgate cycle connected the theme of Lancelot and Guinevere with the Grail legend through the figure of Galahad, Lancelot's son by Elaine, daughter of Pelles the Grail warden. In the branch of the Vulgate cycle known as the *Queste del Saint Graal*, an austerely religious work reflecting the mystical teaching of Bernard of Clairvaux, Galahad achieves the vision of God through the Grail as fully as is possible in this life, whereas Lancelot, stained by his adultery with Guinevere, is shown as a novice whose progress along the Mystic Way requires a life of penitential discipline. The Lancelot story was prefaced by a branch of the cycle based on Robert de Borron's *Merlin*, a verse romance which had recounted Arthur's begetting (as in Geoffrey), his fostering by Antor, father of Kay, and his winning of the crown by drawing a magic sword from a stone. The writer of the Vulgate cycle turned this work into prose and extended it by a long and wearisome pseudohistorical narrative dealing with Arthur's wars against the Saxons. A final branch, the *Mort Artu*, contained an account of Arthur's Roman campaign and war with Mordred (based on Geoffrey), to which was prefixed the story of Lancelot's renewed

adultery with Guinevere and the disastrous war between Lancelot and Gawain which ensued. (*See* also articles on GAWAIN; GUINEVERE; LANCELOT; MERLIN; and PERCEVAL.)

A later prose romance (*c.* 1240), formerly known as "the pseudo-Borron" but described as the "post-Vulgate" romance by modern scholars, combines the story of Arthur with material from the prose romance of Tristan, and completely discards the pseudo-historical approach in favour of a thoroughly romantic treatment which develops such themes as the incestuous birth of Mordred through the commerce between Arthur and his sister; the appearance of Excalibur out of a lake (to match its disappearance into the lake at the end of the *Mort Artu*); the striking of the Dolorous Stroke (the slaying of King Pellean with the Holy Grail lance) by the unfortunate knight Balin, who thus inaugurates the marvels and enchantments of Britain which can only be ended by the pure knight Galahad; the fight in which the twin brothers Balin and Balan kill each other; and the final destruction of the Arthurian kingdom by King Mark of Cornwall.

The Survival of Arthurian Legend.—The legend, as it appears in the Vulgate cycle and the post-Vulgate romance, was transmitted to the later English-speaking world by Sir Thomas Malory (*q.v.*). In the 15th century, English chroniclers showed a renewed interest in Geoffrey's *Historia* and in Tudor times—*e.g.*, in Michael Drayton's *Polyolbion* and Edmund Spenser's *Faerie Queene*—the fictitious kings of Britain became more or less incorporated into the official national mythology. Thanks to the chroniclers and Malory, the legend remained alive in England in the 17th century although it had by then lost its interest for continental readers. Milton meditated an epic on Arthur. Cherished mainly by antiquaries during the 18th century, it again became popular in the Victorian era, favoured as it was by medievalizing tendencies in art and religion, and enjoyed a dubious second flowering in the works of Tennyson, Swinburne, William Morris and others. In the 20th century writers continued to draw on the legend: the American poet Edwin Arlington Robinson wrote an Arthurian trilogy in verse, and in England T. H. White retold the stories freshly and skilfully in a fine series of novels collected as *The Once and Future King* (1958). Charles Williams wrote a considerable body of verse on Arthurian themes, notably in *Taliessin Through Logres* (1938) and *Arthurian Torso*, ed. by C. S. Lewis (1948).

See also **Index references under "Arthurian Legend" in the Index volume.**

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(F. WH.)

ARTICHOKE. The globe, common, green, Italian, French or Paris artichoke (*Cynara scolymus*) is sometimes also called the true artichoke to distinguish it from the Jerusalem artichoke (*Helianthus tuberosus*), a quite different plant. Both plants belong to the family Compositae (*q.v.*).

Globe Artichoke.—The globe artichoke is a large, coarse, herbaceous, thistlelike, perennial plant. The edible parts are the fleshy bases of the immature flower heads, together with the fleshy bases of the large bracts attached. The aboveground parts die down each year after flowers are formed. New shoots arise the next season from buds of the underground crown atop the perennial rootstock. These shoots produce rosettes of deeply cut, pinnatifid, woolly leaves two to three feet long; later, sturdy, branched flower stalks rise three to five feet. The fully developed heads of purplish flowers are six inches or more across. After four to eight years the cluster of rosettes from a crown becomes very crowded, reducing the size and quality of heads formed. The plant then is renewed by planting divisions of the crown or rooted offshoots that arise from it. Seeds are produced by mature flower heads, but the plants are propagated vegetatively because the seedlings do not come true to variety.

The artichoke is native to lands about the middle and western Mediterranean, whence it was carried to the eastern Mediterranean region about 2,000 to 2,500 years ago. In ancient and medieval times the young or blanched leaves rather than the flower heads were eaten. The modern, edible-flowered form was first recorded in Italy about 1400. From there it was taken to France and England. It was introduced to Louisiana by the French and to California by the Spanish in colonial times. It is popular and extensively grown in France, Belgium and the Mediterranean countries. In Europe from the 17th to 20th centuries the leaves of artichoke were believed to have some specific medicinal properties. The plant has no recognized value in medicine in America.

Globe artichoke requires a rich soil and a mild, humid climate. It is grown in the United States on a large scale only in the mid-coastal counties of California near the ocean. About 8,000 to 10,000 ac. are harvested annually; yields average about two tons per acre.

Jerusalem Artichoke.—The Jerusalem artichoke is a tuber-bearing type of sunflower, native to North America. A wide range of wild forms can be found in the United States. The aboveground part of the plant is a coarse, usually much-branched, frost-tender annual, six to ten feet tall. The numerous showy flower heads appear in late summer or early autumn, have yellow ray flowers and yellow, brownish or purplish disk flowers. The underground tubers vary from oblong to much elongated, regular to rough and branched, and from very small up to three to four ounces. Skin colours range from light buff through yellowish to brown, red and purple. The tubers are very thin-skinned and soon shrivel on exposure to dry air; the flesh is white and crisp. The plant is propagated by planting the tubers.

Samuel de Champlain reported seeing the Jerusalem artichoke about 1605 in the gardens of the Indians on Cape Cod. The plant was first described by Colonna in Italy in 1616. It was introduced into England in 1616 or 1617, probably into France about the same time, and was grown in northern Germany in 1632. It has long been cultivated extensively in France as a stock feed and has attracted some attention as a potential crop plant in northern Europe. In America it is rarely cultivated, but small quantities are used in making pickles, relishes and dietary preparations.

The tops and tubers of Jerusalem artichoke contain no starch. The carbohydrates of the tuber occur mainly as inulides, along with 1% to 3% of free sugar. There is no good evidence that man or animals derive food value from these inulides.

The flavour of the tubers suggested to Champlain, and to others later, the flavour of the artichoke, and the name Jerusalem artichoke was first recorded in 1622. The origin of "Jerusalem" in the name is not definitely known. (V. R. B.)

ARTICLES OF CONFEDERATION. The Articles of Confederation, the first constitution of the United States, were written in 1776–77, ratified March 1, 1781, and served until they were replaced by the constitution of 1787 on March 4, 1789.

The leaders of the American Revolution were thoroughly familiar with a central government: that of Great Britain. They were familiar too with the idea of a central government in America, since many plans for one had been proposed during the 18th century. Most of the plans had been for frontier defense and none had been adopted, so they offered little guidance in 1776.

When Americans declared their independence they agreed that the new nation must have a common government, but they disagreed then, as they continued to disagree for generations, about the kind of government it should be and, above all, about the amount of power it should have. One group of leaders in 1776 wanted a strong central government with the power to regulate trade, control finance, dispose of western lands, check state legislative majorities and intervene within the states to maintain order. They wanted what came to be called a "national" government, but in 1776 such leaders were a minority. They were opposed by most of the men who had been the aggressive revolutionary leaders, men who had denied the authority of parliament over the colonies and

who had insisted that each colonial legislature was supreme within its own domain. Equally important in their political thought was their distrust of powerful government and of men in political office. They believed that when men gained political power they inevitably tried to gain even more power and that in so doing they often corrupted government and subverted the liberties of the people. Therefore, when the revolutionary leaders wrote the state constitutions, they limited the power of officeholders and protected the people from government by bills of rights.

When men who held such beliefs took up the formation of a constitution for the United States, they rejected a document proposed by the "nationalists." The constitution finally adopted by the continental congress in 1777 and sent to the states for ratification provided for a strictly "federal" government, which had no authority over the states or their citizens. The Articles of Confederation declared specifically that "each state retains its sovereignty, freedom, and independence" and all powers and rights not "expressly delegated to the United States, in Congress assembled." Members of the continental congress were elected annually by the state legislatures and subject to recall at any time. Distrust of power seekers was expressed in the provision that no man could be a member of congress for more than three years in any six. Congress was denied the power of taxation, a logical reflection of the long fight against the taxing power of the British parliament. Nor did congress have the power to regulate trade, although it was given the exclusive power of making commercial treaties.

Opposition to granting the taxing power to congress was so overwhelming that it was not debated, but lesser issues, which continued to be issues in later constitutional history, were debated fully. One was the question of representation. The states with large populations insisted that they should have more votes in congress than the small states. The latter, and those leaders fearful of a powerful central government, insisted on the equality of the states and established the rule that each should have one vote. A second issue was the apportionment of common expenses. The northern states, assuming their lands to be of high value, argued that population was the best index of wealth and ability to pay. The southern states, with poorer land and large populations, established the principle that expenses should be apportioned according to the value of improved lands. The most important conflict concerned western lands. Five states had definite western boundaries, and they insisted that congress should have control. The other states, some with claims extending to the Pacific ocean, inserted a provision in the articles prohibiting congress from interfering with the lands of the states. Maryland, a "landless" state, backed by speculators with interests in the region claimed by Virginia, refused to ratify the articles. Finally, Virginia ceded the Old Northwest to congress, requiring it to nullify speculators' claims, and Maryland was forced to ratify on March 1, 1781.

Despite the evident distrust of centralized power embodied in the Articles of Confederation, they both limited the independence of the states and granted significant authority to congress. The citizens of each state were guaranteed the privileges of the citizens of any state to which they moved. Provision was made for the extradition of criminals fleeing from one state to another. A court of arbitration, under the supervision of congress, was provided for the settlement of disputes among states. The freedom of the states was limited by the powers granted to congress. It had the sole power of making peace and war and appointments of officers, except regimental officers, of troops in the service of the United States. It had sole control of diplomatic negotiations. It could borrow money, issue paper money and fix the value of money coined by it and the states. It had the sole authority to fix weights and measures, establish and manage a post office and manage affairs with Indians not a part of any state.

Despite the lack of coercive authority over the states and their citizens, the Articles of Confederation had many of the important provisions later incorporated in the constitution of 1787. *See* also UNITED STATES (OF AMERICA): *History.*

See Merrill Jensen, ***The Articles of Confederation: an Interpretation of the Social-Constitutional History of the American Revolution 1774–1781*** (1940). (M. JN.)

ARTIFICIAL LIMBS: *see* PROSTHETICS.

ARTIFICIAL ORGANS are machines designed to replace the functions of organs of the body for varying periods of time, usually during surgery. The artificial kidney, heart-lung machines, and mechanical hearts, the subjects of this article, are the leading examples of artificial organs. (For artificial limbs *see* PROSTHETICS.)

Artificial Kidney.—This apparatus removes, by dialysis (*q.v.*), noxious metabolic substances from the blood. These substances accumulate because of faulty kidney function and can be lethal if they continue to increase. In using the artificial kidney, blood from an artery is led through sterile coils of tubing (made from a semipermeable membrane such as cellophane) lying in a suitable salt solution bath. The blood is prevented from clotting in this altered environment by adding heparin (*see* THROMBOSIS AND EMBOLISM: *Anticoagulant Therapy*). The harmful products of uremia (insufficient kidney function) move out of the blood, where they are in higher concentration, pass through the cellophane wall, and collect in the surrounding fluid. When the blood has traversed this circuit it returns to the patient, purified by dialysis during its passage.

"Vividiffusion," or an artificial kidney, was first described by John J. Abel, L. G. Rowntree, and B. B. Turner in 1913. Unsolved technical problems limited the effectiveness of the machine, however. The first successful clinical instrument, developed by W. J. Kolff (1944), consisted of long lengths of tubing wound horizontally on a slotted wooden drum. Blood from the patient flowed through these casings, which then dipped into a reservoir filled with an appropriate exchange solution as the cylinder rotated.

Other dialyzing units subsequently developed included vertical windings of dialyzing tubing on a cylinder (Nils Alwall, 1947) and multiple cellophane "sandwiches" overlaid with impermeable plastic or rubber sheets (Leonard T. Skeggs and Jack R. Leonard, 1948). Variations on these concepts have been built into other types of artificial kidneys that are widely available. Although they can serve only as a temporary and incomplete replacement for normal renal function, artificial kidneys have permitted reversibly damaged kidneys to recover. (For the surgical transplantation of kidneys *see* TRANSPLANTS, TISSUE AND ORGAN.)

Heart-Lung Machines.—These consist of an artificial lung (oxygenator) and a substitute heart (pump). For nearly a century beginning about 1868, scientists attempted to develop a mechanical unit capable of (1) restoring oxygen to blood depleted of this element in its movement through the tissues, and (2) removing the excessive carbon dioxide that accumulates during this same passage. Many of the same investigators worked also on the development of a pump to supplant heart action temporarily (*see* below). Decades of animal investigation culminated in the first successful application of an artificial heart-lung machine to an operation on man, by John H. Gibbon, Jr., on May 6, 1953. Within a brief time other scientists, working independently, revealed heart-lung machines they had developed. In the 1960s the Gibbon type (stationary screen), DeWall-Lillehei (bubble oxygenator with a collecting helix), Björk-Kay-Cross (rotating solid, fluted, or straight disk), Dennis (rotating screen disk), and other devices improvised from the principles embodied by these types were in use in dozens of surgical centres throughout the world.

For intervals of an hour or more any one of the proven types of heart-lung machines can accept the entire venous return of a large (100 kg. [220 lb.]) patient. In such a case the blood is pumped back into the patient's arteries in a volume sufficient to maintain life at even the most distant parts of the patient's body as well as in those centres with the greatest requirements (brain and nervous tissue, liver, adrenals, kidneys). To do this, up to 5,000 ml. (about 1⅓ gal.) or more of blood must be moved each minute. While the heart is relieved of its pumping duties it can be stopped by drugs or cooling and then started by warming or electrical means. Meanwhile the surgeon can open this organ and repair or replace valves or close abnormal holes inside.

Prolonged dependence on these units as replacements for the lung and heart was not practical in the 1960s. Equipment was

too bulky; also, the lining surfaces of the oxygenator and all tubing were less compatible than the blood vessels of the patient. Therefore, while the machines were being used, blood had to be made incoagulable by the use of heparin (which can be reversed at will with other drugs) to prevent the development of clots that might break loose and either plug the unit or damage the patient.

By means of these machines tens of thousands of children and adults with heart defects, both congenital and acquired, have been operated on successfully with establishment of improved heart function and circulation. Once these necessary corrections have been made, for congenital lesions particularly, the patient's life expectancy is, under most circumstances, comparable to that of a person born with a normal heart.

Mechanical Hearts.—Instruments capable of replacing the pumping action of the normal heart for prolonged periods of time, without damaging excessively either the fluid or the cellular elements of whole blood, were the goal of investigative groups working in the 1960s on specific parts of the problem. On the way to this goal, several kinds of appliances were tried; they were designed to reduce, rather than take over entirely, the total work load of a heart with impaired functional capacity. In general these units consisted of either (1) counterpulsation (diastolic augmentation) equipment that pulsed the blood during the heart's "resting" phase between beats, or (2) an auxiliary ventricle that substituted temporarily by pumping a portion of the normal cardiac output. Use of these devices under experimental conditions provided certain limited benefits to the circulation, including the heart; but the benefits were achieved at the expense of creating serious new biological problems which, if allowed to continue, would have been incompatible with health. (R. L. V.)

ARTIFICIAL RESPIRATION. The timely administration of artificial respiration to persons who have stopped breathing while their hearts are still beating often decides whether these persons live or die. Artificial respiration, if applied quickly and properly, can prevent deaths from drowning, choking, strangulation, suffocation, carbon monoxide poisoning and electric shock.

In all of these events except electric shock, breathing ceases because there is not enough oxygen in the blood to enable the heart muscle and respiratory centre of the brain to function properly. When the oxygen in the blood becomes insufficient (anoxia), the heart usually continues to beat, although as a rule so feebly that there may be no noticeable pulse for about five minutes after respiration stops. This is not true, however, in electric shock, which causes momentary paralysis of the heart muscle as well as interruption of the flow of blood to the respiratory centre of the brain.

FIG. 1.—METHOD OF CLEARING AIR PASSAGE BEFORE APPLYING ARTIFICIAL RESPIRATION TO CHILDREN

Rescuer holds child in head-down position and sharply pats him on back

Resuscitation by artificial respiration consists chiefly of two actions: (1) establishing and maintaining an open air passage from the upper respiratory tract (mouth, throat and pharynx) to the lungs, and (2) exchanging air and carbon dioxide in the terminal air sacs of the lungs while the heart is still functioning. Time is an important factor in successful resuscitation not only in the urgency with which a first aid method is used but also in the continued application of a technique that may eventually revive an unconscious victim.

Two methods of artificial respiration were recommended by the American National Red Cross and the American Medical Association in the early 1960s. One method, known as expired air inflation or "mouth-to-mouth breathing," is widely accepted for use with children and infants and also can be applied to adults when other methods are not effective.

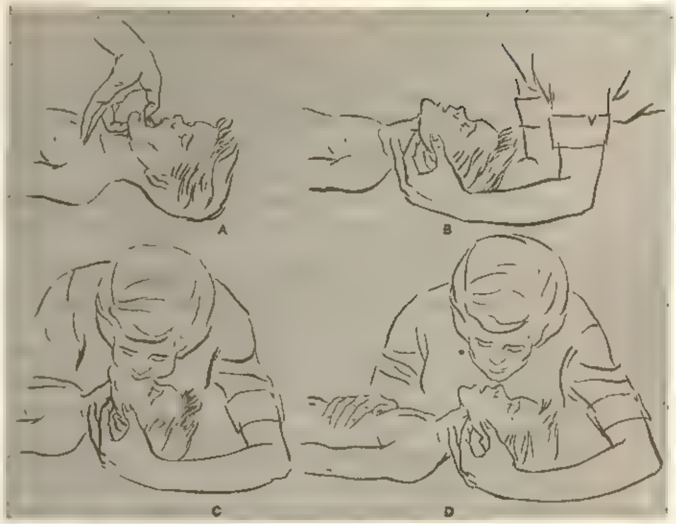

FIG. 2.—MOUTH-TO-MOUTH RESUSCITATION FOR A CHILD

(A) Rescuer opens child's air passage. (B) Rescuer holds jaw with hand under angle of child's jaw and (C) places mouth over child's mouth and nose, breathing gently to inflate the child's lungs. (D) When child's lungs expand, rescuer places gentle pressure on abdomen to assist exhalation

Mouth-to-Mouth Technique.—The first step in resuscitation, no matter what type of artificial respiration is used, is to quickly clear the mouth and throat of any foreign material or mucus that might obstruct the air passage. In the case of an infant or child hold the victim in a head-down, face-down position with the right hand and forearm (fig. 1). Pat him sharply on the back with the other hand. This should clear the upper respiratory passages.

To prepare for mouth-to-mouth breathing, place the child on his back. With the thumb and middle finger of the left hand (thumb under the tongue) lift the lower jaw forward and upward to open the air passage fully (fig. 2[A]). Hold the jaw in this position with the left hand under the angle of the jaw (fig. 2[B]). The rescuer should place his mouth over the child's mouth and nose, making a relatively leakproof seal (fig. 2[C]). Breathe into the child's mouth with positive pressure. With an infant use short puffs; larger amounts may damage his lungs. As the chest rises and the lungs expand the rescuer should place his right hand on the upper abdomen between the ribs and the navel (fig. 2[D]). With gentle pressure of the right hand the air is expelled from the lungs.

The rescuer should take a deep breath during each exhalation of the victim; the mouth-to-mouth inflation-exhalation cycle should be repeated about 15 to 20 times a minute.

With an adult the same procedure is followed except that both hands are generally needed to elevate the jaw in an upward and

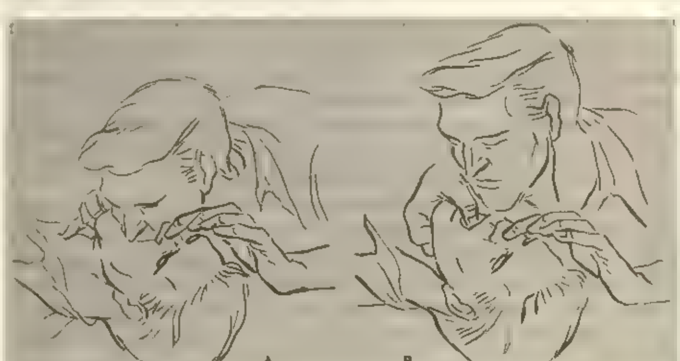

FIG. 3.—MOUTH-TO-MOUTH RESUSCITATION FOR ADULTS

(A) Rescuer elevates victim's jaw, clamps nostrils and places mouth over victim's mouth, breathing to inflate the victim's lungs; (B) rescuer allows victim to exhale before repeating forced inhalation

outward position where it can be maintained with the right hand (fig. 3). Use the fingers of the left hand to clamp the nostrils of the victim. Press the mouth firmly against the lips of the victim to make a tight seal. Inflate the lungs of the victim with forceful, short, even breaths, causing the chest to rise as the lungs are filled. Allow passive exhalation (fig. 3[B]) and then repeat the forced inflation 12 to 15 times a minute.

In both youngsters and adults, mouth-to-mouth resuscitation should be continued until normal breathing returns or the victim is pronounced dead by a physician.

In May 1958 the American Medical association published the report of the Symposium on Mouth-to-Mouth Resuscitation which stated:

"Resuscitation with expired-air breathing is simple and effective. It is readily adaptable to babies, children and adults without adjunct equipment. Rescuers can maintain mouth-to-mouth breathing for an hour or more without fatigue even when the victim is twice the size of the rescuer. Skilful performance of expired air breathing is an easily learned lifesaving procedure. It has revived many victims unresponsive to other methods and has been proved in real emergencies under field conditions."

The Holger Nielsen Method.—Another method of artificial respiration that has been widely used is the "back pressure-arm lift" method. This technique was first described in 1932 by Col. Holger Nielsen of Denmark.

The procedure is as follows: (1) Place the victim on his abdomen (fig. 4) with face turned to one side and the elbows bent so

FIG. 4.—HOLGER NIELSEN BACK PRESSURE-ARM LIFT METHOD

(A) Rescuer places hands on victim's back and, slowly rocking forward, exerts steady pressure; (B) rescuer releases pressure by rocking backward, lifting victim's arms forward and up and then down

that one cheek rests on the back of the hands. Quickly clear the victim's mouth and throat of any material that might obstruct the free flow of air. At the same time pull the tongue forward. (2) Kneel at the head of the victim while facing him; place open hands on the victim's back (fig. 4[A]) at a level just below the armpits with fingers spread and thumbs touching. (3) Rock forward slowly on extended arms while exerting steady pressure downward on the back. This forces air out of the lungs. Do not exert sudden or violent pressure. (4) Release the pressure slowly and rock backward while grasping the arms of the victim just above the elbows (fig. 4[B]); lift the arms forward and upward until you meet resistance, then slowly lower the arms to the ground. This arm-lift causes active inspiration by pulling on the chest muscles and arching the back.

The cycle of press and release-lift and release should be repeated 10 to 12 times a minute and continued until natural breathing occurs or the victim is pronounced dead.

Drowning.—In cases of near-drowning it is imperative to start artificial respiration as quickly as possible and to provide to the lungs a sufficient supply of oxygen so as to ensure the continuing function of the heart and the brain. Do not be concerned about water in the lungs or the stomach. Valuable time should not be wasted in an effort to evacuate the water or loosen the clothing.

Place the unconscious victim on his back and start mouth-to-mouth resuscitation. If the stomach bulges when inspiration is forced, exert moderate pressure over the stomach area during expiration and thereby evacuate some of the water from the stomach.

FIG. 5.—BACK PRESSURE-HIP LIFT METHOD

(A) Rescuer lifts victim's hips, rotating them in pivoting motion; (B) rescuer lowers victim's hips, placing hands on victim's back to force air out of lungs with steady pressure

See that the air passage from mouth to lungs remains open and that no regurgitated water or food is allowed to accumulate in the mouth. Do not turn the victim over in an attempt to empty the stomach.

If the lungs expand and expiration can be heard or felt, it can be assumed that the most effective method of artificial respiration is being used and no attempt should be made to change to another method. Use of the mouth-to-mouth technique should continue until the victim resumes breathing or a physician pronounces him dead. Shallow breathing by the victim should be supplemented by short mouth-to-mouth assistance that does not interfere with his natural exhalation.

If mouth-to-mouth resuscitation is not productive, some type of manual artificial respiration should be used such as the Nielsen method described above, or a modification of the Nielsen method called the "back pressure-hip lift" method in which the rescuer straddles the prone victim at the hips. While the rescuer supports himself on one knee and the opposite foot, he lifts the hips of the victim upward about 12 in. and rotates them with a pivoting motion (fig. 5[A]). Then the hips are lowered and the rescuer quickly places his outstretched hands on either side of the victim's back below and lateral to the shoulder blades (fig. 5[B]). Slow, steady pressure is exerted downward, forcing air out of the lungs.

The cycle is then repeated with a pivoting motion in the opposite direction; each cycle lasts 10 to 15 sec.

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(J. H. Cs.)

ARTIGAS, JOSÉ GERVASIO (1764–1850), father of Uruguayan independence and national hero, was born June 19, 1764, probably in Montevideo; his ancestry was Spanish. As a youth he was a rural gaucho or cowboy. In 1797 he entered the Spanish military forces, then mainly engaged in exterminating bandits. In 1810 Artigas offered his services to the Buenos Aires patriot junta leading the independence movement against Spain. After a brilliant victory at Las Piedras, he laid siege to Montevideo, held by Spanish forces, but a Spanish request for Portuguese help from Brazil and the patriots' defeat at Guaqui led to the lifting of the siege. In the face of superior Portuguese forces, Artigas led a dramatic mass exodus, involving some 16,000 persons or about one-fourth of the population of Uruguay, to Argentine territory.

Artigas became the champion of federalism against Buenos Aires' efforts to assert centralized control over the whole Río de la Plata region. A confused period of civil war resulted in 1814. In the next two years Artigas was at the zenith of his power, ruling over approximately 350,000 sq.mi. of what is today central Argentina and Uruguay. His emphasis on decentralization proved

his undoing, however. A later Portuguese invasion ultimately forced Artigas out, although he resisted bitterly for more than three years. In 1820 he withdrew to Paraguay, where he spent the rest of his life. He died Sept. 23, 1850, in Ibiray near Asunción.

Artigas is regarded as the chief creator of Uruguayan independence although that movement was not finally won until several years after his retirement. *See* URUGUAY: *History*. (R. H. FI.)

ARTIGAS, a department bordering the Uruguay river in extreme northwest Uruguay, with Argentina on the west and Brazil to the north and east. It was named in honour of José Gervasio Artigas (*q.v.*), the national hero of independence. It is the least densely populated department in the country, with only 70,426 inhabitants (1954 est.) in a territory of 4,682 sq.mi. Artigas, like most of Uruguay, is ranching country. Its rolling, somewhat rocky pastures are good but subject to damaging droughts. A low range of foothills, the Cuchilla de Belén, traverses the southern part of the department. There is some agriculture, with sugar cane, oranges, grapes, forage and maize as the principal crops. The capital city, Artigas, faces Brazil across the Cuareim (or Quaraí) river. (M. I. V.)

ARTILLERY. As constituted in mid-20th century, this category of military weapons was difficult to define exactly. In common parlance it meant all manner of big guns, howitzers and rocket launchers, as distinguished from small arms (*q.v.*) or infantry weapons. The traditional dividing line between the two classes was calibre .60 (0.6-in. or 15-mm.); weapons with bore diameter greater than calibre .60 were considered artillery and those with smaller bores were considered small arms. But there were many exceptions to the rule. Portable rocket launchers like the bazooka with its 2.36-in. (60-mm.) bore or the larger 3.5-in. (89-mm.) superbazooka and recoilless rifles of 57-mm. and larger were sometimes classed as small arms because they were used by infantry troops and could be handled by one or two men. Small mortars also were often classed as infantry weapons rather than artillery. At the other end of the scale, the large rockets and guided missiles that emerged during and after World War II added a whole new category of weapons capable of performing an artillery function but operating on principles radically different from conventional guns and howitzers. Between these two extremes were rapid-firing aircraft weapons ranging from machine guns of calibre .30 and .50 up to larger pieces of 20 mm., 37 mm. and even 75 mm., plus aircraft rockets. With these aircraft weapons the distinction between infantry use and artillery use was, of course, not applicable. Though similar to their ground counterparts, these aircraft weapons were usually not designated as artillery but as aircraft armament, just as the big guns mounted on tanks were referred to as tank armament.

The term artillery also described the personnel or artillerymen who transported and served the weapons and the branch of the army to which such personnel were assigned. Organization of units and employment of weapons are discussed later in this article and also in the articles ARMY and TACTICS. For the differences between military gunnery and naval gunnery *see* GUNNERY, NAVAL. For a description of artillery shells, fuzes and propellants, *see* AMMUNITION, ARTILLERY; FUSE; PROPELLANTS. For an exposition of the physical laws governing the flight of projectiles, *see* BALLISTICS.

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  3. 15th Century
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  6. Laying
  7. Fire
  8. Use of Various Types of Ammunition
IX. Tactics
  1. Application of Fire
  2. Observation
  3. Co-operation With Other Arms
X. Attack
  1. Approach March
  2. Dispositions
  3. Plan
  4. Close Support
  5. Counterbattery Work
  6. Harassing Fire
  7. Pursuit
XI. Defense
  1. Dispositions
  2. Plan
  3. Repulse of Assaults
  4. Antitank Defense
  5. Counterbattery
  6. Harassing Fire
  7. Withdrawal
XII. Antiaircraft Defense

During World War II and the years that followed, artillery matériel was subject to various classifications. A simple method was to divide it into two basic groups: (1) mobile or field artillery which was capable of comparatively quick transfer from one place to another; and (2) immobile artillery, or artillery of position, being heavy cannon which, once emplaced in a permanent seacoast or fortress defense, was rarely moved. Because World War II was a war of rapid movement over wide areas, mobile artillery assumed greater importance while immobile artillery of the old fixed-fortification type tended toward obsolescence. A new type came into service during the 1940s and took the name of self-propelled artillery. It consisted of guns or howitzers mounted on armoured tanklike carriages that moved under their own power instead of being towed by truck or tractor.

In field use there were many specialized classes of artillery such as mountain guns or howitzers, tank and antitank guns, and antiaircraft weapons. Each class had its own peculiar requirements and its own technique of fire. In terms of army organization, artillery was sometimes classed as battalion, regimental, divisional, corps or army. As their names indicated, these classes steadily increased in calibre, range and effectiveness from battalion up to corps, though army artillery was usually a composite of all types. Another common practice was to classify artillery pieces as light, medium or heavy. The lines dividing these classes differed among the armies of the world. The U.S. army placed in the light category artillery weapons up to the 105-mm. howitzer; in the medium category the 155-mm. howitzer; and larger guns and howitzers in the heavy category. (See *Artillery in World War II* below.) Still another classification described the various types of artillery weapons as guns, howitzers, heavy mortars or rocket launchers. Briefly, for arms of like calibre, the gun was a long-barrelled, long-range weapon with a relatively flat trajectory (path followed by the projectile); the howitzer had a shorter barrel, less range and followed a moderately arched trajectory; the mortar had a very short barrel, short range and a hairpin-shaped trajectory because of the high angle at which it was fired. Intermediate types possessed some of the characteristics of both guns and howitzers and

were referred to as gun-howitzers. Rocket launchers were simple tubes or guiding rails that held the rockets before firing and aimed them in the desired direction.

I. ORIGIN AND EARLY HISTORY

Before the invention of gunpowder, artillery in France and England signified bows and arrows. Thus, the weapons of the Genoese crossbowmen at Crécy (1346) were referred to by Jean Froissart in his account of the battle as *leur artillerie,* while Roger Ascham in *Toxophilus* (1545) wrote that, "Artillerie nowadays is taken for two things: gunnes and bowes." Confusion resulted from changes in meaning undergone by certain technical words in the course of time, changes to which may be ascribed much of the uncertainty existing as to the origin and evolution of many instruments in modern use. Thus, the "gunnes" of Ascham meant to Geoffrey Chaucer no less than three different objects, as indicated by his employment of the earlier form "gonne" to designate: a throwing machine (in his translation of *Le Roman de la rose*); a missile (*Legende of Good Women*); and finally a cannon (*Hous of Fame*). Naturally, the uninitiated, discovering the word "artillerie" (or "gonne") in a work of early date would be inclined to endow it with its modern meaning, and so perhaps to surmise the existence of ordnance at a period considerably antedating that of its actual introduction.

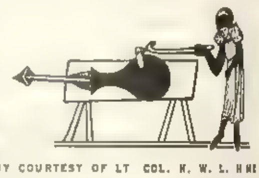
Obviously, before the artillery of modern times could take its shape, some agency for propelling missiles, at once simpler and more powerful than the physical means employed in the earlier forms of projectile weapons (*see* ENGINES OF WAR), had to be discovered. Such an agency was gunpowder, a mixture of three ingredients—sulfur, charcoal and saltpetre. The English friar Roger Bacon (*c.* 1220–*c.* 1292), described certain of its properties in a volume written sometime prior to 1249. But there is nothing in that work to indicate that he possessed any idea of its possible use as a propellant. He realized that it could and would explode, and might, as a result, be adaptable to the arts of warfare, but further he apparently failed to speculate.

The question as to who took the next step and used the explosive mixture as a propellant, thus making it gunpowder, has been a matter of endless debate among historians. The 19th-century belief that the Chinese or the Hindus invented cannon lost ground after publication of Col. H. W. L. Hime's *Gunpowder and Ammunition* in 1904, exposing errors in translations of ancient documents. Some historians gave credit to the Arabs for devising a crude type of firearm called a *madfaa* as early as 1304, but the evidence to support this thesis was far from conclusive. Researchers found no convincing evidence that any of the crusaders from Europe encountered firearms in all of their many battles with the Turks during the middle ages.

In Europe the name most often mentioned by 19th-century historians as inventor of cannon was that of an obscure German monk of the 14th century known as Berthold Schwarz or Berthold the Black, apparently so named for his interest in the black art of alchemy. Substantial evidence to support this view was altogether lacking. As for the date of the invention of cannon, the best we can say is that it probably occurred between 1320 and 1325. The claim that the year 1313 introduced cannon to the world rested on the following widely quoted entry in the official records of the city of Ghent for that year: "Item, in this year the use of *bussen* (*i.e.,* "cannon") was discovered in Germany by a monk." After study of the original Ghent records in 1923, Sir Charles Oman in his classic work, *The Art of War in the Middle Ages, A.D. 378–1485* (1924), rejected this evidence on three counts: (1) it was a marginal note in the early copies of the record book; (2) it was not a contemporary entry but had been added later; and (3) it actually appeared under the year 1393 in the earliest copy.

1. Early Artillery (14th Century).—Though precise data as to the origin of cannon were lacking, historians found numerous references to the use of firearms by the English, Scots, Germans, Moors and others in the second quarter of the 14th century. As early as 1327 a drawing of a crude cannonlike device appeared without explanation in an English manuscript in the library of Christ Church, Oxford (*see* fig. 1). Most historians concluded that the battle of Crécy, often quoted as the earliest occasion where gunpowder was employed by the military in projectile weapons, must yield priority to other instances of the use of this destructive combination. But all references to artillery in the early years, including Crécy, were fragmentary and inconclusive.

2. Construction.—The outlines of the piece shown in the Christ Church manuscript explain why early cannon were commonly described as *vasi* or *pots-de-fer* ("iron pots") since its contours are identical with those of a modern vase; viz., bulbous base, narrow curving neck and flaring mouth. They likewise indicate its characteristics with respect to size, shape, manner of mounting and firing better than words could accomplish. And despite the obvious unsuitability of an arrow-type projectile for discharge from a firearm (an unsuitability belied in some measure by the successful development more than 400 years later of harpoon guns for whale fishing), this unhandy combination continued in use for well over two centuries. As time passed, cannon balls of roughhewn stone were employed, followed by cast-iron and wrought-iron balls.



BY COURTESY OF LT COL. H. W. L. HIME

FIG. 1.—EARLY TYPE OF CANNON

As to method of manufacture, the first artillery pieces seem to have been constructed of cast bronze or brass and were very small. Soon after, guns of wrought iron appeared, but not of cast iron since the technique of producing successful casts with ferrous metals did not develop until the 15th century. It reached England relatively late. Research by the British Iron and Steel institute fixes 1509 as the approximate date of the first iron cannon to be cast in England. Wrought iron, because of its slag inclusions, was far from a perfect medium in which to work, but it was long employed for lack of something better, and with it guns of substantial dimensions were produced. The usual practice was to arrange one or more layers of hand wrought-iron bars or rods side by side in a circle, then weld their abutting surfaces together like the staves of a barrel (whence the name gun barrel). To fill the interstices that remained, molten lead was often employed. Then, to give added strength and solidity, wrought-iron rings were driven onto the sheaf of welded bars so closely together from breech to muzzle as to cover entirely that which lay beneath.

Since it was difficult to attach an integral breech piece to this open-ended affair, many cannon so constructed were made breech-loading, though in some instances a hollow bronze cylinder, open at one end and closed at the other, was driven into the breech end of the welded barrel to serve as a powder chamber. Thus the enclosed end of the cylinder became the breech of a completed muzzle-loading cannon. For the breechloaders, powder chambers were supplied by welding to the open breech of the barrel tube a skeletonized cylinder of a diameter somewhat greater than that of the bore, cut away at the top and open at the forward end where it joined the barrel to become a rearward extension thereof. Into the cutaway top of this barrel extension, a movable, ready loaded chamber (powder container) could be dropped. This was simply a hollow vessel closed at one end, with a handle attached for easy manipulation. The rear (closed) end of this cylinder abutted against the closed (breech) end of the welded-on barrel extension. The forward end lined up with the breech end of the barrel tube. The ball was pushed into the open rear end of the barrel, then the movable powder chamber dropped into position behind.

Early nomenclature for firearms of all kinds, as indicated, was confusing. The English words cannon and gun (the latter can be traced back to about 1350, the former at least to Froissart) derive respectively from the Latin *canna* ("a tube") and *mangonel,* a powerful pre-gunpowder stone-hurling engine of war. Mortar has always been applied to a short, stubby cannon because of its resemblance, in its earliest forms, to the conventional vessel of the chemist and apothecary. Bombard was also used to describe early guns, large and small. Thus *bombardes-à main* ("hand bombards") are mentioned as in use at the siege of Bonifacio in 1420, while the diminutive form *bombardelle* appears in an earlier Italian

manuscript of 1381. However, after the art of casting great guns was mastered during the last decades of the 14th century, bombard came gradually to apply only to large pieces of artillery now long obsolete.

The efficiency of these crude specimens of artillery was severely limited (were any limitation necessary) by the "serpentine" powder of the day, which was truly a powder and not the grained substance now known. This required no little skill in handling, and an experienced gunner could develop the full capabilities of a piece where a tyro was likely to blow it up (and himself and crew into the bargain) or else be plagued either with a succession of misfires (the charge failing to burn when the match was applied) or a series of "overs" or "shorts" (the missile falling beyond or on the near side of the target). The whole secret lay in the fact that the finely divided mixture would form into a solid mass practically impermeable to flame when rammed too vigorously, or simply fizzle out like a weak firecracker when seated with insufficient force. Only when put in place with the delicate touch gained from long experience, which left it loose enough for a flame to spread quickly through its fine interstices, yet packed tightly enough to build up what constituted, in effect, an explosion rather than a progressive, but ballistically impotent, conflagration, did it really perform satisfactorily. (*See* GUNPOWDER.)

Further, it was soon discovered that such powder, when mixed beforehand and transported for any distance, tended to separate out, the heaviest component (sulfur) settling to the bottom, and the lightest (charcoal) rising to the top. Fired in this state, it was even more than ordinarily inefficient. The result was that the gunner had to mix the several ingredients on the field of battle, a precarious maneuver in view of the fact that the lighted matches of the musketeers were everywhere about. Thus he became a man apart, feared and shunned by all and sundry. For more than three centuries following the invention of the cannon most artillerists were civilian specialists called "artists." The French army employed civilian "artists" as cannoneers as late as 1800.

3. 15th Century.—Dating, however, from about 1429, one finds record of an important achievement—the "corning" of powder. Briefly, this involved the mechanical incorporation, in fixed proportions, of the three ingredients so firmly and intimately that there was no longer any tendency for them to become dissociated on handling, plus the added feature of turning out the finished product in "grains" of various sizes according to the purpose for which intended; viz., small grains for small guns, large grains for large ones. Large grains fired in a small piece burned so slowly that much of the charge left the muzzle unconsumed, its effect thus entirely wasted. Small grains in a large piece burned so fast as to develop dangerous pressures in the chamber, and sometimes even to burst the tube, before the ponderous shot ahead could fairly get started. The grains of the new product, though of about equal weight, were irregular in shape, hence could not ball up into a conglomerate mass as did the serpentine. Instead, the interstices so necessary to the swift propagation of the flame were thus automatically provided, and the explosion of each successive charge was uniform and highly effective. So effective was it indeed that though the employment of corned powder in small arms went rapidly forward, it was a full century before its adaptation to artillery had become complete; for the cannon of the period were wholly unequal to the strains set up by this improved propellant, nor was the art of gun founding able to meet the situation thus arising for many decades yet to come.

The 15th century saw the manufacture of enormous bombards that still rank among the largest pieces of artillery ever built. It is significant that they appeared in such widely separated regions as Scotland, Belgium, Turkey and Russia. Edinburgh castle's "Mons Meg," of uncertain origin but probably built before 1500, weighed five tons and could throw a 19½-in. iron ball nearly a mile. "Dulle Griete," the giant 13-ton bombard of Ghent, had a 25-in. calibre and fired a 700-lb. stone. The largest of all, the "Tsar Cannon" of Moscow, had a 36-in. bore, weighed nearly 40 tons, and was cast by Andrei Chokhov in 1586. Some of the most formidable bombards of the 15th century were those used by the Turks when they captured Constantinople in 1453. All these were smooth-bore pieces. Rifling the bores of artillery pieces was attempted as early as the middle of the 15th century, but apparently without much success. Serious efforts to develop it are said to have been made by the Swiss Jean Maritz during the early 1700s, but manufacturing difficulties held it in abeyance until the 19th century.

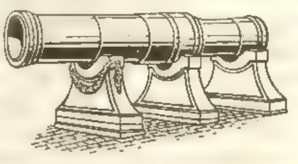


FIG. 2.—DULLE GRIETE, GHENT, BELG.

Despite the inventive genius constantly devoted to the development of firearms, artillery included, the 15th century waned and closed without these new agencies of warfare having gained sufficient recognition to receive special classification either on the basis of relative size or tactical employment. Thus, Francesco di Giorgio Martini, writing a few years prior to Charles VIII's expedition against Naples (1494), describes ten different types of firearms, and adds that this by no means exhausts the list. Yet he draws no distinction between cannon and shoulder weapons. To him the bombard, 20 ft. long and firing a 300-lb. ball, falls in the same category with the scopietto, which measured 24–36 in. over-all and discharged a missile weighing ½ to ¾ oz. All were to him "artillery."

Nevertheless, a differentiation, among the heavier pieces at least, was taking place, if insensibly, and before the 15th century ended field artillery as distinct from the more ponderous and relatively immobile artillery of position may be said to have been born. Prior to this time, field artillery consisted simply of such guns of its siege train as an army was able to bring into the field. But the Italian wars, which Charles VIII initiated, stimulated French ingenuity to the development of means whereby guns could be endowed with a fair degree of mobility. These included the uniform mounting of ordnance on wheeled carriages (in place of the clumsy sledges theretofore prevalent) and the employment of well-trained horses, rather than the slow-footed oxen, as draft animals. Thus, while the Italians and Spaniards were still entrusting the transport of their artillery to that sluggish beast, and Maximilian I possessed draft teams sufficient to move but half of his siege train at a time, the sturdy French horses were learning to draw heavy cannon on level roads at a pace equalling the marching speed of cavalry.

But the French were not alone in their efforts to make artillery a mobile arm. Indeed, the Italian Bartolomeo Colleoni (d. 1475) is credited with being the first captain to develop a true field artillery tactic, locating his light guns in the rear of other elements, and firing through gaps in these which were opened at a given signal. Nevertheless, such practices were far from general, and most Italians considered Charles VIII's employment of field guns as something quite revolutionary. Fortunately for him, he so outweighed his adversaries in the quantity and quality of his artillery, not to mention pieces exceeding in calibre any yet known in Italy, all mounted on scientifically designed carriages and operated by trained gunners, that his superiority in that arm was maintained throughout all the earlier Italian campaigns, its reputation alone being in some instances, as at Fornovo, sufficient to undermine enemy morale.

It was during this century that artillery acquired a characteristic which it had lacked (to the considerable limitation of its effectiveness); namely, the trunnions whereby the gun tube was affixed to its mount, about which it could be rotated when an increase or decrease in range was desired, and through which the shock of discharge was transferred in large measure to the carriage. In earlier types, the simple cylindrical tube or barrel was commonly set into a heavy wooden framework, a stout cross member of which abutted against the breech and received from it the impulse of recoil. This crude design did not by any means yield without a struggle to the more advanced one in which trunnions figured, for the obvious reason that it was much easier to cast a plain tube than one from which two excrescences projected outward opposite one another at right angles to the tube axis. But the advantages of the trunnions were so outstanding that the

simpler but less efficient trunnionless type was finally replaced entirely by its more adaptable competitor.

4. 16th Century.—The French successes naturally stimulated others to emulate their efforts. The younger duke of Ferrara, whose father (d. 1505) had long been interested in ordnance and was one of the few of noble birth to engage in its production prior to 1500, turned out specimens in considerable numbers and of increasingly high quality. In 1509 was witnessed the destruction by his artillery of the dread Venetian fleet which had proceeded up the Po to within a short distance of his capital, an event which contributed enormously to the increasing prestige of artillery in general. Only the following year, the French accomplished the reduction of Legnano chiefly through the agency of two of Ferrara's guns of tremendous size, the casting of which he had personally superintended.

As the 16th century neared mid-point, the artillery policies of all great nations of that day, which had been developing without rhyme or reason for more than 200 years, appeared ready for a complete overhaul. Calibres and varieties of guns approached infinity; standardization was unknown. To reduce this chaos to some sort of system, Charles V of Spain decreed, in 1544, a total of seven models of cannon which would thenceforward be made for, and used by, the armies of his empire. These included a cannon (40-pounder), a cannon-moyen (34-pounder), two types of 12-pounder culverins, two 6-pounders and a 3-pounder falcon. Early pieces were often named after birds of prey. The French were quick to follow suit, and in 1550 Henry II issued an edict restricting the number of calibres to 6, the heaviest a 33-pounder weighing, with its carriage, 8,000 lb., and drawn by 21 horses; the lightest a 2-pounder to which two horses were assigned. Later (1584) two additional types were permitted, a 12- and 24-pounder (calibres which the Spaniards had found useful in the Low Countries).

The practice of the day involved the transport of these pieces muzzle foremost, their massive trails dragging on the ground behind, and their equine motive power stretched out in single file, so that each gun when on the march must have occupied interminable yards of road space. Nor did the passage of time simplify the picture, for the 33-pounder of 1633 had increased in weight by 400 lb., and the horses drawing it now numbered no less than 25, though some progress could be recorded in the fact that the weapon was now hauled trail foremost.

These gestures of Charles of Spain and Henry of France, while aimed in the right direction, left much to be accomplished. Thus, among a few of the shortcomings of contemporary artillery may be mentioned their want of limbers, a complete lack of uniformity among carriages, the quite common and often disastrous failure to provide the artillery train with any spare parts for emergency repairs (save an occasional extra wheel) and so on. No specific powder charges were established, though practice favoured the use of a weight of the very indifferent propellant then current which actually equaled that of the shot. Three sizes of powder were employed—large-grained for the heavier guns, small-grained for the lighter and a still finer type for priming all varieties.

During this century the art of gun founding was introduced into England by ordnance-minded Henry VIII after he had been forced by lack of a home industry to reach overseas and employ the famous Fleming, Hans Poppenruyter, to supply him with nearly 150 pieces of varying calibres, including the celebrated set of bombards known as the "Twelve Apostles." He likewise imported (*c.* 1515) foreign armourers and established schools of instruction for native artificers. Nor was he entirely satisfied with the ordinary solid shot then in use, but undertook to augment these with crude types of shell described by a contemporary as: ". . . hollow shot of cast yron, stuffed with fire-works or wild-fire: whereof the bigger sort for the same had screws of yron to receive a match to carry fire kindled, that the fire-work might be set on fire to break in small pieces the same hollow shot, whereof the smallest piece hitting any man would kill or spoil him." Here we see, in the type "stuffed with fire-works," the beginnings of the explosive shell and, in that containing "wild-fire," of incendiary projectiles.

In the German states, calibre simplification was not then carried as far as in France. Thus there is illustrated and described in Napoleon and Gen. Ildefonse Favé's work on artillery as in use during the period 1550–1600 no less than 11 varieties of mobile cannon, from a little 1-pounder to a huge piece discharging a 94-lb ball. Further, there existed among all of these, save the very smallest, subclassifications which brought the total to the impressive figure of 40, the heaviest of which called for no less than 60 horses to get it into motion.

But far more important than the number of cannon types employed in France, Spain or Germany at this time were the premonitory rumblings then coming out of Italy to predict the birth of a new science—ballistics. Given written expression by the famous mathematician Niccolo Tartaglia (*q.v.*) in works which appeared in 1537, 1546 and 1551, these constitute the first recorded scientific approach to the theory of gunnery as distinguished from the prevailing rule-of-thumb practice. And although in large measure incorrect, this author's ideas on the trajectory of a cannon ball (previously held to be a straight line from gun muzzle to some point in space, after which the missile fell suddenly to earth) were so far ahead of his day that he justly deserves the title of first ballistician.

5. 17th Century.—By this time some artillerymen were beginning to realize that certain practices, though hoary with age, lacked foundation in logic. Thus it had from the very beginning been customary to make the barrels of cannon (as contrasted with mortars; howitzers came along later) outlandishly long to afford opportunity for the complete combustion of the serpentine powder originally employed in them. Then came the introduction, and finally the general adoption, of corned powder, which burned faster and more evenly, and accomplished as much in short barrels as its predecessor had in long. Yet for a long time barrels continued to be made long, no one quite knew why. Similarly, though some of the earliest cannon to be cast with trunnions had these located where they properly belonged—with their long axes in the same plane as that of the long axis of the bore—practice soon departed from this, and trunnions came to be set on a level with the bottom of the bore and remained so situated for generations. As a result there was at each firing an undue strain on the trail of the piece which, as the strength of powder increased, frequently gave way under the force so applied. Not until the latter half of the 18th century was this patent error generally corrected.

During the first half of this century, Gustavus Adolphus of Sweden introduced (1626) his famous leather guns, so named because the external casing of the barrel was of that material. The bores, however, were metal (copper) tubes. Every effort was made to curtail weight, and as a result that of the gun itself, apart from its light carriage, came to but 90 lb., and the piece could easily be drawn by two men. Designed as the last word in mobility, it possessed that qualification in high degree but embodied at the same time a deadly disadvantage; for on repeated firing it became so hot that a new charge would often ignite spontaneously. This led to its supersedure (1631) by matériel of more substantial, it less mobile, character, and further effort to develop a truly light artillery remained in abeyance until resumed in the century following by Frederick the Great.

During this period, calibres of French cannon underwent further change by reason of the adoption of various foreign pieces. This resulted in an increase in varieties from six to seven, the largest piece now being a 48-pounder, then ranging downward through 32-, 24-, 16-, 12- and 8-pounders to one of 4 lb. But here all order ended; for the kingdom was divided into a number of artillery districts, each commanded by a lieutenant general of that arm. And the cannon and all their accessories of one district differed from those in the next. Each calibre of gun employed wheels of a size unlike that used by any other calibre. Spare carriages were taken into the field, but those of one district would not mount the guns from another. In but one feature was simplification of the practices of the preceding century evident: powder had become standardized in grains of a single size and, ballistically speaking, this evidenced a retrogression. But here again, specimens from the several districts were likely to exhibit marked variations in strength, though for the most part a charge of but two-thirds the weight of the ball now accomplished what had required weight for weight a

century earlier, the quality of powder having improved to this extent over the intervening years.

6. 18th Century.—This century was to witness a period of marked ordnance activity on the part of all major European nations. Among the high lights may be noted the abolition in France (1732) by General Valière of all mobile pieces above the 24-pounder, thus making that calibre the nation's heaviest field weapon. Coincidently he decreed a uniformity in the methods of fabricating cannon never before attempted. Unfortunately, his efforts ceased at this point. There remained as many different designs of gun carriages as there were manufacturing arsenals. Axletrees continued to be of wood. Limbers, when used at all, were too low, and draft horses were still strung out in single file ahead of the guns to which they were hitched.

Turning to England, we find the groundwork of modern ordnance theory and practice laid by Benjamin Robins (1707–51), whose *Principles of Gunnery* (1742) exploded ancient superstitions about the nature and action of gunpowder and the flight of projectiles, and formed the basis of all later scientific studies in these fields. Gunners were now for the first time able to measure with considerable exactness the muzzle velocities of projectiles delivered by their pieces as a result of his invention of the ballistic pendulum, a device whereby the energy of a projectile suddenly halted in its flight could be accurately estimated and translated into terms of velocity.

By the time of Robins' death, strenuous efforts were again being made on the continent toward developing a truly efficient mobile ordnance (field artillery). Thus, the Seven Years' War found Prussia in the midst of a series of experiments with pieces weighing from 80 to 150 times as much as the balls they fired, while by 1762 the Austrians had standardized on guns all 16 calibres long (i.e., with tubes 16 times their diameter in length), all 115 times the ball in weight, all firing missiles carefully cast to a true spherical form and with so little windage (excess in diameter of bore over that of projectile) that they achieved excellent results with powder charges not exceeding in weight one-third that of the missile.

Other nations were not insensible to these developments and, by 1765, Jean Baptiste de Gribeauval, who became chief inspector of artillery in 1776, had commenced yet one more revamping of French matériel. This resulted in even further reduction in the number of different calibres employed in the field, these now totaling but three, the heaviest a 12-pounder, the others carrying 8- and 4-lb. balls respectively. These were all 18 calibres long and 150 times the weight of the shot for which designed, thus continuing the now well-established trend toward reducing the length and weight of field pieces. Once again, much attention was paid to securing balls of true sphericity and correct diameter, thus making possible the same reduction in powder charge as had been effected by Austria, i.e., to one-third that of the ball in weight.

Another innovation was the introduction, for field use, of a light howitzer of 6-in. bore. Yet another, which marked a real milestone in artillery progress, was the disposition of draft horses in double files in place of single file. Six horses now sufficed to draw the 12-pounder—four for the lesser sizes, a pleasing contrast with the numbers required a century earlier. Limbers, then casually in use, became standard equipment. These were large, six-wheeled affairs, but higher and more serviceable than those of Valière. The limber box (a combination receptacle for ammunition and seat for some of the gunners) failed, however, to gain acceptance despite Gribeauval's strenuous efforts, though he did succeed in establishing interchangeability of wheels and other parts, and in introducing iron axletrees, elevating screws, tangent scales and prefabricated cartridges. These replaced the old loose powder and shot and embodied carefully weighed powder charges sewed into cloth bags, to one end of which a shot was securely affixed, the whole being swept down the bore of the piece and seated at the breech by a vigorous movement of the rammer. They were, however, in no sense a new invention, Adolphus having used them with some success in the century preceding.

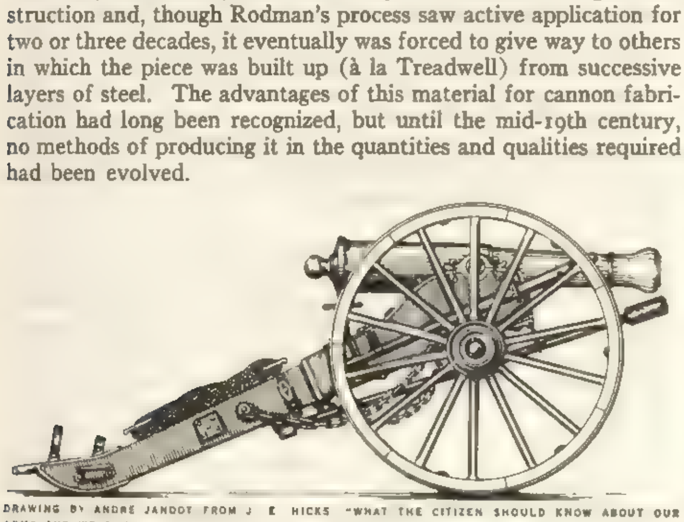
Other of Gribeauval's achievements included the classification of land ordnance into three well-defined groups (field, siege and coast defense) according to the purpose for which intended. In the first category he endeavoured unsuccessfully to educate his countrymen to the importance of horse artillery, an ultramobile element first employed by Frederick the Great (1759), designed to maneuver with cavalry in the manner in which field artillery operated with infantry. Not, however, until after the outbreak of the French Revolution was such a unit found in the French service, its counterpart, incidentally, appearing in England at approximately the same time. The latter years of the 18th century are marked by the invention (1784) by a British lieutenant (later general), Henry Shrapnel, of a form of spherical case shot for use against personnel, destined to bear his name and to supplant most other types of artillery ammunition for well over a century to come.

7. 19th Century.—This century was to record a series of advances in ordnance practice so brilliant as to render the artillery in use when the century closed probably ten times as efficient as that which marked its opening. Contributing factors included progress in chemistry, mechanics, metallurgy, optics and associated sciences which made possible: (1) the perfection of a workable rifled cannon, long sought by ordnance engineers but never before successfully attained; and (2) the adaptation to rifled cannon of elongated projectiles which (a) because of their more streamlined form were less affected in flight by wind than were the round balls they displaced; (b) by reason of the stabilizing spin imparted them by the rifling grooves, flew much straighter; and (c) being decidedly heavier than a ball of like diameter, ranged much farther than the spherical form. But to propel these heavy bolts, more and better powder was required. This was made available through the researches of Capt. (later Gen.) Thomas J. Rodman (U.S.A.), who produced a "mammoth" brand of powder shaped as large hexagonal prisms and perforated to permit the flame to burn outward as well as inward from the prism surface. Thus the initial violent evolution of gas from the burning grains, followed at once by a progressive decrease in gas production as the surface of unburned powder exposed to the flame was steadily curtailed, gave way to a situation where, though the external surface of the grains constantly shrank, internal surfaces, provided by the perforations, were enlarging with each instant. The final effect was to stretch out materially the period of mass evolution of gas and of high pressures on the chamber walls, and so to develop, in effect, a prolonged steady push against the base of the projectile rather than a sudden blow, with maximum stresses much moderated. But before this achievement had been recorded, workers in other fields, attacking the problem from different angles, had succeeded in producing guns both of bronze and cast iron, the two materials used almost exclusively in the founding of cannon for centuries past, and which possessed high physical characteristics that enabled them to withstand pressures formerly unthought of. In the case of bronze, this result was attained by the admixtures of certain proportions of phosphorus to the copper-tin alloy. However, the achievement came too late (1870); the day of the bronze cannon was over.

Toward enlarging the capabilities of iron pieces, two Americans offered solutions. One, a civilian engineer, Daniel Treadwell (1791–1872), designed a built-up, muzzle-loading cannon in 1841, which he evidently believed his exclusive invention, though his claims have been disputed in favour of a Frenchman (M. Thiery), said to have developed a similar piece in the 1830s. Treadwell's gun, in its final form, consisted of a central tube of cast iron or steel, surrounded by a series of wrought-iron or steel hoops, shrunk on after heating, and in some instances united also by screw-threaded joints. This basic method of construction was later successfully adopted in the United States by Robert Parrott and in England by William Armstrong (q.v.) and Blakely and, save for improvements in means and materials, became the modern practice. But Treadwell received no adequate encouragement from the military, and died disappointed and discouraged.

The other system was developed about 1845 by Rodman and was quite different. Instead of casting guns as solid cylinders of iron later to be bored out, the ancient and honourable method, he cast them hollow about a removable core through which a stream of water was slowly passed. Cooling thus took place from within

outward (the external walls were kept warm meanwhile), succeeding layers of metal from bore to surface undergoing compression as those overlying slowly shrank, thus accomplishing, but by a radically different method, just what Treadwell had done. But cast iron, like bronze, had had its day as a material for gun construction and, though Rodman's process saw active application for two or three decades, it eventually was forced to give way to others in which the piece was built up (à la Treadwell) from successive layers of steel. The advantages of this material for cannon fabrication had long been recognized, but until the mid-19th century, no methods of producing it in the quantities and qualities required had been evolved.



DRAWING BY ANDRE JANDOT FROM J. E. HICKS "WHAT THE CITIZEN SHOULD KNOW ABOUT OUR ARMS AND WEAPONS"; BY COURTESY OF W. W. NORTON & CO., INC.

FIG. 3.—U.S. 6-LB. FIELD GUN USED IN THE CIVIL WAR

Alfred Krupp (Germany) was the first to produce a successful all-steel gun. Drilled out of a single block of cast metal, it was the marvel of its day. The first specimen to be shown at a world exposition, a modest six-pounder displayed at London in 1851, attracted universal attention. Within ten years Krupp was producing guns of 8-in. bore and larger, all from solid blocks of cast steel. However, after other makers had demonstrated the possibilities of all-steel guns on the built-up (hooped) system, he gradually adopted that method of fabrication also.

The military world was now (1850s) enjoying rifled cannon which projected heavy missiles to what were then considered stupendous ranges, this as a result of the improved powders and stronger gun tubes. Capt. Paul le Boulengé of the Belgian army invented an instrument (chronograph) which constituted a material improvement for measuring velocities over Robins' ballistic pendulum. But it still lacked accurate means of estimating the forces exerted by the burning powder gases against the breech of a weapon. As a result, current methods of determining the strength of the walls required to withstand these were based more on trial and error than anything else. But here again Rodman came to the rescue by designing a gauge which permitted very accurate calculation of the pressures engendered.

Three factors were still lacking to make the gun the super-efficient engine it became with the advent of the 20th century. These were: (1) a successful system of breech loading; (2) a satisfactory smokeless powder; and (3) means to dampen the forces of recoil when the piece was fired so that it could be relaid on its target quickly and accurately. In respect of the first, breech-loading cannon of fair efficiency had been produced as early as the 1840s by Cavalli, a Sardinian officer, and Baron Wahrendorff of Sweden. The time was ripe for such a development, for as guns became longer and heavier, the mechanics involved in getting the charges properly inserted into their ponderous muzzles, ramming them home, then returning the pieces to their firing positions and relaying them upon their targets became increasingly complicated, and a satisfactory system of breech loading more urgently indicated. During the 1860s and 1870s, several such methods were perfected simultaneously in France (Col. C. Ragon de Bange), Germany (Krupp), Spain (Freyre) and the United States (Broadwell).

In England during the 1850s, Sir William Armstrong and Sir Joseph Whitworth had developed wrought-iron, built-up, rifled cannon. Whitworth's was noteworthy in possessing a hexagonal bore. The American Civil War of 1861–65 offered the first opportunity for a mass trial of rifled guns and, to a limited degree, of breechloaders as well. Even so, the vast majority of cannon used in that conflict were smooth-bore cast-iron (plus some brass muzzle-loaders, although steps to modernize these by reaming out the original bore and driving into it a rifled tube of wrought iron or steel were taken during this period and continued for a number of years thereafter. Wire-wound guns in which countless turns of fine wire coiled under tension replaced shrunken-on hoops as reinforcement for a relatively thin central tube had already been under development from about 1855 but were yet to receive the recognition later accorded them.

In the field of propellants (*q.v.*) black powder, which reigned supreme, produced so much smoke as to obscure both firer and target after a heavy volley, or broadside, and left such heavy fouling in a gun bore as to require frequent cleaning if accuracy were to be maintained. In addition, it was, despite the notable achievements of Rodman and others, far from under full control in the matter of the chamber pressures it developed. A new propellant, smokeless, without residue and capable of being harnessed over a much wider range of its activity was urgently indicated. The answer appeared at hand when, during the 1860s, Baron General von Lenk conducted a prolonged field test of guncotton (first compounded a few years previously) in the Austrian artillery. But a lack of stability and consequent tendency to spontaneous explosion in storage led to its eventual rejection. So it remained for the French chemist Paul Vieille (1887) to harness this unruly substance by gelatinizing it into colloid form with the aid of suitable solvents, and thus make available to the military world the propellant it had so long awaited.

And now the science of mechanics, which had already solved the problem of breech loading, came again to the aid of the artilleryman and gave him a gun mount so ingeniously designed as to permit it to absorb the tremendous recoil developed when a modern piece is fired, this without rearward movement of the carriage or displacement of the barrel from its original position once action and reaction had their effect. This was accomplished by suspending the gun tube proper in a cradle and interposing between the two compression cylinders, heavy spiral springs or other means of accumulating, as the barrel swept rearward, the energy necessary to return it to its original position, once recoil effects had been dissipated, rather than transmitting these to the carriage. Prior to the development of such a system, the gun and its mount, to which it was rigidly affixed, recoiled to distances varying with the calibre of the piece and charge employed, then had to be brought back "into battery" by human effort and pointed again at the target. With the perfection of such counterrecoil mechanisms, artillery finally acquired all the more important characteristics which it possessed at the commencement of World War I.

There was a revival of interest in the rocket during the closing years of the 1700s and particularly in the early part of the 19th century, after the weapon had been neglected as an implement of war for several centuries. In their wars with the British, for instance, native Indian troops used rockets. During the Napoleonic Wars British warships launched rockets in their attacks on continental coastal cities, and the field forces used them in both siege and battle. The "rocket's red glare" in "The Star Spangled Banner" was not a phrase penned by Francis Scott Key without foundation in fact. In the bombardment of Ft. McHenry, defending the city of Baltimore, Md., ships of the attacking British fleet were equipped with rocket-firing devices which were used with spectacular effect. *See* ROCKETS AND GUIDED MISSILES.

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II. WORLD WAR I

The types of artillery equipment in use by the three major powers involved at the beginning of World War I (Great Britain, France and Germany) did not vary to any marked degree. All

proved deficient in range, the British equipment being initially at a particular disadvantage in this respect. It will be apparent that there were, however, important differences in the allotment of the artillery as between divisions, corps and armies and in the aggregate proportions of the various types of equipment. The Germans had a marked advantage in the possession of a large number of howitzers capable of assisting in both field and siege operations. Both Britain and Germany had six-gun batteries while the French batteries were of four guns. All three countries had divisional artillery commanders, but France alone had an artillery commander at corps headquarters. Viewed in the light of subsequent experience, it would seem that both the British and French tactical doctrines of 1914 unduly emphasized the importance of mobility to the detriment of firepower. The German doctrine appears to have been better balanced in this respect and the Germans also realized more fully the necessity for co-ordination of combined action of the artillery with that of the other arms. All three countries had grossly underestimated the quantities of ammunition which would be required. The British reserve was calculated upon a basis of a probable expenditure of 7 rounds of the biggest field-pieces per day, but in World War I the actual daily expenditure for some light guns occasionally rose to 500 rounds or more. No country had fully appreciated the effect upon artillery power of the development of railways, motor traction, aircraft, telegraphs, telephones, radio and survey.

1. Evolution of Equipment.—The British field artillery stood the test of the war well and the minor defects which appeared were easily remedied. The proportion of medium and heavy artillery was vastly increased, the equipments adopted being 60-pounder and 6-in. guns and 6-in., 8-in. and 9.2-in. howitzers. Superheavy howitzers of 12 in. and upward and guns on railway mountings of 9.2 in. and upward were brought into use. Much publicity was given the German "Big Berthas," howitzers with bore diameters of 42 cm., or nearly 17 in. And mortars, a type of weapon which had long been discarded, made their reappearance for the war of position. The ranges of all weapons were increased, field artillery ranges rising to about 10,000 yd. and even more in the case of French and German equipments; the greatest range (viz., 76 mi.) was attained by the German 21-cm. guns used to shell Paris (*see* BIG BERTHA). The British field guns, which had started the war with shrapnel ammunition only, were supplied with high-explosive shell in addition before the battle of Loos. Shrapnel was abolished for 4.5-in. howitzers, and in the heavier pieces high explosive was almost exclusively used. Smoke shells were introduced for the lighter types of guns and howitzers in 1916. In July 1915 the Germans first employed gas shells, and this type of shell came into general use in steadily increasing numbers.

It is noteworthy that the supply of gas ammunition never equaled the demand and that the use of gas was still in its infancy at the end of the war (*see* CHEMICAL WARFARE). An advance in the control of fire was effected by the development of observation from aircraft. Intercommunication was improved by the more extended use of the field telephone and of radio. Survey, sound-ranging and flash-spotting units were provided for co-operation with artillery. The lighter types of artillery were still generally horse drawn in 1918 although trucks were used, especially by the French, to transport a portion of their field artillery. The heavier pieces were drawn by motor tractors of various designs ranging from the four-wheel-drive truck to the caterpillar.

2. Evolution of Organization and Command.—A comparison of the development of artillery organization and command in the British, French and German armies shows that, notwithstanding their initial differences and the separate lines of evolution which were followed, all three arrived at similar solutions of fundamental problems. The changes introduced may be summarized as follows: (1) Artillery command was centralized as much as was consistent with effective control. This proved the best means of co-ordinating action, of economizing force and of concentrating fire at the right time and at the right place.

Centralization of control was often carried to excess, however, in the western theatre. This change in the system of artillery command entailed an increase of artillery headquarters staffs. (2) The necessity for a strong reserve, in the hands of the higher command, of both field and heavier types of artillery led to the creation of large numbers of artillery units outside the organization of formations. In 1914 the proportion of field artillery to infantry in an army was about 6 guns to 1,000 rifles. By the end of World War I the proportion of all types was about 10 guns and howitzers per 1,000 rifles, roughly 6 field, 2 medium, $1\frac{1}{2}$ heavy and $\frac{1}{2}$ superheavy. (3) The allocation of equipments to formations was based upon their ranging powers and their degrees of mobility. Thus, field artillery (in the United States light artillery) was seldom allotted to formations higher than the division; medium and heavy artillery were normally allotted to corps, while superheavy guns were directly under armies. (4) The corps was recognized

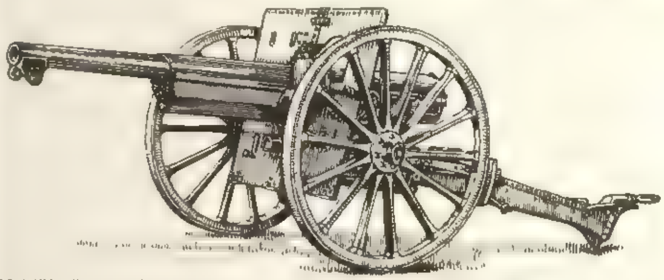

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FIG. 4.—FRENCH-DESIGNED 75-MM. FIELD GUN, MODEL 1897, USED BY U.S. FORCES IN WORLD WAR I

as the most suitable formation for the control of counterbattery work and special staffs were provided for this task. The divisional artillery of an infantry division, U.S. army, consisted of two regiments each of six batteries of four 75-mm. guns, one regiment of six batteries each of four 155-mm. howitzers and one trench mortar battery.

3. Evolution of Tactics.—The evolution of equipment and organization and the evolution of tactics were, of course, interdependent. It was naturally on the western front that artillery tactics were most fully developed. During the first operations in 1914 sharp lessons were learned. It was soon evident that because of the hitherto unrealized power of small-arms fire in defense, attacks must be well prepared by artillery. Tactical mobility had, in fact, become dependent upon firepower, but neither side had the artillery or the ammunition to provide firepower in adequate measure. At Le Cateau the British learned the disastrous results of attempting close support of infantry with guns disposed too close to the foremost troops. The early engagements also demonstrated the necessity for distributing guns in depth in defense and for concealing them if they were to avoid destruction. The need for increased quantities of medium and heavy artillery was soon apparent.

During the trench warfare of the winter of 1914–15 new developments began to take shape. Attempts were made to engage targets by night and to provide defensive barrages. Air observation of artillery fire also found favour. The employment of barbed-wire entanglements introduced a new task for artillery in the preparation of infantry attacks.

The operations of 1916 and 1917 were based upon the fact that, given sufficient artillery and ammunition, limited advances of 2,000 or 3,000 yd. at a time could be almost guaranteed. Enormous concentrations of artillery supported every attack. Thousands of tons of ammunition were fired daily during an operation on a front of a few miles. Surprise continued to be sacrificed, for the artillery carried out preliminary bombardments often lasting four or five days. Rolling barrages of great depth and heavy counterbattery fire were the unvarying accompaniment of the actual advances. Such were the methods of artillery action adopted in the battle of the Somme (1916), the French attack at Verdun (1916), at Arras (1917), in Gen. Robert Nivelle's attack on the Aisne (1917), at Messines and in the third battle of Ypres. The Germans, in their attack at Verdun in 1916, had endeavoured to obtain some measure of surprise by reducing the preliminary bombardment to ten hours and, in Field Marshal Edmund Allenby's attack

at Gaza, measures were successfully taken to deceive the Turks who might otherwise have been warned of the British plan by the five days' preliminary bombardment. But none of the commanders had as yet appreciated the paralyzing effect of the brief and intense hurricane bombardment of short duration which was adopted in 1918.

It became apparent, however, that a drastic change in tactical methods must be made if decisive success was to be obtained. The defender could, in great measure, counter the form of artillery support then in vogue, heavy as it was, by suitable adjustment of his infantry tactics; the ammunition expenditure entailed proved too great a strain on industrial resources; and the effect of the fire on the ground was such as to create new obstacles for the attackers. In the defense, artillery action had taken the form of "counterpreparation" to break up impending attacks by neutralization of hostile artillery and of stationary barrages close to the foremost trenches to repel assaults once they were launched.

The advent of tanks had an important bearing on artillery tactics. At the battle of Cambrai it was demonstrated that tanks could carry out tasks which had previously fallen to the artillery. They had a very great demoralizing effect; they could create gaps in barbed wire; and they could neutralize small-arms fire. The employment of tanks had a considerable influence in bringing about the abolition of lengthy preliminary bombardments and the consequent simplification of the problem of ammunition supply. The battle of Cambrai further proved that effective artillery support could be given, by means of survey methods, without previous registration.

The German successes on the western front in 1918 were largely the result of skillful artillery tactics, for the development of which Colonel Bruchmüller was chiefly responsible, the element of surprise being thus safeguarded. Their new tactics had first been employed, and with marked success, at the battle of Riga in Sept. 1917. Secrecy was observed in the preliminary concentration and other arrangements. Each attack was preceded by a short hurricane bombardment of a few hours' duration designed to produce moral rather than material effects and containing an element of surprise in the repeated withdrawal of fire to the forward defenses after it had apparently passed on. Gas and smoke shell were extensively used; counterbattery fire was heavy. The advances were supported in their initial stages by intense concentrations on enemy strong points and the infantry was boldly followed up by field artillery.

A counter to the German artillery tactics was eventually devised by the French in Champagne. Careful artillery counterpreparation was carried out for some time before the German attack which the enemy had not been able to keep secret. Troops were thinned out in the forward zone, in which the first shock of the attack was to be absorbed, and the main line of defense was organized in the rear, the artillery fire being adjusted to correspond with these arrangements.

A hurricane bombardment of 15 minutes, followed by a creeping barrage, was adopted with complete success by Allenby in his final break through the Turkish lines in Sept. 1918.

During 1918 the use of concentrations of fire increased. Gen. Charles P. Summerall (U.S.A.) in 1918 first tried out concentrating the fire of all his divisional artillery in front of one infantry brigade at a time when the infantry could go no farther with the help of the rolling barrage. Later, in the November attack in the Argonne, he gave his army corps heavier artillery support than had been seen up to that time. The system of artillery command at last admitted of centralization or decentralization according to the varying situation. A return was made to a long preliminary bombardment when the British 4th army attacked the Hindenburg line in September; surprise had then ceased, however, to have great value because of the extent of the Allied offensive and the disappearance of the enemy's reserves.

When operations ceased, the art of tactics was on the threshold of a new era of development which had been ushered in by the renewal of mobility, by the introduction of tanks and by the mechanization of transport. (*See* also TACTICS: *World War I.*)

(J. N. K.; M. B. H.)

III. BETWEEN WORLD WARS I AND II

The art of gun design and manufacture languished during the two decades from 1918 to 1938. In France, Great Britain and the United States the antiwar spirit was strong, leading to disarmament treaties that nourished the hope that war would never occur again. Commercial firms that had manufactured munitions for World War I were denounced as "merchants of death" and in all the western democracies the development of new or improved weapons was hampered by lack of interest and lack of funds.

In the United States there was no commercial manufacture of field artillery and even the government arsenals were barely able to keep from closing. The U.S. army devoted most of its limited artillery funds to development of a 37-mm. antitank gun, a 75-mm. field gun to supersede the French 75, a 75-mm. pack howitzer and a 105-mm. howitzer.

The Germans, being disarmed, had to limit their developments to theory except insofar as from time to time they found an opportunity, through relations with the U.S.S.R., to carry out some experimentation with the Russians. The Russians, from the beginning of the organization and armament of their World War II army, showed a tendency to develop new tactical ideas and therefore to modify their artillery armament to suit these ideas. In general, their artillery doctrine differed from the French one of using large concentrations of fire primarily under one command and leaned toward the splitting up of their artillery in small groups assigned directly to infantry units. The Italians, while closely following the French theory, showed a decided tendency after World War I to put into practice German theoretical solutions of artillery problems, insofar as their financial status would permit rearmament.

The Abyssinian campaign in 1935–36 gave the Italians the opportunity to test their theories with respect to the supporting artillery for infantry in mountainous countries and the relationship between artillery and aviation and the means of transport of artillery. The Italians steadily developed the idea that the infantry commander should have immediately available the lesser calibres needed for the assault. Therefore, besides small mortars which could be carried forward by the troops by hand, they had in each infantry regiment one battery of 65-mm. mountain guns carried on pack mules.

1. Spanish Civil War.—The Italians discovered that in many instances larger calibres could not keep up with the infantry and at other times could not be emplaced where they could reach enemy positions well up on a mountain. They therefore came more and more to use bombing by airplane as a means of supplementing their artillery fire. The Italians found that pack and horse-drawn artillery were essential because the use of mechanized and motorized artillery was greatly limited by the lack of roads and the difficulties of the terrain. A large and well-equipped road-building force enabled them to make a much greater use of mechanized and motorized artillery than would have been the case with other armies with nothing more than their customary organization and equipment for this purpose.

The result of the German, Italian and Spanish experimentation in battle in the Spanish civil war showed the need for increase in all types of artillery and, in general, larger calibres. The cannon as an aviation weapon was shown to be a necessity. The cannon as the principal tank weapon was shown to be an essential for all heavy combat. In other words, just as artillery weapons had steadily increased as essential parts of the armament of infantry units so had the artillery become an essential part of aviation and tank armament. There is little doubt that the experience in Spain with a few airplanes armed with a cannon of around 20 mm. was the reason for the large use of airplanes armed with cannon by the Germans in World War II.

In all assaults in Spain in 1938 and 1939 the artillery bombardment was followed by aerial bombardment from heavy bombers upon the same targets as those upon which the artillery had fired. The accompanying artillery fire during the infantry assault was dispensed with. There were no rolling barrages and no concentrations on the first objectives of the infantry. Artillery concentrations were on the rear of this objective. The accompanying artillery fire

was furnished by aviation and by tanks armed with cannon. The aviation attacked with light bombs and machine guns by dive bombing, one plane after another from one flank of the objective to the other. It repeated this until the infantry had reached the point where further air attacks became dangerous.

Tanks with cannon were distributed at intervals in the infantry assault wave. Their guns furnished fire on all critical points encountered by the infantry during its advance. Wherever the infantry was held up, a number of tanks with cannon and dive bombers would make a concentrated attack. The use of tanks with cannon of around 47 mm. and up frequently resulted in the 37-mm. antitank guns proving ineffective, this because of the longer range of the tank cannon and its bigger bursting charge. The consequence was that the 65-mm. mountain gun was more and more used as an antitank gun. Besides its greater range and bigger bursting charge it could, being a much smaller target, be emplaced in positions which an ordinary field gun of 75 mm. or 77 mm. could not use. This was because the latter was such a large target it would be destroyed by the enemy's fire.

The first German antiaircraft artillery used in the Spanish civil war was a 77-mm. gun. These guns were in mechanized batteries of four pieces each. It was soon found that the range was not great enough, the trajectory not flat enough and the bursting charge not large enough. Therefore, a new piece of 88-mm. calibre, and of greater length than the 77-mm., was constructed in Germany and shipped to Spain. This piece could reach any bomber with a war load. All sighting apparatus was set and corrected by remote control from a range-finding party some distance from the guns and in a position such that it had a good view of the target. These guns, instead of being emplaced in line, were emplaced at the four corners of a square probably 109 yd. to a side. When not firing on targets in the air the guns were used to fire at targets on the ground. Their long range made them particularly effective not only against positions well up on mountains but also against the rear areas including all the roads over which enemy tanks, artillery and supplies had to advance. The guns were field artillery in that they could be put in or out of battery in a relatively short period of time and could move easily over roads and also over terrain which was not too difficult.

As the result of their experiences in Spain the Germans and Italians made a number of changes in their armament and tactics. It may be said that these changes had to do with increasing the proportion of artillery to infantry, making cannon a part of aviation armament, increasing the number of tanks with cannon and the calibre of these cannon, and improving the communications between all parts of their armed forces so that the maximum benefit could be derived from their artillery fire for both offensive and defensive purposes.

By the use of cannon in aviation and in tanks it can be said that in addition to "fire and movement," that is, fire to cover movement, there is "fire in movement." "Fire in movement" was the basis of the success of the German armoured or panzer divisions in 1939 and 1940.

IV. COASTAL ARTILLERY

In the 19th century coastal artillery (or seacoast artillery as it was sometimes called) attained a position of substantial importance as a special branch of artillery. All leading military powers prepared their coastal cities, harbours or strategic waterways for defense against naval attack by the installation of both fixed and mobile artillery weapons capable of firing high-explosive shells at enemy ships far out to sea with a fair degree of accuracy.

Big coastal guns were elaborately protected from hostile fire by being emplaced behind thick earth and concrete fortifications, and were sometimes effectively camouflaged. In most instances these fortifications were equipped with underground storage rooms for supplies and had their own electrical systems. In some of them complicated mechanisms were installed to raise the guns above ground long enough to fire; the huge gun tubes were then quickly retracted into their concealed and well-protected pits. To control the fire of long-range coastal guns, observation posts were set up at points along the coast and were connected by wire communications to the gun position. The data reported by observers were processed in the plotting room and the target's location, speed and direction of movement were calculated. Just before World War II the British army experimented with radar for the control of coast artillery batteries.

During the first quarter of the 20th century the United States installed seacoast batteries at all its principal harbours, in the Panama Canal Zone and at naval bases in its island possessions. The coast artillery guns ranged in size from 3-in. pieces to huge 16-in. weapons and included 12-in. mortars that were designed to drop heavy shells on the armoured decks of warships. These weapons were supplemented by antiaircraft guns, searchlights and guns of smaller calibre for direct fire at high-speed motor torpedo boats and small submarines.

Coast artillery assumed such importance in the United States after the turn of the century—when memories of the Spanish-American War were still fresh—that the army created a coast artillery corps (CAC) separate from the field artillery in 1908. In addition to the coastal guns it had responsibility for the installation and control of submarine mines and in World War I took on a significant new responsibility when antiaircraft defense became a military necessity.

Coast artillery played only a minor role in World War I, and during the years that followed it gradually declined further as the bombing plane came into its own. As time passed, it became apparent that coastal batteries could be bombed too easily from the air, attacked from the rear or bypassed altogether. Early in World War II the fall of Singapore, Britain's mighty bastion in the far east, came as a severe shock to the whole western world. The Japanese had managed to approach Singapore through the jungle on the land side, where its defenses were weak, while its great coastal guns silently pointed out to sea. Even before the fall of Singapore the U.S. army had reorganized its forces along lines that dropped the CAC as a separate entity, at the same time that horse cavalry was supplanted by armoured forces. By the end of World War II most military authorities were convinced that fixed seacoast artillery had become obsolete. The U.S. army dismantled many of its old seacoast fortifications and turned them over to nearby cities to be used as public parks. (*See* COAST DEFENSE.)

(H. C. T.)

V. ARTILLERY IN WORLD WAR II

The lines of battle, the areas they encompassed, the speed with which situations changed, the frequent combinations of land, sea and air elements in one engagement and the co-ordinated, simultaneous use of all arms and services in every campaign makes an abbreviated outline of the part played by a single arm in World War II an impossible task.

In previous wars—which were primarily wars of position and which progressed from battle to battle in a relatively confined sector of the globe—it was possible to trace the progress of organic artillery and point out the spectacular and victorious roles it played in combat, often occupying the spotlight of attention as the sole active participant for long periods. Such continuity of participation during World War II cannot be narrated in a brief account because (1) the use of artillery as a weapon was not confined to an organic unit like the field artillery or the coast artillery corps, but was shared by the infantry and armoured cavalry (later known as armour or armoured forces) as well as the artillery; and (2) combat artillery units were engaged, withdrawn and re-engaged in so many different areas and participated in such varied types of operations that it is difficult to separate their action in a short description from the work of the rest of the fighting team. In substance, the story of such artillery is the story of World War II.

In general, the employment of organic artillery followed the techniques foreshadowed by the Spanish civil war. Despite widespread feeling early in World War II that aircraft bombing might supplant artillery, the role of guns remained significant. Experience demonstrated that the most concentrated bombing of which planes were capable could not achieve the same results as pounding by heavy artillery. For attacking strongly fortified positions,

only artillery was able to maintain constant, accurate, highly destructive fire on specific targets, unaffected by darkness or bad weather.

As rapid-firing guns and howitzers were used to lay down thunderous barrages, consumption of artillery ammunition reached astronomical proportions. In the first two days of the attack on Monte Cassino in Italy, U.S. artillery units fired something like 11,000 tons of ammunition. Total output of artillery ammunition in the United States from 1940 to 1945, counting all sizes from 20 mm. to 240 mm., totaled nearly 1,000,000,000 rounds, exclusive of bombs, grenades, mines and billions of rounds of small-arms ammunition.

It was estimated that if all the 105-mm. shells produced in the United States had been laid end to end they would have extended twice around the earth at the equator. The variety and complexity of both weapons and ammunition were so great that only broad classifications may be described here. Detailed data are in the countless technical manuals prepared by the armies using each type of weapon.

Artillery development in World War II moved forward along several distinct lines. All nations increased the calibres of their mobile field weapons as horses and mules were replaced by trucks and tractors that helped solve the problem of mobility. Before this time the weight of mobile artillery had been inescapably governed by the power of horses, with even the 75-mm. gun requiring a team of six or eight horses. Typical of the trend toward larger calibres was the U.S. army's action to replace its 75-mm. guns, modeled on the famous French 75 of World War I, by the 105-mm. howitzer.

The trend toward more powerful guns was also motivated in large part by the appearance of tanks with thicker and tougher armour. At the same time, heavy weapons such as railway guns, coast defense guns and guns of permanent fortifications such as the Maginot and Siegfried lines fell into the discard. (*See* FORTIFICATION.)

No new gigantic weapons appeared in World War II to compare with the much-publicized Paris gun of World War I. Instead the Germans brought forth new types of weapons, long-range V-1s (flying bombs) and V-2s (rockets) that were launched against England and Allied-held points on the continent during the latter part of 1944 and early 1945. Meanwhile Allied forces introduced the proximity fuze that automatically exploded artillery shells when they came within range of their target. Used first at sea for antiaircraft fire, the proximity fuze proved equally effective in firing on ground troops.

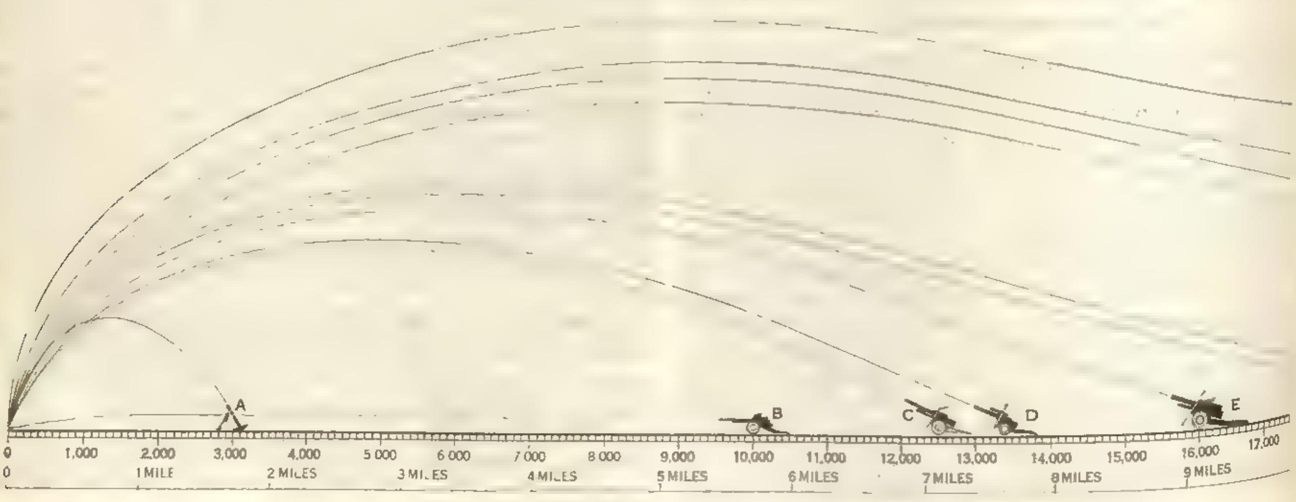
Because World War II was a war of rapid movement, altogether different from the trench warfare of 1914–18, the demand was not for bigger guns but for lighter, more mobile weapons. Rapidity of fire and speed of movement and emplacement were prime considerations. To achieve these ends, gun carriages were equipped with pneumatic tires and with improved bearings and springs to permit towing at high speeds. A major innovation along this line was the introduction of self-propelled artillery. Instead of being towed by horses, trucks or tractors or carried on the backs of mules, guns and howitzers were mounted on tank chassis or on other vehicles so they could travel speedily over rough terrain and fire without taking a long time for emplacement. In the Pacific ocean area the terrain and limited area of many of the islands did not provide opportunity for use of highly mobile matériel but did require powerful weapons for dislodging well-entrenched troops. Following the lead taken by British forces in their attack on Sicily, guns and rocket launchers mounted on ships were used in conjunction with aircraft bombing to provide a beach barrage that blasted coastal areas with high explosives before troops went ashore. Of equal importance were three classes of artillery that had come into prominence during the years since 1918—antiaircraft, antitank and aircraft—all of which played a major role in World War II. If to these are added recoilless rifles and the bewildering array of rocket launchers that appeared during the 1940s the multiplicity of artillery weapons at the disposal of field commanders is obvious.

Lines of classification between guns and howitzers and between small arms and artillery were frequently blurred, and weapons were not easily separated into mutually exclusive categories. The old U.S. army classifications of field artillery and coast artillery gradually lost their importance and after the war were merged into one branch known simply as artillery. Under these circumstances the weapons are best discussed under the headings of light, medium and heavy artillery, with additional special classes such as mortars, antiaircraft guns, aircraft weapons, recoilless rifles and rockets.

1. Light Artillery.—In the U.S. army the light artillery classification included the 37-mm. antitank gun and other weapons up to the 105-mm. howitzer. The chief weapons in the British field artillery ranged from the small 2-pounder (37 mm.) to the 3.7-in. howitzer and the famous 25-pounder (88-mm.) gun-howitzer. These guns and howitzers were used as mobile field artillery, towed or self-propelled, and as tank or antitank (AT) weapons.

The 37-mm. AT gun was light in weight (about 900 lb. when mounted on its carriage) and was maneuverable in areas denied to other artillery. Its maneuverability combined with its rapid rate of fire (25 rounds per minute) and seven-mile range made it a versatile weapon, equally useful for firing canister at enemy troops or armour-piercing shells at light tanks. In the Pacific area its maneuverability made it a favourite with troops. It served as a field gun on its own two-wheeled mount and was also placed on tanks, armoured cars and light trucks as a tank destroyer. Although used in large numbers, the 37-mm. steadily lost ground during World War II because it was too small to penetrate the armour of any but the lightest enemy tanks.

To defeat the new heavier armour, a Soviet army gun of 45 mm. had been battle-tested in Spain. The British 57-mm. (6-pounder) AT gun was a still more powerful weapon, but effective antitank fire demanded guns of even greater range and striking power. The U.S. army adopted a 3-in. AT gun with special ammunition that could penetrate more than three inches of tank armour at



2,000 yd.

The Germans used 50-mm. and 75-mm. antitank guns but also went a step further with their famous 88-mm. triple-threat gun that could fire against tanks, planes or personnel with equal ease. This gun was also mounted in heavy German Tiger tanks used in North Africa in 1942–43 and could knock out Allied tanks before they could come within range with their 75-mm. guns. The U.S. army's 90-mm. field gun failed to achieve the flexibility of its German rival.

Two howitzers rounded out the class of U.S. light artillery weapons, the 75-mm. pack howitzer and the 105-mm. howitzer. The former was the U.S. counterpart of mountain guns employed by armies of other nations. It could be towed by a small truck or could be disassembled and carried in several loads on the backs of mules up mountain trails inaccessible to larger guns. Special containers known as paracrates were made for dropping the parts of this weapon by parachute from airplanes. Far more important was the 105-mm. howitzer, produced for the armies of the United Nations in greater numbers than any other artillery piece. It could throw a 33-lb. high-explosive shell as far as seven miles and was supplied with a dozen types of ammunition, including an armour-piercing round, smoke shells and shells filled with propaganda leaflets. More ammunition was fired from the 105-mm. howitzer than from any other piece of U.S. artillery in World War II. Mounted on a motor carriage, it first saw service with British troops in 1942 in North Africa, where it was nicknamed "The Priest" because of the pulpitlike appearance of its machine-gun mount.

The light artillery of the Soviet army in World War II included a 76-mm. gun and a mountain howitzer of the same calibre. A new 85-mm. gun appeared in the postwar years.

2. Medium Artillery.—As there were only two U.S. army weapons in this classification during World War II, the 155-mm. howitzer and the 4.5-in. gun, the classification tended to merge with heavy artillery. Because of their long ranges and heavy firepower these weapons were used to blast road intersections and other fixed targets and to harass the enemy's lines of communication. The 155-mm. threw a 95-lb. projectile for a maximum range of nine miles. The range of the 4.5-in. was over 12 mi., but as its projectile weighed only 55 lb. it was far less effective than the howitzer. The standard medium weapons of the German army included a 100-mm. gun and a 150-mm. howitzer. As a close support weapon the latter was mounted on an armoured vehicle and nicknamed "Grizzly Bear."

Soviet medium artillery included a 100-mm. gun, a 122-mm. gun and a 152-mm. gun-howitzer. The latter two weapons were made more mobile in the postwar years and could be emplaced more rapidly.

3. Heavy Artillery.—Like the other two classes, heavy artillery of British-U.S. forces included both guns and howitzers—the 155-mm. gun, the 6-in. (153-mm.) and 8-in. (203-mm.) guns, the 8-in. howitzer and the 240-mm. howitzer. Despite the size and weight of these pieces they could be towed by powerful tractors and thus shared with the lighter weapons the all-important quality of mobility.

The 155-mm. gun, familiarly known as "Long Tom," fired a 95-lb. projectile at the rate of one round per minute for a distance of 15 mi. The huge 8-in. gun had a barrel 34 ft. long and weighed, with its carriage, over 30 tons. It fired a 240-lb. shell for 20 mi. at the rate of one per minute, and was considered the Allied answer to the German 170-mm. gun. Because of its great size and weight the 8-in. gun and its mount had to be broken into two sections for transport over roads and bridges. Cranes were needed for assembling the piece and handling the heavy shells.

The 8-in. howitzer fell between the 8-in. gun and the 155-mm. howitzer in terms of weight of projectile (200 lb.) but below them in range (about ten miles). It could be mounted on the same carriage as the 155-mm. gun. The 240-mm. howitzer was the largest piece of artillery to see action with the U.S. army, throwing a 360-lb. projectile for 15 mi.

Soviet heavy artillery included a 203-mm. howitzer, 210-mm. gun, 280-mm. howitzer and a huge 305-mm. howitzer. In the postwar years the Soviet army adopted a newly designed 203-mm. howitzer that had much greater range (28,000 yd.) and could be emplaced in a matter of minutes. It was probably capable of firing atomic shells.

4. Mortars.—World War II mortars formed a distinct class of weapons used by front-line troops to lob projectiles over hills or other obstacles into enemy positions at short range. They were simply constructed and sufficiently light in weight to be disassembled and carried by foot soldiers for short distances. Unlike other artillery weapons they had smooth bores (with some exceptions), were loaded from the muzzle and fired fin-stabilized projectiles. They needed no recoil mechanisms as their closed breech ends were fitted to a base plate on the ground.

Best known of the U.S. army mortars was the 60-mm. that weighed only 43 lb. and had a range of from 200 to 2,000 yd. The 81-mm. mortar that replaced the British 3-in. Stokes mortar of World War I had a range exceeding one mile. Two large mortars of 105 mm. and 155 mm. were produced in limited numbers for the U.S. army, and one gigantic piece dubbed "Little David" was constructed in 1944. Its bore diameter of 914 mm. ($36\frac{1}{4}$ in.) was precisely the same as that of the "Great Mortar of Moscow" built in the 16th century. It fired a projectile weighing 3,700 lb. and, unlike most mortars, had a rifled bore. Designed to destroy subterranean fortifications and industrial targets, it came too late in the war to be of use and was generally considered an impractical weapon.

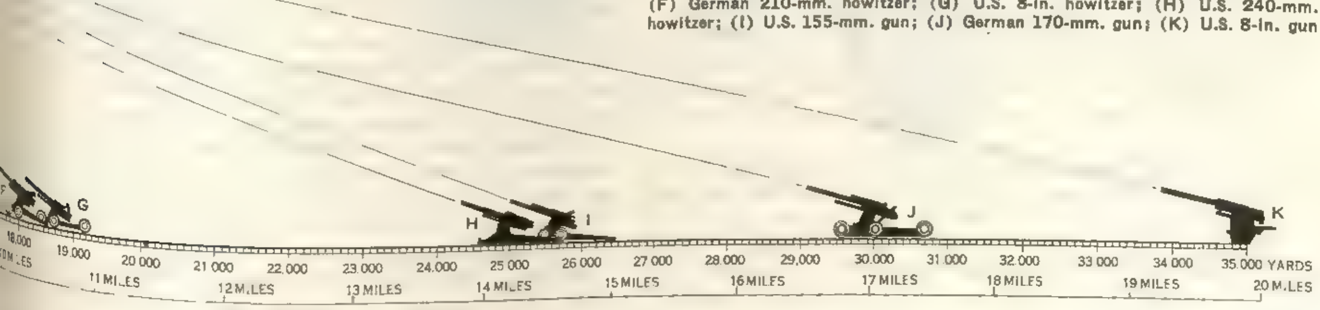
Another exception to the rule that mortars had smooth bores was the 4.2-in. chemical mortar. The projectile for this weapon had a rotating band (or driving band in British terminology) of soft copper measuring slightly less than the bore, allowing the shell to slide easily down the tube. Upon firing, the force of the propellent gases expanded the rotating band to engage the rifling and cause the shell to spin in flight, thus improving its accuracy.

During World War II and the postwar years, the Soviet army emphasized heavy mortars and classed them as artillery rather than infantry weapons. Its 240-mm. mortar was the largest calibre weapon of its type in use by any army in the 1950s.

5. Antiaircraft Artillery.—Adaptation of aircraft to military purposes during the early years of the 20th century naturally stimulated development of special weapons to shoot them down.

FIG. 5.—DIAGRAM ILLUSTRATING THE COMPARATIVE RANGES OF TYPICAL WORLD WAR II WEAPONS

(A) U.S. 81-mm. mortar; (B) British 57-mm. antitank gun; (C) U.S. 105-mm. howitzer M2; (D) British 25-pounder gun-howitzer; (E) U.S. 155-mm. howitzer; (F) German 210-mm. howitzer; (G) U.S. 8-in. howitzer; (H) U.S. 240-mm. howitzer; (I) U.S. 155-mm. gun; (J) German 170-mm. gun; (K) U.S. 8-in. gun



For zeppelins and low-flying planes, rifles and machine guns sometimes did the trick, but for planes flying at greater altitudes guns of artillery calibre had to be called into play. As the mounts for field guns were not designed to permit them to be pointed toward the sky they were at first emplaced on hillsides or on built-up mounds of earth for high-angle fire.

During the latter part of World War I guns adapted for anti-aircraft (AA) fire were placed on special mounts that permitted them to point skyward, and some were mounted on heavy trucks to give them mobility. But, lacking the elaborate fire-control instruments needed for accurate AA fire, the guns were quite ineffective.

The military airplane raised a whole series of new and baffling problems for gun designers and artillerists. The guns not only had to point nearly straight up but also had to be designed for speedy aiming and firing. An accurate estimate of the height of the enemy plane had to be made so the time fuze could be set to explode the shell when it reached the same height as the plane. A direct hit on a high-flying plane was more than any gunner could expect, but exploding a shell within lethal range of a plane was within the realm of possibility. The plane's speed had to be estimated to enable the gunner to determine how much "lead" he had to take, just as a duck hunter must learn to aim ahead of his intended victim. High-velocity weapons obviously were needed to reduce to a minimum the time required by the shell to reach its target, for as much as 20 sec. might elapse before a shell reached an altitude of 20,000 ft., and in 20 sec. a fast plane might travel more than two miles. Rapidity of fire was desirable to give the gunner more chances to hit his fleeting target; long range became essential as attacking planes flew at 20,000 ft. or higher; and giant searchlights were needed to play on the sky at night and catch enemy planes in their beams. Light, medium and heavy AA guns were all needed to provide defense against planes coming in at low, intermediate or high level.

In World War II AA guns up to 40 mm. were rapid-firing automatics, while the larger guns were loaded by hand or with a mechanical rammer. The smaller calibres were supplied with tracer ammunition that enabled the gunner to see where his shots were going. Extraordinary progress was made during the 1930s and the 1940s in developing machines for speedy computation of the mathematical problems involved in AA fire.

Elaborate height finders, computers and directors of great mechanical complexity were introduced to improve the effectiveness of all AA guns. British forces effectively employed radar as early as 1940 to alert ground and air forces to the approach of enemy planes. Perhaps the most sensational new ordnance device of the 1940s was the VT or proximity fuze containing a miniature radar set that automatically exploded shells when they came within range of an airplane.

The AA weapon most used by British and U.S. forces in World War II was the automatic 40-mm. gun originally produced and sold internationally by the Bofors firm of Sweden. It proved as effective for close-in AA defense of naval vessels as for service on land, and was employed in both air-cooled and water-cooled models, firing a two-pound projectile to a height of three miles at a rate of 120 rounds per minute. The British navy also used a 2-pounder gun known as a "pompom" and the U.S. army employed early in the war a 37-mm. automatic AA gun that fired a 1½-lb. projectile. These intermediate AA guns were sometimes mounted on half-track vehicles in combination with calibre .50 machine guns. They proved valuable for close support of troops in forward areas and for patrolling roads to protect truck convoys from strafing and bombing. For close-in defense the 20-mm. gun designed by the Oerlikon Machine Tool works in Switzerland was widely used on British and U.S. naval vessels but eventually gave way to larger guns.

The German 88-mm. AA gun, mentioned above in the account of the Spanish civil war, was one of the most successful and most widely publicized weapons of World War II. Its counterpart in the U.S. army was a 90-mm. gun that fired a 24-lb. projectile to a height of more than 30,000 ft. and which soon replaced the older 3-in. gun. The British employed 3.7-in. and 4.5-in. AA guns extensively, as well as rocket projectors known as Z-guns or U.P. (unrotated projectile) weapons.

The largest U.S. army AA gun to see service late in World War II was the 120-mm. (4.7-in.) "stratosphere" gun that fired a 50-lb. projectile to a height of 50,000 ft. Because of its great size and weight it could be used only in fixed positions to defend supply bases in the rear. Of larger calibre but shorter range was the U.S. navy's 5-in. double-purpose gun developed in the 1930s to reach planes at about 35,000 ft. (*See* also AIR POWER.)

6. Gun Carriages and Mounts.—The mount or carriage upon which an artillery piece is affixed for transport and operation is as much a part of the over-all weapon as is the barrel from which the projectile is fired and the mechanism that controls the aim and explodes the propelling charge. Mobile mounts range from the comparatively simple two-wheeled tow carriages to heavy tanks and mammoth trucks. Each mount is designed to provide maximum mobility for the weapon, to overcome as much as possible the obstacles presented by difficult terrain, to provide sufficient strength and endurance to stand up under the terrific strain of combat and to furnish an efficient and rigid firing base for use in unprepared field positions.

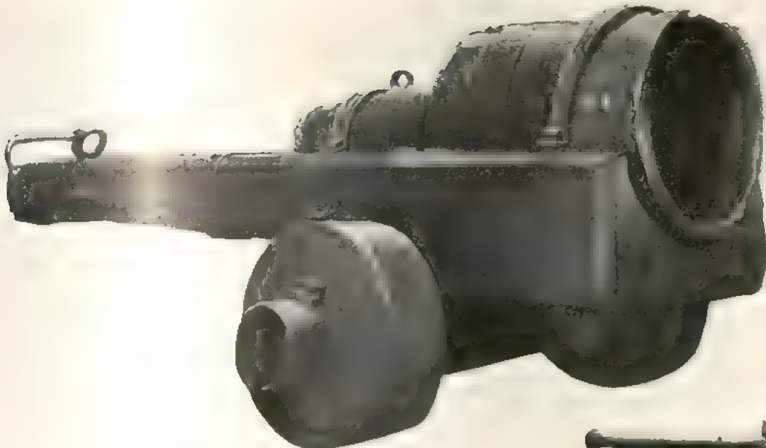
The smaller-calibre and lighter-weight artillery pieces, such as those used by the infantry in its own support, are fired either from the shoulder or from bipod or tripod mounts the legs of which rest directly on the ground to support the guns when fired. These pieces require no associated rolling or mobile equipment since they are transported in ordinary weapon carriers or other types of trucks up to the rear area of operations, from which point they are handled manually by the using troops. The 57-mm. and 75-mm. recoilless rifles are examples of the lighter artillery which is fired from the rigid two- and three-legged mounts.

Howitzers and guns in the light and medium artillery class, unless mounted on a self-propelled vehicle, are transported on two-wheeled, rubber-tired tow mounts from which they are fired when set up for action. These mounts, attached to trucks and other types of motorized vehicles, are pulled in the same manner and at relatively the same speeds as an ordinary low-built trailer. Trailer-type mounts are also used for some of the weapons in the heavy artillery category. Designed to support great weights, the mounts are rolled on four or more double, rubber-tired wheels. The tow mounts for the largest mobile weapons, with six large rubber-tired wheels, are provided with flexible axle supports in order to permit adjustment of the wheels when being rolled over the rough, uneven terrain that must be negotiated in combat. The prime movers, or tow vehicles, for these mammoth weapons are armoured tractor vehicles which mount their own smaller weapons for protection against surprise air or infantry attack.

The most radical mounts for practically all ranges of modern artillery are, of course, the tanks and other types of self-propelled armoured vehicles. Tanks and other armoured combat vehicles are, in essence, self-contained mobile forts that provide their own motive power, mount their own assortment of weapons, carry their own ammunition and have thick armour protection for crew and interior equipment. Mechanically revolving turrets permit aiming the main gun or guns in all directions and at the desired elevation. Mounted machine guns enable the crew to defend themselves against close enemy attack in the same manner that infantry protects guns and gunners operating at immobilized artillery firing positions.

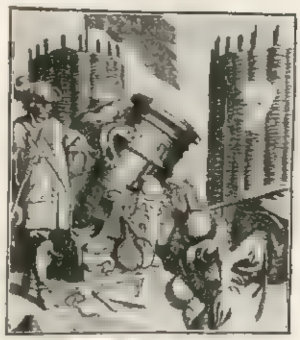
Howitzers and guns mounted on self-propelled carriages have a decided advantage over the weapons made mobile by being towed by another vehicle. Like the tanks, these self-propelled carriers are provided with protective armour, stow their own ammunition and mount the guns in such a way that they are capable of being fired within a few minutes of the time they move into position. Furthermore, being dependent upon their own motor power for transportation, they can quickly change position to take full advantage of the unpredictable fortunes of battle. Rough terrain offers no serious difficulty to their mobility because, like the tanks, they are track-laying vehicles.

Another of the self-contained carriers furnishing its own motor power, its own ammunition stowage space and serving as the mount

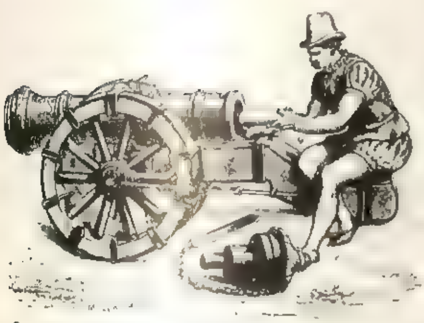


A 14th-century 15-in. bombard of wrought iron which threw a stone shot weighing about 160 lb.

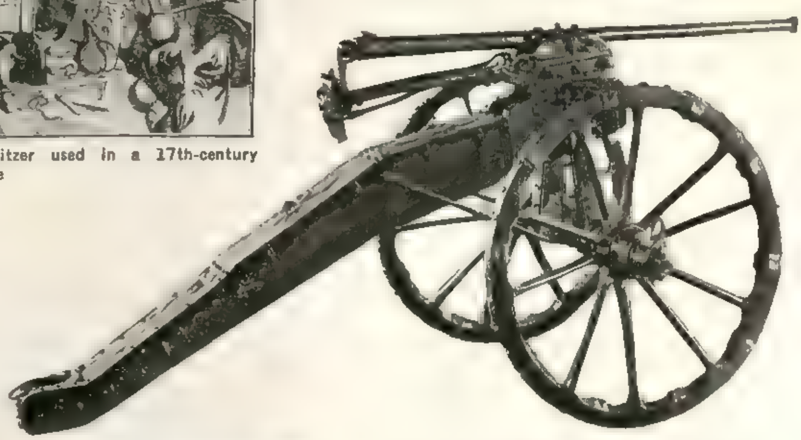
Peterara, an early breech loader of forged iron, 1461–63, made of bars of iron hooped together with iron rings



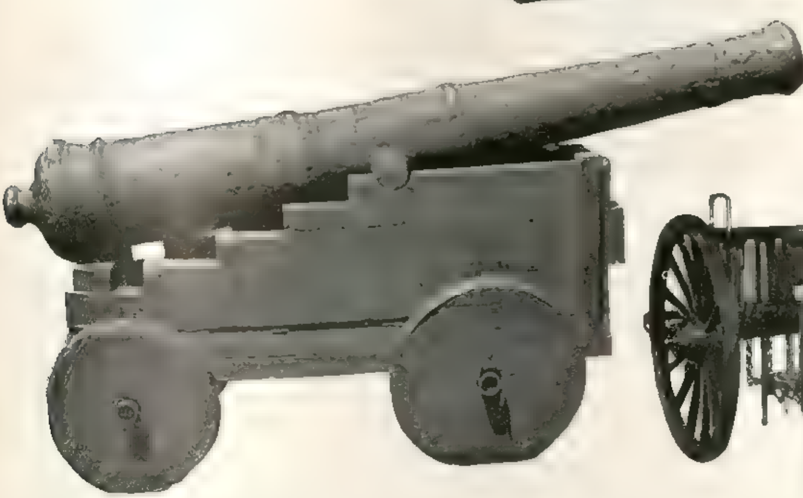
Howitzer used in a 17th-century siege



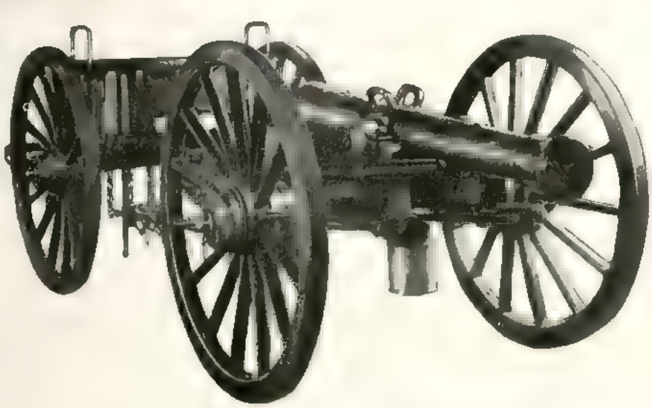
German breech-loading cannon of the 16th century



Falconet, a wrought-iron field gun of the 17th century mounted on a swivel carriage of the period



Cannon used at the battle of New Orleans, 1815

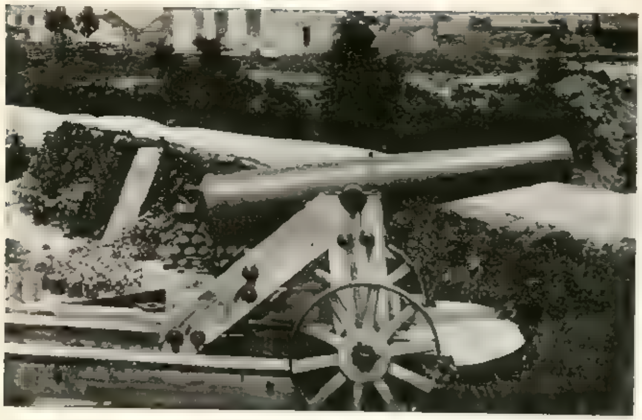


French brass field gun of the time of Napoleon III, which was presented by him to Queen Victoria in 1858

TYPES OF EARLY ARTILLERY

BY COURTESY OF (TOP LEFT, TOP RIGHT, CENTRE RIGHT, BOTTOM RIGHT) THE WAR OFFICE, LONDON; PHOTOGRAPHS, (CENTRE LEFT, CENTRE SECOND LEFT, BOTTOM LEFT) THE BETTMANN ARCHIVE

ARTILLERY

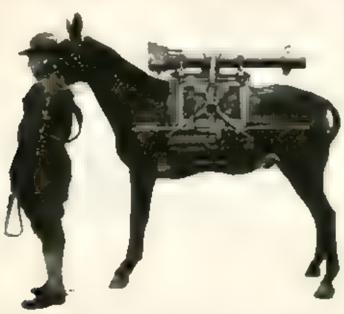


Confederate naval gun, Yorktown, Va., used in the battles of 1862

The "Dictator," a 13-in. mortar at Petersburg, Va. Photographed by Mathew Brady

Cannon of the 2nd U.S. artillery, Civil War

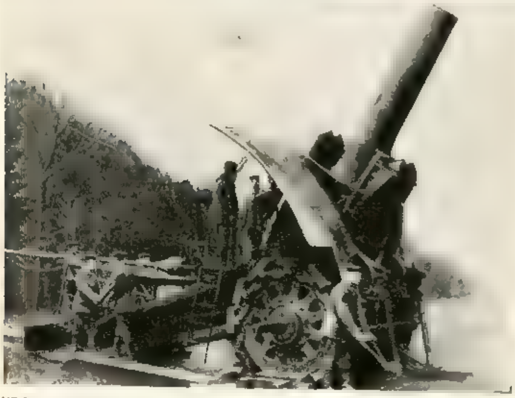
The Rodman 15-in. gun shown near Alexandria, Va., during the Civil W



Barrel of U.S. 75-mm. pack howitzer of the type used in World War I. Designed for transport in hilly terrain, it could be broken down into sections carried by mules

French 75-mm. gun, one of the most famous weapons of World War I

German heavy trench mortar, 25 cm., World War I



"Big Bertha," German 42-cm. mortar which threw a shell weighing 1,980 lb.

U.S. 37-mm. gun of World War I

ARTILLERY OF THE U.S. CIVIL WAR AND WORLD WAR I

BY COURTESY OF (THIRD ROW LEFT, BOTTOM RIGHT) THE NATIONAL ARCHIVES, (THIRD ROW CENTRE) SERVICE CINÉMA DES ARMÉES, (THIRD ROW RIGHT) THE IMPERIAL WAR MUSEUM, (BOTTOM LEFT) U.S. ARMY; PHOTOGRAPHS, (TOP AND SECOND ROWS) THE BETTMANN ARCHIVE

Firing a 155-mm. rifle. U.S., World War II

Railway carriage-mounted 14-in. rifle. U.S., pre-World War II

Howitzer, 16-in. U.S., pre-World War II

Antiaircraft gun, 40-mm., and crew, North Africa. U.S., World War II

Antitank gun, 37-mm., a rubber-tire mounted development of a World War I weapon. U.S.

Howitzer, 105-mm. and crew, U.S., World War II and later

British gun-howitzer, 25 pounder. World War II

German 88-mm. gun in firing position, North Africa. World War II

ARTILLERY FROM WORLD WAR I TO WORLD WAR II

BY COURTESY OF (ALL EXCEPT TOP RIGHT, SECOND ROW LEFT) U.S. ARMY; PHOTOGRAPHS, (TOP RIGHT) INTERNATIONAL NEWSREEL, (SECOND ROW LEFT) EWING GALLOWAY

ARTILLERY

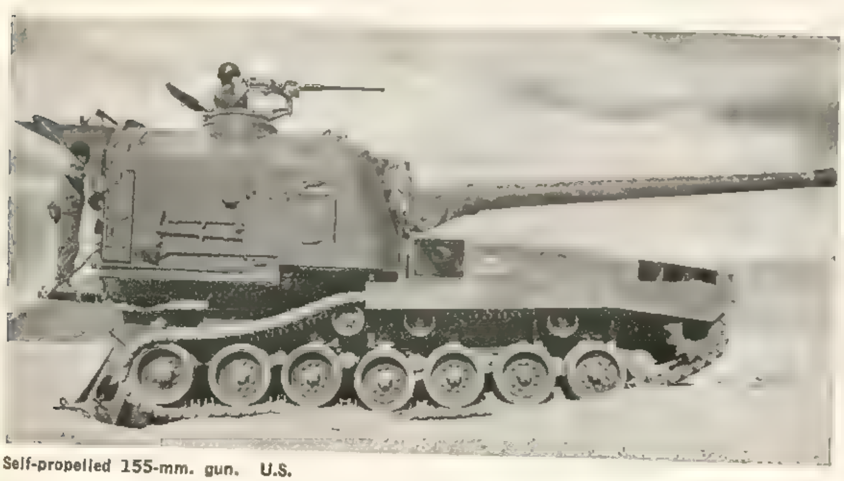
Howitzer, 155-mm., and crew in action in Korea in 1950. U.S.

Firing the 280-mm. cannon designed for atomic shells. U.S.

The Skysweeper, 75-mm. automatic antiaircraft gun equipped with radar. U.S.

Soviet-made 85-mm. antiaircraft gun captured in North Korea

U.S. 81-mm. mortar



Self-propelled 155-mm. gun. U.S.

"Honest John," U.S. artillery rocket and launcher

WEAPONS OF WORLD WAR II AND LATER

BY COURTESY OF (ALL EXCEPT BOTTOM LEFT) U.S. ARMY, (BOTTOM LEFT) U.S. MARINE CORPS

for a 37-mm. gun is the six-wheeled armoured car. This is primarily a reconnaissance vehicle of great speed when operated over cross-country roadways. It takes the place in modern warfare formerly occupied by the horse cavalry. (*See* also ARMOURED FORCES; ARMOUR, TANK AND AIRCRAFT; ARMOURED CAR; TANK.)

7. **Aircraft Artillery.**—Artillery took to the air in the second quarter of the 20th century, supplementing the calibre .50 machine guns that continued as the main armament of most military planes. Rapid-firing cannon of 20 mm., 23 mm. and 37 mm., firing explosive shells, were widely used both for air-to-air combat and for strafing targets on the ground. Specially designed guns of 75-mm. calibre also were fired successfully from planes at ground targets but they saw only limited combat service. The emphasis in World War II was on long range and rapidity of fire rather than on greater calibre, for in airplanes the weight of gun and ammunition was a prime consideration and rapidity of fire increased the chances of hitting a fast-moving target. Rockets as well as guns were installed in aircraft both for air-to-air combat and for air-to-ground attack. One of the largest was the U.S. navy's "Tiny Tim" which belied its name by measuring 11.75 in., nearly 300 mm., in calibre.

8. **Recoilless Rifles.**—The recoilless rifles developed in serviceable form for the U.S. army in World War II were sometimes classed as small-arms weapons, because they could be handled by one or two soldiers, and sometimes as artillery, because they were of large calibre and fired artillery-type shells. Though ordnance designers in both Europe and the U.S. had long known of the theoretical possibility of producing weapons with no kick or recoil, and Comdr. Cleland Davis of the U.S. navy had actually produced primitive models during World War I, the development of serviceable, lightweight recoilless rifles by U.S. army ordnance experts in 1944 stands as one of the outstanding new ordnance developments of World War II.

The first model adopted was a 57-mm. rifle designed and developed at Frankford arsenal, Philadelphia, Pa. Patented by William J. Kroeger and C. Walton Musser, it was at first known as the "Kro-Musket," and was soon followed by a 75-mm. model, and later by a 105-mm. These weapons were recoilless because exhaust vents in the breech and perforations in the cartridge case permitted some of the propellent gases to escape rearward, thus balancing the forward and rearward thrusts. The great benefit from this design was that it eliminated the need for heavy mounts and recoil mechanisms. A major disadvantage was the back blast that revealed the weapon's position and made its use impossible in airplanes or other confined spaces. The 57-mm. rifle weighed only 40 lb., could be fired from the shoulder and had an effective range of more than two miles. The 75-mm. rifle weighed over 100 lb. and was normally fired from a small machine-gun mount. Within their ranges, these accurate weapons were effective against tanks, machine-gun nests, pillboxes and other field fortifications.

9. **Rockets.**—World War II witnessed the revival of these weapons that were probably of more ancient lineage than cannon but had virtually disappeared from the battlefield in the 19th century. They ranked high among the most significant weapons of the 1940s. While their use in combat generally followed the same lines as conventional artillery, they were radically different in design and capabilities. Being light in weight and readily portable, they were used in airplanes, small landing craft and in ground situations where conventional artillery could not be employed.

When the United States entered World War II in Dec. 1941, there was not a serviceable rocket in its arsenals. In fact, it was not until after the war was well under way that the U.S. began producing rockets.

Within a short time after the rocket project was initiated, however, the much-publicized bazooka (*q.v.*) was in service, giving the individual foot soldier an antitank weapon with the striking power of artillery. Much earlier the British army had employed antiaircraft rockets and the Soviet army had greeted the invading Germans with rocket barrages.

Although all major powers in World War II used rockets, both large and small, the principal pioneers in their development as long-range artillery weapons were the Germans. An American, Robert H. Goddard, had carried on important work in this field in the years between World Wars I and II, but the U.S. armed services had not made full use of his research. German ordnance experts, building on the work of Goddard and their own research, produced one of the most spectacular weapons of the war, the long-range, supersonic V-2s capable of bombarding London from bases on the continent. The V-2s greatly extended the range of artillery bombardment and as long as World War II lasted there was no defense against them except to discover and attack their launching sites. (*See* ROCKETS AND GUIDED MISSILES.)

VI. COLD WAR ERA

After World War II, in an atmosphere of international tension marked by the cold war and by armed conflict in Korea and elsewhere, artillery development continued. Emphasis centred on rapid-firing AA weapons, guns capable of firing atomic shells and rockets capable of carrying either atomic or conventional warheads.

In 1953, just eight years after the first atomic bomb had been dropped on Japan, the U.S. army announced that its ordnance experts had succeeded in developing a long-range gun capable of firing an atomic shell. The first test of this 280-mm. weapon, which could fire conventional as well as atomic shells, took place May 25, 1953, at the Atomic Energy commission's proving ground near Las Vegas, Nev. Its maximum range was about 20 mi. and its weight 85 tons. Suspended between two truck units, the A-gun could be transported over good roads at a speed of 35 m.p.h. and could be speedily emplaced and readied for firing in ten minutes. Later research was directed toward building smaller and more maneuverable atomic weapons. In 1957 the U.S. army announced that it had developed an 8-in. atomic shell.

In 1953 the U.S. army also announced its new Skysweeper, a 75-mm. automatic AA gun equipped with radar that could scan the sky, spot hostile planes miles away, follow their course in daylight or dark and automatically aim the gun. It could fire 11½-lb. high-explosive shells, with proximity fuzes, at the rate of 45 per minute. But the Skysweeper and all other conventional AA guns were rivaled by new rockets that could be guided to their targets by remote electronic controls, even though the target plane took evasive action. Chief among these, for the U.S. army, was Nike, a 20-ft.-long liquid-fueled missile announced late in 1953. So effective was Nike in tests that it was installed in batteries throughout the United States for defense of vital areas. Meanwhile the U.S. navy developed AA missiles to be launched from ships at sea and the air force designed rocket missiles for air-to-air and air-to-ground combat.

While Nike and other missiles were proving their effectiveness in tests against conventional aircraft, scientists began to study an altogether different air-borne threat, the long-range ballistic missile, traveling at many times the speed of sound and carrying a nuclear warhead. The German V-2 rockets of 1944–45 had carried only conventional explosives and had come too late in the war to have a decisive effect. But they had been impossible to intercept and had opened the door to a whole new realm of military weapons that called for complete revision of traditional concepts of time and space in waging war.

After World War II the armed services of all major powers planned, developed and tested such a variety of new rocket weapons, both guided and free, that it is not feasible in this space to list even their names. The U.S. army adopted Corporal as its first combat-ready, guided ground-to-ground missile, and Honest John as an unguided rocket capable of carrying either an atomic or a conventional high-explosive warhead. Redstone was an experimental long-range rocket modeled after the German V-2, but much larger and heralded as the basis for a future 1,500-mi. ballistic missile. Both the U.S. army and the U.S. air force developed 1,500 mi. missiles in the mid-1950s, and in 1958 the air force Atlas missile attained a range of over 6,000 mi. The Soviet Union meanwhile claimed that it had similar missiles. It was generally assumed by rocket specialists that most such weapons were Kitty Hawk types; *i.e.*, early designs that would eventually become obsolete because of the swift advance of technology. Information

concerning new rocket weapons that might be of value to a potential enemy was held in closest secrecy. Emergence of these new weapons, so different from guns and howitzers of the past, was considered by many as marking the beginning of a new era in the world's military history and perhaps as bringing to a close the long and colourful career of traditional artillery as a major factor in warfare. *See* ROCKETS AND GUIDED MISSILES.

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(H. J. RE.; M. B. H.; H. C. T.)

VII. ORGANIZATION

1. United States.—To visualize the place of artillery in the U.S. army, it is essential to look at the over-all combat organization and then dwell in more detail upon the artillery sections. The smallest complete combat organization of the U.S. army, comprised of all the arms and most of the services and capable of sustaining itself over an extended period in battle, is the division. A typical infantry division in World War II was built around a nucleus of three infantry regiments. Its artillery element consisted of three light artillery battalions, one medium artillery battalion and one antiaircraft battalion.

In the reorganized infantry division of the post-Korean war period the three infantry regiments were replaced by five battle groups. The artillery battalions remained as the basic tactical and administrative units of the divisional artillery but were equipped to use both atomic and conventional weapons. Battalions were classified as direct support or general support; self-propelled or towed; and as either gun, howitzer or missile units.

Batteries, comparable to infantry companies, were the units that made up the artillery battalions. As the smallest administrative units in the artillery, batteries were capable of operating as separate tactical organizations. As a rule, a battalion had three batteries—two firing batteries and one headquarters and service battery. Firing batteries were designated, according to their weapons, as howitzer batteries, gun batteries or rocket batteries. Other specialized types were observation batteries and searchlight batteries.

In the three-brigade division (*see* DIVISION, MILITARY) announced in 1961 divisional artillery consisted of three direct support battalions armed with 105-mm. howitzers and two general support battalions whose armament would normally be 155-mm. or 8-in. howitzers or missile type weapons.

Above the division was the corps artillery, a flexible organization consisting of artillery battalions attached to the corps. The expression artillery with the corps denoted all artillery responsible to the corps, including that in the divisions subordinate to the corps. Above the corps artillery was army artillery, consisting of units assigned to the army and not reassigned to lower echelons. It generally included the most powerful guns, along with others of smaller calibre, and constituted a strategic reserve to be employed at the army commander's discretion to turn the tide of battle.

2. Great Britain.—In broad outline, the organization of the British artillery in World War II and the postwar years remained similar to that of the U.S. army, but there were some confusing differences in terminology. Though the artillery branch of the British army was of sufficient strength and importance to be considered a corps, it retained the traditional name of royal regiment of artillery. The basic tactical unit of the British artillery was the field regiment, normally commanded by a lieutenant colonel and composed of three batteries equipped with 25-pounders or their equivalent. The field regiment corresponded to the U.S. battalion in terms of its tactical role, but in terms of size the British battery was more nearly the equivalent of the U.S. battalion. Going one step farther down the scale, the British troop, typically a 4-gun unit within the battery organization, corresponded in size to a U.S. 4-gun battery.

3. Soviet Union.—Artillery, often referred to by Soviet leaders as "the god of war," has always played a leading role in the Soviet army. The artillery arm and its services made up from 25% to 35% of all personnel in the Soviet army during World War II and the years that followed. It included conventional field artillery, antitank and antiaircraft guns, heavy mortars, rocket launchers and guided missiles, but not self-propelled artillery, which was assigned to the armoured forces. An average Soviet artillery division in World War II, consisted of from 18 to 24 firing batteries, but this number was reduced in postwar years. Each artillery battalion was made up of three or four batteries, with either two or four pieces to each battery. Battalions of the same type were organized into brigades, thus forming howitzer brigades, mortar brigades, rocket launcher brigades, etc.

A still larger grouping, the artillery corps, consisted of two or three artillery divisions and two or three small antiaircraft divisions as well as several special purpose artillery brigades and regiments. The artillery corps facilitated the massing of great numbers of artillery pieces for a major offensive. This high degree of centralized control developed early in World War II following disastrous losses, and was made necessary in part by the shortage of trained artillery officers. The high command withdrew a large share of the artillery from its rifle divisions and placed it in artillery divisions under the over-all direction of army headquarters.

In the period following World War II the Soviet army relaxed its highly centralized control of artillery to some extent. It returned a substantial amount of artillery firepower to the rifle divisions. Each regiment in a rifle division was equipped with 76-mm. self-propelled guns, 57-mm. antitank guns and large mortars such as the 120-mm. mortar. In addition, the division had two artillery regiments, one equipped chiefly with 76-mm. guns or the newer 85-mm. guns, and the other with 122-mm. howitzers and huge mortars. The division commander exercised operational control over both artillery regiments. The Soviet tank division possessed a great deal of mobile firepower in the form of 152-mm. self-propelled guns plus a regiment of huge mortars, a regiment of truck-mounted rocket launchers and a battalion of howitzers.

(H. C. T.)

VIII. TECHNIQUE

1. Occupation of a Position.—The actual process of coming into action may be described in a few words. The location for each gun is established in accordance with the mission, the expected direction of fire and the restrictions of the terrain. Each gun is brought to its position, unlimbered and laid parallel, and enough ammunition to fulfill expected requirements is unloaded. Only those items required for the conduct of fire are kept at the firing battery position, the balance being located in sheltered positions nearby or in some rear area. The noncombatant vehicles form the "second line of wagons."

2. Choice of a Position.—The nature of the position to be occupied depends primarily upon the task which is to be carried out. Although "open" positions may have to be occupied on occasions, they are generally to be avoided since guns are quickly silenced in modern war if they come into action in full view of the observing posts of the hostile artillery. As a rule, therefore, artillery uses positions concealed from view behind a ridge or other cover, the elevation and direction necessary to hit the target being signaled by an observer who may be either on the ground or in the air. The choice of the position varies to some extent with the nature of the equipment; for instance, an elevated position is better adapted than a low one for high-velocity guns because of their flat trajectory.

Other factors which have to be considered are: (1) the desirability of a field of fire immediately in front of the guns for shooting at hostile tanks; (2) concealment from air observation; (3) avoidance of ground in which pockets of gas might lie; and (4) approaches for ammunition supply. It is usually possible, however, to satisfy only the more important requirements in each particular situation. Cover from hostile fire, as distinct from observation,

cannot often be obtained from the configuration of the ground, because, if a gun can shoot over a covering feature, the hostile shells can also clear it. Most of the lighter types of artillery are therefore provided with shields which, with the armoured ammunition wagons (caissons), afford some measure of protection to the guns and detachments. Guns are usually brought into action about 20 to 25 yd. apart, this interval being considered sufficient to minimize the damage which may be done by hostile shellfire.

3. Ranging.—This process serves to determine the elevation at which a gun will hit the target, or, more correctly, the elevation at which the greatest possible number of shells will fall on the target. This elevation is not necessarily that due to the map range, since it is affected by the temperature, height of barometer, strength of the propellant, degree of wear of the gun and other factors. When a number of shells are fired from a gun which is pointed at a given elevation, they do not fall in the same place, but are distributed over a space which, at medium ranges, may be 100 yd. or more in depth. The centre of this space is termed the "mean point of impact." The first step in ranging is to determine, by observation of the fall of the shells, two elevations, usually 400 yd. apart, at the higher of which the shells will fall beyond the target and at the lower of which they will fall short. This bracket is split successively by applying corrections in range equal to one-half of the bracket in the direction of the target until the bracket is reduced to 100 yd., at which time the bracket is split by a 50-yd. correction and fire for effect begun. Ranging for line, *i.e.*, for lateral direction, is carried out in the same way, and is generally simultaneous with ranging for elevation. When air bursts are desired it is also necessary to determine by observation the fuze time which will produce bursts at the most effective height above the ground; however, through the use of radar-activated VT fuzes, the optimum height of burst is obtained automatically.

4. Ranging by Map or Survey Methods.—It is possible to open effective fire by surprise without preliminary ranging, if the range and line can be obtained by measurement from accurate large-scale maps or, in the absence of such maps, by "fixing" the positions of guns and targets by survey methods. For such predicted shooting certain meteorological and other information is necessary to determine the corrections which must be applied to the true range and line. Special sections in corps and division keep the batteries informed as to atmospheric conditions. The guns must be carefully calibrated, a process which consists in determining the error due to wear at a known range. Survey methods cannot generally be used in very mobile operations because of the time required to carry out the necessary preliminary work.

5. Sound, Flash and Radar Ranging.—These techniques perform dual functions: determining the ranging of friendly guns and locating enemy guns. They are effected in one of three ways: by observing and correlating the moment at which the sound of the burst of a shell or report of a gun reaches each of a chain of recording instruments; by performing an intersection on the observed flash; or by following the path of the shell on a radar screen and extrapolating to its origin or terminus.

6. Laying.—Elevation may be defined as the vertical inclination of the gun, direction as the horizontal inclination to the right or left, necessary to direct the path of the projectile to the object aimed at. In order to lay the gun in the line of sight (*i.e.*, the line joining the sights and the point at which aimed) the gun has to be traversed right or left so as to point in the proper direction, and also adjusted in the vertical plane. The simplest form of laying is called the direct method, which is employed if the point at which aimed is the target and can be seen by the layer who can then merely look over or through the sights. But the point laid on is rarely the target itself. In war, the target, even if visible, is often indistinct, but in most cases it cannot be seen at all from the gun position. An aiming point, a conspicuous point quite apart and distant from the target, has then to be employed (indirect method). When the guns are behind cover and no natural aiming point can be seen, an artificial aiming point is often made by placing a line of aiming posts in the ground. A method which is now obsolete was provided by the paralleloscope, which was a mirror set a few feet from the gun. When this device was used, the layer kept the gun in the correct line of fire by laying upon the reflection of the sights in the mirror. Finding the line in the case of indirect laying involves the calculation of the angle at which the guns must be laid in order that, when the sights are directed upon the aiming point, the shell will strike the target. When a gun is laid for elevation by the indirect method, two angles to the horizontal plane have to be allowed for, viz., that due to range and that due to the difference in level between the gun and the target. The latter is called the angle of site. When the target is above the level of the gun, the angle of site has to be added to the elevation due to the range; when the target is below the level of the gun the angle of site has to be deducted. In all cases the actual elevation of the gun to enable the shell to strike the target is a purely mechanical adjustment, the gun being moved to the required angle with the aid of an elevation indicator or a clinometer. Frequently the battery commander directs the guns from a point at some distance, communication being maintained with radio or by field telephone. Instruments of precision and careful calculation are, of course, required to fight a battery in this manner, many allowances having to be made for the differences in height, distances and angle between the position of the battery commander and that of the guns. (*See* RANGE FINDERS; SIGHTS, GUN.)

7. Fire.—Three methods of fire for effect are used within the battery. These are:

Gunfire, in which the guns fire independently at any rate which may be ordered;
Battery fire, in which the guns fire in succession throughout the battery;
Salvo fire, in which the guns are fired simultaneously on the order of the gun position officer.

The application of fire by batteries acting in combination is dealt with in the section on *Tactics,* below.

8. Use of Various Types of Ammunition.—High-explosive shells are fired by all guns and howitzers against troops in the open, for offensive and protective covering fire, for antiaircraft fire and for general harassing purposes. The explosive charge within the shell causes the shell case to burst and fill the air with small, high-velocity, jagged fragments. Armour-piercing shell is used to breach the armour of tanks and is composed of a core of high-carbon alloy steel or tungsten carbide, with a shock-spreading cap of hard steel. Smoke shells are used for screening effect, to mask hostile fire, to deny observation to the enemy and to produce casualties from the burning particles. Shells with smoke fillers of various colours are used to signal and to mark targets for attack by other means. Illuminating shells are used to provide light on the battlefield to disclose enemy locations and night movements and to facilitate observation and adjustment of fire. Other artillery shells may be used to spread toxic or nontoxic gases or propaganda leaflets.

One of the most famous secret weapons of World War II was the U.S.-developed proximity or VT fuze which added greatly to the effectiveness of both ground and antiaircraft artillery. This fuze contains a tiny electronic device which sends and receives impulses as it spirals through the air in the nose of a shell. As the shell approaches its target, the electronic device automatically explodes the projectile at a predetermined height over it, producing perfect air bursts 20 or 30 ft. above the ground. The VT fuze put an end to the inaccuracies associated with the mathematically calculated and manually set time fuzes in use during the greater part of the war. Shells that explode at the ideal height, round for round, are tremendously more effective than those that burst too far above the target or too close to it, particularly when the maximum burst is diminished if the nose burrows into the ground before the explosion occurs.

The VT fuze, which was put into combat use in the winter of 1944, was also adapted for antiaircraft artillery and proved its mettle as a dependable destroyer of bomber and fighter aircraft. It was responsible for blasting to bits in mid-air hundreds of the German buzz bombs that were hurled against Great Britain and the Allied supply concentrations. (For a description of various types of projectiles *see* AMMUNITION, ARTILLERY.)

IX. TACTICS

In modern war it is found that infantry troops, in face of opposition, are immobilized and driven to seek cover as soon as they get within the zone of the enemy's aimed rifle and machine-gun fire. Attacking troops can continue to advance (and without advancing no decision can be gained) only by enlisting the aid of an arm which is capable of keeping down the enemy's fire while itself remaining sufficiently immune by reason of the distance from which it can operate, or by armoured protection as in the case of tanks. Artillery affords the principal means of dominating the enemy's fire. The advent of tanks, however, profoundly affected the role of position artillery in battle. Tanks are capable of relieving the artillery of various forms of support required by infantry and cavalry, but tanks themselves require artillery support if they are not to suffer heavy casualties. Further, the relative position of tanks and artillery became confused since some of the most modern types of armoured artillery on self-propelled carriages are themselves tanks under a different name.

Developments during and after World War II greatly increased the range, accuracy, firepower and mobility of artillery. A further important advance was in methods of survey. There are certain limitations to the full development of the power of artillery, the most serious of which is perhaps the difficulty of including in mobile formations sufficient artillery to break down modern defenses, and of supplying it with ammunition. Good signal communications between artillery commanders, their guns and the troops they are supporting are of vital importance.

1. Application of Fire.—The principles of surprise, concentration and economy of force (*i.e.*, economizing strength while compelling dissipation of that of the enemy) are generally held to be of special importance in the application of artillery fire. To obtain surprise it is necessary first to conceal the concentration of the guns and the occupation of positions. In order to evade detection by hostile aircraft, large movements of artillery are generally carried out at night. Should they be carried out by day, skillful use of cover is necessary to screen movement from observers on the ground.

Once the guns are in position, care has to be taken not to disclose their position by firing prematurely and, to this end, the survey methods of working out lines of fire and ranges, already alluded to, are of particular value, since the warning which used to be given by preliminary registration can be eliminated by their adoption in certain circumstances. There is, further, considerable scope for exploiting the value of surprise after the presence of the guns has been disclosed by the opening of fire. Stereotyped systems of shooting should be avoided and damage and casualties increased by bringing fire to bear on the enemy at unexpected times and places and in unexpected ways.

Concentration of effort is as essential in the employment of artillery as in the case of any other arm. The maximum amount of fire must be directed upon the targets which are of greatest importance, and bombardments should be intense and short rather than weak and prolonged. The best means of securing concentration is to centralize command, and it is thus a general principle that control should be vested in the highest commander who can exercise it effectively in any given situation. For effective control, a commander must be in communication with the guns and in touch with the ever-changing situation of the troops he is supporting. When operations are of a deliberate character, intercommunication is comparatively easy to maintain and information is fuller. Control may then be exercised from divisional or even corps headquarters. In very mobile operations, however, artillery brigade or battery commanders will often have to act upon their own initiative, subject to broad instructions from their superior commander.

The maintenance of the principle of concentration involves a strict observance of the allied principle of economy of force. Artillery should be allotted economically. However, artillery never is retained tactically in any reserve status. The various types should be employed against the targets they are designed to engage. Thus, it would be wrong to use a powerful weapon for a task which could be equally well performed by a less powerful one, the life of which is longer and its ammunition more easily supplied. Fire should never be opened without a definite object, and the expenditure of ammunition should be proportionate to the tactical importance of the task. Economy is further obtained by accuracy of fire, but occasions arise when some degree of accuracy may have to be sacrificed to save time and to ensure surprise.

2. Observation.—Whenever possible, artillery fire is directed by observation which may be carried out from the ground or from the air. Ground observation is most suitable for shooting on targets on the immediate front of friendly troops, and observation posts are selected, whenever possible, so that they may overlook the foremost elements of the troops who are being supported as well as the areas in which targets are to be engaged. Observation from aircraft is largely used for counterbattery work, for fire on distant targets and for dealing with vulnerable and fleeting targets which cannot be seen from the ground. In modern armies the requirements of the artillery in air observation are met by army aircraft and the co-operation of the air forces. Aerial photographs of enemy positions and rear organization are of great value in the discovery and selection of targets. Balloons were widely used in World War I for purposes of observation, but they were handicapped by their vulnerability and the distance from the enemy at which they must operate. The helicopter supplanted and far surpassed the balloon as the aerial observer for artillery, particularly when targets are located at relatively close ranges. Helicopters can take off and land vertically and do not require the facilities of prepared airfields. They can maintain a static position in the air while at the same time they possess considerable speed and complete flexibility insofar as directional flight is concerned.

3. Co-operation With Other Arms.—Since the role of the artillery is to support the other arms, its action is governed by their requirements. The question of co-operation with the other arms is, therefore, one of special importance. Artillery officers of all ranks have to keep themselves informed of the general situation and plans of commanders whom they are supporting. The best means of ensuring good co-operation is for headquarters of artillery and of units with whom they are co-operating to be in close proximity. Liaison officers are also used to aid in keeping touch and artillery patrols may be sent forward to supplement personal reconnaissance and the information furnished by artillery observers. The artillery frequently has to rely on close reconnaissance airplanes or on rockets or other special signals for information of the situation of the forward troops. However radio and wire telephonic communications between observers and artillery headquarters are usually relied upon and are the most dependable forms of transmitting information. The other arms are trained to supply constant information to the artillery as to their movements and the obstacles which they encounter; this information is essential if artillery support is to be effective. Another important aspect of co-operation lies in the co-ordination of the action of the artillery with that of the weapons of the other arms. For example, position artillery fire must be directed in such a way as best to supplement the fire of machine guns and the action of tanks.

X. ATTACK

In the attack the object of the artillery is to assist the other arms to maintain their mobility and offensive power. Its tasks may be summarized as follows: (1) artillery preparation; (2) covering fire; (3) close support; (4) counterbattery work; (5) harassing fire; and (6) co-operation in pursuit.

1. Approach March.—An army advances against the enemy covered by the advanced guards of its several columns. During the approach march some light field and possibly some medium artillery will usually be allotted to the advanced guards, in addition to tanks, whose duty it is to drive in the enemy's protective troops by bold and vigorous action. If the artillery allotted to the advanced guards proves insufficient to overcome the enemy's resistance it may be reinforced from the main bodies. If the enemy is in strength, a stage will be reached when the advanced guards will no longer be able to advance and when the main bodies or

portions of them will be deployed. A plan of attack will then be formed by the commander of the force. If the enemy has been met on the move, or found in a hastily occupied position, the situation will call for rapidity of action, since the dominant need will be to prevent him from seizing the initiative or strengthening his defenses. If, on the other hand, he is in an organized position strengthened by artificial defenses such as wire entanglements, trenches, foxholes, etc., the attack cannot be launched without deliberate and methodical arrangement and it must be supported by a strong concentration of artillery.

2. **Dispositions.**—In disposing the artillery, the governing considerations are: (1) concentration of the maximum fire to assist the decisive phases of the attack; and (2) ability to support the advance to as great a distance as possible without moving the guns. This last requirement entails siting the guns well forward, the most advanced field guns being as a rule no farther behind the leading troops than is necessary to obtain cover and to clear the heads of the infantry.

3. **Plan.**—The artillery plan comprises the scheme of fire and the arrangements for command, control, communications and movement of artillery in support of the advance. A commander will often have to decide whether it is important or not to use the full power of his artillery in his attack. To develop its full strength the artillery may often require more time for preliminaries than the other arms, and a plan of attack may suit it which does not best suit the other arms. In such a case a commander will generally treat his artillery as the predominant arm if the enemy's defenses are strong.

Artillery preparation consists of the bombardment of the enemy's defenses before the attack is launched, its objects being to inflict loss and damage, to cut wire obstacles—if tanks are lacking—and to undermine morale. If the enemy's positions are not strong or if tanks are available, artillery preparation may be dispensed with and surprise ensured thereby. If it is undertaken it should be as short and heavy as possible.

Covering fire may take the form of a barrage (*i.e.*, a belt of fire) moving ahead of the assaulting troops; of concentrations upon successive localities; of smoke screens; or a combination of any or all of these forms of fire. A barrage has some measure of destructive and neutralizing effect on all troops on the ground over which it passes. It is the simplest method of giving support when the enemy's positions cannot be located with accuracy—and in the two world wars this was the normal state of affairs, because of the difficulty of seeing machine-gun posts, etc. In face of strong opposition, reliance would have to be placed upon considerable reinforcements of army artillery units or upon tanks to supplement the action of the artillery. As a rule, in providing covering fire, light artillery is used to shoot nearest to the assaulting troops, who are trained to move as close as possible to the bursts, and medium and heavy artillery are used to give depth to the fire and to shoot on more distant targets. Ordinarily, covering fire is arranged in its early stages according to a timetable based on the expected rate of advance of the troops or upon the attainment of predetermined phase lines or objectives. Subsequent support is given by observed fire from guns advanced, if necessary, during the fight.

Smoke shells are fired by artillery in conjunction with other types of ammunition or alone. The principal use of smoke is to furnish concealment to attacking troops in order to enable them to move unobserved for the purpose of effecting surprise. By its use an attack can get to close quarters without being seen and smoke clouds can often be so disposed as to enable the assault to be launched from an unexpected direction. Smoke screens may also be used to conceal the movement of reserves. Smoke is also of great value in reducing casualties among the assaulting troops by preventing the enemy's fire from being aimed or observed, and it should therefore be the object of the attacker to use it in such a way as to blind artillery observation posts and to mask machine-gun positions, strongly defended localities and antitank weapons. Smoke screens may also be put down by artillery to protect open flanks, or to prolong a front of attack and so induce the enemy to disperse his fire.

The tendency of an enemy, when a smoke cloud is put down, is to pour a heavy fire into it and this fact has to be borne in mind in evolving plans for its employment. The actual production of a smoke screen requires great skill and the wind and weather have to be carefully considered. If smoke is fired indiscriminately it may interfere seriously with observation from both ground and the air, with reconnaissance during battle, with signaling or with operations of troops on the flanks. (*See* SMOKE: IN WARFARE.)

4. **Close Support.**—The prearranged covering fire may not be sufficient to overcome all resistance to the advance and leading units therefore have to be accompanied by some artillery to obviate the delay which would be entailed in signaling to guns at a distance. So much is generally admitted; but the nature, command and organization of the accompanying artillery are matters on which opinions differ. Moreover, the infantry are not satisfied with guns of accompaniment, but demand a weapon of their own in the actual firing line to deal with tanks. (*See* INFANTRY.)

5. **Counterbattery Work** comprises the location, neutralization and, when possible, destruction of the enemy's artillery. The problem of dealing with the hostile guns is given much greater attention in all armies than was the case before World War I. It enters into operations of every kind and in varying degrees lies within the sphere of responsibility of every artillery commander. Special counterbattery staffs are generally provided at corps headquarters. The chief sources of information as to the enemy's artillery are: (1) observers in aircraft; and (2) flash-spotting and sound-ranging units on the ground. In addition, artillery and infantry observers are trained to send back information. A portion of the attacker's medium and heavy artillery is usually given the task of engaging the hostile guns before and during an action with the object of keeping down their fire and so facilitating the advance of the assaulting troops.

6. **Harassing Fire.**—The objects of harassing fire are to wear down the enemy's fighting spirit, to inflict casualties and damage upon him, to prevent movements of reinforcements and ammunition and generally hinder the conduct of the defense. Harassing fire has to be reduced to a minimum in mobile war because of the small quantities of ammunition which are available; in deliberate operations or static warfare there is great scope for its development.

7. **Pursuit.**—During an advance, artillery is pushed forward to support the infantry and to assist them in pressing the enemy, batteries usually being moved alternately within divisions to ensure that the covering fire will be continuous. But to obtain decisive results in a pursuit it is necessary to launch against the enemy a special pursuing force, composed of mobile troops. Mechanized artillery is of special value with such a force, and it should be handled with the greatest boldness, risk being accepted which would not be justifiable at other times. (*See* ARMOURED FORCES.)

XI. DEFENSE

In defense the artillery assists in the protection of the other arms and co-operates with them in repelling the enemy's assaults. Its tasks may be summarized as follows: (1) counterpreparation; (2) fire to repel assaults; (3) antitank defense; (4) counterbattery work; and (5) harassing fire.

1. **Dispositions.**—In defense the artillery has to be sited in such a way that it will be able to bring the full weight of its fire to bear in front of the line of infantry defenses on which the commander intends to stop the enemy. In mobile war the infantry defensive position will generally consist of a chain of defended localities, and it will usually be in front of this line that the artillery will be required to shoot in order to break up an assault. In more deliberate operations, however, time and resources may permit of the defensive position's being more highly organized. It may then consist of a lightly held forward zone, intended to absorb the first shock of a heavy attack, and a strongly held main zone in which the battle is to be fought out. In this type of defense the bulk of the artillery has to be sited farther back with the object of bringing the main weight of its fire to bear in front of the main zone, a

small proportion only of guns being allotted to support the troops in the forward zone.

The bulk of the guns are not sited in such advanced positions in defense as in attack for two reasons: (1) that they may not be easily neutralized by the attackers' artillery; and (2) that they may not be overrun in the first rush of an assault. A proportion of the guns must be in forward positions, however, for the purpose of engaging the enemy's artillery and rear communications and of hindering arrangements for an attack. The fulfillment of these requirements results in the defender's artillery being distributed in depth. An important factor which must also be considered in disposing the artillery is the problem of antitank defense. This is discussed below. An essential requirement of defensive positions to be occupied by infantry, besides facilities for siting the guns, is suitability for artillery observation. It is always desirable that there should be some rising ground from which observation can be carried out, and such localities should be so far behind the foremost defenses that they will not be captured, and the eyes of the defense blinded, by a minor penetration by the enemy.

2. Plan.—The artillery plan of defense comprises, besides the arrangements for dispositions, the scheme of defensive fire and the policy which is to govern counterbattery action. Surprise is as important in defense as in attack and it is therefore important that the fire plan should not be disclosed prematurely. A favourite device is to keep as many as possible of the defending guns silent until an attack develops and then to engage the enemy with an unexpectedly heavy fire. In order to conceal the battle positions of the defending artillery, guns which are required to be active often shoot from temporary positions which they vacate before the enemy's attack is launched. It is important to make arrangements to concentrate as much as possible of the available artillery fire on any particular portion of the front which may be attacked by the enemy and to make all possible preparations to support counterattacks. Smoke should be used with caution in defense since it is liable to obscure the view of the defenders and so to hamper their fire.

Counterpreparation is the term applied to fire which is delivered with the object of breaking up an attack before it can be launched. It is directed against probable forming-up places and forward communications in order to disorganize the enemy's troops when they are suspected of being about to assault. A plan of predicted fire is usually arranged as soon as a defensive position is occupied but, if the enemy's troops can be seen and signal communications can be maintained, it is more effective to shoot with direct observation.

3. Repulse of Assaults.—Once an attack is launched it becomes the aim of the artillery to direct fire on the assaulting troops and reserves. It is desirable that, as in the case of counterpreparation, such fire should be controlled by observation, but this is not often practicable. Attacks may be launched under cover of smoke or in the half-light of dawn, and signal communications may be cut by hostile fire; even when other conditions are favourable, observation will be rendered impossible when there is such a force of artillery that observers are unable to distinguish the shells of their own batteries. It is therefore a rule to detail targets to be engaged by all batteries with predicted fire. Such targets will generally be the most probable lines of approach for the enemy and other vulnerable portions of the front, and the fire of the guns must be carefully co-ordinated with that of the infantry weapons, especially with that of machine guns.

4. Antitank Defense.—A considerable share of the responsibility for antitank defense falls upon the artillery. The antitank weapons of the infantry are generally reinforced in the forward defenses by some light or field pieces which are sited in concealed positions from which they can deliver a sudden fire at short range. A serious objection, however, to the employment of artillery in this task is that guns sited in forward and exposed positions are of little use for general purposes of defense. A second line of defense is formed by the main force of the artillery, all battery positions being chosen as far as possible so as to provide a field of fire against tanks. In addition, some guns have to be disposed for the protection of headquarters and other important points in the rear.

5. Counterbattery.—Attack of enemy batteries is generally carried out by the defenders with the object of weakening the hostile artillery before an assault is launched. Once the attack develops, however, it may be preferable to direct the full power of the defending artillery for a time upon the assaulting troops.

6. Harassing Fire.—In a defensive action of a temporary nature this form of fire will not generally be developed because of the necessity for economizing ammunition. When resources permit, however, an enemy's offensive preparations may be considerably hampered by a well-devised scheme of harassing fire.

7. Withdrawal.—When a force is retiring in the face of an enemy, mobile artillery is of particular value for covering the withdrawal of the other troops. Thus, rear guards usually contain a large proportion of guns. Enemy columns should be engaged at long ranges with the object of forcing them to halt and deploy as frequently as possible. Command of the artillery will generally have to be decentralized to infantry brigades or corresponding units in this form of operation, and batteries should retire alternately in order that continuous support may be provided.

XII. ANTIAIRCRAFT DEFENSE

The use of military airplanes in World War I forced artillery to take on a new dimension. Instead of being confined to lateral firing from one point on the earth's surface to another, it now had to reach skyward to attack enemy bombers. New gun carriages had to be designed to point guns straight up, or at least at very high angles of elevation, and new techniques had to be devised for gauging the height and speed of enemy planes and for computing the proper aiming point for the antiaircraft weapons. For control of AA fire, the height finder was the counterpart of the range finder employed by field artillery, but it was only one of many ingenious devices needed to cope with the problem of attacking fast-moving, high-flying planes capable of taking evasive action in three dimensions. Of great importance were time fuzes that exploded shells after a predetermined time of flight and, in World War II, the remarkable VT fuzes that automatically caused shells to burst when they came within range of a target. The location and tracking of targets by visual and aural means were replaced during World War II by radar, which was more accurate and was not limited to short distances, clear weather and daylight. (See *Antiaircraft Artillery* above. *See* also AIR POWER.)

In early prediction equipment it was necessary to observe the target from at least two locations and compute firing data by plotting from curves on drums and quadrants. The data were then transmitted by telephone to the guns and applied manually. Later a continuous flow of data was computed mechanically through action of the sighting device upon carefully prepared and correlated cams and variable-speed devices. The computers in use during the 1950s took the position and course of the target directly from the radar, computed its predicted position electronically and transmitted the firing data directly to the guns in the form of electrical signals which elevated, traversed and set fuze data on the guns automatically.

Powerful antiaircraft guns normally were concentrated in fixed positions near cities, ports or supply bases. When effectively used, they were able to make the attackers pay a heavy price for their bombing raids. Troops in advanced bases were accompanied by lighter mobile AA weapons while columns on the march defended themselves with still lighter weapons such as the famous Bofors 40-mm. gun. Close co-ordination between AA batteries and the air force was essential to avoid firing on friendly planes.

During the 1950s new rocket weapons entered the picture. The most effective of these were the guided missiles, so different from conventional weapons that they constituted a revolutionary new category of AA matériel. After being fired from ground launchers, the missiles were subject to control from the ground by intricate electronic devices and could be guided toward enemy planes even though the planes took evasive action. They could attain supersonic speed and thus prove more than a match for jet planes. In the United States, batteries of Nike missiles for AA defense were placed near scores of important target areas and troops were

specially trained for their operation. The first type of Nike missile, known as Nike-Ajax, was soon supplemented, and to some extent replaced, beginning in 1958, with Nike-Hercules, a longer ranging missile capable of carrying a nuclear warhead.

See also references under "Artillery" in the Index.

(J. N. K.; M. B. H.; H. C. T.; P. G. Bn.)

ART INSTITUTE OF CHICAGO. The Art institute was incorporated on May 14, 1879, for the "founding and maintenance of a school of art and design, the formation and exhibition of objects of art, and the cultivation and extension of the arts of design by any appropriate means." It is financed primarily by voluntary gifts and bequests. The building on Michigan avenue at Adams street was designed by Shepley, Rutan and Coolidge, and houses more than 150 galleries, classrooms, studios and offices, the Ryerson art library, the Burnham architectural library, Fullerton hall, the Goodman Memorial theatre and a restaurant. The paintings represent Italian, Netherlandish, Flemish, French, Spanish, German, British and U.S. schools, notably from the Bartlett, Coburn, Eddy, Kimball, Palmer, Ryerson, Winterbotham and Worcester collections. Late 19th- and early 20th-century French painting collections are especially important. The department of prints and drawings includes drawings, engravings, etchings, lithographs and a library of graphic arts. The Japanese print collection is one of the largest in the world. The Buckingham collection of ancient Chinese bronzes and the Tyson collection of Chinese ceramics are outstanding. There are also collections of sculpture, primitive art, historic (European and American) furniture, ceramics, silver, textiles and the Thorne Miniature rooms. The school is the largest art school in the country. All phases of art, including the theatre, are taught from children's classes to the master's degree level. Two bronze lions by Edward Kemeys at the entrance are often used as symbols of Chicago. Lorado Taft's "Fountain of the Great Lakes" is at the south terrace. Museum educational work includes lectures, sketch classes and gallery tours.

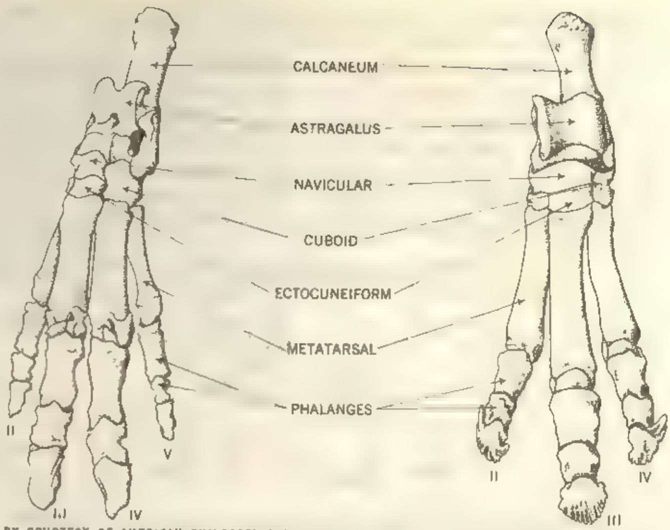
(R. P. T.)

ARTIODACTYL, any member of the order of ungulate mammals (Artiodactyla) comprising the pigs, camels, deer, goats, sheep, cattle, antelopes and other living and extinct forms.

General Characteristics.—In artiodactyls, the main axis of the limb passes between the third and fourth toes. Each of these toes is well developed and more or less equal in size. The second and fifth, or outer toes, are considerably smaller or entirely absent. The first toe is never present in living forms but is preserved in the forefoot of some of the earliest fossil swinelike species. The ordinal name Artiodactyla, meaning even-toed, is an allusion to the fact that all living members of the group, except peccaries with three functional toes on the hind foot, have either two or four toes on each forefoot and hind foot. The name Paraxonia, also applied to the group, refers to the disposition of the third and fourth digits to each side, respectively, of the main axis of the whole foot. In the so-called odd-toed ungulates, or Perissodactyla, the main axis of each foot passes through the middle, not to one side, of the third toe, which is always conspicuously larger than any of the other toes. (*See* Perissodactyl.)

The bodies of artiodactyls are supported in walking on the two middle toes of each foot except in the hippopotamus, where all four toes of each foot reach the ground. The toes of all recent artiodactyls, except camels, are encased in hoofs. In camels, the two middle toes are contained in a broad pad that forms the sole of the foot. The hoofs of the extinct North American *Agriochoerus* are clawlike; the animal may have been arboreal. Along with the modification of the foot bones, the ulna of the front leg in living forms is greatly reduced and more or less joined to the radius and, with the exception of chevrotains, the humerus is without an entepicondylar foramen. In the hind leg the fibula is vestigial and the third trochanter of the femur is absent.

Most artiodactyls, particularly the males, possess one, or rarely two paired frontal appendages in the form of horns or antlers; an unpaired third horn was present in some extinct deer. The muzzle of artiodactyls is long, the brain case small, the nasal bones not expanded behind; in most artiodactyls, the socket for the eye is completely encircled by bone. A clavicle is absent. There



BY COURTESY OF AMERICAN PHILOSOPHICAL SOCIETY FOR PROMOTING USEFUL KNOWLEDGE

FIG. 1.—(LEFT) LEFT HIND FOOT OF PIG SHOWING TWO CENTRAL TOES, CHARACTERISTIC OF ARTIODACTYLA, COMPARED WITH (RIGHT) LEFT HIND FOOT OF TAPIR SHOWING THE ODD-TOED CONDITION CHARACTERISTIC OF PERISSODACTYLA. (ROMAN NUMERALS INDICATE THE NUMBER OF DIGITS THAT PERSIST FROM THE EARLIER FIVE-TOED HOOFED MAMMALS.)

are seven neck vertebrae, even in the giraffe. The number of thoracic vertebrae varies from 12 in the camel to 15 or 16 in the hippopotamus, but the combined number of thoracic and lumbar vertebrae never exceeds 19 in living artiodactyls. There are five sacral vertebrae and a variable number of caudal vertebrae.

The number of teeth in all artiodactyls is derived from the basic formula of three incisors on each side of the upper and lower jaw, one canine, four premolars and three molars, a total of 44. The upper incisors and first premolar are absent in most ruminants. The upper canine may be developed into a long tusk or may be absent. The lower canine is well developed in swine and hippopotami but is reduced or incisiform in ruminants. Artiodactyl molars are of several types. Brachydont molars are low-crowned. Hypsodont molars are high-crowned, but the bases of the enamel folds that define the cusps are not visible from the grinding surface. The three or four main cusps of brachydont molars are usually conelike, or bunodont. The main cusps of hypsodont molars are generally crescent-shaped, or selenodont. In molar crowns of intermediate height, the cusps of one side may be bunodont while those of the opposite side are selenodont. This type is called bunoselenodont. The structure of the molars as well as that of the limb bones are of the greatest importance in the classification of the artiodactyls.

The stomach of living ruminant artiodactyls is divided into three or four chambers. In swine and hippopotami the stomach is less specialized and not adapted for rumination. A caecum and a gall bladder are usually present. The uterus is bicornuate and, except in the hippopotami, the testes descend into a scrotum.

Artiodactyls are well provided with integumentary glands. Mammary glands are always present in the inguinal region and sometimes are also present in the abdominal region, as in swine. Odoriferous glands are distributed on various parts of the body

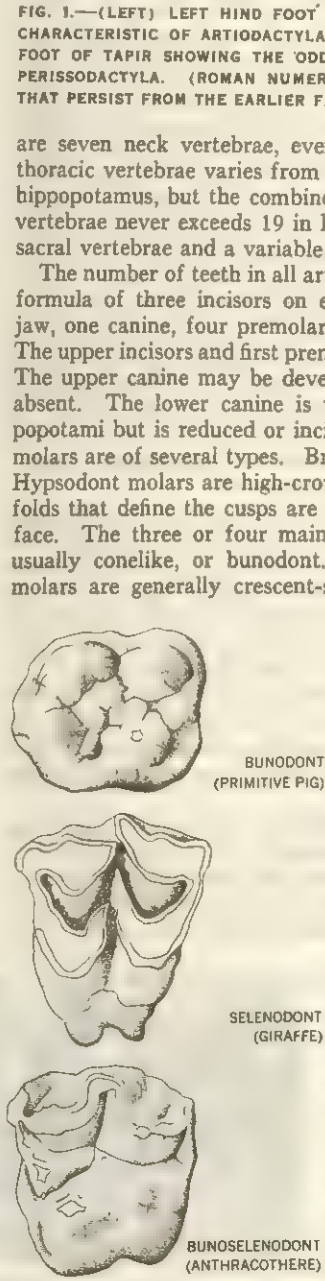
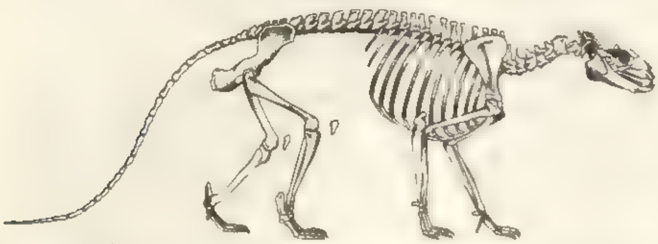


FIG. 2.—GRINDING TEETH OF ARTIODACTYLS (SURFACE VIEW)

including the inguinal and abdominal regions, middle of the back, front of the eye, forehead, feet and tail.

Artiodactyls have a keen sense of smell. Their hearing is also acute, but their sight is less developed. Most artiodactyls are nocturnal and therefore depend on smell for selecting food and distinguishing between their own and other kinds of animals. Diurnal, plains-dwelling ungulates also depend more on detection of wind-borne smells and sounds for survival than they do on vision. The mating instinct is also stimulated and guided by smell.



FROM P. GRASSÉ, "TRAITÉ DE ZOOLOGIE"

FIG. 3.—SKELETON OF AN EXTINCT, PROBABLY ARBOREAL ARTIODACTYL, AGRIOCHOERUS LATIFRONS

Artiodactyls are essentially terrestrial. Some, like goats, may climb; others, like the hippopotamus, are at home in water. No living artiodactyl, however, is arboreal or wholly aquatic and none is fossorial. All artiodactyls are herbivorous, and swine are omnivorous. Most artiodactyls are gregarious. Some species, notably certain antelopes, bison, caribou and white-lipped peccaries, form herds numbering hundreds or thousands of individuals. Generally, males and females live apart except during the breeding season. At this time the males may fight each other for domination of the females. The rut usually takes place during the fall in the temperate zones but may occur at variable times of the year in the tropical zone. Gestation usually lasts longer in the larger artiodactyls than in the smaller. One, two, rarely three young are born to most ruminants during the spring in the temperate zones and at about the beginning of the rainy season in the tropics. In domestic pigs, as many as 14 young may be born in one litter. Young ungulates can follow their mother within a few hours after birth.

Artiodactyls are native to all continents except Australia and Antarctica. Some representatives of the order, particularly swine, deer and buffalo, are also indigenous to many of the larger islands except New Guinea, New Zealand, Tasmania and those of the antarctic region. Farm and game artiodactyls, however, have been introduced by man into practically all parts of the world where suitable fodder is available. (*See* also ZOOGEOGRAPHY.)

All living and fossil Artiodactyla are arranged in three suborders, the Suiforms, Tylopoda and Ruminantia. They will be discussed below in that order. A complete classification of Artiodactyla, based upon that of G. G. Simpson, appears at the end of this article.

Suiformes.—Among living artiodactyls only pigs, peccaries and hippopotami are classified as suiformes. They are nonruminants although their stomachs are more or less subdivided into specialized sections. From one to three upper incisors are present in each jaw, the lateral incisors being the first ones to disappear. The lower incisors project forward; the canines are well developed, tusklike and generally ever-growing; the molars are bunodont; the orbit, or eye socket, is never separated from the temporal fossa; horns are absent; ulna and fibula are not greatly reduced and the middle two foot bones are never completely fused to form a cannon bone.

Typical pigs appeared in Europe between 25,000,000 and 30,000,000 years ago. *Palaeochoerus* of the end of the Oligocene may be regarded as the archetype of the true pig family Suidae. It spread into India and Africa during the Miocene before disappearing altogether. The genus *Sus*, to which most modern pigs including the domestic form belong, made its appearance in the upper Miocene of Europe and advanced into Asia, reaching India during the Pliocene. Wart hogs, including the living genus Phacochoerus, arose in Africa about the end of the Pliocene. Other surviving members of the pig family are the Asiatic pygmy hog *Porcula*, the East Indian babirussa (*Babirussa*), the African river hog (*Potamochoerus*) and the forest hog (*Hylochoerus*). (*See* also PIG; BOAR.)

True peccaries, family Tayassuidae, differentiated in Europe about the same time, if not earlier, than true pigs. One branch of peccaries, beginning with *Perchoerus*, reached the western hemisphere and survived to this day. The old world branch of peccaries, typified by the Oligocene genus *Doliochoerus*, spread into Asia before it disappeared altogether during the Pliocene some 8,000,000 or 9,000,000 years ago. Living peccaries are now represented by two species in tropical America, the collared peccary (*Tayassu tajacu*) and the larger white-lipped peccary (*Tayassu pecari*). (*See* also PECCARY.)

The family Hippopotamidae is made up of three genera, of which only one, *Hexaprotodon*, is extinct. This genus appeared about 20,000,000 years ago at the end of the Miocene in the Mediterranean region and in India and persisted until the Pleistocene. One of the living forms, *Hippopotamus amphibius*, now confined to Africa south of the Sahara, had already advanced well into Africa and Europe during the upper Pliocene and reached England in the Pleistocene. The third member of the family is the west African pygmy hippopotamus, *Choeropsis liberiensis*. (*See* also HIPPOPOTAMUS.)

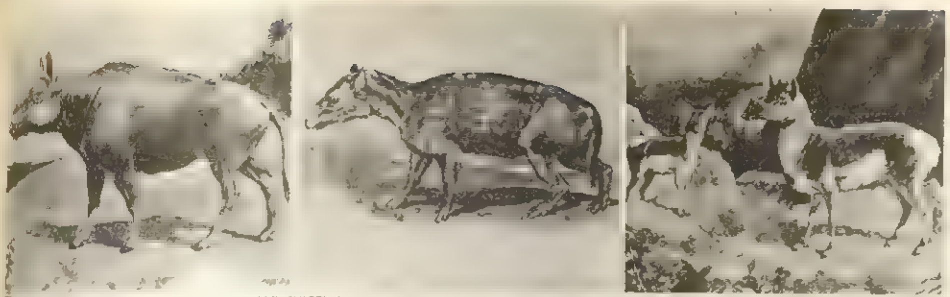
The most ancient of the suiformes are the extinct paleodonts. These piglike animals lived in Europe and North America some 30,000,000 to 60,000,000 years ago during the Eocene and Oligocene. Some of the oldest of these fossils belong to the family Dichobunidae. They were rabbitlike in size, possessed 44 teeth, small incisors and canines and rather simple molars. Another family, the Entelodontidae, widely distributed in Europe and North America during the Oligocene, included specialized forms ranging in size from pigs to hippopotami. The unique characteristic of entelodonts is the presence of a large process extending from each cheekbone and two similar ones projecting from each side of the lower jaw.

Ancodonts are piglike suiformes with 44 teeth, the upper molars selenodont, the lower bunoselenodont. They lived about 20,000,000 to 50,000,000 years ago in Asia, Africa and North America. Of the two known families, the Anthracotheriidae is the more primitive. Anthracotheres were generally large, the skull of one being five feet long. Their size, heavy skeleton, well-developed four toes on each foot and a rudimentary fifth toe on the forefoot in some species, certain characters and aquatic habits suggest a close relationship with hippopotami. The similarities, however, probably developed independently in each group. The second family of ancodonts, the Anoplotheriidae, is known only from the Middle Eocene to the Middle Oligocene of Europe.

The Oreodonts comprise a numerous but rather homogenous group of extinct suiformes with selenodont molars and four or

(LEFT) BY COURTESY OF DADE THORNTON FROM NATIONAL AUDUBON SOCIETY; (CENTRE, RIGHT) ERNEST P. WALKER

FIG. 4.—LIVING ARTIODACTYLS: (LEFT) ARABIAN CAMEL (CAMELUS DROMEDARIUS); (CENTRE) CHEVROTAIN (TRAGULUS JAVANICA); (RIGHT) PYGMY HIPPOPOTAMUS (CHOEROPSIS LIBERIENSIS), WITH YOUNG



BY COURTESY OF (LEFT, RIGHT) THE AMERICAN MUSEUM OF NATURAL HISTORY FROM A MURAL BY CHARLES R. KNIGHT; (CENTRE) CHICAGO NATURAL HISTORY MUSEUM

FIG. 5.—RESTORATIONS OF EXTINCT ARTIODACTYLS: (LEFT) ENTELODON; (CENTRE) BOTHRIODON; (RIGHT) PROTOCERAS

five toes on the forefoot. They lived in North America from 20,000,000 to 40,000,000 years ago. One of the genera, *Merycoidodon*, was about three feet long and nearly 15 in. high at the shoulder. Its limbs were primitive in structure, the radius and ulna being completely separated and the forefoot provided with four long toes and a rudimentary thumb. A related genus, *Brachycrus*, may have had a well-developed proboscis. *Agriochoerus* had five toes on the forefoot and claws instead of hoofs.

The Cainotheriidae is a family of small extinct European ungulates of uncertain affinities and unknown origin. It appeared suddenly about 40,000,000 years ago, flourished for about 10,000,000 years, then disappeared. The animals were rabbitlike in size, appearance and, probably, in habits. Their skull was marked by a sagittal crest, bony orbital ring, large tympanic bullae, a complete set of 44 teeth, five-toed limbs and with the lower leg bones separate and capable of a degree of supination exceptional among artiodactyls.

Tylopoda.—The suborder Tylopoda is composed of two families, the Camelidae, which includes modern camels and llamas, and the Xiphodontidae, made up of several extinct forms. Living camels are characterized by having: padded toes; a stomach adapted for rumination; a diaphragm with an ossification; red corpuscles of the blood ovate and not circular as in all other mammals; three upper incisors in each jaw of the young individual (only the third lateral incisor persists in the adult); canines differentiated from incisors and present in upper and lower jaws; molars selenodont and hypsodont; and auditory bullae filled with cancellous tissue. Neither the stomach nor the "hump" of camels serves as a reservoir for water.

Camels originated in North America during the upper Eocene, about 40,000,000 years ago. Like horses, they underwent most of their evolution on the North American continent before invading Asia and South America during the Pleistocene. (*See* also CAMEL; LLAMA.)

The family Xiphodontidae includes primitive selenodonts of the middle Eocene and lower Oligocene of Europe. They appear to be nearest the Camelidae but not certainly ancestral to them.

Ruminantia.—The suborder Ruminantia is the most widespread, most varied and most abundant of ungulates. It is the dominant herbivore group of the world and has been so for more than 30,000,000 years. The name Ruminantia alludes to the ruminating or cud chewing habit of the animals. Rumination is made possible by the division of the stomach into four connected chambers (three in camelids). Food when first swallowed enters the first chamber, or rumen, where it is softened by fermentation. It then passes into the second chamber, the reticulum or honeycomb bag, where further fermentation takes place. The food is then regurgitated into the mouth in the form of balls, or cuds. Each cud is thoroughly rechewed and then reswallowed. Because of its more fluid condition the rechewed mass filters through the coarser contents of the reticulum into the third and fourth chambers, where digestion continues. (*See* also RUMINANT.)

The most primitive of recent ruminants are the chevrotains of the family Tragulidae. They can be traced to the Miocene, where they seem to have evolved from a still more primitive group, possibly the Gelocidae, which dates back some 40,000,000 years to the upper Eocene. The Hypertragulidae is another family of extinct tragulidlike artiodactyls that includes such precursors of modern ruminants as *Archaeomeryx* of the upper Eocene of Mongolia and *Leptomeryx* of the North American Oligocene. The extinct Protoceratidae with their two and three pairs of long horns are the oddest of the tragulidlike ungulates. They arose during the lower Oligocene of North America and survived until the Pliocene.

The deer family, Cervidae, evolved from early traguloids during the Oligocene 30,000,000 to 40,000,000 years ago. *Eumeryx*, one of the oldest of known fossil deer, lived during the early Oligocene of China and Mongolia. The American branch of the deer family appeared some 25,000,000 to 30,000,000 years ago. (*See* also DEER.)

The Giraffidae arose about 25,000,000 years ago in the Miocene of Asia and ranged into Europe and Africa. They are closely related to both Cervidae and Bovidae but may be nearer the former. The living genera of the family are the African giraffes (genus *Giraffa*) and the okapi (genus *Okapia*). (*See* also GIRAFFE; OKAPI.)

The Antilocapridae appeared during the Miocene of North America. The horns of the pronghorn are bifurcated as in deer and the horny sheath is shed annually. The bony core of each horn, however, is permanently fixed to the skull as in true antelopes. Many forms with bizarre horns were developed but only one species, the pronghorn antelope, survives. (*See* also PRONGHORN.)

The most highly specialized and diversified family of ruminants is the Bovidae. It arose sometime during the Miocene in Asia and spread into Europe, Africa and the new world. Living representatives include the domestic cattle, goats, sheep, antelopes and all other hollow-horned ruminants. The horns of bovids are never shed. *See* also BOVIDAE.

CLASSIFICATION AND DISTRIBUTION

(*indicates extinct)

- Suborder Suiformes
  - Infraorder Palaeodonta*
    - Superfamily Dichobunoidea*
      - Family Dichobunidae* (Eocene: North America; Eocene-Oligocene: Europe).
      - Family Choeropotamidae* (Eocene: North America, Asia; Eocene-Oligocene: Europe).
      - Family Cebochoeridae* (Eocene-Oligocene: Europe).
      - Family Leptochoeridae* (Oligocene: North America).
    - Superfamily Entelodontoidea*
      - Family Entelodontidae* (Eocene-Miocene: North America; Oligocene: Europe; Eocene-Oligocene: Asia).
  - Infraorder Suina
    - Superfamily Suoidea
      - Family Suidae—pigs (Oligocene-Recent: Europe; Miocene-Recent: Africa, Asia; world-wide in domestication).
      - Family Tayassuidae—peccaries (Oligocene-Recent: North America; Pleistocene-Recent: South America; Oligocene-Miocene: Europe; Pliocene: Asia).
      - Family Hippopotamidae—hippopotami (Pliocene-Pleistocene: Asia; Pliocene-Recent: Africa; Pleistocene: Europe).
  - Infraorder Ancodonta
    - Superfamily Anthracotherioidea*
      - Family Anthracotheriidae* (Eocene-Miocene: Europe; Eocene-Pleistocene: Asia; Oligocene-Miocene: Africa, North America).
      - Family Anoplotheriidae* (Eocene-Oligocene: Europe).
    - Superfamily Cainotherioidea*
      - Family Cainotheriidae* (Eocene-Miocene: Europe).
  - Infraorder Oreodonta*
    - Superfamily Merycoidodontoidea*
      - Family Agriochoeridae* (Eocene-Miocene: North America).
      - Family Merycoidodontidae* (Eocene-Pliocene: North America).
- Suborder Tylopoda
  - Family Xiphodontidae (Eocene-Oligocene: Europe).
  - Family Camelidae—camels, llamas (Eocene-Pleistocene: North America; Pleistocene-Recent: South America, Asia, North Africa; Pleistocene: Europe).
- Suborder Ruminantia
  - Infraorder Tragulina

Superfamily Amphimerycoidea*
  Family Amphimerycidae* (Eocene-Oligocene: Europe).
Superfamily Hypertraguloidea*
  Family Hypertragulidae* (Eocene-Miocene: North America; Eocene: Asia).
  Family Protoceratidae* (Oligocene-Pliocene: North America).
Superfamily Traguloidea*
  Family Gelocidae* (Eocene-Oligocene: Europe, Asia).
  Family Tragulidae—chevrotains (Miocene-Recent: Asia; Miocene-Pliocene: Europe; Pleistocene-Recent: Africa).
Infraorder Pecora
Superfamily Cervoidea
  Family Cervidae—deer (Oligocene-Recent: Asia, Europe; Miocene-Recent: North America; Pleistocene-Recent: South America).
Superfamily Giraffoidea
  Family Lagomerycidae* (Miocene: Europe, Africa, Asia).
  Family Giraffidae—giraffe and okapi (Miocene-Pleistocene: Asia; Pliocene: Europe; Pliocene-Recent: Africa).
Superfamily Bovoidea
  Family Antilocapridae—pronghorn antelope (Miocene-Recent: North America).
  Family Bovidae—domestic cattle, sheep, goats, gazelles, buffalos, etc. (Miocene-Recent: Europe; Pliocene-Recent: Asia, Africa; Pleistocene-Recent: North America; world-wide in domestication).

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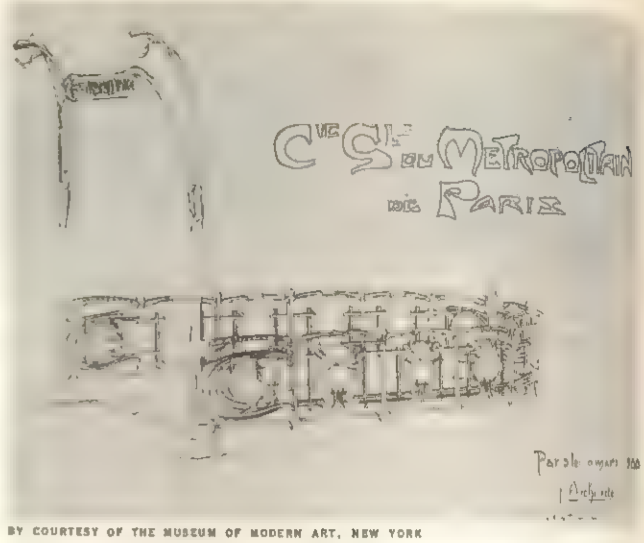
(PH. H.)

ART NOUVEAU, a defined style of architecture and decoration, was launched in the 1890s by Belgian architects. Self-conscious in its reaction to the imitative styles of the 19th century, *art nouveau* was rooted partly in the determined individualism of William Morris and the arts and crafts movement (*q.v.*) in England, and partly in a valid appreciation of new materials and mechanical developments. This fusion of structural features and naturalist aesthetics resulted in a style that included the long, sensitive, flowing line of both a Paris Métro station and a rich Tiffany glass vase.

Indications of this style appeared in expositions of paintings, graphic arts, furniture and interior design as early as 1884 in Belgium and England. The first major application in architecture, however, was Henry Van de Velde's villa at Uccle, Belg., in 1894–95. The success of this building led Samuel Bing, an avant-garde Paris decorator, to invite Van de Velde to introduce his new style at the Dresden exposition of 1897. The style was first designated the *style belge* and, in 1895, the *style nouveau;* not until 1898 did it become known as *art nouveau,* a name used by Bing for the art galleries he opened in 1896. Bing was a born showman. It was largely because of his promotion of this very new style that it was adopted by the French decorators and became the fashionable, elaborate manner in which to refurbish houses, shops and restaurants. The Paris International exposition of 1900 brought the movement enthusiastic recognition.

Van de Velde was chiefly interested in the architectural application of new principles; he wrote much in their support. After 1902 his activities were concentrated in Germany where the style flourished and became known as *Jugendstil.* Van de Velde's most important structure was the Folkwang museum, Hagen, Ger. (1901).

An important contemporary of Van de Velde, the Belgian architect Victor Horta, designed numerous houses and public buildings in the style, notably the Maison du Peuple commissioned by the city of Brussels and completed in 1897. The popular fame of houses and the church of the Holy Family, by Antonio Gaudí, transformed the city of Barcelona into a capital of *art nouveau.* Removed from the mainstream of the movement, Gaudí developed an individual style which nevertheless incorporated the leading characteristics of *art nouveau.* He continued to work in this style until his death in 1926. In Paris, Hector Guimard designed



BY COURTESY OF THE MUSEUM OF MODERN ART, NEW YORK

HECTOR GUIMARD'S "PROJECT FOR MÉTRO STATION," PARIS, 1900

the stations of the Métro (the underground railway), as well as other buildings and structures.

In the applied and decorative arts, *art nouveau* flourished throughout all Europe. The tendency to obliterate the straight line, to maintain a continuous flow of linear movement, is particularly evident in the interiors of restaurants like Maxim's in Paris and in the fashionable shops of the day in European capitals. Wall areas were treated as large decorative panels or were hidden by mirrors and overlaid with delicate moldings that wound around corners and onto pillars, deliberately obscuring architectural form. In addition to flower motifs, the peacock was a central decorative theme: the eyes of the tail were repeated through whole interiors and the curves of the spread fan were echoed over and over.

International expositions and fairs provided excellent showcases for the new style. Not only exposition buildings but individual rooms, furniture and art objects were designed in *art nouveau* and met with great success.

By 1902, *art nouveau* reached the apex of its international phase. The exposition that year in Turin, Italy, had for its theme the application of *art nouveau* to buildings and interiors. It was also the crossroads of the style. Most nations of Europe were represented and variants of the style were readily apparent. Belgian and French interpreters of Van de Velde's texts had elaborated them as far as possible. German, Austrian and English architects and designers gradually changed to a simpler, rectilinear manner which led to the International style. After 1902, *art nouveau* was found mostly in toiletries, jewelry, vases, wallpaper and other purely decorative products reflecting the frivolous prosperity of western Europe in the early 20th century.

In the United States, the glass and bronze designs of Louis Comfort Tiffany are the outstanding examples of the style: his glass is iridescent, his bronze flows in S-curves.

It was in execution that *art nouveau* became confused; positive values lie in its theories and principles, and in its liberating impact on the public. Despite the superficiality of its final phase, *art nouveau,* by successful application of a unified aesthetics and linear emphasis, made an important contribution to the development of modern architecture and applied arts.

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(H. F. L.)

ARTOIS, an ancient province of France, corresponding to the modern *département* of Pas-de-Calais, less the *arrondissements* of Boulogne and Montreuil. Its capital was Arras (*q.v.*), and other important places were St. Omer, Béthune, Aire, Hesdin, Bapaume, Lens, Lillers, St. Pol and St. Venant.

The names Artois and Arras are derived from the Atrebates, who

inhabited the district in the time of Caesar. From the 9th to the 12th century Artois belonged to the counts of Flanders. It was promised in 1180 to Philip II Augustus of France by Philip of Alsace, count of Flanders, as the dowry of his niece Isabella of Hainaut, and was conferred in 1237 as an appanage by Louis IX of France on his brother Robert, who died in 1250. His son, Robert II of Artois, was killed at the battle of Courtrai in 1302. His son Philip having predeceased him (1298), Artois was adjudged to Robert II's daughter Mahaut (Matilda) as against Philip's son Robert, who attempted to support his claim to the countship by forged titles. Banished from France (1332), Robert of Artois took refuge in England and incited King Edward III to make war upon Philip VI of France (*see* HUNDRED YEARS' WAR). His descendants, the counts of Eu (*q.v.*), continued to style themselves counts of Artois. By the marriage of Mahaut (d. 1329) with Otto IV, Artois passed to the counts of Burgundy, with whom it remained, so that the marriage of Mary, daughter of Charles the Bold, to the Austrian archduke Maximilian brought it to the house of Habsburg (*see* BURGUNDY; FRANCHE-COMTÉ). Louis XI, however, occupied portions of Artois, and the claims of Austria were contested by France until the treaty of Senlis (1493). When the Habsburg possessions were partitioned on the abdication of the emperor Charles V, Artois went to Spain with the rest of the Burgundian inheritance. At the end of the Thirty Years' War, Artois was again conquered by the French, and the conquest was ratified by Spain in the treaty of the Pyrenees (1659). The treaties of Nijmegen (1678) and Utrecht (1713) confirmed French sovereignty. The title of comte d'Artois was borne by Charles X of France before his accession.

See J. Lestocquoy, *Histoire de la Flandre et de l'Artois* (1949).

ARTS AND CRAFTS MOVEMENT. The arts and crafts movement, which flourished in England during the 1880s and '90s, was one of many reformatory efforts protesting the social, moral and cultural confusions that accompanied the Industrial Revolution. The movement opposed the imitative architecture and shoddy, ugly, mass-produced objects of its era by reviving handicrafts and designing for them. Walter Crane, an arts and crafts leader, maintained that "the true root and basis of all Art lies in the handicrafts," reflecting the attitude of many progressives of the period, who sought in design the expression of individuality joined with expressions of fitness for use, the nature of materials and the nature of fabrication. Twentieth-century western architecture and design accept these ideals, though handicrafts no longer challenge industrialization.

Precursors to the movement in England were the Gothic Revivalists, the Pre-Raphaelites and John Ruskin, the most influential writer in English on art. In 1859 William Morris built his home from Philip Webb's designs, and two years later opened a shop where interior furnishings could be ordered. Morris and his friends endeavoured actually to practise the principles of medieval craftsmanship, not merely to imitate its forms or effects. They remastered the crafts; Webb rediscovered English vernacular building. Together Morris and Webb led the English domestic revival, which evolved into the less antiquarian arts and crafts movement. Meanwhile Japanese architecture and crafts won over artistic London at the 1862 World's fair, demonstrating principles remarkably parallel to Morris' and introducing cheerful light colourings. In the 1860s and '70s Christopher Dresser published schematic botanical ornament while Charles Locke Eastlake popularized advanced interior design to English-reading audiences. All this influenced the nascent arts and crafts.

In 1882 Arthur H. Mackmurdo (a disciple of Ruskin's), Selwyn Image and others founded the Century guild for craftsmen. In 1886 the same group began the revival of hand printing in the magazine the *Hobby Horse*. An association for encouraging cottage crafts also started in 1884 as did the Art Workers' guild, two of whose founders were W. R. Lethaby, later principal and moving spirit of London county council's Central School of Arts and Crafts, and Walter Crane, first president of the Arts and Crafts Exhibition society. This society, sheltering several groups, may be considered the focus of the movement. Ruskin and Morris were its prophets; two generations of enthusiasts had learned that art was all one—the generally accepted difference between fine arts and applied arts seemed destructive and artificial. Delegates from the Art Workers' guild approached the Royal Academy of Arts, suggesting joint exhibitions. After many meetings no agreement was reached.

The Arts and Crafts Exhibition society then was formed and held its first show in 1888. In the society's catalogue notes of 1889 Crane stated the aesthetic character of the movement ". . . plain materials and surfaces are infinitely preferable to inorganic or inappropriate ornament." Distinguished exhibitors included William De Morgan, potter; W. A. S. Benson, metal designer; and C. R. Ashbee, who founded two schools and in 1888 his own Guild of Handicraft, which lasted 20 years.

Some progressives, however, voiced dissent. Lewis F. Day, a leading designer, in 1882 said "the public . . . want machine work . . . they will not pay much heed to us." Oscar Wilde said that good machinery was graceful and that the line of strength and the line of beauty were one. John D. Sedding, designer-architect, in 1888 accepted the machine. William Morris in his socialist vein asked "what business have we with art at all unless all can share it?"; but *The Studio*, in 1893 London's new progressive art periodical, assessed the Arts and Crafts Exhibition society's fourth show as "the work of a few for the few." The same review recognized, however, a worthy protest against design as "a marketable affair, controlled by the salesman and the advertiser, and at the mercy of every passing fashion."

The '90s were full years for the arts and crafts. C. F. A. Voysey, Webb's gifted successor in architecture, became famous, though his cottage style was known earlier to enthusiasts like young Frank Lloyd Wright. Voysey's wallpapers and printed fabrics also aroused widespread admiration with their light colours and uncluttered, simplified plant patterns. Ernest Gimson's cabinetwork reached a high level. William Morris made a last contribution, his great Kelmscott press books. The arts and crafts replaced orientalia in an important shop, Liberty and Co., soon identified with the movement.

Later in the decade a group of young architects and designers, brilliantly led by C. R. Mackintosh, gave the movement new liveliness and a new centre, Glasgow. The Scots established good foreign connections, especially with Austria and Germany, and were open to the allure of ornament and the influence of aesthetic artists and writers, such as Beardsley and Wilde, which the English craft adherents rarely were.

Several craftsmen gained prominence in England between 1900–10: T. J. Cobden-Sanderson and Emery Walker founded the Doves press; Frank Brangwyn, the painter, designed distinguished rugs and furniture; Ambrose Heal translated the craftsman's style into popularly priced, well-made furniture.

In Europe during the 1890s and 1900s the influence of the arts and crafts movement expanded. A. W. Finch, the potter, in 1891 carried it to Belgium where G. Serrurier-Bovy took it up; in 1897 Finch moved to Finland, becoming an eminent arts and crafts teacher. In Holland H. P. Berlage and in Austria Otto Wagner, both leading architects, after 1895 preached gospels similar to those of the arts and crafts movement; they were followed by younger men, many leaving the *art nouveau* (*q.v.*) for this stricter, quieter style. This trend was true still later in Germany, after Peter Behrens and Richard Riemerschmid were converted. The *art nouveau* and the arts and crafts were allied to fight against historic revival styles; they were shown together in many exhibitions in Belgium, France and Germany, as well as in ten progressive periodicals that sprang up, after *The Studio's* success, from 1895 to 1898 in Germany, France and Austria. The Belgian Henry van de Velde reorganized the Weimar Academy of Art in 1900 along English craft school lines and his successor Walter Gropius kept some of this when he transformed the school into the *Bauhaus* (*q.v.*).

At East Aurora, N.Y., in 1895 Elbert Hubbard set up a deliberate evocation of William Morris' workshops. In 1897 Bostonians organized the first American Society of Arts and Crafts. In California the Greene brothers built and furnished handsome homes which showed much arts and crafts as well as Japanese influence.

Gustav Stickley's magazine, *The Craftsman*, popularized mission furniture and bungalows in the United States from 1901 to 1916. Frank Lloyd Wright at Chicago, close to the craftsmen in style, voiced realistic doubts in his repeated lecture, *The Art and Craft of the Machine*. In fact few important arts and crafts designers personally practised crafts, and many worked regularly for industry. C. R. Ashbee, visiting Chicago in 1900, was strongly impressed by Wright and later sponsored him in Europe. By 1911 Ashbee wrote that modern civilization rested on machinery, and the arts and crafts protest dissolved into craft activity, an esteemed specialty of modern design. *See* also FINE ARTS.

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ART SELLING. An art sale is a sale of a work of art by an auctioneer, an art dealer or the artist himself. Art dealing may be carried out not only by dealers who have established businesses, but also by middlemen between the artist and the buyer, between the sales room and the public and between the excavator or explorer and the public. Works of art also may be sold through commission, in which case the artist comes into direct contact with the purchaser, filling a particular demand rather than supplying the general needs of the market.

History of the Art Market.—Art in the heroic, Homeric and classical ages was a craft and the artist an artisan, sometimes a wanderer moving from town to town looking for employment. In Greece, the city-state was the sole large buyer of art. Commissions were by public competition and consent, and an artist could not secure a position in the community by offering works to a general market. During the age of Alexander the Great, the growth of private wealth created a demand for art objects, but the great change that was to affect the market was that artists began to acquire some philosophical education, thus raising themselves from the level of tradesmen. Zeuxis' painting earned him a fortune, and Apelles became the confidant of Alexander himself.

During the conquests of the Roman republic in the 2nd and 1st centuries B.C. artists were often slaves and the prices of works of art were low, but toward the end of the Roman empire works of art from other countries and other ages acquired a rarity value previously confined to the cult objects of religion. The change from an agrarian society to the urban society of imperial Rome led to an exceptional rise in private fortunes, which promoted activity in the art market. Rome already possessed an art-dealing quarter near the Via Publica, and Suetonius records what was virtually an art auction conducted by the emperor Caligula himself. Most art purveyors were Greeks, Alexandrians and other middle easterners. The profession of artist continued to be considered low even though art itself was winning new respect, and successful painters and sculptors sometimes showed their social embarrassment by refusing to take money for their great works. Plutarch calls Polygnotus "not ungentlemanly" because he frescoed a public building without asking for a fee. In Byzantium the court, as the centre of intellectual and social life, was the sole purchaser of art, on behalf of church and state.

During the early middle ages lack of fluid capital prevented dealing in works of art, although there was considerable patronage. However, ecclesiastics like Suger (*c.* 1081–1151), abbot of St. Denis near Paris, in their quest of precious objects with which to adorn their churches, stimulated an interest in these things. There are many instances of traffic in luxury objects such as illuminated manuscripts, statues in Nottingham alabaster and other works of art, which found their way all over Europe. But because of the church's disapproval of commerce, the art trade was restricted and the artist became once more an anonymous artisan. The collapse of feudalism and the breakup of the static equilibrium of early medieval culture led to the renascence of monetary and commercial activity. The birth of an urban *bourgeoisie* brought with it a need for craftsmanship, and artisans and merchants became the two new occupational groups creating a revolution in the trade in works of art. After the 12th century a more or less regular art trade was established, and not only did works of art travel from country to country but artists moved from place to place in order to fill orders from the town corporations and churches.

The rising *bourgeoisie*, through town corporations, exercised important buying power, but not until personal fortunes had grown were individuals able to purchase works of art for themselves. A regular market for art then began to take shape, inducing the artist to leave his lodge and settle in a town as an independent master, selling to individual clients. In the 14th century artists and architects became members of guilds supplying families such as the Strozzi and Medici in Florence, who then outdid the corporations in purchasing works of art. These artistic commissions were mainly gifts to churches or monasteries, and not until the 15th century were works of art bought for personal use in the home or private chapel. The change from commissioner to collector meant that the collector no longer ordered what he needed but bought what he was offered, and this encouraged artists to paint what they themselves wanted; conversely Paolo Uccello, in painting what he wanted, at the same time was perhaps unconsciously satisfying the needs of a wider public with his portable "easel" pictures. Competition between the upper *bourgeoisie* and the papal *curia* for an artist's services caused prices to rise. Along with living artists, whose works were bought by merchants for resale, the antique art trade flourished. In the 16th century there was a regular demand for monuments of the past, which sent dealers looking for excavators and sites. Like a modern art dealer, Giovanni Battista della Palla ordered from artists and acquired from private owners *objets d'art* for the French king.

Something like modern art dealing began in the Netherlands in the 17th century—first the artists themselves sold their own and other pictures, then book and print sellers, jewelers, frame makers and even innkeepers dealt in art. Art dealers became too numerous and the individual townships had to restrict art selling to those who were in the painters' guilds; since many artists were too busy working to trade, it often fell to their apprentices to do so for them. When art-dealing apprentices left the studios to set up independent businesses, they regulated the market and developed a clientele who relied on their advice and went to them for a specific kind of art. This led to individual dealers giving instructions to particular artists to meet special requirements.

The sale of works of art in the modern era can be divided into phases, each characterized by the predominance of a special but nonexclusive relationship between buyer and seller. The most active phases of art marketing, such as auctions and sales from dealers' galleries, have taken place in times of marked political, economic or social change. One of the greatest stimulants to the art market was the sale, after his execution, of the superb collection of Charles I of England. The French Revolution and the Napoleonic Wars both produced mass buying and selling, the results of which founded many of the leading national art galleries of Europe. World Wars I and II stimulated trade in art objects. The extraordinary rise in art prices during the first half of the 20th century was connected with the progressive economic deterioration of Europe, the economic growth of the United States, the devaluation of currencies and racial and national persecutions, which set a premium on works of art as easily transportable securities. Heavy taxation and its accompanying social changes also were responsible for releasing onto the market heirlooms that would normally have remained out of the dealers' hands. Taxation also stimulated art buying: since most countries do not impose any tax on capital gains, the amateur who buys a work of art and sells it at a profit can count the profit as entirely his, while in the United States the tax system induces citizens to buy works of art by offering them a tax deduction in any one year on the appraised value of a work, provided it is handed over to a public gallery upon the purchaser's death.

Art buying, dealing and selling shift from country to country with historical changes. In the 16th century Romans were buyers of art; in the 18th they became sellers to British collectors. In

the 20th century the British became sellers to the U.S. buyer, whose preferences largely have guided the world art markets. Art treasures are considered secure investments by U.S. financial advisers, and the United States' position as the wealthiest capitalist country, together perhaps with a desire to create a cultural background and artistic heritage, has caused one of the greatest booms in art buying. It turned New York into an art capital, competing with Paris and London as the most important art selling and buying centre of the western world.

Various influences were responsible for developing U.S. taste in art. Prominent among them was the Museum of Modern Art, New York (founded 1929), which devoted itself not only to showing new trends in contemporary American and European art but in educating the public in the history and foundation of modern art through its exhibitions, lectures and other activities, which reach to many parts of the world. This activity created unreal prices in specific art trends in which the museum was particularly interested, and the museum's influence over U.S. contemporary taste (and thus over its spending) was so strong that many dealers in Paris and London would not think of handling a modern artist whose work was not either owned or sanctioned by the museum. Another influence in the development of the U.S. art buying public was Lord Duveen of Millbank (*q.v.*). Duveen concentrated only on old masters, since he realized that these could not be replenished and would grow more valuable the rarer they became; his absolute rule of the market during five decades transformed U.S. taste. He caused a price inflation for the works he supported by buying back what he sold at almost the same price and, though the market formed by such a salesman died with him, he implanted a buying frame of mind in the U.S. public.

An indispensable element in the U.S. art market as in others has been the fluctuation of taste. An example of the effects of a revolution in taste may be seen in the discovery in the 19th century of early Renaissance painting. After the time of Raphael (1483–1520), works of art of the preceding three centuries were regarded as curiosities. The reawakening of public taste to a realization of their beauty and value produced a burst of activity in the art market, especially in England, where amateurs had long collected such works. Scholars have influenced popular taste, and the work of the art historians G. B. Cavalcaselle and G. Morelli and later Bernard Berenson (*qq.v.*) had great effect in establishing sound canons of appraisal of the qualities of old masters. More dramatically, contemporary art grew steadily in favour after the 1930s, under the auspices of many museums of modern art, and most new commercial art galleries are devoted primarily to modern art. Extravagant variations in taste produce alterations in price, mostly due to causes that are impossible to analyze. In 1955 Christie's of London sold for £11,500 a work by Titian that had been bought in 1918 for £98; it had always been recognized as a Titian, and there had been no appreciable reassessment of that artist's work.

Sale by Commission.—Artists generally have been active in promoting the sale of their own work, and their relationship with the purchaser has ranged from that of executor of a commission to that of resident painter. In Florence the artists competing for work on doors of the baptistery of the cathedral were kept for a year by the Calimala (wood finishing organization) while they worked on their models and, when Lorenzo Ghiberti was chosen, he was paid a yearly salary while he worked on the doors themselves for 20 years. French painters, such as François Boucher and Jean Honoré Fragonard, could never have succeeded without royal patronage. Although the advent of a new monied class, the artist's own rise in social stature, and organized commercial gallery selling all tended to break up the direct link between artist and patron, yet national or international organizations, government institutions and private businesses still commission works directly from living artists; *e.g.*, Pablo Picasso was commissioned to provide a mural for the United Nations building in New York. In modern times subjects are seldom dictated by commissioners to artists, who usually have freedom to chose their own manner of expression.

Auction Sales.—This method of art dealing did not really become popular until the 18th century in England, when James Cock made Covent Garden a centre of the art world with his famous auctions and even artists, such as William Hogarth, themselves organized private auctions of their work. In 1766 James Christie opened his auction rooms in Pall Mall against the competition of about 60 other auction houses, including Sotheby's, which had been opened in 1744 by Samuel Baker. Christie's concentrated on works of art, and the saleroom became not only an auction house but a place where artists displayed recent work. With the fall of the French monarchy, Paris declined as an art market and London found itself the centre of most European art buying. The combined results of the French Revolution, the Industrial Revolution and the fortunes accumulated during the growth of the British empire made London increasingly important as an international art buying centre, particularly through the auction rooms. Christie's enjoyed a huge success in the fine arts trade and was joined after World War I by Sotheby's, which until that time had specialized in selling books and prints. After World War II these two houses held the lead in international auction sales of fine art, with the Parke-Bernet galleries in New York city and the Galerie Charpentier in Paris.

The success of London's auction houses is attributable partly to the low normal commission rate on sales, 10% as compared with the basic rate of 15% in the United States and 16–21% (on a sliding scale) in Paris. (Also to be taken into consideration in the United States is a New York state sales tax and a federal tax on certain kinds of goods; and in France a sales tax.) Further, there is no import or export duty on works of art entering or leaving England.

Auction sales in England and the United States usually are run similarly: the sale is advertised in prominent magazines and newspapers by the gallery; a "reserve," or minimum price, is placed on the work by the seller so that it does not go too cheaply through lack of bidding; the auctioneer then takes open bids at the auction. The auctioneer, who generally does not accept responsibility for the attributions of the works disposed, is an employee of the auction house and can often "bid up" the work for sale until it reaches its reserve by calling out bids that are not actually made. "Rings," or combinations based on prearranged mutual agreements, may be formed between dealers who bid against outsiders but not against each other.

In Paris, the auction is run by a *commissaire priseur* ("valuer") whose name is advertised with the sale. He is frequently an expert on the objects for sale, and often the success of the auction depends on his reputation. He may hire the auction room himself, he takes a commission on the sales paid by the buyer and assumes the responsibility of the attributions. The bids are written down, collected and handed to the *commissaire priseur*, who then calls them out. This is a secret bid. Of Paris' two most important auction houses, the Galerie Charpentier is privately owned, holding auctions at irregular intervals interspersed with exhibitions, and the Hôtel Drouot is the official government auction house, holding as many as six or seven regularly announced sales daily.

In the Netherlands, the Dutch auction system has been in use for centuries. It is a complicated technique that involves two sales of the same object. For instance, a provisional bidder might go up to 250 guldens for an object but, instead of the sale terminating, it then begins again by the auctioneer calling out double the provisional bid, say 500 gulden. He works backward toward the first price and at any point another bidder can call out "mine," which indicates he wants the object for that price. If this does not happen, the first bidder gets the object at the original price. In order to stimulate bidding during the first part of the sale, the provisional bidder gets a commission on the final sale if he does not get the object.

Art Dealers.—The main spur to art dealing came in the 18th century with the progress of archaeological excavations in Italy, which produced a wealth of statues, marbles, vases and terra cottas, as well as pictures, that were eagerly sought. Rome was the centre of selling where such men as the English banker Thomas Jenkins, the Italian sculptor Bartolomeo Cavaceppi and the

Scottish painter Gavin Hamilton produced and sold the *bric-a-brac* of Hellenistic and imperial Rome. So great was the passion for this activity and so contagious the enthusiasm it engendered that some of the purchasers turned amateur dealers themselves; *e.g.*, Sir William Hamilton and Lyde Browne, the elder, of Wimbledon, who sold his collection of statues to the empress Catherine of Russia for £23,000. Joseph Smith (1682–1770), British consul at Venice, was a prominent art dealer of the 18th century. Major artists have been dealers: the collection of Charles I was amassed partly through the efforts of Rubens, Daniel Mytens and others, while Sir Peter Lely, Sir Godfrey Kneller, Sir Joshua Reynolds and Sir Thomas Lawrence were all dealers as well as collectors.

The 19th century saw the elevation of the picture dealer to his modern position of dominance, in which, rather than merely supplying a prospective consumer with a desired object, he plays an extensive and influential aesthetic role as an active shaper of taste. He acts in liaison between customer and artist and, being in a position to find out quickly what the former expects from the latter, he can suggest to the artist the size, subject and manner most suitable for sale. He constantly looks out for fresh talent. (Ambroise Vollard's "discovery" of the Postimpressionist and Fauve painters in Paris at the beginning of the 20th century won him a place in art history). Dealers who sell contemporary works for artists usually do so on a commission basis, although the artist can often hire the services of the gallery for an exhibition. Occasionally, the dealer pays the artist a fixed sum for all his works and then sells them for whatever price the market will bear, as was the case with the painter Maurice Utrillo and his arrangement with the Petrides brothers.

Sales From Exhibitions.—Another type of selling is that effected through bodies of artists holding at fixed intervals large organized exhibitions, to which outsiders may be invited to submit works and at which sales are made with little or no commission. The most famous of these are the Royal Academy exhibition, London, held annually each summer, and the various academic and independent *salons* in Paris in the latter part of the 19th and at the beginning of the 20th century. Just as in Venice in the 17th and 18th centuries local artists would display their wares once a year in St. Mark's square, so at exhibitions of art in several cities of the United States, artists "claim" a length of railing or boarding on the street and hang their pictures, which are sold to passers-by; and in London similar exhibitions have sprung up, particularly since the 1950s. See also ART FORGERY.

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(M. A. A.)

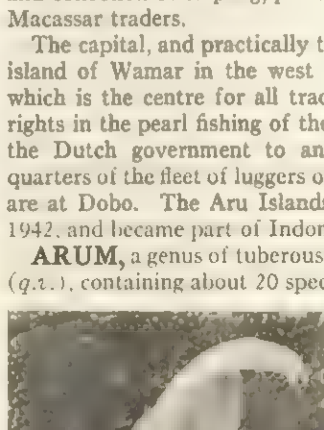
ARU ISLANDS (PULAU-PULAU ARU), the easternmost group of islands in the south Moluccas (*q.v.*) (Maluku province) belonging to Indonesia, lie in the shallow Arafura sea, between 5° 22′ and 7° 01′ S. and 134° 05′ and 134° 52′ E., on the edge of the submarine continental shelf of Australia and New Guinea. They are composed of one large island, Tanahbesar, 122 mi. long and 58 mi. wide, and nearly 100 smaller islands, the total area of the group being 3,306 sq.mi. Tanahbesar, of irregular, oblong form, is virtually divided into five separate islands (Kola, Wokam, Kobroor, Maikoor and Trangan) by three narrow channels of varying width and depth from 10 to 300 ft. They have been variously interpreted as remainders of stream courses which once traversed the former land surface between New Guinea and the Aru Islands or as fault lines. All the islands are low, mostly horizontal layers of coralline limestone, and covered with a dense forest; the coast is often very swampy. The vegetation includes screw pines, palm trees, kanari and tree ferns; in Trangan, the southern portion of Tanahbesar, there are grassy plains, and along the coast and river banks are mangroves.

The population (1956 est.) was 27,006, of mixed Papuan and Malayan stock, as in the Tanimbar Islands, but of darker colour though less dark than that of Papuans proper; smooth rather than curly hair; and thin lips. The natives, divided into *Pata-lima* and *Pata-siwa*, showing influence of Tidore and Ternate, are mostly pagan, though Christianity has made a little headway, and some are Muslims. In the western islands, the Voorwal, where the Muslims and Christians mostly live, including Chinese, Buginese and Macassarese settlers, the villages are near the coast and nearly hidden among clumps of trees. In the eastern islands, the Achterwal, they stand on high rocks. The houses of the pagans are often of rough wood and *atap*, crowded close together; they are entered by a trap door in the middle of the floor.

Usually a shed in the centre of the village harbours the protective spirit of the community to whom offerings are made. The Aru islanders are a gentle quiet people; there is little crime among them, and they retain their old laws and customs and are largely governed by their own chiefs. Many of the men wear a single short garment round the waist and the women a very short and tight sarong, home woven, but they decorate themselves with bead necklaces, anklets, bracelets, earrings of copper, plaited leaves and combs of bone or wood. The animal life is Papuan and includes several birds of paradise, including the king bird of paradise. Many natives find occupation in hunting this magnificent bird for its plumes which are used for ornaments. Little ground is tilled, except by the Christians and Muslims, and the communally owned uncultivated ground is hunted and explored for sago and other food products. Wives are purchased, a man becoming absolute master of his wife, and his brother having the right to marry her on his death. The principal means of subsistence are agriculture (amongst the Voorwal peoples), sale of bird of paradise plumes and collection of trepang, pearl and tortoise shell for Chinese and Macassar traders.

The capital, and practically the only port, is Dobo, on the small island of Wamar in the west where only a few people live but which is the centre for all trade. The islanders retained certain rights in the pearl fishing of the east coasts, which were leased by the Dutch government to an Australian concern. The headquarters of the fleet of luggers obtaining pearls and mother-of-pearl are at Dobo. The Aru Islands were occupied by Japan in Aug. 1942, and became part of Indonesia in 1949. (J. O. M. B.)

ARUM, a genus of tuberous-rooted herbs of the family Araceae (*q.v.*), containing about 20 species found in Europe and the Mediterranean region, and represented in the British Isles by the well-known lords-and-ladies, cuckoopint or wake-robin (*A. maculatum*), which yields the somewhat poisonous Portland arrowroot. The black calla (*A. palaestinum*), native to Syria and Palestine, is a greenhouse plant resembling the calla lily.



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LORDS-AND-LADIES (ARUM MACULATUM)

Arum is also the common or popular name for several other plants related to the genus *Arum* but considered generically distinct. Among them are the water arum (*Calla palustris*), several calla lilies (*Zantedeschia*) and some plants in the genera *Anthurium* and *Arisaema*. All have an acrid or poisonous juice. See CALLA; CUCKOOPINT. (N. Tr.)

ARUNDEL, EARLS OF. The question of deciding who was first earl of Arundel is complicated by the admission by the crown in 1433 of a claim by John Fitzalan (*see* below) that the earldom was and always had been vested in the castle of Arundel. Had this claim been investigated, which it was not, it could have been shown that the assertion was untrue. Nevertheless, applied retrospectively, the admission of 1433 would mean that ROGER DE MONTGOMERY, who came to England from France in 1067 and was created an earl, with lands in Sussex including Arundel castle, is

to be considered 1st earl of Arundel, though he was known by other titles; *e.g.*, earl of Chichester. (*See* also SUSSEX, EARLS AND DUKE OF.) He was succeeded by his two sons, but in 1102 the 3rd earl was exiled and attainted, and his honours and estates were forfeited to the crown.

In 1138 WILLIAM D'AUBIGNY married Adelaide, widow of Henry I, and acquired Arundel castle as part of her dowry. He was confirmed in possession of the castle and honour of Arundel by Henry II in 1155. HUGH, the 5th in this line, died in 1243, and his estates were divided among his sisters and cousins and their children, Arundel castle passing to his nephew, JOHN FITZALAN. Neither John nor his son appears to have been known as earl of Arundel. Moreover, all of the above-mentioned earls appear to have been merely earls "at" Arundel. RICHARD FITZALAN (1267–1302), who was made earl of Arundel probably in 1289, seems to have been the first to be specifically so created. He is, therefore, here considered as the 1st earl, though, by virtue of the claim of 1433, he is held by some to be the 8th earl (in the d'Aubigny line). Richard fought for Edward I in Wales, France and Scotland and died on March 9, 1302.

He was succeeded by his son, EDMUND (1285–1326), 2nd earl, who married Alice, sister of John de Warenne, earl of Surrey. A bitter enemy of Piers Gaveston, Arundel was one of the ordainers appointed in 1310; he declined to march with Edward II to Bannockburn, and after the king's humiliation he was closely associated with Thomas, earl of Lancaster, until about 1321 when he became connected with the Despensers by the marriage of his son with Isabella, daughter of the younger Hugh. Thenceforth he sided with the king. He was executed at Hereford by the partisans of Queen Isabella on Nov. 17, 1326.

Edmund's son, RICHARD (*c.* 1313–76), 3rd earl, who obtained his father's earldom and lands in 1331, led one of the divisions of the English army at Crécy and took part in the siege of Calais; he also fought in the naval battle with the Spaniards off Winchelsea in Aug. 1350. He was one of the regents of England in 1355 and died on Jan. 24, 1376. His marriage to Isabella was annulled in 1345. By his second marriage he left three sons, the youngest of whom, Thomas, became archbishop of Canterbury, while the eldest, RICHARD (1346–97), became 4th earl of Arundel and of Surrey. This Richard was a member of the royal council during the minority of Richard II, and about 1381 was made one of the young king's governors. About 1385 he joined the baronial party led by the king's uncle, Thomas of Woodstock, duke of Gloucester, and in 1386 was a member of the commission appointed to regulate the kingdom and the royal household. As admiral of the west and south he gained a victory over the French and their allies off Margate in 1387. Then came the king's futile attempt to arrest Arundel, which was the signal for the outbreak of hostilities. The Gloucester faction quickly gained the upper hand, and the earl was again a member of the royal council. After a personal altercation with the king at Westminster in 1394 Arundel underwent a short imprisonment. In 1397 he was involved in a conspiracy against Richard II and was beheaded on Sept. 21.

Richard's only surviving son, THOMAS (1381–1415), 5th earl, was made by Richard II a ward of John Holland, duke of Exeter, from whose keeping he escaped about 1398 and joined his uncle, Archbishop Thomas Arundel, at Utrecht, returning to England in 1399 with Henry of Lancaster, afterward King Henry IV. In Oct. 1400 he was restored to his father's titles and estates. Arundel joined the party of the Beauforts and was one of the leaders of the English army that went to France in 1411; then after a period of retirement he became lord treasurer on the accession of Henry V and was at the taking of Harfleur in 1415. He died on Oct. 13, 1415. His wife was Beatrice (d. 1439), a natural daughter of John I, king of Portugal, but he left no children, and the lordship of Arundel passed to his second cousin, JOHN (1385–1421), Lord Maltravers, who was summoned to parliament as earl of Arundel in 1416.

John's son JOHN FITZALAN (1408–35), 7th earl, did not secure the earldom until 1433, when as the "English Achilles" he had already won great distinction in the French wars. He was created in 1434 duke of Touraine and continued to serve Henry VI in the field until his death from wounds, on June 12, 1435, at Beauvais. The earl's only son, HUMPHREY (1429–38), died in April 1438, when the earldom passed to John's brother WILLIAM (1417–87), the 9th earl, and the dukedom of Touraine became extinct. William was succeeded by his son THOMAS (1450–1524), 10th earl.

HENRY FITZALAN (1512–80), 12th earl, son of WILLIAM (1483–1544), 11th earl, by Anne, daughter of Henry Percy, 4th earl of Northumberland, was born on April 23, 1512, and succeeded to the earldom in 1544. He took part in the siege of Boulogne (1544) and was appointed lord chamberlain and a privy councilor in 1546. He was one of the council of 12 appointed by Henry VIII to assist the executors of his will during the minority of Edward VI. He was twice arrested and twice released on various charges at the instigation of Northumberland. In June 1553 he alone of the council refused the "engagement" of the council to support Edward's "device" for the succession which passed over his sisters, Mary and Elizabeth, as illegitimate, in favour of Lady Jane Grey, though he signed the letters patent. On Edward's death, while pretending to support Northumberland, he secured the proclamation of Mary as soon as Northumberland had left London. Under Mary I he held a series of high appointments, including the lord stewardship which he retained under Elizabeth I. But as one of the leaders of the Catholic nobility he fell under suspicion, resigned his offices in 1564 and was more than once disgraced. In 1569 he was implicated in the intrigues of Thomas Howard, 4th duke of Norfolk, but although he appears to have received money from Spain, the evidence against him was insufficient, and he was released in March 1570 and even recalled to the council. After the discovery of the Ridolfi plot he was once more arrested and liberated only after the execution of Norfolk in 1572. He died on Feb. 24, 1580. At his death the title passed through his daughter Mary, the wife of the beheaded Norfolk, to the Howards.

PHILIP HOWARD (1557–95), 13th earl of Arundel, eldest son of Thomas Howard, 4th duke of Norfolk, executed for high treason in 1572, and of Lady Mary, daughter and heiress of Henry Fitzalan, 12th earl of Arundel, was born on June 28, 1557. He was married in 1571 to Anne, daughter and coheiress of Thomas Dacre, Lord Dacre. On the death of his maternal grandfather in Feb. 1580 he became earl of Arundel. In 1582 his wife became a Roman Catholic and was committed to the charge of Sir Thomas Shirley by the queen. He was himself suspected of disloyalty and was regarded by the discontented Roman Catholics as the centre of the plots against the queen's government and even as a possible successor. In 1583 he was with some reason suspected of complicity in Francis Throckmorton's plot and prepared to escape to Flanders, but his plans were interrupted by a visit from Elizabeth I at his house in London and by her subsequent order to confine himself there. In Sept. 1584 he became a Roman Catholic and made another attempt to leave England. He was then brought before the Star Chamber and sentenced to a fine and imprisonment for life. He was released for a time but was again arrested on a charge of high treason and, in 1589, condemned to death. The sentence was not executed, and he died in the Tower of London on Oct. 19, 1595. Arundel wrote three treatises on virtue. In 1929 he was beatified.

THOMAS HOWARD (1585–1646), 14th earl of Arundel, and earl of Surrey and of Norfolk, son of Philip, 13th earl of Arundel and of Lady Anne Dacre, was born on July 7, 1585, and educated at Westminster school and at Trinity college, Cambridge. On April 18, 1604, he was restored to his father's earldoms of Arundel and Surrey and to the baronies of his grandfather, Thomas, 4th duke of Norfolk. His fortunes fluctuated under James I and Charles I; he held many high offices and was more than once imprisoned. In 1641 as lord high steward he presided at the trial of the earl of Strafford. This closed his public career. He again became estranged from the court, and in 1641 he escorted Marie de Médicis to Holland, remaining abroad, with the exception of a short visit to England in that winter, and taking up permanent residence at Padua, Italy. He contributed a sum of £54,000 to the king's cause and suffered severe losses in the Civil War. On June 6, 1644, he was created earl of Norfolk. He died at Padua, when on the point of returning home, on Oct. 4, 1646.

The 14th earl is best remembered for his patronage of the arts and for his magnificent collections. These were dispersed after his death, most of the marbles and statues being given to Oxford university in 1667 to become known later as the Arundel (or Oxford) marbles. The library was given to the Royal society and to the College of Heralds, the manuscript portion of the Royal society's moiety being transferred to the British museum in 1831 and forming the present Arundel collection.

In 1606 the 14th earl married Alathea, daughter and heir of Gilbert Talbot, 7th earl of Shrewsbury, by whom, besides three sons who died young and one daughter, he had James, who predeceased him, HENRY FREDERICK (1608–52) who succeeded him as 15th earl of Arundel and earl of Surrey and of Norfolk, and William Howard, Viscount Stafford, executed in 1680. Henry Frederick's son THOMAS (1627–77), 16th earl, succeeded by the reversal (1660) of the attainder of 1572, to the dukedom of Norfolk, in which the earldom has since been merged.

ARUNDEL, THOMAS (1353–1414), archbishop of Canterbury and chancellor of England, who played an important part in politics during Richard II's reign, and was a determined opponent of the Lollards (*q.v.*). He was the third son of Richard Fitzalan, earl of Arundel and Warenne, by his second wife, Eleanor, daughter of Henry Plantagenet, earl of Lancaster. In 1373 Thomas Arundel was archdeacon of Taunton, and in April 1374 he was consecrated bishop of Ely.

During the early years of Richard II's reign Arundel belonged to the party led by Thomas, duke of Gloucester; Henry, earl of Derby (afterward King Henry IV); and his own brother Richard, earl of Arundel. In 1386 he became chancellor for three years, and in 1388 archbishop of York. In 1391 he became chancellor again, but resigned in 1396 on his appointment as archbishop of Canterbury. In the following year Gloucester, Warwick and Arundel were arrested and he himself was impeached by the commons on a charge of complicity in forcing a council of regency on Richard during his minority. He was condemned and banished, and at the same time demoted from Canterbury to St. Andrews. At the end of 1397 he left England for Rome, and joined Henry of Lancaster. (The Thomas Arundel whom according to Froissart the Londoners sent to encourage Henry to assume the English crown was apparently not the bishop, but his nephew and namesake, the earl of Arundel.) In 1399 he accompanied Henry to England, where he became chancellor again for a few days and also archbishop of Canterbury. He witnessed the abdication of Richard and crowned Henry IV on Oct. 13.

The main work of his later years was the defense of the church and the suppression of heresy. He was instrumental in passing the statute *de haeretico comburendo* (1401) under which William Sawtrey was the first Lollard to be burned. He successfully opposed the attempts to disendow the church made by the parliament of 1404, but he was unable to persuade Henry to pardon Archbishop Scrope. In 1407 he became chancellor again for two years. During this period he passed constitutions against the Lollards at Oxford. In 1411 he went on an embassy abroad, and in 1412 he became chancellor for the last time, until the accession of Henry V. He took a leading part in the proceedings against the Lollard Sir John Oldcastle, Lord Cobham. He died on Feb. 19, 1414, and was buried at Canterbury.

See *The Cambridge Medieval History*, vol. vii, ch. 15 (1949) and vol. viii, ch. 11 (1936); W. A. Pantin, *The English Church in the Fourteenth Century*, ch. 2 (1955). (PL. GN.)

ARUNDEL, a municipal borough of West Sussex, Eng., is situated 11 mi. E. of Chichester and 21 mi. W. of Brighton by road. Pop. (1961) 2,617. It lies on a hill slope above the river Arun, and its castle, rising from the summit of the hill, was placed to guard not only the passage along the river through the South Downs to the north but also the east-west route along the coastal plain.

The first mention of the place is in 877 as Harundell (O.E., Harhundell, "horehound valley"; the plant horehound being prolific in the neighbourhood). In the time of Edward the Confessor it seems to have consisted of a mill and an earthwork, but it appears in Domesday Book as a thriving borough and port. It was the head of one of the six rapes (administrative divisions) of Sussex and was granted by William the Conqueror to Roger de Montgomery, who restored and extended the castle on the site of the earthwork. From very early times, markets were held within the borough on Thursday and Saturday, and in 1285 a grant of two annual fairs in May and December was obtained by Richard Fitzalan, earl of Arundel, but neither markets nor fairs are now held. In 1580 the earldom passed to the Howards, of whom Sir John Howard had been created 1st duke of Norfolk in 1483. The borough returned two members to parliament from 1295 to 1832 and one member until 1868. Arundel is a borough by prescription and in 1586 Elizabeth I acknowledged its incorporation and ancient rights. Once a flourishing river port, it is now a quiet country town with considerable tourist traffic in summer. The canal that linked it with Chichester harbour is dry. The town was partially destroyed by fire in 1338.

Arundel castle, which has long been one of the seats of the dukes of Norfolk, was frequently assaulted and greatly damaged in the Civil War. However, it was repaired and improved by Thomas, 8th duke of Norfolk, between 1716 and 1720 and was restored by Charles, 11th duke (d. 1815), and Henry, 15th duke (d. 1917), who between them made it one of the most splendid baronial mansions in England. There is a beautiful park of 1,100 ac. containing Swanbourne lake. The Perpendicular parish church of St. Nicholas, rebuilt in 1380, contains fine ironwork and wall paintings. The eastern part, which belongs to the duke of Norfolk is walled off from the remainder and only entered from the castle precincts. Formerly the collegiate church of the Holy Trinity and now known as the Fitzalan chapel (Roman Catholic), it contains memorials of the Fitzalan and Howard families. The Gothic Roman Catholic church of St. Philip Neri (cathedral of the Arundel and Brighton diocese) was built by Henry, 15th duke of Norfolk, in 1873. *See* also ARUNDEL, EARLS OF.

ARUNDELL OF WARDOUR, THOMAS ARUNDELL, 1ST BARON (*c.* 1562–1639), son of Sir Mathew Arundell of Wardour castle, Wiltshire, served with great distinction as a soldier of fortune under the emperor Rudolf II against the Turks, and was created a count of the Holy Roman empire. His assumption of a foreign title was strongly resented by Elizabeth I, who sent him to the Fleet prison on his arrival in England in 1596. He was soon released, but next year was again imprisoned for a short time on another charge. James I gave him his English peerage in 1605, but he repeatedly fell under suspicion because of his Catholic faith during the reigns of James I and Charles I. He died on Nov. 7, 1639. Arundell was a devout Catholic, but the accusations of disloyalty made against him appear to have been unfounded.

His grandson, HENRY ARUNDELL (*c.* 1607–94), 3rd baron, who succeeded in 1643, fought on the Cavalier side in the Civil War. At the Restoration he regained the family estates and became an officer of the queen's household. He was employed by Charles II in negotiating the treaty of Dover. Denounced by Titus Oates as a participator in the "Popish plot," Arundell, with four other Roman Catholic peers, was impeached and imprisoned. He was released in Feb. 1684. After the accession of James II, the charge was annulled, and Arundell was for a time keeper of the privy seal. He died on Dec. 28, 1694.

ARUNTA (ARANDA). The description of this Australian tribe in W. B. Spencer's and F. J. Gillen's classic of 1899 made a great impact on studies in social anthropology and comparative religion; the Arunta became famous. They occupied a pear-shaped region of about 25,000 sq.mi. in central Australia. It included the upper Finke river and its northern tributaries, the MacDonnell ranges and the Todd and Hale river courses east of Alice Springs. The rainfall varies from 5 to 10 in. a year in different parts.

Having migrated across deserts into this comparatively hospitable region, the Arunta increased. The groups that hived off to occupy new food-gathering grounds remained separated for months each year and for longer periods during droughts. As a result, there are five Arunta subtribes, marked by differences in dialect and in some cases also in social organization, in ritual practices and in doctrinal emphasis. Each regards itself as the true Arunta.

Material equipment included the nonreturn boomerang, a barbed wooden spear and an ovate-shaped spear thrower with a stone chisel fixed on the handle end. Fire was produced by sawing the hardwood edge of the spear thrower across the softer wood of the shield.

Behaviour was, and is, based on classificatory kinship. Marriage is between the children of cross-cousins, own or classificatory. In the southern division, kinship, marriage and descent rules are correlated with a four-section system, but in the rest of the tribe with an eight subsection system of grouping relations and of codifying ritual affiliations. Both systems spread from the northwest. Polygyny was practised.

The doctrine of pre-existence and reincarnation was fundamental. Human spirits sojourned in centres where the ancestors of the *Altjiranga* (the "Dreaming"), the creative era, performed significant acts and rituals, or left parts of their bodies or died. A person whose conception was realized near such a centre was a reincarnation of a local ancestor. The ancestors were also in totemic relationship with natural species and phenomena (*see* TOTEMISM). Men whose pre-existent spirits were associated with a particular totemic centre performed rituals which caused the "souls" or "emanations" to go forth from it and increase the species in due season. During ritual, the creative past became operative in the present. Males had to pass through long and severe initiation training and ordeals (including circumcision and subincision) before being admitted to totemic rituals with their sacred chants and symbols (*tjurunga*), be the latter permanent of wood and stone, or objects made for the occasion only. Sorcery caused illness and death. "Pointing bone" technique was believed in. Doctor-men, who had passed through special revelatory rites and training, could cure, protect and also exert psychological influence in general. Burial ritual expressed the social value of the individual. The body was interred.

Arunta art, mainly geometrical and symbolical, was mostly temporary, being expressed on ritual paraphernalia and on the bodies of the actors. A modern group of Arunta has become successful as water-colour artists, specializing in landscapes. The language is complex and very rich and, as in other tribes, is a suitable medium for aboriginal poetical powers.

Greatly reduced in numbers during the first 70 years of contact, the Arunta showed signs by the 1960s of holding their own and even of increasing, as a result of readaptation, medical services and greatly improved conditions. *See* AUSTRALIAN ABORIGINES.

See W. B. Spencer and F. J. Gillen, ***The Native Tribes of Central Australia*** (1899); T. G. H. Strehlow, ***Aranda Traditions*** (1948).

(A. P. E.)

ARUSHA REGION, TANGANYIKA: *see* NORTHERN REGION, TANGANYIKA.

ARVAL BROTHERS, in Roman antiquities, a college or priesthood (*Fratres Arvales,* "brothers of the field"), consisting of 12 members, elected for life from the highest ranks in Rome, and during the empire always apparently including the emperor. (The British museum contains a bust of Marcus Aurelius in the dress of a *Frater Arvalis.*) Their chief duty was to offer annually public sacrifice for the fertility of the fields. There is proof of the high antiquity of the college, which was said to have been older than Rome itself, in the verbal forms of the song with which, down to late times, a part of the ceremonies was accompanied, and which is still preserved. No mention of the *fratres* occurs in Cicero or Livy, and literary allusions to them are very scarce; but there remains a long series of the *acta* or minutes of their proceedings, drawn up by themselves and inscribed on stone. Excavations (1570–1869) in the grove of the Dea Dia about 5 mi. from Rome yielded 96 of these records, dating from A.D. 14 to 241. The brotherhood, almost forgotten in republican times, was revived by Augustus. In his time the college consisted of a master (*magister*), a vice-master (*promagister*), a *flamen* and a *praetor,* who were assisted at the sacrifices by four chorus boys, sons of senators, having both parents alive. Each wore a wreath of corn, a white fillet and the *praetexta* (a characteristic garment of prepubertal boys). The election of members was by co-optation on the motion of the president, who, with a *flamen,* was elected for one year.

The great annual festival was held in honour of the anonymous Dea Dia, a field deity of uncertain identity, on three days in May. It is a matter of dispute whether this festival was identical with that called Ambarvalia (*q.v.*). The ceremony of the first day, on which a sumptuous banquet took place, followed by a distribution of doles and garlands, was held in Rome itself. On the second and principal day of the festival the ceremonies were conducted in the grove of the Dea Dia. They included a dance in the temple of the goddess, at which the song of the brotherhood was sung, in language so antiquated that it was hardly intelligible (text and translation in Mommsen, ***History of Rome***) even to Romans of the time of Augustus.

Special mention should be made of the ceremony of purifying the grove, which was held to be defiled by the felling of trees, the breaking of a bough or the use of any iron tools. The song and dance were followed by the election of officers for the next year, a banquet and races. On the third day the sacrifice took place in Rome, and was of the same nature as that offered on the first day. The *Arvales* also offered sacrifice and solemn vows on behalf of the imperial family on Jan. 3 and on other extraordinary occasions. The brotherhood is said to have lasted till the time of Theodosius. A small frieze of the Antonine period found near Lyons may represent the actual sacrificial ceremony of the *Arvales* to the Dea Dia.

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(R. B. LD.)

ARVE, a river of eastern France, is a tributary of the Rhône, which it joins in Switzerland below Geneva. Rising in Savoy in the heart of the Alps, the Arve collects the drainage of the northwestern side of the Mont Blanc massif, and about Chamonix its valley separates that massif from the Aiguilles Rouges to the west. Below the basin of Sallanches, in the northern portion of the great longitudinal valley that lies between the crystalline core of the Alps and the limestone Préalpes, the Arve turns northwest to traverse the prealpine zone by the gap between the Chablais and Bornes massifs. There it occupies a valley through which Alpine ice debouched on to the Alpine foreland during the Great Ice Age. Below Bonneville, in the district known as Faucigny, the Arve valley is wide, low-lying and highly cultivated, though broken by morainic hills. The valley is the gateway to Chamonix (*q.v.*) and the glaciers and highest peaks of the French Alps, and its course of over 62 mi. presents some of the finest and most varied Alpine scenery. (AR. E. S.)

ARVERNI, the ancient Celtic tribe of the modern region of Auvergne in central France whose chieftain, Vercingetorix (*q.v.*), led the great rebellion against Julius Caesar in 52 B.C. In the previous century they had built a considerable empire in southwestern Gaul, but their chief, Bituitus, was overcome by the Romans in 121, and the new Roman province of Gallia Narbonensis pushed the tribe northward beyond the mountain range of the Cévennes. A weakness of the coalition of the year 52 between Arverni and Aedui was their rivalry for Gallic primacy, but the rebels severely defeated Caesar at the Arvernian hill fort Gergovia before Vercingetorix surrendered at Alesia (*q.v.*). Under the empire, although they assisted Vindex' rising in A.D. 68, the tribe seems to have been peaceful and prosperous, with the status of *civitas libera* or "free city." Their capital was moved to Augustonemetum (modern Clermont-Ferrand), and the sanctuary there of Mercurius Dumias on the Puy-de-Dôme summit became famous.

(G. E. F. C.)

ARYABHATA (b. 476), Hindu astronomer and mathematician, was born at Kusumapura near Pataliputra (Patna), India, on the upper Ganges. He was the author of the *Aryabhatiya,* written in verse couplets, which gives the rules of mathematics as known in his time. (*See* also CHRONOLOGY: *Hindu.*) Most of this work deals with astronomy and spherical trigonometry, the remainder consisting of 33 rules in arithmetic, algebra and plane trigonometry, including quadratic equations, the sums of powers of the first *n* natural numbers and a table of sines. The work was published in Sanskrit at Leiden, Neth., in 1874 (French trans., 1879).

Aryabhata gave a very accurate value for pi (π), $3\frac{177}{1250}$ (3.1416), and he taught that the daily rotation of the heavens was a mere appearance due to the axial rotation of the earth. (D. McK.)

ARYAN, a Sanskrit word meaning "noble," was once commonly used to refer to the entire family of languages now known as "Indo-European"; it was also used, more restrictively, as the name of the Indo-Iranian subdivision of that family. In modern times, particularly in National Socialist Germany, the term became infected with political connotations that have made it almost useless. Even in the purely linguistic meaning, common in the 19th century, it has been abandoned. *See* also INDO-EUROPEAN; INDO-ARYAN LANGUAGES. (J. WH.)

ARYA SAMAJ, a vigorously reforming sect of modern Hinduism, founded in 1875 by Swami Dayanand Saraswati (1824–83) at Bombay. Swami Dayanand established the Arya Samaj (Society of Aryas) on the basis of the Vedas (*see* SANSKRIT LITERATURE) as divinely revealed; he denounced all later additions and commentaries as false. The Vedas, as interpreted by the method laid down by Dayanand, may be said to be the theology of the Arya Samaj and are held to contain all truth and all knowledge, including the basis for modern science. The Arya Samaj is completely opposed to idolatry, is sternly monotheistic and denies the efficacy of priestly intervention. Its organization and services are strongly reminiscent of Protestantism.

The Arya Samaj opposes the caste system, based upon birth, as un-Vedic and insists that caste should reflect merit. Among its active reforms have been opposition to child marriage and to untouchability, which it works to eliminate. It is organized in local *samajas*, which send representatives to provincial *samajas* and to an all-India *samaj*. Each local *samaj* elects its own officers in a democratic manner. By 1931 the Arya Samaj was estimated to have upwards of 1,000,000 members; no reliable figures are available after that date.

The Arya Samaj has sought to revitalize Hindu life and to instill self-confidence and national pride among Hindus. It has established a network of excellent schools and colleges, including the Dayanand Anglo-Vedic college in Lahore, which teach rigorously in the Vedas and in modern sciences. It has also built missions, orphanages and homes for widows, while undertaking famine relief and medical work.

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ASA, in the Bible, son (or perhaps brother) of Abijah, and third king of Judah (I Kings xv, 9–24), *c.* 911–870 B.C. He was a contemporary of Baasha, Zimri and Omri of Israel, but little is recorded of his long reign except some religious reforms and conflicts with Baasha. Baasha fortified Ramah, 5 mi. N. of Jerusalem, and Asa bribed the king of Damascus to renounce his league with Baasha and attack him. Baasha was forced to retreat, the building material which he had collected at Ramah being used by Asa to fortify towns to the immediate north of Jerusalem. The Book of Chronicles relates a story of a sensational defeat of Zerah the "Cushite," and a great religious revival in which Judah and Israel took part (II Chron. xiv–xv, 15). Asa was succeeded by his son Jehoshaphat (*q.v.*).

ASAFETIDA, a gum resin obtained chiefly from an umbelliferous plant (*Ferula foetida*), allied to the giant fennel (*q.v.*), native to Iran and Afghanistan. It grows to five or six feet, and when four years old is ready for yielding asafetida. The stems are cut down close to the root, and a milky juice flows out which quickly sets into a solid resinous mass. A freshly exposed surface of asafetida has a translucent, pearly white appearance, but it soon darkens in the air, becoming first pink and finally reddish-brown. In taste it is acrid and emits a strong onionlike odour because of the presence of organic sulfur compounds.

The gum resin is relished as a condiment in India and Iran, and has been used in Europe and the U.S. in perfumes and for flavouring. In the regions of its growth the whole plant is used as a fresh vegetable, the inner portion of the full-grown stem being regarded as a luxury.

ASAHIGAWA, a city of Hokkaido, Japan, on the Ishikari river, is in the agriculturally important Kamikawa basin. Settled by government subsidized farmer soldiers in 1893, Asahigawa became the railway, agricultural marketing and industrial centre of northern Hokkaido. Asahigawa's industries include brewing, especially *sake* (rice wine), lumber, pulp and wood products and cotton textiles. Pop. (1960) 188,309. (J. D. EE.)

ASANSOL, a town in the Burdwan district of West Bengal, India, is situated in the heart of the Raniganj coal field, 132 mi. W. of Calcutta, on the Eastern railway. Pop. (1961) 103,405. Area 4 sq.mi. The Grand Trunk road runs right across the town from east to west, and on both sides of it stand shops, offices and hotels. Asansol is the headquarters of a subdivision and is of growing industrial importance. It is an outstanding centre of the coal trade, and a railway centre with a large railway workshop and a railway colony. Jaykaynagar, a suburb of Asansol, has a big aluminum works. (S. P. C.)

ASARABACCA (*Asarum europeum*), a low, stemless perennial plant of the birthwort family (Aristolochiaceae), native to the woods of Europe and north temperate Asia, and occurring wild in some English counties. The allied North American species are commonly called wild ginger. Asarabacca is a small creeping herb with a pungent, aromatic rootstock, kidney-shaped leaves and small purplish bell-shaped flowers. It was formerly grown for medicinal purposes, the underground stem having cathartic and emetic properties.

ASBEST, a town in Sverdlovsk *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., lies on the eastern flank of the Urals, 37 mi. E.N.E. of Sverdlovsk, on a branch railway from the main Sverdlovsk-Tyumen line. Pop. (1959 census) 60,053. It owes its existence to the presence of asbestos, first discovered in 1720. It is the largest asbestos mining and processing centre of the U.S.S.R., the vicinity of the town supplying most of the Soviet Union's annual production of 150,000 tons. (R. A. F.)

ASBESTOS, a general term applied to any mineral that can be easily separated into flexible fibres and that can be spun or felted to make noncombustible fabrics.

The name is derived from the ancient Greek name for a fabulous stone that, once set on fire, could not be quenched, probably quicklime.

The noncombustible character and spinning qualities of asbestos fibre were undoubtedly known to the ancient world. Plutarch mentions "perpetual" lampwicks used by the vestal virgins, and Pausanias records a lamp with a wick that was not consumed, being made of "Carpasian linen," or mineral fibre from Carpasius in Cyprus. Shrouds of woven asbestos appear to have been used in ancient times for the cremation of nobility, and thus Pliny refers to it as *linum vivum*—"the funeral dress of kings." The beginning of the modern asbestos industry was in 1868, when 200 tons of raw material were produced in Italy.

Varieties.—Of the several types of asbestos, chrysotile, the fibrous variety of serpentine, is the most important; the others all belong to the amphibole group of minerals of which anthophyllite, amosite, crocidolite and tremolite-actinolite are the principal varieties.

Chrysotile, the fibrous form of the mineral serpentine (*q.v.*), constitutes the bulk of commercial asbestos. It is a hydrous magnesium silicate with the chemical composition $Mg_3Si_2O_5(OH$. The individual fibres are white, but the colour of the aggregate in the veins varies from green to greenish-yellow to amber. The chief occurrence of chrysotile is in veins in altered peridotite associated with massive serpentine, where the asbestos may be found either as cross fibre, roughly perpendicular to the vein walls, or as slip fibre, parallel to the walls. The fibres range in length from $\frac{1}{16}$ to $1\frac{1}{2}$ in. in most deposits but in places may be as long as 12 in. The world's greatest deposits of this type are in Quebec, Can., and the Ural mountains, U.S.S.R. Only 5% to 10% of the rock mined is asbestos; the remainder is serpentine.

Chrysotile also occurs in limestone near the contact with small

intrusions of basic igneous rock. The average fibre in these deposits is longer than that found in peridotites but is frequently harsher and less flexible. Asbestos deposits in the Transvaal, Republic of South Africa, and Arizona are of this type.

Anthophyllite, a magnesium-iron silicate, $(Mg,Fe)_7Si_8O_{22}(OH)_2$, is an orthorhombic amphibole. It is characteristically in long coarse fibres having low tensile strength. Anthophyllite is of little commercial importance although small amounts have been mined in South Africa and in Maryland and California.

Amosite, an iron-rich anthophyllite, is characteristically found in cross-fibre veins with fibres usually several inches in length. It is variously coloured and may be brown, gray or yellowish-green. Amosite is more brittle than chrysotile but is more acid resistant and thus has specialized uses. The world's supply of amosite comes entirely from the Republic of South Africa.

Crocidolite is a soda-iron, monoclinic amphibole, $Na_2(Fe_3{}^{2+}$-$Fe_2{}^{3+})Si_8O_{22}(OH)_2$. It occurs in cross-fibre veins up to three inches wide with a characteristic dull blue colour and for this reason is commonly referred to as blue asbestos. It has a higher tensile strength than chrysotile but is less resistant to heat and fuses to a black glass at a relatively low temperature. Some crocidolite is found in Australia and in Bolivia, but the major commercial source is South Africa, where it is found in a siliceous rock rich in iron known as ironstone.

Tremolite-actinolite are monoclinic amphiboles and the type referred to under the names amphibole asbestos, hornblende asbestos or merely asbestos. The chemical composition of tremolite is expressed by the formula $Ca_2Mg_5Si_8O_{22}(OH)_2$; iron may substitute in part for magnesium, and when it reaches 2% the mineral is called actinolite. Pure tremolite asbestos is white, but actinolite is green.

Tremolite asbestos characteristically is fine and silky and occurs in slip-fibre veins. This is the original material to which the name asbestos was given. The fibres of some amphibole asbestos instead of being easily separated are interwoven into a felted mass. If the aggregate is in thin flexible sheets, it is called mountain leather; if in thick sheets it is called mountain cork. Both varieties are light gray to white in colour and have an apparent specific gravity of less than 1.

Uses.—Because asbestos is incombustible and is capable of being woven into fabrics, it is a valuable industrial material. Crude asbestos is graded into nine main groups, but only the best grades are spinning fibre. To be of high commercial value asbestos must possess length and fineness of fibre combined with infusibility, toughness or relatively high tensile strength and flexibility. Asbestos fibre resembles fine polished wire, free from serrations of any kind that would add to the difficulties of spinning. Under high magnification, fibre is seen to consist of numerous fine threads crowded together. The longer fibre can be carded and spun into yarns, either alone or with additions such as cotton or small sizes of brass or copper wire. Spun products are woven into fabrics of varying weights, thickness and densities to meet numerous industrial needs.

Some of the principal uses are for drop curtains in theatres, for fireproof wall linings and for boiler pipe packing. Yarns spun with fine wire are used for fabric for brake linings; woven asbestos belts convey cement clinker and other hot products. When impregnated with rubber, asbestos is utilized for heat insulation and for gaskets. Asbestos yarns, impregnated with graphite and suitable greases, are used for steam and pump packings; ropes, cords, twine and threads are made for various purposes. Asbestos gloves and other articles of clothing are worn by firemen and by workers in foundries and other places where fire is a hazard. Various products are used to insulate electric conductors; fibre shorter than spinning stock is used for making coverings for steam pipe, hot-water pipe and boilers. Certain classes of short asbestos fibre are mixed with cement or gypsum and molded into various shapes for special purposes or pressed into millboard, wallboard, corrugated siding, shingles or tiles. Asbestos sheets deaden sound, and asbestos papers are used where dampproof and fireproof coverings are required. Short fibres are used as an ingredient in paint and roofing cements.

Production and Consumption.—The consumption of asbestos fluctuates from year to year, but in general there was a steady increase after about 1930. The industry expanded rapidly after World War II, with Canadian production increasing especially after the early 1950s. Prospecting for new deposits was intensified, and there were increased efforts to develop substitutes and synthetics. The world consumption of asbestos of all grades in 1930 was 338,783 tons; by 1950 it had risen to an estimated 1,200,000 tons and in the second half of the 20th century approached 2,000,000 tons. Approximately 60% was produced in Canada, 6% in the Republic of South Africa, 6% in Southern Rhodesia (Federation of Rhodesia and Nyasaland), 4% in the United States, 2% in Swaziland, 2% in Italy and the balance mostly in the U.S.S.R. Data were not available from the U.S.S.R. after 1938, when 86,000 tons were produced, but output was estimated at about 16% of the world total. About 95% of the world production is chrysotile asbestos.

Asbestos products are manufactured in the United States, England, U.S.S.R., France, Germany, Austria, Italy, Canada, Spain, Belgium and Australia. The United States is the largest user, ordinarily consuming nearly half of the world's output; about 95% of this amount is usually imported.

See also Index references under "Asbestos" in the Index volume.

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ASBJØRNSEN, PETER CHRISTEN (1812–1885), and **MOE, JØRGEN ENGEBRETSEN** (1813–1882), collectors of Norwegian folklore whose *Norske folkeeventyr* is a landmark in Norwegian literature, were closely united in their lives and work and are rarely named apart. Asbjørnsen was born in Christiania (Oslo) on Jan. 15, 1812. The son of a glazier, he had to give up medical studies and at the age of 20 became a private tutor in eastern Norway, where he began to collect folk tales. He had met Moe, born at Hole in Ringerike on April 22, 1813, when Moe was 14. Moe, the son of a rich and highly educated farmer, graduated in theology from Christiania university in 1839; religious scruples combined with ill-health made him give up thoughts of the ministry and he became a tutor, spending holidays in collecting folklore in southern Norway. Meanwhile Asbjørnsen had become a naturalist and made investigations along the fiords for Christiania university, adding all the time to his collection of tales. When in 1837 Moe discovered this, he urged a joint publication, to which Asbjørnsen agreed.

Their main problem was one of form: the Norwegian literary style of the day was too like that of Denmark to be suitable for national folklore, while the various dialects of the actual narrators were too local for the purpose. A new style had to be forged. Finally they adopted the Grimms' principle, in their *Kinder- und Hausmärchen*, of reproducing tales in their traditional and popular form, without dialect, but in a simple language. In 1837 the first tales appeared in *Nor*, and some were then published as *Norske folkeeventyr* ("Norwegian Folk Tales") in 1841. Further collections, enlarged and illustrated, appeared in 1842, 1843 and 1844, the whole being published in 1852 with critical notes. The influence of this work was striking. Accepted all over Europe as a major contribution to comparative mythology, it was widely translated, the most popular English version being Sir George Dasent's *Popular Tales From the Norse* (1859). In Norway it provided a national source of inspiration and a stylistic model to young writers. It is usually said that the vigour of these concise and humorous tales came from Asbjørnsen and their charm from Moe, but in fact, although Asbjørnsen was a jovial man and Moe a quietly reflective one, their contributions are indistinguishable.

Each, however, published individual works. In 1845 Asbjørnsen published *Norske huldreeventyr og folkesagn*, a collection of fairy tales, in descriptive settings. In 1856 he was appointed forest

master and was sent by the government to examine methods of timber preservation in various other European countries. In 1860 he introduced Darwin's *Origin of Species* to the Norwegian public. He died in Christiania on Jan. 5, 1885.

In 1850 Moe published a set of lyrics which placed him among the first and best Norwegian romantic poets. *I brønden og i kjaernet* (1851) and *En liden julegave* (1860) are books of stories for children. In 1853 he eventually took holy orders, and rose to be bishop of Christiansand in 1875. He died there on March 27, 1882.

See Sir Edmund Gosse, *Studies in the Literature of Northern Europe* (1879); Illit Grøndahl and Ola Raknes, *Chapters in Norwegian Literature* (1923).

ASBURY, FRANCIS (1745–1816), the first bishop of the Methodist Episcopal Church consecrated in America, arrived in Philadelphia late in 1771. There were then in the colonies but three Methodist meeting houses and about 300 communicants. Forty-five years later, when his incredible labours ended, there were nine annual conferences and 412 Methodist societies with a membership of 214,235. When he began his work, Methodism was confined almost wholly to America's eastern shore. At the close of his career the movement had spread over every state east of the Mississippi river, then the nation's western boundary. He organized scores of Methodist societies, ordained more than 4,000 preachers, traveled approximately 270,000 mi.—mostly on horseback over rough roads and unsurveyed mountain paths—and preached more than 16,500 sermons. He crossed the Alleghenies 60 times. "My horse trots stiff," he wrote in his journal, "and no wonder when I have ridden him upon an average of 5,000 miles a year for five years successively."

Francis Asbury was born at Handsworth, Staffordshire, four miles from Birmingham, on Aug. 20, 1745, the son of Joseph and Elizabeth Rogers Asbury. His father was a yeoman, a humble, hard-working man; his mother, of Welsh descent, was devoutly religious and was confident that her son would become a great religious leader. At the age of 14 he experienced a spiritual awakening and began to attend meetings for Bible reading and prayer. With very limited schooling he was licensed as a local preacher. Admitted at 21 to the Wesleyan conference, for four years he served as an itinerant preacher. In Aug. 1771, when at a conference John Wesley called for volunteers to go to America, Asbury responded first. After eight days at sea he wrote in his journal: "Whither am I going? To the New World. What to do? To gain honour? No, if I know my own heart. To get money? No; I am going to live to God, and bring others so to do." This was his purpose to the last.

He landed at Philadelphia on Oct. 27, 1771, and left on Nov. 6, 1771, on his first itinerary. He acted independently in making his plans. He began by preaching in inns, jails and by the wayside—wherever he found hearers. Soon he was made Wesley's general assistant. With this authority he proceeded to enforce Wesley's rules for his preachers and societies. There was iron in his character. He determined to stand against all opposition, "stedfast as a wall of brass." He insisted that every preacher must travel a circuit. When the American Revolution broke out and pro-British sympathizers departed, Asbury, convinced that independence was inevitable, remained. At the Christmas conference (Dec. 1784), when the Methodist Episcopal Church was organized, he refused to accept from Wesley appointment as general superintendent, insisting that election must be by vote of the preachers. For long years he was not well, yet, suffering intolerable pain and distress, so weak that he had to be lifted from his sulky, he continued to travel and preach. He died on March 31, 1816.

Asbury was not a learned man or, from the standpoint of sermon composition, a great preacher. He preached on simple themes with such deep earnestness that his preaching carried conviction and resulted in decision and in changed lives for great numbers of people. His *Journal and Letters* were published in three volumes (1958). *See* also METHODISM: *United States.*

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ASBURY PARK, a city of Monmouth county, N.J., U.S., was founded in 1871 by James A. Bradley who named the seaside resort for Rev. Francis Asbury, the first U.S. bishop of the Methodist Church. Bradley guided the development of the community until his death in 1921. It became a borough in 1874, and a city in 1897. In 1933 it adopted a council-manager form of government. (For comparative population figures *see* table in NEW JERSEY: *Population.*) The community attracts many New Jersey resort visitors, ranking second only to Atlantic City. Prominent sites along the beach boardwalk are the Auditorium and the Convention hall.

Asbury Park was the scene of a spectacular ship disaster in Sept. 1934, when the "Morro Castle" caught fire at sea in a northeast gale and was beached near the Convention hall, where the ship continued to burn, with a loss of 134 lives. (E. R. D.)

ASCALON (ASHKELON or ASKALON), an ancient city of Palestine. Its now desolate site, on the coast of Israel 12 mi. N. of Gaza, occupies a rocky amphitheatre including about ¾ mi. of shore with traces of a harbour in the southwestern area. From the sand-swept terrain shattered columns and remnants of ruined buildings testify to former greatness. The site is plentifully supplied with wells, and vines, olives and fruit trees flourish in the fertile coastal plain. An Israelite settlement, Migdal Ashkelon, stands near the ancient site.

History.—Traces of habitation reach back to about 2000 B.C., and Ascalon appears in the Egyptian execration texts of about this time. In the Amarna letters (14th century B.C.) Ascalon is one of the cities that ask the Pharaoh to provide assistance against the Apiru (Habiru); it would appear that Ascalon was allied with Gezer and Lachish against Abdu-Khepa, the prince of Jerusalem. In the 13th century Ramesses II stormed Ascalon; the town had evidently rebelled with Hittite encouragement. About 1220 B.C. certain Palestinian cities, among them Ascalon, rebelled against their Egyptian overlord Merneptah: "Carried off is Ascalon" sings the Egyptian poet of the period. Ascalon is not mentioned among the cities of Judah in Josh. xv, and it appears as a Philistine city, one of the Pentapolis, from the days of Samson to the 6th century. Tiglath-pileser III (745–727 B.C.) of Assyria received tribute from Mitinti of Ascalon, who later revolted. Sennacherib captured the city in 701 when Sidqia refused to submit; Sidqia, his wife, children and brothers, together with the city gods, were deported to Assyria, and Sarru-lu-dari, son of Rukibtu, their former king, was installed as ruler. Subsequently Ascalon was a vassal of Esarhaddon and Ashurbanipal (*qq.v.*). Nebuchadnezzar met stiff opposition in the Philistine plain and was forced to capture and destroy the city, deporting the leading citizens to Babylon (604 B.C.). Conquered by Alexander the Great, the city became Hellenized, and following his death its fate as a vassal was determined alternately by the Ptolemies and by the Seleucids. Though it was a centre of Hellenism, it opened its gates to the Jewish leader Jonathan Maccabaeus (147) and later to Alexander Jannaeus. Herod the Great, who adorned it with monumental buildings, was born there. From 104 B.C., for four and a half centuries it was a free city of the Roman empire. In A.D. 636 it passed into Arab hands.

During the crusades (*q.v.*) Ascalon was the key to southwestern Palestine. Baldwin III of Jerusalem completed the Frankish conquest of Palestine in 1153 after a successful six-month siege of Ascalon. In 1187 it was retaken by Saladin after feeble resistance; he burned the city and demolished its defenses at the approach of Richard I Coeur-de-Lion in 1191. Richard promptly set about restoring it, but under the terms of a truce the following year the walls were once more destroyed and the city abandoned. In 1240 Richard of Cornwall began rebuilding, but in 1270 the Mameluke sultan Baybars I, in accord with his scheme of defense, destroyed the fortifications and blocked the harbour with stones. Ascalon was the scene of fighting between British and Turkish armies in World War I.

Excavations.—After a preliminary survey in 1913, the Palestine Exploration fund organized operations there (1920–23) under

the supervision of J. Garstang and W. J. Phythian-Adams. Herod's cloisters—the "court surrounded by columns" of Josephus —were exposed and a number of statues, among them one of Isis-Tyche, were recovered. The stratification of the site was determined and a date of about 2000 B.C. for the earliest traceable habitation established. Distinctive Philistine ware appears after the destruction of the Canaanite town about 1200 B.C.

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ASCANIAN DYNASTIES, branches of a German family influential from the 12th century to 1918. The name, adopted during the first quarter of the 12th century, was derived from Aschersleben, where the counts of Ballenstedt had a castle in the midst of possessions northeast of the Harz mountains. Albert the Bear (*q.v.*) was the first to raise the family's rank from that of count to margrave. Having been invested with the North mark in 1134, he extended it east of the Elbe to form the mark of Brandenburg (*q.v.*). These lands remained under the senior branch of the Ascanians till it became extinct in 1320. In 1180, meanwhile, on the fall of Henry the Lion, duke of Saxony and Bavaria, Bernard, one of Albert's younger sons, had obtained those of Henry's territories in the Elbe region which carried the title duke of Saxony. In 1260 these lands were divided into two duchies, Saxe-Lauenburg in the northwest and Saxe-Wittenberg in central Germany, for the sons of Bernard's son Albert. Saxe-Wittenberg, which secured the Saxon electoral title in 1356, passed in 1423, on the extinction of the Ascanian branch there, to the margraves of Meissen (of the house of Wettin). Thus the name Saxony, which originally belonged to a tribal land in the North German plain, was transferred to the southeast and to the upper Elbe (*see* SAXONY). The Ascanians of Saxe-Lauenburg, however, lasted till 1689. Yet another Ascanian principality was Anhalt (*q.v.*), the basis of which was formed when the original possessions of the family (from Aschersleben to Zerbst and Dessau) passed to Bernard's elder son Henry in 1212. The Ascanians ruled in Anhalt till 1918.

See H. Krabbo, *Regesten der Markgrafen aus dem askanischen Hause* (1910–20). (H. Lz.)

ASCARIS, the genus name of certain roundworms (class or phylum Nematoda) that are parasitic on various animals. *A. lumbricoides*, the giant intestinal roundworm that infects man (especially children), is prevalent in warm, moist areas where conditions of sanitation are inadequate. Closely allied forms are *A. suis*, found in pigs, and *A. megalocephala*, in horses. *See* also ROUNDWORM; PARASITOLOGY: *Roundworms*.

ASCENSION, a small British island of volcanic origin in the south Atlantic, lies 700 mi. N.W. of St. Helena (*q.v.*). Area 34 sq.mi. The island is within the influence of the southeast trades (latitude 8° S.) and the lee side is subject to "rollers," which break on the shore with great violence. Green Mountain, a huge elliptical crater, is 2,870 ft. above the sea, while the surrounding tablelands vary from 1,200 to 2,000 ft. Steep ravines, lined with masses of lava and ending in small bays, are typical. The climate is remarkably healthful. The average rainfall is about 6 in. in Georgetown on the coast and 25 in. on Green Mountain, March and April being the rainy months. The natural vegetation includes purslane, rock roses, ferns and mosses. The island is the resort of sea turtles, which come in thousands to lay their eggs on the shores between January and May. Like St. Helena, the island does not possess any indigenous vertebrate land animals. There are some wild donkeys and goats, rabbits, wild cats and a few partridges. The "wideawake" birds (sooty terns) frequent the island in vast numbers to lay their eggs.

The island was discovered by the Portuguese João da Nova Castella on Ascension day, 1501. It remained uninhabited till after the arrival of Napoleon at St. Helena (1815), when it was garrisoned by the British government. A settlement named Georgetown (locally known as Garrison) was made on the northwest coast. The island was under the rule of the admiralty till 1922, when it was transferred to the administration of the colonial office and made a dependency of the colony of St. Helena. The local manager of Cable and Wireless, Ltd., serves as resident magistrate. The population in 1963 was estimated at 475. In World War II the island was used as a refueling base for U.S. aircraft and in 1957 a station was constructed on it as part of the U.S. long-range proving ground for guided and ballistic missiles. Britain's first overseas civil satellite communications station was completed there in 1966.

See E. H. Ford, *The History and Postage Stamps of Ascension Island* (1933); C. C. Watts, *In Mid Atlantic* (1936), "Ascension Island," *Scot. Geogr. Mag.* (Jan. 1933); *Colonial Report* on St. Helena (biennial). (J. D. HA.)

ASCENSION, FEAST OF THE, the 40th day after Easter, commemorating the taking up of Jesus Christ into heaven, as witnessed by the apostles, apparently on Mt. Olivet (Mark xvi, 19; Luke xxiv, 51; Acts i, 1–11). Ranking with Christmas, Easter (*qq.v.*) and Pentecost in the universality of its observance among Christians, the feast was celebrated as early as the end of the 4th century, according to testimony of Etheria, Chrysostom, the historian Socrates and Augustine. Augustine, in fact, declares that in his day it was already celebrated "in all the world."

A distinctive feature of its liturgy in the western church is the extinguishing of the paschal candle after the gospel has been chanted, as a symbol of Christ's leaving the earth. Despite the idea of separation indicated in this act, which might be expected to set a note of sadness, the whole liturgy of Ascension-tide, through the ten days to Pentecost, is marked by joy in the final triumph of the risen Lord. One of the central themes is the kingship of Christ (hence the frequent use of Psalms xxiv and xlvii in the liturgy of the feast); and a theological implication is that the Ascension is the final redemptive act conferring a share in the divine life on all who are members of Christ. In the words of the Roman preface, Christ "was lifted up into heaven so that he might make us partakers of his Godhead."

In the middle ages, the people's delight in the visual and dramatic found an outlet in various ritual practices that came to be associated with the feast. A procession, in imitation of Christ's journey with his apostles to the Mount of Olives, and the raising of a crucifix or a statue of the risen Christ through an opening in the church roof were widespread customs identified with Ascension. *See* also CHURCH YEAR.

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ASCETICISM. The Greek word from which asceticism derives means practice or training for the attainment of an ideal or goal; it was applied to soldiery, athletics, and learning, as well as to virtue and piety. In modern usage, however, the term is commonly employed to mean a religious exercise or exercises, often involving difficulty and pain, by which self-conquest in a physical or spiritual sense is promoted and eventually more or less perfectly achieved. While asceticism often is looked upon as a preparation for mysticism (*q.v.*), current usage tends to restrict it to the realm of merely human activity; mysticism, on the contrary, implies a state in which the divinity acts and the soul remains more or less passive.

Asceticism is found in practically all religions but especially in those that profess dualism or stress the opposition of soul and body, of the divine and the world (*see* DUALISM). It is practised (1) to avoid or frighten away a divine force that is conceived as evil; (2) to prepare for union with a divine force in order to be strengthened; (3) to please a divinity by offering sacrifice; and (4) to make reparation for sin and thus attain to holiness.

In general the practices of asceticism may be divided into spiritual and physical. Spiritual ascetical practices include silence, guard of thoughts, spiritual reading, prayer, obedience, and the acceptance of humiliation. Physical practices may be either negative or positive. Negative practices often are concerned with food, drink, and sex, consisting in abstention from certain food and drink either for a time or permanently, or in decreasing the intake of food or drink, and in temporary or permanent abstention

from sex relations. Positive asceticism is practised by enduring heat or cold, embracing homelessness, living in a narrow cell or on a pillar, using hard beds or rough clothing, going barefoot, reducing the amount of sleep or sleeping in an uncomfortable posture, going on pilgrimage, omission of bathing and other bodily care, remaining immobile in certain positions, lying on spike beds, wearing chains or other painful bonds, flagellation, and self-mutilation, etc.

Asceticism can be practised individually, as by hermits, or socially in convents and monasteries. Magic and magical practices also often involve asceticism. Indeed according to some authorities there is a magical as well as a religious asceticism, the magical being profane and this-worldly in purpose. In this view, however, religious and magical asceticism are inextricably interwoven. Often magical asceticism can be equated with a kind of mysticism.

Judaism.—Asceticism in early Judaism was limited, since God was acknowledged as creator of the world and of the body. The principal forms were abstention from sex relations (Ex. xix, 15) and fasting, which was practised in times of bereavement, pestilence, war, etc. (Joel i, 13 ff.; Jer. xxxvi, 6). In the Old Testament asceticism usually was practised to move the deity to mercy, but on occasion its purpose was mystical. Among the several ascetic practices of the Nazirites was abstention from wine. The Essenes renounced personal property, practised obedience and silence, and engaged in hard labour. But even the Qumran community, which seems to have been the most ascetical Jewish sect, was far from considering asceticism an end in itself.

In late and contemporary Judaism, asceticism also occupies a subordinate position. Its principal practice seems to be observance of the Law, *e.g.*, in its prescriptions in regard to food, etc.

Greek Religion.—In Greek religious practice asceticism was a peripheral phenomenon, confined for the most part to certain cults. Orphism imposed abstention from animal food and beans. Early Pythagoreanism, which seems to have been influenced by Orphism, also practised ascetical silence; later, dualism led it to widen its ascetical practice. Greek philosophy, especially that of the Cynics and Stoics, tended to be in practice ascetical.

Christianity.—Jesus imposed an ascetical program when he described the life of his followers as a narrow way along which they were to carry their cross (Mark viii, 34). Self-denial and self-abnegation also were stressed. The Christian is to prefer Christ to his nearest and dearest (Luke xiv, 26), to expect persecution (Matt. x, 23), and to watch and pray (Mark xiii, 33). This evangelical asceticism is conceived as principally interior, since merely exterior devotion, fasting, and almsgiving have no value (Matt. vi). Moreover love of God and the neighbour are conceived as more meritorious than asceticism.

During the centuries before monasticism became prominent, a number of ascetical practices appear. In the 2nd and 3rd centuries the prospect of martyrdom was ever present to many Christians. The widespread practice of chastity arose at the same time. In the early 3rd century a study of the theory of asceticism was made by Clement of Alexandria and Origen. Under the influence of Greek philosophy, they concluded that it was necessary in Christian living for the purification of the passions, as a means of loving God more, and as the gateway to mysticism. During the 4th century monasticism united in itself the currents of Christian asceticism. Various practices were experimented with, and the heroes of asceticism (*e.g.*, the pillar saints) became popular heroes.

In the medieval West, Christian perfection was placed by St. Thomas Aquinas and other theologians in the fulfillment of the commandments of love of God and the neighbour. All Christians, no matter what their state or condition, were held to be called to this perfection. Asceticism, in some instances extreme, was conceived as a means to progress in holiness and as a help in the struggle against sin.

At the time of the Reformation, the Protestant leaders in principle rejected asceticism as a perversion of the Gospel. The doctrines of the depravity of human nature and of justification by faith alone, as well as the rejection of good works, undermined the theoretical foundations of asceticism. The Christian life in itself (soul free, to conquer the world in the world, as Troeltsch put it) and not the ascetical life was Luther's ideal. As a matter of fact, however, much asceticism was carried over into Lutheranism from its Catholic antecedents. Calvinism and pietistic Protestantism went further in this direction; in some instances as far as Puritanism. Methodism and some of the Baptist denominations further revived asceticism.

At a time when Protestants were breaking away from medieval practice in this matter and the humanists were decrying asceticism St. Ignatius Loyola in his *Spiritual Exercises* standardized Roman Catholic practice for the modern period. He noted that exterior asceticism was employed either to make reparation for past sins, or to overcome oneself by bringing the lower faculties into subjection to the higher, or to obtain some grace or gift from God. He also summarized a balanced program of exterior asceticism when he wrote:

> The first kind of exterior penance concerns eating. In this matter, if we do away with what is superfluous, it is not penance but temperance. We do penance when we deny ourselves something of what is suitable for us. The more we do this, the better the penance, provided only that we do no harm to ourselves and do not cause any serious illness. The second kind of penance concerns sleep. Here, too, it is not penance when we do away with the superfluous in what is pampering and soft. But it is penance when in our manner of penance we take away something from what is suitable. The more we do this the better it is, provided we do not cause any harm to ourselves and do not bring on any notable illness. But we should not deny ourselves a suitable amount of sleep, except to come to a happy mean in case we had the habit of sleeping too much. The third kind of penance is to chastise the body, that is to inflict sensible pain on it. This is done by wearing hairshirts, cords, or iron chains on the body, or by scourging or wounding oneself, and by other kinds of austerities. The more suitable and safe form of penance seems to be that which would cause sensible pain to the body and not penetrate to the bones, so that it inflicts pain, but does not cause sickness. For this end it would seem more suitable to chastise oneself with light cords that cause superficial pain, rather than in any other way that might bring about serious internal infirmity (Exercises 82–86 from *The Spiritual Exercises of St. Ignatius: a New Translation*, by Louis J. Puhl, S. J., The Newman Press, Westminster, Md., 1951.)

St. Ignatius like St. Benedict and the other Roman Catholic masters put more stress on interior asceticism—*i.e.*, on obedience, silence, and humility—than on exterior. Instead of encouraging men to harden themselves by striving to become heroes of physical endurance, they shifted the emphasis to the interior, from the flesh to the spirit.

Recent times, perhaps, have witnessed a decline of exterior asceticism in the church, although Charles de Foucauld (*see* FOUCAULD, CHARLES EUGÈNE, Vicomte de) is one of the most striking examples of penitential holiness in the history of Christianity. (E. A. R.)

Eastern Religions.—Asceticism has classically had an important place in the religious life of the East, especially in Hinduism and Buddhism. The earliest scriptures of Hinduism, the Vedas, speak of a strange figure, the "long-haired" *muni* (Rigveda x, 136, 3–5), who by means of various ascetic practices was able to achieve states of ecstasy and execute extraordinary feats, such as flying through the air. Of a similar nature was the *vratya* (Atharvaveda xv, 3 ff.), who by asceticism and such physical acts as breath control (*pranayama*) was capable of achieving a wide range of magical powers (*siddhis*). It appears that these early ascetics stood outside the orthodox Aryan community, possibly as representatives of earlier, indigenous cults. However, by the time of the early Upanishads (*c.* 600 B.C.) ascetic practices of all sorts were evidently regarded as appropriate to and in a sense necessary for the attainment of a variety of goals, whether religious (*e.g.*, spiritual liberation) or otherwise (*e.g.*, mundane happiness, magical powers, the indefinite prolongation of life).

Although the ancient ascetic practices were many and varied, they were comprehended in a single word—*tapas* ("heat"). In the Vedas, where the word occurs infrequently, *tapas* refers to inner pain or "heat" created by the practice of physical austerities. Hence it came to mean any religious penance or act of privation or torture that was voluntarily assumed or self-inflicted. In later Hinduism the practice of *tapas* was especially associated with the psychophysical discipline of Yoga (*q.v.*) as the means by which

the *yogi* achieved supernatural powers and extraordinary states of consciousness. Among the austerities prescribed in the sacred literature are silence, difficult and usually painful bodily postures, physical privations, and self-tortures. The ultimate purpose of such exercises has been, of course, the attainment of spiritual liberation (*moksha*)—freedom from the limitations of matter and from the cycle of rebirth and the realization of ultimate reality (spirit, God). Over the centuries there have appeared within sectarian Hinduism many orders of ascetics, several of them reputedly founded by great religious figures, such as Shankara, Ramanuja, and Madhva. These ascetics have exercised a considerable influence upon popular piety, if for no other reason than that the giving of alms to monks (*sadhus*) and nuns (*sadhvis*) brings spiritual rewards to the laity. Moreover, ascetics have been regarded as possessing supernatural powers to see the future, to heal infirmities, and to dispel evil.

In Buddhism asceticism has had a somewhat different nature and significance. On the one hand its renunciation of the world and the flesh was more complete than that contained in the Hindu doctrine of the Four Stages (*ashramas*) of Life, which ordained as the normal course the practice of austerities (*tapas*) and celibacy only after one had fulfilled the duties of a householder, begetting children and enjoying material possessions. In early Buddhism the monastic life of celibacy and poverty was regarded as the norm, the only path to Enlightenment. On the other hand Buddhism denounced as unprofitable the excesses of self-mortification and other austerities that have characterized Hindu asceticism. According to tradition, in the course of his own efforts to gain Enlightenment Gautama Buddha tried the way of extreme asceticism and found it profitless. Thus he cautioned his disciples against the extreme of self-torture as well as that of self-indulgence and advocated a "middle way."

From the standpoint of physical austerities, then, Buddhist asceticism was generally more moderate than that of Hinduism. The Buddhist monk (*bhikkhu*) and nun (*bhikkhuni*), having renounced all worldly attachments (including family and material possessions), were to cultivate virtue, self-awareness, and compassion and to avoid any excess of sentiment and action (such as *tapas*) that would lead to pain and disquiet the mind. The goal of Buddhist asceticism was simplicity of life and its practice was moral discipline and mental training rather than self-torture and physical privation. In fact the body was to be properly cared for (bathed, rested, fed) as the necessary vehicle for reaching Enlightenment. At the same time, however, it was to be regarded as completely ephemeral and vile, and the monk, strictly controlling the senses and the passions, was to meditate upon the inherent corruptibility and ugliness of the flesh.

Of other Eastern religions, Islam has also had a place for asceticism, although it never was so prominent or comprehensive an aspect of that religion as it was of Hinduism and Buddhism. Indeed it may be said that although all devout Muslims are obliged to undertake as religious duties certain privations (*e.g.*, fasting during the month of Ramadan, abstinence from alcoholic drinks), the Koran and the Holy Law are strikingly nonascetic in tone. Nonetheless a fully developed asceticism did establish itself in the mystical school of Islam, Sufism (*q.v.*). The Sufis generally regarded the material world, including the body, as a threat to the highest spiritual development. Thus, claiming to follow the ascetic examples of the prophets, they ordained poverty, fasting, chastity, mendicancy, and, in some instances, self-torture as paths to the ultimate goal of *fana'*, self-annihilation, making possible union with God. (H. P. S.)

See also references under "Asceticism" in the Index.

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ASCH, SHOLEM (1880–1957), novelist, playwright and short-story writer, the most turbulent and controversial figure in Yiddish literature and also one of the most internationally acclaimed. Born in Kutno, Poland, on Nov. 1, 1880, he received a traditional Jewish education, though close association with Christians exposed him to a strong non-Jewish influence. He began professional writing at 19; his first triumph came in 1904 with *Dos Shtetl*, a prose work which cast a romantic glow over Jewish life and also introduced the *leitmotiv* of all his work—his religious mysticism, which, as later developed, distinguished between "faith," which unites, and "religion," which divides. Asch's preference for "faith," disregarding historic differences, was unacceptable both to Jews and to the more orthodox Christians, although his books were widely read and praised by the religiously minded. In 1907 he wrote *God of Vengeance*, a play which introduces on the stage a brothel in which a Holy Scroll of the Law is installed; it aroused violent Jewish public reaction to what was considered a sacrilege and a defamation. With the outbreak of World War I Asch settled in the United States and continued writing, mainly novels; he wrote almost entirely in Yiddish, his books being translated into German and then into English and other languages. *Salvation* (1934; literal title "The Jew of the Psalms") is considered the peak of his art and contains the epitome of his philosophy. His famous Christological series began with *The Nazarene* (1939), a novel in the grand manner, presenting Jesus Christ in the likeness of the gospels; it was followed by *The Apostle* (1943), a huge, sprawling work dealing with St. Paul, and *Mary* (1949). All were great popular successes. In his later years Asch lived in England and then in Israel, where he was accepted with mixed feelings; he died in London on July 10, 1957, while on a visit there.

ASCHAFFENBURG, a town in Bavaria, Ger., lies on the right bank of the Main river near the foot of the Spessart mountains, 26 mi. S.E. of Frankfurt. Pop. (1961) 54,131. The Renaissance castle of Johannisburg, of red sandstone, replaced a former castle destroyed in 1552 which stood on the site of the Roman castrum overlooking the river. It was built in 1605–14 as a residence for the archbishops and electors of Mainz. In the chapel are an alabaster high altar and a pulpit by Hans Junker. The 12th-century church of SS. Peter and Alexander on the Stiftsberg in the old part of the town contains the predella with the "Lamentation of Christ" by Mathias Grünewald (*q.v.*) and a Romanesque crucifix. On the north side of the church is a 13th-century cloister. Collections in the Stadt and Stift museum include manuscripts and paintings taken from the castle in 1945. The town's main industries are the manufacture of men's clothing, coloured paper and machine and precision tools. Originally a Roman settlement, Aschaffenburg came under the jurisdiction of Mainz toward the end of the 10th century. It was fortified in 1122. In 1292 a synod was held there, and in 1474 an imperial diet, preliminary to that of Vienna, at which the Aschaffenburg Concordat was decided. In 1814 the town became Bavarian and in 1866 the Prussians defeated the Austrians in the neighbourhood.

ASCHAM, ROGER (1516–1568), English scholar and writer, famous for his enlightened humanism and for his prose style, was born at Kirby Wiske, near York. His father, John Ascham, of a family well known in Yorkshire, was steward to Lord Scrope of Bolton. He sent all his three sons to Cambridge: Thomas, fellow of St. John's college in 1523; Anthony, a graduate in medicine (M.B.) in 1540, author of books of popular medicine and almanacs; and Roger. As a boy, Roger was taken into the family of Sir Humphrey Wingfield, a lawyer and official of the prominent Wingfield family of Suffolk, who lived at Brantham, near Harwich. Wingfield, as Ascham later wrote affectionately, "ever loved and used to have many children brought up in learning in his house," providing a tutor, his chaplain Robert Bonde, and training them also in archery.

The same patron sent Ascham in 1530 to St. John's college, Cambridge. This was the time when the new Renaissance enthusiasm for the classics, especially Greek, was at its height; after Ascham had qualified to teach, he wrote enthusiastically in 1543 (new style), "Aristotle and Plato are now read by the boys in their original language . . . Sophocles and Euripides are now more familiar to us than Plautus when you were here . . . Yet we do not treat the Latin writers with contempt, but we cherish the best of them who flourished in the golden age of their literature." This study not only made competent scholars, but also prepared for state employment those who could write effective Latin.

Ascham took his B.A. degree in 1533 (old style; 1534, new style), and was elected a fellow of St. John's. The M.A. followed in 1537, and he was appointed reader in Greek in the university. Though he rejoiced in the company of the many enthusiastic scholars, he was dissatisfied with his income of £4 a year, and he sought higher patronage. He first offered his learning to the archbishop of York by translating into Latin an early Greek biblical commentary; he also dedicated to the king a treatise on archery which exhibited both classical learning, on which Henry prided himself, and concern for military training. The work, *Toxophilus* ("lover of the bow"), was published in English in 1545. Henry granted Ascham an annuity of £10, at that time an adequate living.

Ascham was made public orator of the university in 1546, and in this capacity wrote many official letters. But he was soon to depart. His teacher and friend Sir John Cheke, the first regius professor of Greek, had gone to court as tutor to Prince Edward; William Cecil, also of St. John's, had begun the official career which was to make him Elizabeth's chief minister; and Ascham's own pupil, William Grindal, followed Cheke to become tutor to Princess Elizabeth. When Grindal died in 1548, Ascham in turn became her tutor in Greek and Latin for two years; then, by Cheke's influence, he was appointed secretary to Sir Richard Moryson, English ambassador to the emperor Charles V. The ensuing three-year service took Ascham to Augsburg, Innsbruck, aside to Venice, and back by the Rhine cities to Brussels and home; he wrote many of the envoy's dispatches, and also (such was the force of classical enthusiasm) read Greek authors with him. He was appointed Latin secretary to Edward VI; in 1553 he was confirmed in this post by Queen Mary (his earlier outspoken Protestantism notwithstanding), and in 1559 by Queen Elizabeth. He served Elizabeth until his death on Dec. 30, 1568, not only as the composer of official letters to foreign rulers (like John Milton a century later), but also as not the least among the humanists who adorned her court, reading Greek with her, and welcomed for his learning and his conversation.

Ascham severed his connection with Cambridge in 1554 when he married Margaret Howe, who bore him three sons, Giles, Dudley and Sturm (named after the great German teacher). When his son Giles entered Westminster school, he made his father's letters accessible to the headmaster Edward Grant, a recent graduate of St. John's college; Grant brought out an edition of them in 1576, the first of seven editions, and the first separate edition of the correspondence of an English humanist. Grant praised the letters for their Latin style, but they are most important for their revelations of Ascham's personal history, or, in the case of the private letters written home from Germany, for their observation of the religious wars there. One such letter was published separately as a very incomplete *Report and Discourse of the Affairs and State of Germany* (1570).

Ascham wrote two books, both in English. The *Toxophilus* was written as a dialogue, in the manner which Renaissance humanists had learned from Cicero. The first or learned part demonstrated the military importance of the bowman from the Parthians to the contemporary Turks, while the second discussed archery as a sport (its position was like that of cricket today), dealing with both the training of the archer and the care of the instruments. The book's chief value is that of the familiar essay, with its warm personal interest and its observation of everyday life.

The Schoolmaster is Ascham's better-known work; it exists in the first manuscript draft of 1564, and in the expanded version of 1568 which was published by Ascham's widow in 1570. The title applies to only a small part of the book, which presents an effective method of teaching Latin prose composition, the heart of English classical education. A larger concern of the book is with the "psychology of learning" (to use a modern term), and Ascham discussed with mature wisdom the qualities needed in a student, and characteristically deplored the general use of corporal punishment both at school and at home. His greatest concern is with what would now be called the education of the whole man, and he recommends training in manners and morals as Sir Thomas Elyot had done in *The Governor* (1531). Ascham was shocked by the behaviour of the "great ones" of the land, which permitted the wildness and "italianate" behaviour of youth. The book contains much vivid observation, as well as eloquence in stating an intellectual and moral ideal of personality in a lively, individual style. The humanity of the book and of its author makes Ascham the outstanding literary personality of the generation following that which had been dominated by Sir Thomas More. As an enlightened and engaging writer of English prose Ascham is assured a steady literary fame.

Bibliography.—The only complete edition of the writings and letters of Ascham is that of J. A. Giles, *The Whole Works,* 3 vol. published as 4 (1864–65). The two books and the *Report* were edited as *The English Works* by W. Aldis Wright (1904). The letters written in English were edited from the manuscripts by Albert McHarg Hayes (Princeton dissertation, typescript, 1933). The life by Edward Grant, published with the letters in 1576, is included in the Giles ed., vol. iii. *See* also Alfred Katterfeld, *Roger Ascham. Sein Leben und seine Werke* (1879). (G. B. P.)

ASCHELMINTHES, a problematical phylum of microscopic to small, pseudocoelomate wormlike animals that includes the following classes (some of which are themselves often given phylum rank): Gastrotricha, Kinorhyncha, Nematomorpha, Priapulida, Rotifera (*qq.v.*) and Nematoda (*see* Roundworm).

ASCHERSLEBEN, a town in Germany in the district of Halle, is a railway junction and is situated some 30 mi. N.E. of Halle. Pop. (1964) 35,641. It lies in the region of the extensive potash deposits on the northern edge of the lower Harz mountains and most of the people are employed in the potash-mining industry. There is a brown coal mine just north of the town and the Mansfeld copper slate deposit to the south. Aschersleben became especially known for its seed raising, and many nationally owned and private seed-raising enterprises supply grain and vegetable seeds to the entire German Democratic Republic. Farming is carried on in the area. The chief industries are tool, paper and cloth manufacture. Aschersleben was probably founded in the 11th century by Count Esico von Ballenstedt, ancestor of the house of Anhalt; it received municipal rights on the Halberstadt model in 1266. On the death of Otto III (1315) it passed to the bishop of Halberstadt and, after 1648, to Brandenburg. The town hall dates from 1518.

ASCITES, the term in medicine applied to an effusion of noninflammatory fluid within the peritoneal cavity. It is not a disease in itself but is one of the manifestations of disease elsewhere—usually in the kidneys, heart or in connection with the liver circulation. Obstructed portal circulation is the commonest cause of well-marked ascites. It may be confused with encysted fluids or with inflammatory exudates as in tuberculosis.

Ascites is produced by (1) diseases within the liver, as cirrhosis and cancer; (2) diseases outside the liver, as cancer of the stomach, duodenum or pancreas, causing pressure on the portal vein, or enlarged glands in the fissure of the liver. Ascites is one of the late symptoms in the disease and precedes dropsy of the legs which may come on later due to abnormal pressure on the large veins in the abdominal cavity. In ascites due to heart disease the dropsy of the feet and legs precedes the ascites, and there will be a history of palpitation, shortness of breath and perhaps cough. In the ascites of kidney troubles there will be a history of general edema including puffiness of the face and eyes on rising in the morning. (F. L. A.)

ASCLEPIADES of Bithynia, Greek physician, was born at Prusa in Bithynia (modern Bursa, Turk.) in 124 B.C., and flourished at Rome about the end of the 2nd century B.C. He traveled

much when young, and seems at first to have settled at Rome as a rhetorician. In that profession he did not succeed, but he acquired great reputation as a physician.

He founded his medical practice on a modification of the atomic or corpuscular theory, according to which disease results from an irregular or inharmonious motion of the corpuscles of the body. His remedies were directed to the restoration of harmony, and he trusted much to changes of diet, accompanied by friction, bathing and exercise, though he also employed emetics and bleeding. He recommended the use of wine. His pupils were numerous, and the school formed by them was called the Methodical. He is stated to have been the first to use music in the treatment of the insane. Asclepiades died at an advanced age.

ASCLEPIADES of Samos (fl. *c.* 270 B.C.), was the earliest and most important of the Alexandrian epigrammatists. He is given as the author of about 40 poems in the Greek anthology, mainly love songs, and was probably the first to introduce into poetry such symbols as Love the archer. A friend of Theocritus, he was addressed by him under his pen name of Sicelidas.

See J. W. MacKail, *Select Epigrams From the Greek Anthology*, with trans (1911).

ASCLEPIUS (Asklepios; Lat. Aesculapius), the Greek god of medicine, the son of Apollo and the nymph Coronis. He probably came from Thessaly. The centaur Chiron taught him the art of healing. At length Zeus, being afraid that he might render all men immortal, slew him with a thunderbolt.

Homer, in the *Iliad*, mentions him only as a skilful physician, whose sons, Machaon and Podaleirius, are physicians in the Greek camp before Troy. In later times, however, he was honoured as a hero—for example, at Athens—and eventually worshiped as a god. The cult began in Thessaly, but temples were erected to Asclepius in many parts of Greece, near healing springs or on high mountains. The practice of sleeping in these sanctuaries was very common, it being supposed that the god effected cures or prescribed remedies to the sick in dreams (*cf.* the modern practice in the Aegean island Tenos, cited by M. P. Nilsson in *History of Greek Religion*, p. 300 [1925]). All who were healed offered sacrifice (especially a cock), and many tablets, recording their names their diseases and the manner in which they had been cured, have been discovered at Epidaurus (*q.v.*), the god's most famous shrine. Herodas, in his fourth mime, gives a description of one of Asclepius' temples and of the offerings made to him. Festivals in honour of Asclepius are known to have been observed in cities as widely separated as Ancyra in Asia Minor and Agrigentum in Sicily. The cult was introduced to Rome by order of the Sibylline books (293 B.C.), to relieve a pestilence. A delegation sent to fetch the image of the god from Epidaurus returned bringing instead a snake in which the god was thought to reside. A temple was assigned to him on an island in the Tiber.

Asclepius is frequently represented in ancient sculpture and as a coin type, standing, dressed in a long cloak, with bare breast; his usual attribute is a clublike staff with a serpent coiled around it. This staff with its single serpent is the only true symbol of medicine. The caduceus with its winged staff and intertwined serpents, which is frequently used in the U.S. as a medical emblem, is without medical relevance since it represents the magic wand of Hermes or Mercury, the messenger of the gods and the patron of trade. Asclepius is often shown accompanied by Telesphorus, the boy genius of healing, and his daughters, Hygieia, the goddess of health, and Panacea. Votive reliefs representing such groups have been found near the temple of Asclepius at Athens. His extremely popular cult yielded late and slowly to Christianity.

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(T. V. B.)

ASCOLI, GRAZIADIO ISAIA (1829–1907), Italian linguist, a pioneer in dialect studies, was born on July 16, 1829, in Gorizia. Without formal higher education, he wrote his first major work in 1854 on oriental languages. He was professor at Milan from 1860 to 1907. His contributions in Indo-European, Celtic and Romanic linguistics were notable, but he is mainly known for his work in dialectology. In 1873 Ascoli founded the journal *Archivio glottologico italiano*, which he edited until 1907. In vol. i he published "Saggi ladini" on the previously neglected Raeto-Romanic dialects; in vol. viii appeared his "Italia dialettale," a model classification of Italian dialects. He emphasized the importance of studies of living vernaculars. He rejected, as a matter of method, the tenets of the neogrammarian school concerning sound laws. Ascoli was greatly honoured during his lifetime. He died in Milan on Jan. 21, 1907. (E. Pm.)

ASCOLI PICENO, a city and province of the Marches, central Italy. The provincial capital, Ascoli Piceno lies among wooded hills (chiefly oaks and chestnuts) about 500 ft. above sea level at the confluence of the Tronto and Castellano rivers, which surround it on the north, east and south, 130 mi. N.E. of Rome by road. Pop. of commune (1961) 50,125. Two of the main streets correspond with the old Roman thoroughfares and there are remains of the Roman city wall (4th to 2nd centuries B.C.) as well as much of the medieval wall. There are two Roman bridges, one of which was partly destroyed by the Germans in 1944, and remains of a theatre, an amphitheatre, a capitol and a temple of Vesta. With the introduction of Christianity (*c.* 300) pagan temples became churches and later Benedictine cloisters were built. In 1006 the civil power passed to bishops and feudatories but internal quarrels caused fortifications to be built, including numerous towers, a few of which still stand, mostly truncated or incorporated in houses. Defense at this period involved much destruction with the consequent formation of slums, many of which remain. The medieval castle, high on the hill, was largely destroyed in 1798 and the fortress of Malatesta (1349) is now a prison.

In 1245 St. Francis constituted his Order in Ascoli, and the great Gothic church dedicated to him was built in 1265. The cloisters are now the market place. The Palazzo dell'Arrengo and the Palazzo del Popolo (now a museum) date from the end of the 13th century. After 1300 the town declined from loss of trade and internal strife. The cathedral, founded between the 8th and 12th centuries, was enlarged between 1481 and 1592. Carlo Crivelli (*q.v.*) started an artistic movement in the town about 1486. Ascoli Piceno contains a picture gallery, a public library (opened 1856) with incunabula, early printed books, manuscripts and parchments, and a museum (founded 1779). The chief industries are agricultural, but there are chemical and electrical works and other smaller businesses.

Known to the Romans as Asculum Picenum, the ancient city was captured by them in 268 B.C. during the building of the Via Salaria. It played a leading part in the Social War against Rome; the praetor C. Servilius provoked a massacre of the Romans there in 90 B.C. but P. Strabo besieged and took it in 89 B.C. Caesar occupied Asculum after crossing the Rubicon and later it became the capital of Picenum (*q.v.*). It was captured by Totila in A.D. 545. In 781 Charlemagne gave Ascoli to Pope Adrian I and it was made a Papal state; in 1183 it became a republic with free judicial administration. It was taken by Frederick II in 1242 but in 1266 it again became a papal possession, keeping some of its former rights, and entered a period of great prosperity. Under French domination from 1798 to 1815 it returned to papal jurisdiction after the fall of Napoleon and became part of the Italian kingdom in 1860. Bridges were blown up during World War II and the town was captured by the Allies in July 1944.

ASCOT, a village of Berkshire, Eng., 6 mi. S.S.W. of Windsor, famous for its race meetings. At the Royal Meeting, held on four days in June, it is customary for the sovereign to drive down the course each day in an open carriage accompanied by members of the royal family and guests, also in carriages. The Gold Cup is one of the most important races of this meeting. The race course is on Ascot heath and was laid out by order of Queen Anne in 1711. Ascot is in the ecclesiastical parish of Ascot Heath (pop., including Sunninghill [1961], 7,799).

ASELLI (Asellio), **GASPARE** (1581–1626?), Italian phy-

sician who contributed to the knowledge of the circulation of body fluids by discovering the lacteal vessels, was born at Cremona in 1581, became professor of anatomy and surgery at Pavia and practised at Milan, where he died about 1626.

He described the lacteals (lymph vessels in the intestine that take up certain products of digestion) in *De lactibus sive lacteis venis,* which was published in 1627 just before the *De motu cordis* of William Harvey, who appears to have been unaware of Aselli's work. Earlier observations on the lacteals by the ancient Greeks and the great Italian anatomists Fallopius and Eustachius had been sporadic and without comprehension of their function and importance.

Aselli's discovery occurred in 1622 during the vivisection of a dog that had been richly fed just prior to the operation. On opening the abdomen he noticed whitish cords that exuded a creamlike liquid. Upon careful repetition of the experiment he described these new vessels as *venae albae et lacteae*.

See T. L. Pagel, *Einführung in die Geschichte der Medizin,* ed. by Karl Sudhoff, 2nd ed. (1915); Arturo Castiglioni, *A History of Medicine,* trans. and ed. by E. B. Krumbhaar (1947). (I. V.)

ASEN (Assen), the first dynasty of the second Bulgarian empire (*see* Bulgaria), founded by the brothers Asen and Peter, landowners and boyars from Turnovo, whose actual family name was Belgun. While some historians have contended that the family was of Vlach descent, it was more probably Kuman-Bulgarian in origin, but there is written evidence that the Asens considered themselves and were considered abroad as the rulers of both the Vlachs and of the Bulgars.

In 1186 after a violent dispute with the Byzantine emperor Isaac II Angelus, Asen and Peter led a popular rising of Vlachs and Bulgars and proclaimed their independence from Constantinople. Asen was crowned tsar as Ivan Asen I at Turnovo, and Peter became ruler of the eastern half of the kingdom, with his residence at Preslav. The brothers invaded Thrace but were defeated, withdrew to the north and, in alliance with the Kumans, conquered northern Bulgaria. In 1187 they checked the imperial army in Thrace and, in the armistice that followed, their younger brother Kaloyan was sent as hostage to Constantinople. He escaped, however, and war broke out, to continue intermittently until the Byzantine forces were thoroughly defeated in 1196. Later in that year Ivan Asen was killed by one of his boyars, Ivanko, who seized power at Turnovo but soon had to seek refuge in Constantinople. Asen's brother Peter ascended the throne but was killed by the boyars in 1197. Kaloyan was then crowned tsar. A shrewd and capable ruler, but violent and cruel, he restored and consolidated his power over northern Bulgaria and began negotiations with Rome. In Nov. 1204 Pope Innocent III's legate bestowed the title of primate of Bulgaria on the bishop of Turnovo, Basil, who then crowned Kaloyan king. With papal backing, Kaloyan now approached Baldwin I, the Latin emperor of Constantinople, but the latter refused a treaty unless Kaloyan reverted to the position of a vassal. In the war that followed, the Latins were defeated at Adrianople in April 1205. Baldwin was taken prisoner and later murdered at Turnovo. For two more years Bulgars and Kumans jointly ravaged Thrace, but in 1207, while besieging Salonika, Kaloyan was killed by one of the Kuman chiefs, probably at the instigation of the tsar's own wife. One of the accomplices, Kaloyan's nephew Boril, proclaimed himself tsar and married his uncle's widow. His incompetent and highly unpopular reign ended in 1218, when Tsar Asen's son Ivan Asen II deposed and blinded him.

Ivan Asen II was a good soldier and a man of wisdom and humanity. He restored law and order, controlled the boyars and, after defeating Theodore, despot of Epirus, in 1230, acquired large parts of Albania, Serbia, Macedonia and Epirus. The record of his achievements, dated 1230, can still be seen in the old church of the Forty Martyrs at Turnovo. One of his daughters was married to the Serbian prince Vladislav, whom Ivan was able to establish as king of Serbia; another was married to Manuel Angelus, ruler of Salonika; and his third daughter, Helen, was betrothed in 1228 to the 11-year-old Latin emperor Baldwin II. The regency of the empire was then offered to Ivan, who agreed in return to give back his conquests in Epirus, western Macedonia and Albania. The Latins, however, afraid of Bulgaria's growing power, repudiated the treaty, and Baldwin was betrothed to the daughter of John of Brienne, king of Jerusalem, who was elected emperor. Ivan Asen gave Helen to the son of the Greek emperor of Nicaea and denounced Kaloyan's agreement with Innocent III, thus separating the Bulgarian Church from Rome. During the siege of Constantinople by the Greeks of Nicaea (1236), the tsar, changing sides once more, allied himself to the Latins, but in 1237 he was finally reconciled with Nicaea and withdrew from the struggle. He died in 1241.

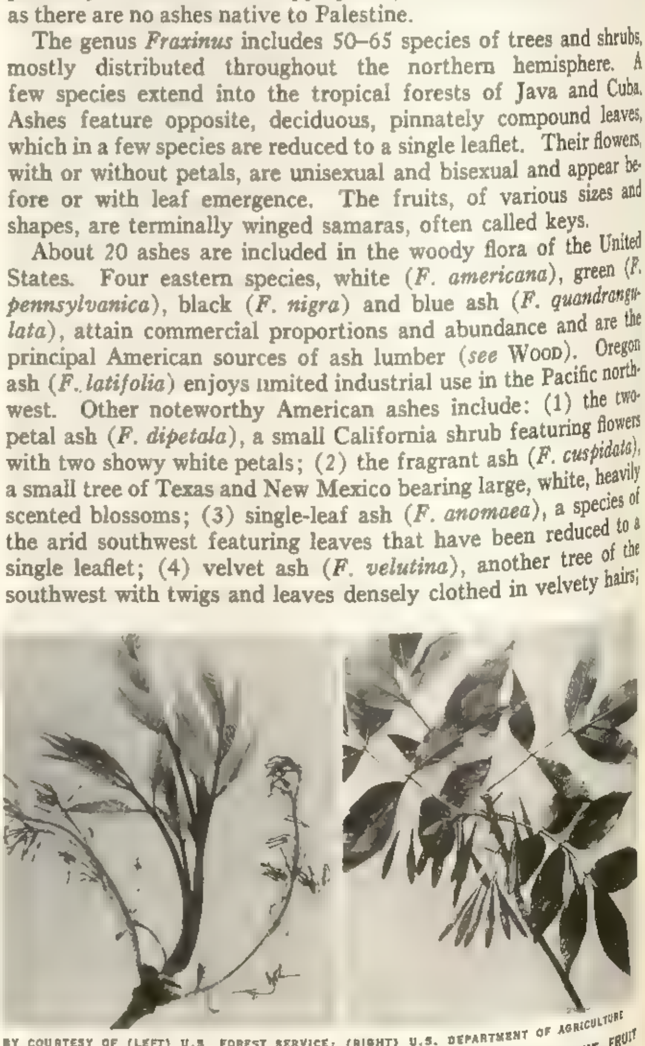
Under Ivan Asen II's sons Kaliman I (1241–46) and Michael I (1246–57), large parts of Thrace, Macedonia and Albania were lost to the Greeks of Nicaea. These reverses played into the hands of the unruly boyars. With their complicity Michael was killed by a prince of the royal blood, who was crowned under the name of Kaliman II (1257), but the boyars killed him also less than three months later. The male line of succession in the Asen dynasty now came to an end, and the Bulgarian crown passed into other hands. In 1262, however, Mitza, a nephew of Kaliman I and Michael, seized power for a short time but then had to flee to Constantinople. His son was crowned as Ivan Asen III in 1279, but a mass rising of the peasantry forced him to leave Bulgaria a few months afterward, in 1280. (N. I. M.)

ASEPSIS: *see* Antiseptics.

ASH, the common name originally applied to members of the genus *Fraxinus* of the olive family (Oleaceae). Unrelated groups, mostly with pinnately compound leaves, are also commonly known as ashes. The Hebrew word *Oren,* translated "ash" in Isa. xliv, 14, probably referred to the Aleppo pine (*Pinus halepensis*), inasmuch as there are no ashes native to Palestine.

The genus *Fraxinus* includes 50–65 species of trees and shrubs, mostly distributed throughout the northern hemisphere. A few species extend into the tropical forests of Java and Cuba. Ashes feature opposite, deciduous, pinnately compound leaves, which in a few species are reduced to a single leaflet. Their flowers, with or without petals, are unisexual and bisexual and appear before or with leaf emergence. The fruits, of various sizes and shapes, are terminally winged samaras, often called keys.

About 20 ashes are included in the woody flora of the United States. Four eastern species, white (*F. americana*), green (*F. pennsylvanica*), black (*F. nigra*) and blue ash (*F. quandrangulata*), attain commercial proportions and abundance and are the principal American sources of ash lumber (*see* Wood). Oregon ash (*F. latifolia*) enjoys limited industrial use in the Pacific northwest. Other noteworthy American ashes include: (1) the two-petal ash (*F. dipetala*), a small California shrub featuring flowers with two showy white petals; (2) the fragrant ash (*F. cuspidata*), a small tree of Texas and New Mexico bearing large, white, heavily scented blossoms; (3) single-leaf ash (*F. anomaea*), a species of the arid southwest featuring leaves that have been reduced to a single leaflet; (4) velvet ash (*F. velutina*), another tree of the southwest with twigs and leaves densely clothed in velvety hairs;



BY COURTESY OF (LEFT) U.S. FOREST SERVICE; (RIGHT) U.S. DEPARTMENT OF AGRICULTURE

WHITE ASH (FRAXINUS AMERICANA): LEFT, FEMALE FLOWERS; RIGHT, FRUIT AND LEAVES

and (5) pumpkin ash (*F. profunda*), a tree of eastern and southern coastal swamps productive of a characteristically light, weak, brash wood of little value.

Known since early Roman times, the European ash (*F. excelsior*) is a timber tree of wide distribution through Europe and Asia Minor. A number of its varieties have been cultivated and used in landscaping for centuries. Notable among these are forms with weeping and dwarflike habits, variegated foliage, warty twigs and branches, and curled leaves. One especially interesting form, *F. e. diversifolia*, which occurs naturally in England and on the continent, features simple and three-parted leaves.

Flowering ash (*F. ornus*) is a handsome tree indigenous to Europe and Asia, the saccharine exudate of its bark being the source of manna (*q.v.*) used as a mild laxative for children. A white wax is obtained from *F. chinensis*, while highly figured veneer is the product of *F. mandshurica* and *F. sieboldiana*.

The European and American mountain ashes are *Sorbus aucuparia* and *Sorbus americana*, of the rose family. The poison ash of southeastern United States is in reality poison sumac (*Rhus vernix*), a member of the Anacardiaceae and a close relative of poison ivy. Prickly ash, a shrub of eastern United States, is *Zanthoxylum americanum*, of the citrus family. *Flindersia* and *Tarrietia* are two Australian genera productive of the silver ash and crow's ash timbers, respectively. The former is a member of the citrus family (Rutaceae); the latter belongs to the Sterculiaceae, the cocoa family. Cape ash, *Ekebergia capensis*, of the Meliaceae, is indigenous to the Cape of Good Hope. (E. S. Hr.)

A'SHA (Maimun ibn Qais), Arabian poet of the 6th–7th century, famous for his description of wines, was born in Manfuha, a village of al-Yamama in the centre of Arabia, and became a wandering singer, passing through all Arabia. Born before Mohammed, he lived long enough to accept the mission of the prophet. He died *c.* A.D. 629. Even before the time of Mohammed he is said to have believed in the resurrection and last judgment and to have been a monotheist, probably under the influence of his patron, Haudha ibn 'Ali, chief of al-Yamama. Several other Arabian poets were also called al-A'sha (the "night blind").

ASHANTI, one of the regions of Ghana, was the core of the old kingdom of Ashanti which was annexed by Britain in 1902. Under the colonial regime (1902–57), the province of Ashanti also included the Brong states in the west, whose related peoples were incorporated in the Ashanti union early in the 18th century (*see* Brong-Ahafo Region).

The Ashanti (Asantefo) belong to the Akan (*q.v.*) peoples of Ghana who occupy most of the southern half of the country. The Akans speak closely related dialects known under the generic name of Twi, which is a Sudanic language of the Kwa subfamily. The dialect spoken by the Ashanti is Asante. About 80% of the people live in small towns and villages. They are predominantly agricultural, practising shifting cultivation and growing maize, manioc, plantain, bananas, yams, and coco-yam among their principal crops for the home market, and cocoa for export.

The rule of matrilineal descent is the key to Ashanti social organization. It governs titles to different offices or property and jural rights and obligations. The extended family is the basis of social as well as political life. Local communities consist of kin groups or lineages, and election to political offices is based on the lineage system. But there is also full recognition of patrilineal descent, which determines certain religious and moral obligations. Ashanti social organization is thus maintained by the recognition of maternal as well as paternal bonds and the reconciliation of their respective obligations, rights, and claims. (K. A. Bu.)

The population of Ashanti was 818,944 at the 1948 census and its area was 24,379 sq.mi. After Ghana attained independence in 1957, Brong-Ahafo region was created from Ashanti, which was reduced to 9,417 sq.mi. The Ashanti population, however, had increased by the 1960s to more than 1,100,000. The capital of the region and the headquarters of one of the eight administrative districts into which it is divided is Kumasi (*q.v.*), the seat of the *Asantehene* (king of the Ashanti). The headquarters of the other districts are Ejisu, Juaso, Offinso, Mampong, Teppa, Bekwai, and Fomena.

The Kwahu scarp, which runs across the country from northwest to southeast, divides Ashanti into two topographically distinct halves. South of the scarp is a thickly forested plateau, which is the true Ashanti country. Kumasi stands at its centre. Twenty-one miles to the southeast is the sacred Lake Bosumtwi, 5 mi. in diameter, which lies at the bottom of a remarkable craterlike depression. North of the scarp, the land is undulating savanna drained by the Volta River.

Golden Stool.—The Kingdom of Ashanti, or the Ashanti union, was one of the last and greatest of the Akan states. The focal point in its history has been its sacred golden stool, the significance of which cannot be appreciated unless some mention is first made of the nature of Akan political society. The primary political unit is the village, governed by a council of clan elders (though less significant today, at the time the Ashanti union was formed the matrilineal clan was fundamental to Akan social life) and by a headman elected by the elders for life as long as he retains their confidence. The headman's authority is not autocratic but representative and paternal. A number of villages form a state (*oman*), whose government by a chief (*omanhene*) and elders is a more elaborate replica of village government. Within each state, one clan provides the royal lineage, and a candidate for the chieftaincy is nominated by the Ashanti queen mother—who is the royal clan's authority on kinship and precedence—for election by the elders.

Ancestor worship plays a large part in Akan life, and clans and states are regarded as comprising the spirits of their dead as well as their living members. A chief is consequently more than a political head: he is the chief earthly representative of his state's and his clan's most important ancestors and the guardian of their interests. One of the principal symbols of the spiritual unity of the state existing in its chief is the latter's stool. Besides being his chair of state, the stool is the repository of his spirit or personality (*sunsum*). The ceremonially blackened stools of departed chiefs are kept in a stool house, where sacrifices are offered to the spirits they represent. Formerly the sacrifices made on important occasions were commonly human, usually slaves. The spiritual continuity of chieftainship is established when, just before taking office, a chief-elect is formally placed on his predecessor's stool for a few moments. A chief's stool may thus be said to symbolize the spiritual unity of a state, its community with its ancestors, and the position of the chief as guardian of the traditions of the state and of his predecessors. A chief may be "destooled" not only because he has lost the confidence of his people but also when he is deemed to have forfeited the trust of the ancestors.

Formation and Growth of the Union.—The original nucleus of the Ashanti union lay in a number of small states established in the forest *c.* A.D. 1600 by small groups of Akan immigrants from the west. These states paid tribute to Denkera, a more powerful Akan state to the southwest. About the middle of the 17th century, the rulers of a number of these states, who were all members of the Oyoko clan, began to cooperate under the leadership of the chiefs of Kumasi in an attempt to check the encroachments from the west of the Doma, another Akan people. When Osei Tutu became *Kumasihene* (*c.* 1680?), he and his *okumfo* (priest) Anokye enlarged this alliance and the Doma were soon decisively defeated.

Osei Tutu and Anokye then determined to free the Ashanti from dependence on Denkera. In their estimation, the existing alliance among the Ashanti states was not adequate to this task, and they determined to convert it into a permanent military union. Such a union was feasible only if they could establish a spiritual community of the whole Ashanti people transcending the particular spiritual unity of each state. Their solution was the golden stool. Tradition asserts that a wooden stool adorned with gold was brought forth from the sky by Anokye before a great assembly of chiefs and people and that it descended gently onto the knees of Osei Tutu. Anokye declared that this stool contained the *sunsum* of the whole Ashanti people and that the strength of the nation depended on its preservation. Thenceforward, since the *omanhenes* present all formally subscribed to this view, every Ashanti had a dual allegiance: to his state stool and chief, and to the golden



PETER BUCKLEY FROM PHOTO RESEARCHERS

FESTIVAL HONOURING CHIEF OF BEREKUM VILLAGE NORTHWEST OF KUMASI. (LEFT) LOCAL ASHANTI QUEEN MOTHER CARRIED TO FESTIVAL. (CENTRE) ELEPHANT-TUSK ORCHESTRA BEHIND ENTHRONED CHIEF. (RIGHT) SIX-FOOT ASHANTI TALKING DRUMS

stool and its guardian, who was now *Asantehene* as well as *Kumasihene*. The golden stool achieved a perpetual sanctity of its own and took precedence of the *Asantehene* himself.

The union thus established duly defeated the Denkera, absorbed some of their subject states, and was drawn on into further wars against their allies in the south. Osei Tutu died in 1712, and shortly afterward his successor seems to have been killed in a war with Akim Kotoku. This disaster was revenged by Opoku Ware (*c.* 1720–50), who brought the northern Akim states and Sefwi into the union, and embarked on extensive conquests to both north and south, a policy further continued by Osei Kojo (1764–77). Thus in the north the Ashanti empire was extended over the ancient Akan state of Tekyiman, over Gyaman and Banda, and as far as Dagomba, while in the south expeditions against Wassaw and the Akim and Akwapim states brought Ashanti into contact with the coast. In 1806–07 an Ashanti army under Osei Bonsu (1800–24) invaded the Fanti states and reached the sea. The commanders of the English and Dutch forts on the coast were forced to recognize Ashanti suzerainty over the Fanti and to accept the Ashanti as landlords of their forts (*see* FANTI).

The underlying motive of these Ashanti conquests seems to have been basically economic. The defeat of Denkera enabled the Ashanti to make contact with the apparently inexhaustible market for slaves and gold afforded by the European merchants at the coast. Conquest of the coastal peoples promised closer control of this trade and its profits together with an assured supply of munitions of war, while inland expansion would provide more slaves and gold for export and a closed hinterland in which Ashanti merchants could profitably retail European goods.

The Ashanti union, however, failed to evolve a mechanism of government for the states it conquered. It assumed that the relation of their rulers to the *Asantehene* would be the same as that of the rulers of the original member states, but the conquered states had spiritual personalities and traditions of their own. Their allegiance was in part a result of the military expediency and economic advantage of siding with the conquering power. But even while the Ashanti were demonstrating this power in the coastal states, its fundamental premises were being destroyed. Between 1804 and 1814 the three European countries whose merchants possessed forts on the Gold Coast—Great Britain, Holland, and Denmark—all outlawed the slave trade for their subjects. Though the Danes and the Dutch gradually lost interest in the coast, the British remained. Their merchants wished to substitute legitimate trade for the trade in slaves, while their government gradually committed itself to the task of abolishing the whole African slave trade and of encouraging the peaceful progress of African peoples. In the Gold Coast this involved first the establishment of a peaceful modus vivendi with Ashanti and eventually responsibility for the protection and government of the coastal peoples among whom the European merchants lived and, therefore, for the ultimate defeat of Ashanti.

Early Contacts with the British.—In 1817 the English merchants negotiated a treaty with Osei Bonsu under which the former were held responsible for the good behaviour of the Fanti states. This led to difficulties; and when in 1821 the British government took over the British forts, the new governor, Sir Charles MacCarthy, organized the coastal peoples to resist Ashanti pressure. In 1824 MacCarthy's forces were defeated and he himself was killed, but two years later the British and their allies routed a new Ashanti invasion. By a peace treaty in 1831 the Ashanti agreed to keep the peace and recognized the independence of Denkera, Akim and Assin, and British and Danish sovereignty in the forts (*see* also BOWDICH, THOMAS EDWARD).

The period from 1831 to 1843 was one of peace and prosperity during which British influence with the coastal peoples steadily increased. But the peace was humiliating to Ashanti, whose expansion had suffered its first major reverse and whose market for slaves was steadily diminishing (with the result that the practice of human sacrifice was on the increase). After 1843 misunderstandings between Ashanti and the local British authorities became increasingly frequent and bitter. Since the British were now clearly the paramount coastal power, the Ashanti held them responsible for the good behaviour of the coastal peoples. But Great Britain's legal relation to the coastal states before 1874 was at most that of a protecting power, and the British authorities did not accept responsibility for the coastal peoples in disputes with Ashanti or for returning to Kumasi fugitives from Ashanti justice.

Great Britain and Ashanti drifted into a hostility which became open in 1863. At first there was little direct conflict, the Ashanti for the most part contenting themselves with expeditions against their immediate neighbours to the south and southeast. In 1869, however, an Ashanti army in Togoland captured a party of German missionaries, and in 1870 the *Asantehene* Kofi Karikari protested against the transfer of the fort at Elmina from the Dutch to the British on the ground that he was still its overlord. In 1873 a full-scale Ashanti offensive was launched toward the coast, and the Denkera and Fanti were soon heavily defeated. The British government was at last convinced of the need for firm action.

Maj. Gen. Sir Garnet (later Viscount) Wolseley (*q.v.*) was sent out as governor and commander in chief, British troops led an invasion of Ashanti, and in Feb. 1874 Kumasi was captured and destroyed.

But, though in 1874 the British finally accepted responsibility for the government of the coastal states, they had no intention of occupying Ashanti. All they wanted was to destroy the Ashanti threat to their coastal colony, and in 1874 it seemed as though this had been achieved. The Ashanti union was breaking up under the stress of defeat, and each of the member states adhered separately to the treaty of Fomena (1874), by which the Ashanti renounced all claims to Denkera, Akim, Assin, Adansi, and the coastal forts; and promised to trade peaceably, to abandon the practice of human sacrifice, and to pay an indemnity. But in the same year, Kofi Karikari was destooled, and his successor, Mensa Bonsu, devoted himself to the reconstruction of the union. The Ashanti states proper were soon restored to their old allegiance, as were some of the more central non-Ashanti states. To go further might have led to further hostilities with the British since some of the remoter former members of the union were now under British influence. Mensa Bonsu shrank from this risk, with the result that he too was destooled (1883). After a period of uncertainty and civil war during which different factions struggled for supremacy in Ashanti, Prempeh, a youth 16 years old, was enstooled in 1888. His authority had been forcibly established throughout the union by 1893.

The British Protectorate and Colony.—The British viewed the events of these years with some mistrust, but failed to adopt any positive policy toward the country until after Prempeh and his party were firmly in control. Eventually in 1895 the Ashanti were charged with failure to observe the terms of the Fomena treaty and required to accept a British protectorate. When the Ashanti tried to negotiate, the British couched their demands in the form of an ultimatum and, early in 1896, occupied Kumasi for the second time. Prempeh and the leading chiefs and members of the royal line were deported to the Seychelles. The Ashanti union was considered dissolved, and its member states were brought under British protection by a series of separate treaties.

The four years 1896–1900 saw an uneasy vacuum in Ashanti. The nation's leaders were exiled, the union was broken, and the golden stool hidden away. The people were sullen and resentful of a power that seemed to have destroyed their nation without actually conquering it. The British failed to understand the situation and, although they maintained a resident in Kumasi, provided neither leadership nor effective administration. During a visit to Kumasi in 1900, the governor of the Gold Coast, Sir Frederic Hodgson, declared that it was an insult to the queen whom he represented that he was not sitting on the golden stool.

CHARLES MAY FROM BLACK STAR

FORT AT KUMASI IN WHICH BRITISH FORCES WERE BESIEGED IN 1900

The Ashanti were scandalized; three days later a whole nation had risen against the British, and Hodgson and his retinue were besieged. Nine months of bitter fighting followed before the British were again in control.

On Jan. 1, 1902, in pursuance of an order in council of Sept. 26, 1901, Ashanti was formally declared a British colony. The country was administered autocratically by the governor of the Gold Coast through a chief commissioner in Kumasi and a number of district commissioners. Direct European rule, together with the social changes resulting from European education and Christian missions, the building of railways and roads, and the development of a cash-crop economy seriously undermined the prestige of the traditional authorities. British rule allowed little effective power to the chiefs, and the people appreciated that such power as was left to them derived from the British government. Destoolment of chiefs became increasingly frequent.

The first British attempt to understand the social and political organization of Ashanti came with the appointment of Capt. R. S. Rattray as government anthropologist in 1920. Rattray was just in time to advise on the policy to be pursued when a few Ashanti accidentally found the hiding place of the golden stool and robbed it of its golden ornaments. In Ashanti eyes the crime was sacrilege punishable only by death. British authority allowed the crime to be investigated by a council of Ashanti chiefs but could not allow the council the status of a court of law; the ultimate sentence for those found guilty was deportation.

The Confederacy Council.—During the 1920s British administration in the Gold Coast as a whole began to move toward indirect rule. In Ashanti, guidance was afforded by Rattray's elucidation of the socially cohesive value of the old authorities. In 1924 chiefs were given definite powers of subordinate jurisdiction, and Prempeh was brought back (he was officially recognized, though as *Kumasihene* merely, in 1926). In 1935 his successor, Prempeh II, was restored to the dignity of *Asantehene*, and an Ashanti confederacy council was recognized by law. But the break with the past had been made, and by the 1960s it was clear that the golden stool could not recapture its former significance. For administrative, economic development and later history of Ashanti *see* GHANA.

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ASH'ARI, AL- (ABU 'L-HASAN 'ALI AL-ASH'ARI) (873–935), Arabian theologian, was born of pure Arab stock in Basra but spent the greater part of his life in Baghdad. He is said to have been a pupil of the Mu'tazilite (rationalist) teacher al-Jubba'i and to have remained a Mu'tazilite until his 40th year, when he was converted to traditional Islamic orthodoxy. His name was in later times attached to the school of orthodox theologians who admitted the validity of reason and created the scholastic theology of Islam, which became dominant among the Shafi'ites. He is said to have written about 300 works, of which only four or five are known to be extant. The most remarkable of these is the *Makalat al-islamiyin*, in which the Muslim sects and heresies are examined and the orthodox creed is set forth.

See also ARABIC PHILOSOPHY; ISLAM.

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ASHBOURNE, an urban district of Derbyshire, Eng., lies 13 mi. WNW of Derby by road on rising ground between two small ravines opening into the valley of the Dove. Pop. (1961)

5,660. Area 1.7 sq.mi. Ashbourne is a marketing centre for the surrounding agricultural districts, and also for fishermen and tourists visiting the scenic Dovedale and Manifold Valley. The church of St. Oswald, dating from 1241, is a cruciform building with a central tower and lofty octagonal spire (212 ft.) and contains brasses and monuments to the Bradbourne, Cockayne, and Boothby families. In Ashbourne Hall, until 1671 the seat of the Cockaynes and from then until 1847 of the Boothbys, Prince Charles Edward stayed in 1745. The oldest of the famous almshouses was founded in 1640. There are many associations with Samuel Johnson, a frequent visitor to John Taylor who occupied the mansion (now the girls' boarding house for the grammar school) opposite the old grammar school (built 1586, now the boys' boarding house). The present school building was built in 1909. The free-for-all traditional Shrovetide football game between Up'ards and Down'ards is still played; the goals are three miles apart. The making of corsets, condensed milk, clocks, and fishing tackle (since 1763) are the chief industries.

ASHBURNHAM, JOHN (*c.* 1603–1671), English royalist, who served Charles I from 1628 as a groom of the bedchamber, is remembered chiefly for his part in persuading the king, on his escape from Hampton Court in 1647, to go to the Isle of Wight rather than abroad. The son of Sir John Ashburnham, who died in 1620, he began a career at court under the patronage of George Villiers, 1st duke of Buckingham. He was treasurer of the Royal Army during the Civil War and commissioner in the Uxbridge negotiations (1644) and then went abroad. After the seizure of Charles I by the army, Ashburnham joined him at Hampton Court in 1647. The king chose wrongly in following Ashburnham's advice, in opposition to that of Sir John Berkeley, to make his escape to the Isle of Wight. In so doing, he placed himself in the hands of Robert Hammond, the governor, before the latter's loyalty had been ascertained. "Oh, Jack," the king is alleged to have exclaimed when he understood the situation, "thou hast undone me!" By this fatal step Ashburnham incurred the unmerited charge of treachery and disloyalty, but of this he was acquitted both by Charles I and Charles II. He was separated, with Berkeley, from Charles on Jan. 1, 1648, and in May was imprisoned at Windsor. In Aug. 1648 he was exchanged for Sir W. Masham, but the same month Charles I's request for his attendance at the treaty negotiations at Newport was rejected, and in Oct. 1648 he was among those marked out by Parliament as "delinquents who shall expect no pardon." After Charles I's death he remained in England, an object of suspicion to all parties, corresponded with Charles II and underwent several terms of imprisonment in the Tower of London and in Guernsey. At the Restoration he was reinstated in his former place of groom of the bedchamber and was compensated for his losses. He represented Sussex in Parliament from 1661 till his expulsion, in 1667, for taking a bribe from French merchants for landing their wines. He died on June 15, 1671.

His grandson John (1656–1710) was raised to the peerage in 1689; this John's descendant Bertram (1797–1878), the 4th earl of Ashburnham, was the collector of the famous Ashburnham Library.

ASHBURTON, JOHN DUNNING, 1st Baron (1731–1783), English lawyer, is chiefly remembered as author of the motion that the "influence of the crown has increased, is increasing, and ought to be diminished," which he brought forward in the house of commons in 1780. He was born at Ashburton, in Devon, on Oct. 18, 1731, and was called to the bar in 1756. In 1762 he was employed to draw up a defense of the British East India Company against the Dutch East India Company, which had memorialized the crown on certain grievances. This masterly document immediately procured him reputation and emolument. In 1763 Dunning distinguished himself as counsel for John Wilkes (*q.v.*), whose case he conducted throughout. His powerful argument in the case of *Leach* v. *Money* (June 18, 1764) established his reputation, and his practice from this period gradually increased. In Jan. 1768 he was appointed solicitor-general, probably under the particular patronage of Lord Chancellor Camden. His friend Lord Shelburne brought him into Parliament in 1768 as member for Calne, which he represented till 1782. He disapproved of the government's further proceedings against Wilkes, which Camden and he both criticized in Parliament in Jan. 1770. On Camden's consequent dismissal he immediately resigned. From this period he was considered as a regular member of the opposition. His motion against the crown in 1780 was carried by a majority of 18. He strongly opposed the system of sinecure offices and pensions; but in 1782, when the marquis of Rockingham became prime minister, Dunning was raised to the peerage and appointed chancellor of the duchy of Lancaster, a rich sinecure. Under Shelburne's administration he accepted a pension of £4,000 a year. He died at Exmouth on Aug. 18, 1783.

(I. R. C.)

ASHBURTON, an urban district and market town in Devon, Eng., lies 20 mi. SW of Exeter and 22 mi. NE of Plymouth by road. Pop. (1961) 2,722. It lies under the southeastern edge of Dartmoor, in the valley of the Ashburn near its confluence with the Dart. Ashburton was a borough by prescription from the early Middle Ages until 1835. Since Saxon times the court leet has elected annually a portreeve (chief officer), a bailiff, and officers such as ale tasters and bread weighers. Ashburton was made a stannary (tin-mining) town by Edward I in 1285. In 1314 Bishop Walter de Stapledon gave the town the chantry chapel of St. Lawrence, whose priest was to keep a "free scole." Henry VIII suppressed the chantry in 1535, but in 1594 the chapel property was bought back from the crown and a grammar school was founded, which continued until 1938. Only the tower remains of the original chapel but an addition was made in the 17th century and it is there that the portreeve is elected. The parish church of St. Andrew, with its 92-ft. tower, was built of granite in the 15th century. The monks of nearby Buckfast Abbey (*see* Buckfastleigh) made Ashburton serge famous in the 16th century but the chief industry is now the tourist trade. (G. M. Mo.)

ASHBURTON RIVER, a stream rising in the Opthalmia range and flowing (when it does flow) for about 400 mi. to fall into the Indian ocean a little north of Exmouth gulf on the extreme western coast of Australia. This area has the greatest rainfall variability of Australia; the mean deviation from the average is over 40% and total annual rainfall has ranged from 1 to 27 in. It also has extremely high temperatures, over 100° F having been recorded for 28 successive days at Onslow. Only after exceptional cyclonic storms ("willy-willies") is "river" more than a courtesy title; it is usually dry more than three miles from its mouth, though in high flood it may be several miles wide. There is some fairly good pastoral country along the length of the river.

(O. H. K. S.)

ASHBY-DE-LA-ZOUCH, an urban district and market town of Leicestershire, Eng., lies in a fertile valley 17 mi. NW of Leicester by road. Pop. (1961) 7,460. Coal seams surrounding Ashby are worked by both deep and opencast mining. Other industries include soap and biscuit making, limestone quarrying, and engineering. There are weekly markets and stock sales. The suffix "de-la-Zouch" was given to Ashby by Alain de Parrhoet la Souche, lord of the manor in the 12th century. In 1461 the manor was granted by Edward IV to Sir William Hastings who became Baron Hastings and whose grandson was created earl of Huntingdon in 1529. Sir William obtained royal licence to enclose land and to build a fortress. Besieged in 1644, this castle surrendered to the parliamentarians in 1645 and was largely demolished in 1648. After the publication of Sir Walter Scott's *Ivanhoe* (1820), in which the castle plays a large part, the 1st marquis of Hastings took measures for the preservation of its ruins. The Perpendicular church of St. Helen contains a finger pillory and monuments to the 2nd earl of Huntingdon (1561) and to the 9th earl (1746), whose wife, Selina, founded a sect of Calvinistic Methodists known as the Countess of Huntingdon's Connexion. The 3rd earl founded the grammar school in 1567.

ASHDOD (Isdud, modern Ashdod Gimel), an ancient city in Israel about 3 mi. inland from the Mediterranean and about equidistant (18 mi.) from Gaza and from Tel Aviv. Pop. (1961) 4,604. Ashdod stands close to a large hillock of red sand (17[illegible] ft.), probably Mt. Azotus on which Judas Maccabaeus fell (1 Macc. ix, 15 ff.). Behind it, extending to the shore cliffs, lie sand

dunes under which the ancient city is probably buried.

Ashdod was an important city of the Philistine Pentapolis and a centre of the worship of Dagon. In Josh. xv it is assigned to the tribe of Judah. The Philistine conquest of Israel resulted in the capture of the Ark of the Covenant, which remained in Ashdod for a time. In the 8th century B.C. Uzziah, king of Judah, seized Ashdod, and soon afterward the city fell into Assyrian hands. In 713 Ashdod joined Egypt against Assyria, but Sargon II reduced the city to submission (Isa. xx, 1). By 701 it again had a native ruler, but Sennacherib's conquest of Tyre (700 B.C.) brought the submission of Ashdod to Assyria again, and the city paid tribute to Esarhaddon and Ashurbanipal. During the second half of the 7th century B.C. the city is said to have withstood a siege of 29 years by Psamtik II of Egypt (Herodotus ii, 157). The inhabitants of the province of Ashdod were opposed to the Jewish refortification of Jerusalem at the time of the return (Neh. iv, 7), and Nehemiah cursed the Jews who had married women of Ashdod whose children could speak only a mixture of languages (Neh. xiii, 23 ff.). Ashdod was captured and cleansed of idolatry by Judas Maccabaeus in 163 B.C., and later (148) it was taken by Jonathan, who burned the temple of Dagon. From the 4th to the 6th century A.D. it was the seat of a Christian bishopric. By the time of the crusades the city was reduced to a small village.

A modern seaport, planned to be Israel's largest, has been built on the site of three ancient ports, Ashdod-yam, Minat Isdud, and Nebi-yunis, which served the inland city of Ashdod. A team of Israeli and U.S. archaeologists conducted three archaeological campaigns, in 1962, 1963, and 1965, at ancient Ashdod, confirming Philistine occupation and identifying remains from the Early Bronze Age through the Byzantine period. Excavations showed that the city began to flourish in the late 16th century B.C. under the Egyptian monarchs of the New Kingdom. (J. S. I.)

ASHER, a tribe of Israel, called after the son of Jacob and Zilpah, Leah's maid (Gen. 30:12 ff.). The district held by this tribe bordered upon Naphtali, and was north of Issachar and Zebulun, and south of Dan. *See* TWELVE TRIBES OF ISRAEL.

ASHER BEN YEHIEL (known as ROSH) (*c.* 1250–1327), Jewish rabbi and codifier, was born in the Rhine District, but, endangered by the persecutions inflicted on the German Jews in the 13th century, he fled to Spain, where he was made rabbi of Toledo. A disciple of Meir of Rothenburg, Asher found his sole interest in the Talmud. He was a man of austere piety, profound and narrow, a determined opponent of the study of philosophy and thus antipathetic to the Spanish spirit. His *Compendium,* compiled between 1307 and 1314 and printed in most editions of the Talmud, differs from previous *compendia* in greater simplicity and in the deference shown to German authorities.

Asher was the father of the codifier Jacob ben Asher (*q.v.*).

ASHEVILLE, a city of North Carolina, U.S., and seat of Buncombe County, in the Appalachian Mountains, is about 119 mi. W of Charlotte, at the junction of the French Broad and Swannanoa rivers. It has long been the cultural, resort, and economic centre of the mountainous counties of the western part of the state. Adjacent to the Blue Ridge Parkway, Asheville is the eastern gateway to Great Smoky Mountains National Park and the Cherokee Indian Reservation. Mt. Mitchell (6,684 ft.), the highest peak east of the Mississippi River, is nearby. The city has a mild climate and is on an uneven plateau averaging 2,200 ft. in elevation. The area is cut by streams and ringed by the higher Blue Ridge, Pisgah, and Newfound Mountains.

Asheville is strategically located at a natural gap through the mountains. The area, which had been Indian territory, was settled after the American Revolution. The first settler was John Burton, who in 1794 laid out a town tract of 21 ac. and named it Morristown in honour of Robert Morris, financier of the Revolution. It was renamed Asheville for Samuel Ashe, then governor of North Carolina, and incorporated in 1797.

Asheville remained a small village until the Western North Carolina Railroad came in 1880, but even before that time the area was widely known as a health resort. The town was chartered as a city in 1883; adopted a commission form of government in 1905; and the council-manager form in 1931. Industries include textiles, paper, cellophane, electric components, wool, minerals, and tobacco.

Millionaire George Vanderbilt, at the turn of the century, built a palatial French château, Biltmore House, on his estate and in 1913 E. W. Grove, a St. Louis manufacturer, built the Grove Park Inn. Asheville also is the site of Pack Memorial Library, holding the Sondley and the Thomas Wolfe collections; and the Thomas Wolfe Memorial, the birthplace of the author. Pop. (1960) 60,192; standard metropolitan statistical area (Buncombe County), 130,074. For comparative population figures *see* table in NORTH CAROLINA: *Population.* (D. J. WR.)

ASHFORD, an urban district in the Ashford parliamentary division of Kent, Eng., 14 mi. SW of Canterbury by road. Pop. (1961) 27,996. It lies on a slight hill in the plains under the downs near the confluence of the upper branches of the Great Stour, and is a considerable road and rail centre. Ashford (Essetesford, Essheteforde) was held at the time of Domesday Book by Hugh de Montfort. A Saturday market and an annual fair were granted to the lord of the manor in the 13th century, and further annual fairs were granted by Edward III and Edward IV. Jack Cade led his men from Ashford in the rebellion of 1450. The cattle trade increased from the latter half of the 18th century because of the fertile pasture land in Romney marsh, and a stock market was established in 1784. The fine Perpendicular church of St. Mary has a lofty tower and many interesting monuments. At nearby Bethersden marble quarries were formerly worked extensively, supplying stone for Canterbury and Rochester cathedrals. Ashford has agricultural implement works, brickyards and breweries, large locomotive and carriage works, and a bicycle industry. The parishes of Kennington and Willesborough were added to the urban district in 1934.

ASHI (*c.* 352–427), head of the Jewish academy at Sura, Babylonia, and one of the two chief editors of the Babylonian Talmud. Under his leadership, the Sura Academy was revived and the gigantic task of collating the scattered notes, sayings, legislative opinions, and homiletic lore was conducted for more than 30 years. After an interruption of several decades, this work was completed by a staff of scholars, headed by Rabina, who directed the Sura Academy in the years 489–500. *See* TALMUD.

See J. Zuri, *Rab Ashi* (1924).

ASHIKAGA, the name of a family that held the title of shogun (military ruler) in Japan from 1338 until 1573, with its capital at Kyōto. The position of the family was established by Takauji (1305–1358), who in 1333 shifted his allegiance from the Kamakura military government to the rebel forces led by the retired emperor Go-Daigo (Daigo II). Go-Daigo rewarded him with landed estates, but he aspired to the title of shogun. After two years of war, Takauji entered Kyōto as a conqueror, declared that Go-Daigo had forfeited his throne, and installed another imperial relative in his place. Thereafter two emperors reigned at the same time: the southern dynasty, so-called because Go-Daigo had retired to the south of Kyōto; and the northern dynasty supported by Takauji and his successors. The schism was terminated in 1392 by the compromise of alternate reigns, although in fact the northern line prevailed.

The Ashikaga family held the title of shogun until 1573, but no shogun ever exercised effective control over all the military leaders and powerful Buddhist monasteries of the land. From 1467 on, civil wars were chronic throughout Japan, and strong feudal lords on occasion drove Ashikaga shoguns out of Kyōto. The last shogun, Ashikaga Yoshiaki (1537–1597), lost his power to his protector, Oda Nobunaga, in 1573. Some of the Ashikaga shoguns achieved fame as patrons of Zen monks who gave particular Japanese form to Chinese arts, as in the case of nō drama, landscape painting, flower arrangement, and the tea ceremony. *See* also JAPAN: *History.* (GE. M. B.)

ASHINGTON, an urban district, in the Morpeth parliamentary division of Northumberland, Eng., 26 mi. N of Newcastle upon Tyne by road. Pop. (1961) 27,304. The district along the river Wansbeck is not without beauty, but there are numerous collieries, one claiming to be the largest in the world, to which the development of the town is due. Associated with the coal

mines, there are some metal foundries. At Bothal on the river (from which parish that of Ashington was formed) is the castle that belonged to the Bertram family in the reign of Edward III. The church of St. Andrew there has Early English to Perpendicular work, and nearby is a ruined chapel of St. Mary.

ASHKENAZIM, the Jews whose ancestors in the Middle Ages lived in German lands and migrated from there to eastern and western Europe and, in the 19th and 20th centuries, overseas. *See* SEPHARDIM, ASHKENAZIM, AND ORIENTAL JEWS.

ASHKHABAD (POLTORATSK from 1919 to 1927), capital of the Turkmen Soviet Socialist Republic, U.S.S.R., since 1924, is situated in the Ashkhabad oasis at the foot of the Kopet Dag about 25 mi. from the Iranian frontier and 325 mi. E.S.E. of Krasnovodsk. Pop. (1959) 169,935. It was founded by the Russians in 1881 as a fort and as capital of the Transcaspian province. It is a station on the Krasnovodsk-Tashkent railway line and an important centre of light industry: there are silk-spinning (of national importance), yarn-spinning, knitting and shoe factories. Food industries include bakeries, meat-packing plants, wineries and candy factories. There is an important factory making windows and glassware. An oil pipeline connects the city with Krasnovodsk.

Ashkhabad is in an earthquake area and a serious tremor occurred in 1948 destroying a large part of the town which has been rebuilt on the same radial plan as before. New public buildings include two theatres, a railway station and a hotel. Higher educational establishments include the Turkmenian A. M. Gorky State university (founded in 1950 with faculties of philology, history and law, physics and mathematics, biology and geography, engineering and physical education). The Turkmen academy of sciences was founded in 1951 from the branch U.S.S.R. academy, and the permanent South Turkestan Archaeological expedition is a division of its department of social sciences. There are specialized middle schools, three theatres and four museums.

Until May 1959 Ashkhabad was also the administrative centre of an *oblast* of the same name, which absorbed the former *oblast* of Krasnovodsk in 1947 and occupied the whole southwestern part of the republic. This *oblast* has now been abolished. The Tedzhen, Kirovsk and Serakhs *raions* were transferred to the Mary *oblast* but this was abolished in 1962 and all *raions* are directly administered from Ashkhabad. (G. E. WR.)

ASHLAND, a city of Boyd county, Ky., U.S., on the Ohio river, 125 mi. S.E. of Cincinnati, just below the mouth of the Big Sandy river. A deep harbour extends the full length of the city's waterfront. Pop. (1960) 31,283; Huntington-Ashland standard metropolitan statistical area (*see* HUNTINGTON), 254,780. (For comparative population figures *see* table in KENTUCKY: *Population.*) In the early years of Kentucky and Ohio settlement thousands of pioneers drifted their flat boats past this spot without stopping. Settlers from Virginia arrived in 1815. Ashland was founded in 1850, and named for Henry Clay's estate in Lexington. Ashland was incorporated as a city in 1870, and has had a council-manager form of government since 1950.

The city stands at the mouth of the narrow but fertile Big Sandy valley which penetrates deep into the eastern Appalachian range. At one time most of the traffic into the isolated highland corners of Kentucky, West Virginia and Virginia started from this point. Subsequently the great log run from the mountains terminated at Catlettsburg and Ashland. Ashland became important, however, as the centre of the early Kentucky iron industry. The Bellefonte furnace was a large producer of iron in the 19th century, and it consumed most of the available timber for several miles about the town. Ashland was linked to central Kentucky and Cincinnati in the early 1900s by the Chesapeake and Ohio railroad, and by 1920 it had begun a new phase of economic development becoming one of the state's most important industrial centres. In the Ashland-Ironton (Ohio)-Kenova-Huntington (West Virginia) region are important iron, metal working, chemical and petroleum industries. (T. D. C.)

ASHLEY, SIR WILLIAM JAMES (1860–1927), English economist and historian of English economic development, was born in London on Feb. 25, 1860, and educated at St. Olave's Grammar School and Balliol College, Oxford. He was successively professor of political economy and constitutional history in Toronto University (1888), professor of economic history at Harvard University (1892), professor of commerce and finance in Birmingham University (1901), and dean of the faculty of commerce there (1902).

Ashley made most important contributions to the history of English industry and the economic development of England in general in his *Early History of the English Woollen Industry* (1887) and his *Introduction to English Economic History and Theory* in two parts. The *Introduction* remained for many years the standard work on the subject and was translated into German, French, and Japanese. He was foremost among the economists who supported Joseph Chamberlain in his campaign for protection for British industry. His *Tariff Problem* (1903) was republished in a new and enlarged edition in 1920.

In addition to his professional and literary work, Ashley sat on many important public committees and commissions of inquiry. He also was joint author of the *Report* of the Unionist social reform committee on industrial unrest (1914). He died on July 23, 1927.

ASHTABULA, a city of Ashtabula county, O., U.S., on Lake Erie, 55 mi. NE of Cleveland. The city derives its name from the river flowing through it called *Hash-tah-buh-lah* (Algonkian, "river of many fish") by the Indians. (For comparative population figures *see* table in OHIO: *Population.*) The first permanent settler arrived in 1803. Matthew Hubbard came in 1804 and became a principal proprietor of the town; Hubbard house, built in 1834 by his brother Col. William Hubbard, was the last station on the underground railroad running from Kentucky to Lake Erie and is still in use standing on a high bluff overlooking the lake at Walnut beach. Because of its location on both the land and water routes from New England, Ashtabula became a stopping place for pioneers entering the Western Reserve. The village was incorporated in 1831 and received a city charter in 1891.

Because of the river, a deep gorge divides the city. One of the most tragic accidents in railroad history occurred on Dec. 29, 1876, when a train of 11 wooden coaches and 2 heavy engines laboured in a blinding snowstorm onto the bridge spanning the gorge. Suddenly the bridge collapsed, plunging 156 persons 75 ft. into the chasm, where the cars caught fire from the heating stoves and oil lamps and 85 people perished.

Industries include shipbuilding, the manufacture of automobile forgings, wood products, farm tools, leather processing, corrugated boxes, sheet metal boilers, plastic auto bodies and cabs, Fiberglas and greenhouse vegetable cultivation. The city is also an important chemical centre. In the 1950s oil drilling was resumed in the area. Two 2,000-ft. docks were added to the harbour facilities to accommodate St. Lawrence seaway shipping. (J. A. TA.)

ASHTON, FREDERICK (WILLIAM MALLANDAINE) (1906–), associate director of England's Royal Ballet and its principal choreographer, was born in Guyaquil, Ecuador, on Sept. 17, 1906. Ashton studied dancing in London under Léonide Massine, Nicholas Legat and Marie Rambert. Mme. Rambert encouraged his first choreographic efforts, in *The Tragedy of Fashion* (1926) and *Capriol Suite* (1930).

Ashton joined the Vic-Wells (later the Royal) Ballet in 1935 and distinguished himself as a mime and character dancer (*e.g.*, Carabosse in *The Sleeping Beauty*, the Gigolo in *Façade*), and as versatile choreographer of about 30 ballets including *Cinderella, Sylvia, Daphnis and Chloë* and the film *Tales of Hoffman* (1950). (LN. MR.)

ASHTON-UNDER-LYNE, a municipal and parliamentary borough of Lancashire, Eng., on the River Tame, a tributary of the Mersey, 6½ mi. E. of Manchester. Pop. (1961) 50,154; on April 1, 1954, part of the rural district of Limehurst was added to the borough and the population thereby increased to 51,335. The derivation from the Saxon *aesc* (ash) and *tun* (an enclosed place) accounts for the earliest orthography, Estun. The addition *subter lineam* is found in ancient deeds because the place is below the line or boundary of Cheshire, which once formed the frontier between Northumbria and Mercia. The manor was

granted to Roger de Poictou by William I, but before the end of his reign was transferred to the Greslets as part of the barony of Manchester. The mayor of the manor still holds the court leet half-yearly. There was a church or chapel there in 1261–62, but the church of St. Michael, begun in 1413, is almost entirely modern. Its stained glass windows are among the finest in England.

The ancient industry was woolen, but soon after the invention of the spinning frame the cotton trade was introduced and as early as 1769 the weaving of cotton yarn by machinery became the staple industry. In addition to cotton, important industries are gas and oil engines, air-conditioning plant, filter equipment, cigarette making, leather and leather goods, plastics and machine tools. There are large collieries in the neighbourhood.

Stamford park, presented by Lord Stamford, is shared with Stalybridge. Ashton-under-Lyne has two technical colleges (one opened in 1954) and a school of art. In 1847 a charter of incorporation was granted.

ASHUR (Assur), the ancient religious capital of Assyria (*q.v.*), identified with modern Qal'at Sharqat in northern Iraq, on a rocky headland overlooking the west bank of the Tigris river about 15 mi. above the mouth of the Little Zab. The first scientific excavations were conducted by a German expedition led by W. Andrae (1903–13).

The place was originally occupied about the middle of the 3rd millennium B.C. by a tribe that probably had reached the Tigris from Syria, for historical tradition refers to a succession of 17 kings dwelling in tents. In the early records Ashur was written as a Sumerian ideogram A-USAR, which may be interpreted as meaning that the place had quay walls. Ashur, or Ashshur as it was subsequently called, was a name applied to the city, to the country and to the principal god of the ancient people known as the Assyrians.

Strategically, Ashur was less well situated than Nimrud (Kalakh) and Nineveh, the other principal cities of Assyria, which were upstream on the opposite bank of the Tigris. But the religious sanctity of Ashur, associated with the memory of the earliest settlers, ensured its continuous upkeep until 614 B.C. when the city was destroyed by the Babylonians. At various periods its citizens enjoyed exemption from taxation. Between the 11th and 7th centuries B.C. several monarchs were buried within the city walls; a space was also reserved for the memorial stelae of the kings of Assyria from Adadnirari I to Ashurbanipal, including one of Queen Sammuramat (Semiramis).

Although it was the religious capital, Ashur was smaller than Nineveh, Kalakh and Dur-Sharrukin (modern Khorsabad). The inner city, which in the 9th century comprised about 150 ac., was defended by a circuit of walls nearly 2½ mi. long. On the eastern side it was washed by the Tigris, along the line of which massive stone and brick-built quays were first erected by Adadnirari I (reigned 1307–1275 or perhaps 1305–1273 B.C.). These were extended and repaired by subsequent kings. On the north side there was an arm of the river and a high escarpment reinforced by a system of buttressed defenses and by a powerful sally port named the *mushlalu*—a semicircular tower of rusticated stone masonry, built by Sennacherib, probably the earliest known architectural example of the kind. Tukulti-Ninurta I (reigned 1244–08 or perhaps 1243–06 B.C.) dug a ditch 20 m. wide along the western side, and 400 years later Shalmaneser III, who built the inner wall, shortened the line of defense and so made it easier to hold. Along this western wall there was a system of towers at intervals of 29–31 m. with a frontage of 8–10 m. projecting 4 m. from the wall. The towers were probably not less than 15 m. high and stood behind a curtain wall 11–12 m. high.

A text of Sennacherib mentions 13 gates as standing in the 7th century B.C., of which seven have been located. The earliest was the *gurgurri* gate in the northwestern corner. This is typically Assyrian in form, defended by heavy flanking towers with staircase leading from an inner guard chamber up to the battlements and closed by three double-leaved doors. Within the city there were paved streets sometimes reinforced with timber balks. A processional way led out of the *gurgurri* gate to a temple built by Sennacherib, the forecourt of which was planted with trees. A catalogue of the town buildings inscribed in the reign of this monarch shows that there were 34 temples in Ashur. Of these temples less than one-third have been found, including those of Ashur-Enlil, Anu-Adad, Sin-Shamash, Ishtar and Nabu; two of the three named are ziggurats, of which that of Anu-Adad, a mighty staged tower of burnt brick, is the best preserved.

Historically the most interesting temples are those devoted to the cult of the goddess Ishtar, or Inanna as she was known to the Sumerians. The associated objects show clearly that the first two foundations (*c.* 2600–2500 B.C.) bore the imprint of Sumerian culture. The fifth in the series belonged to a period when Ashur was ruled by an independent line of rulers, *c.* 1900–1800 B.C., and had trading colonies in Cappadocia. A break thereafter corresponds with a time when Ashur became subject first to Babylon, then to Mitanni, and was of no political importance. The cult however was revived by Tukulti-Ninurta I, who erected a temple to Ishtar-Dinitu ("of the dawn"). There is evidence to support the theory that at this time sexual intercourse took place within the temple under the aegis of the goddess, a practice later on ascribed by Herodotus to Babylon.

In addition to the temples, three palaces were identified. The oldest, ascribed to Shamshi-Adad I (fl. *c.* 1810 B.C.) was a building with a frontage of 112 by 98 m. and followed the plan of one that had been erected at Tell Brak in northern Syria five centuries earlier. Later this building was used as a burial ground. The many private houses found in the northwestern quarter of the site were often spaciously laid out and also had family vaults that were dug beneath their floors and contained many valuable votive deposits, including jewelry, weapons, metal bowls and pottery. The irregular planning of the town and its tortuous streets indicate a strict respect for property rights and land tenure. Other aspects of Assyrian law, particularly relating to women, are known from a series of tablets compiled in the period 1450–1250 B.C. Many inscriptions found include historical and especially religious texts, as well as business documents. Stone sculpture, both in the round and in relief, illuminates the history of Assyrian art at many different periods, as do the thousands of small objects found in the ruins.

Evidence of the sack of Ashur is seen in the violent burning of the *gurgurri* gate, the breaching of the walls and the presence of sappers' tools and arrowheads. When in 401 B.C. the army of 10,000 Greeks commanded by Xenophon passed by, even its ancient name had been forgotten. Even so, some pottery types appear to indicate traces of occupation in the Seleucid period. A part of the city was revived either shortly before or shortly after the Parthian conquest of Mesopotamia (140 B.C.) when a temple was dedicated to Ashur and Sherua, and a vast palace with peristyled courts and pillared hall was erected. *See* Babylonia and Assyria.

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ASHURBANIPAL (Assyrian Ashur-bani-apli) (reigned 669–630 or 626 B.C.), the last of the great kings of Assyria, had been proclaimed crown prince of Assyria during his father Esarhaddon's reign, his brother Shamash-shum-ukin being simultaneously nominated crown prince of Babylonia. His first military concern at his succession was the settlement of Egypt, which Esarhaddon had conquered shortly before his death. The former Egyptian king Tarku (biblical Tirhakah), who had invaded the delta from the south, withdrew at the approach of the Assyrian army, and Ashurbanipal set up an administration under native princes, backed and controlled by Assyrian garrisons. Intrigues between the delta princes and Tarku were discovered and the ringleaders arrested and sent to Assyria. Here Ashurbanipal showed his statesmanship and, forgoing revenge, appointed Necho, one of the princes concerned, as paramount ruler over the delta under Assyrian tutelage. An invasion by Tarku's successor provoked a further Assyrian campaign in Egypt (663 B.C.), during which the Assyrian army destroyed Thebes—an event recalled in

Nahum iii, 8. In the same year Necho died and was succeeded by his son Psamtik.

The pacification of Egypt allowed Ashurbanipal to deal with the Phoenician city of Tyre, which, after siding with Egypt during Esarhaddon's reign, had since withstood a long siege. The kings of Syria and Cilicia hastened to make submission, while Gyges of Lydia, farther west, sought assistance against invading Cimmerian hordes. The Lydian alliance was short-lived, for soon afterward Lydia supplied troops to Psamtik, who had become supreme in the delta and now asserted his independence, expelling the remaining Assyrian garrisons from Egypt by 654 B.C.

The former good relations between Assyria and Elam were ruptured by an attempted Elamite invasion of Assyrian territory during the Egyptian campaign. Once Egypt no longer engaged the Assyrian army, Ashurbanipal, after a brief campaign in the northeast, turned his attention to Elam, conquering the land and setting up a pro-Assyrian king.

In Babylonia Shamash-shum-ukin, loyal to his brother for more than 15 years, now organized a hostile coalition and in 652 B.C. rebelled. His principal ally, Elam, was paralyzed by dynastic troubles, and the Assyrian army was able in 648 B.C. to starve out the Babylonian cities, despite attempts by Arab allies to break the siege. Shamash-shum-ukin himself committed suicide, and Babylonia was placed under a puppet ruler Kandalanu.

With Babylonia settled, Ashurbanipal attempted to re-establish order from the chaos into which Elam had fallen. After several unsuccessful efforts at setting up friendly Elamite princes, Ashurbanipal lost patience and undertook a major punitive campaign in which the principal cities and shrines suffered severely.

Little is known of the events of the final years of Ashurbanipal's reign, but it is clear that the decline of Assyria had set in: the immediate cause was probably economic, the intrusion of Cimmerians and Scythians to the north and of Indo-Aryan peoples to the east having dislocated vital trade routes.

Ashurbanipal's most lasting achievement was in the realm of culture. Some would discount his boast of special ability in the scribal arts, but he certainly showed great interest in literature in collecting at Nineveh a great library of cuneiform texts. This library, discovered in the early days of Assyriology, still forms the basis of that science and is of unique value for the light which it sheds on ancient life and thought. *See* BABYLONIA AND ASSYRIA; *see* also references under "Ashurbanipal" in the Index.

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ASHURNASIRPAL (Assyrian ASSUR-NASIR-APLI, "the god Ashur is guardian of the son"), the name of two Assyrian kings.

ASHURNASIRPAL I, son of Shamshi-Adad IV and uncle of Tiglath-pileser I, ruled Assyria *c.* 1049–31 B.C. His few surviving inscriptions show that the country was impoverished by frequent intruders from the western deserts against whom he warred constantly. Ashurnasirpal I lived in a large palace southwest of the ziggurat at Ashur and used Nineveh as an alternative capital, if a sculptured obelisk found there (now in the British museum) is to be attributed to him rather than to Ashurnasirpal II.

ASHURNASIRPAL II was king of Assyria from 884 to 859 B.C. His great achievement was the consolidation of the conquests begun by his father, Tukulti-Ninurta II, leading to the establishment of the New Assyrian empire. In seven years of arduous campaigning he first subdued the Aramaeans in the upper Euphrates valley and imposed taxes on the states of Laqe and Hindanu. He also marched unopposed to the Mediterranean sea and received tribute from the cities of Phoenicia.

In the north he thwarted Aramaean pressure on the Assyrian city of Damdamusa by storming the rebel stronghold of Kinabu and ravaging the land of Nairi (Armenia). He organized a new Assyrian province of Tushhan to control the border, and there he received tribute from his father's former opponent Amme-ba'ali. In 879 B.C., however, the tribes in the Kashiari hills revolted against Tushhan and murdered Amme-ba'ali. The Assyrian revenge was swift and ruthless.

One reason for the growth of Assyrian prestige and wealth during this reign was Ashurnasirpal's ability to maintain authority over the peoples in the hills to the east. Early in his reign he publicly flayed the rebel governor of Nishtun at Erbil (Irbil) and, in a brief expedition in 880 B.C., dislodged the rebels holding the Babite pass which controlled a main caravan route. Zamua was then made an Assyrian province with a new capital at Atlila.

Ashurnasirpal used the many captives from his campaigns to build a new capital at Kalah (the modern Nimrud). By 879 B.C. the main ("northwest") palace in the citadel, the temple of Ninurta and Enlil, shrines for nine other deities and the city walls had been completed. Botanical gardens and a zoological garden were laid out, and water supplies were assured by a canal from the Great Zab river. The inscriptions and reliefs from this city, to which the king moved from Nineveh, are the principal source for his reign. One of these described his campaigns, building activities and the feast given for ten days to 69,574 people to celebrate the opening of Kalah. A statue of the king (now in the British museum) was found by Sir A. H. Layard in the Ninurta temple in 1847.

See BABYLONIA AND ASSYRIA; NIMRUD.

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ASH WEDNESDAY in the Western Church is the first day of Lent, the fast of 40 days (in imitation of Jesus Christ's 40-day fast in the desert) in preparation for Easter. In the 8th century, Lent in the west began six weeks before Easter and thus 40 days before Good Friday, but as there was no fasting on Sundays it included only 34 days of fast. In order to make up the number of fasting days to 40, four days were added before the first Sunday, and Good Friday and Holy Saturday were counted in also. Lent therefore began six and a half weeks before Easter, on the Wednesday preceding the first Sunday in Lent.

At about the same period in Rome the rites of public penance for notorious sinners coincided with the beginning of Lent. The ceremony of admitting penitents occurred on this Wednesday; they were sprinkled with ashes, dressed in sackcloth and obliged to remain apart until the end of the period of public penance and their reconciliation with the Christian community on Maundy Thursday. When these rites fell into disuse (8th-10th centuries), the beginning of the penitential season of Lent was symbolized by the imposition of ashes on the heads of the whole congregation, clergy and people. Nowadays the ceremony takes place with the marking of a cross on the forehead with the ashes obtained by burning the palms used on the previous Palm Sunday.

In the Anglican Book of Common Prayer a commination service replaces the earlier penitential discipline on this day. Ash Wednesday is also observed in Lutheran churches. Orthodox churches begin Lent on a Monday and therefore do not keep Ash Wednesday. *See* also LENT; CHURCH YEAR.

See H. Thurston, *Lent and Holy Week* (1904); N. M. Denis-Boulet, *The Christian Calendar* (1960). (L. C. S.)

ASHWELL, LENA (originally LENA POCOCK) (1872–1957) British actress, who during World War I organized entertainment for the troops at the front, was born on board ship in the Tyne, on Sept. 28, 1872. She acted with Sir Henry Irving in 1895 in *King Arthur,* and again in 1903 in *Dante,* but established her reputation in Henry Arthur Jones's *Mrs. Dane's Defence* with Sir Charles Wyndham in 1900. Other successes were *The Darling of the Gods* (1903) and *Leah Kleschna* (1905).

From 1907 to 1915 she managed the Kingsway theatre. Later she formed the Lena Ashwell Players and for several years produced good drama at low prices at the Century theatre. In 1908 she divorced the actor Arthur Playfair, whom she had married in 1896, and married Henry (later Sir Henry) Simson. In 1916 she received the Order of the British Empire for her services during the war. She died in London on March 13, 1957. (W. J. M.-P.)

ASIA, the largest of the continents with an area of 17,139,445 sq.mi., has as its conventional western boundaries the Ural mountains and Ural river to the Caspian sea, the Caucasus to the Black

sea, the Mediterranean coasts of Asia Minor and the Levant, and the Red sea. In the east, the Indonesian archipelago and the island chains stretching north through Japan to the Kamchatka peninsula are considered Asian. Viewed on the globe, Asia is a great isosceles spherical triangle having two sides of 6,500 mi. extending from Bering strait to Aden and Singapore respectively, the third side measuring 4,500 mi. and enclosing the Arabian sea and the Bay of Bengal.

This article is organized according to the following outline:

I. PHYSICAL GEOGRAPHY

A. Geologic History

Continents are thought to be formed by the addition to relatively stable nuclear areas, or shields, of fold mountain systems formed from sediments accumulated in geosynclinal troughs. Four major mountain-building episodes may be recognized in Asia, during which portions of previous systems and of the ancient nuclei themselves have been incorporated into the new system along with the younger sediments (*see* fig. 1). Two main groups of Pre-Cambrian shields are distinguishable. The northern, comprising Angaraland and the lesser nuclei (largely submerged) of the Kara and Chukchi seas, appears to have played a more active part, while the southern Gondwanaland group, including Arabia and the Indian peninsula, remained relatively unaffected by movements. The extent of these land masses in Pre-Cambrian times was probably very much greater than that of their present known area, outcropping or concealed beneath later formations. Angaraland together with the Cathaysian land mass, fragments of which formed nuclei in south China and around the Gulf of Chihli, are regarded by some authorities as part of a vast northern continent, Laurasia, stretching through Asia to Europe and North America. A geosynclinal trough, the Tethys sea, separated Angaraland from Gondwanaland.

Little is known of Pre-Cambrian movement in Asia, though one such mountain-building period occurred in south India. The first orogeny for which widespread clear evidence is known, the Caledonian, lasted from Cambrian to Devonian times. The Sayan and Altai mountains show Caledonian structures also found partly obscured by later folds in the Verkhoyansk range. Movement probably took place over a wide area in Outer Mongolia and even in the Himalayas and Indochina. Around the Kara sea nucleus the trends run through Severnaya Zemlya, and west of the Chukchi nucleus through the New Siberian Islands (Novosibirskie Ostrova).

The Variscan or Altaid orogeny spans Carboniferous to Triassic time and has a more extensive influence than did the Caledonian, a good deal of which was probably reabsorbed by the new movements. Fresh folding took place around the Kara sea nucleus, particularly on the west in Novaya Zemlya, whose structures continue in the Urals on the mainland. Hidden Variscan folds may underlie later deposits in the west Siberian plain, and represent extensions of the structures outcropping in the Kazakh uplands. These in turn are linked to fold systems encompassing the southwestern corner of Angaraland; *e.g.*, the Altai, Tarbagatai mountains and Dzungarian Ala-Tau. Much of central Asia was molded at this time, when local nuclei of Fergana and Tarim in the west and Ordos in the east formed stable regions, later to founder as basins, around which fold mountain chains were thrown up. The east-west Astin Tagh (Altyn Tagh), Nan Ling and Tsinling ranges follow the Variscan trend, which may also be seen in parts of the Himalayas, in the Shan states of Burma, Thailand, Malaya and west Borneo. Possibly Formosa, Japan and Korea have Variscan folds, around the east of the south and east China nuclei.

In the far east generally, however, the Yen Shanian (Jurassic-Cretaceous) orogenic epoch was more important. Block faulting, vulcanicity and granitization were more significant than folding in the central parts of this region. Thick Triassic-Jurassic deposits between Angaraland and the Chukchi nucleus were folded up in the Verkhoyansk and Cherski ranges. The Sikhote-Alin (U.S.S.R.), South Korea and south Honshu were all affected, while between the east China and Ordos nuclei occurred the folds of the Shensi coal field. The Nan Ling and other east-west trends of the south China coast are of the same epoch, and continue through the northern Indochina peninsula, Thailand and Malaya into southwest Borneo.

The products of the final phase of mountain building stretch in an immense chain flanking on the south and east all earlier systems and abutting onto the massifs of Arabia and India. Starting in Turkey the ranges run eastward converging on the Armenian knot where they open out southeastward. The Caucasus, continued across the Caspian as the Kopet Dagh, join the system in northeast Iran. In Afghanistan and Baluchistan the influence of the Indian shield is seen in the northward sweep of the Kirthar and Sulaiman ranges and the narrowing of the fold belt in the Pamir knot. In northeast India the trend turns sharply south in the hills of north Burma and continues through the Andaman and Nicobar islands to Sumatra, into the tortuous arcs of Indonesia. Continuing northward in Formosa and Japan, the mainland is reached again in Kamchatka. Severe earthquakes have occurred in the 20th century throughout the Alpine-Himalayan belt in Asia. The greatest instability, evidenced by active vulcanicity and frequent earth tremors, is associated with the island arcs of Indonesia and the far east, where it is possible the orogenic epoch has not yet reached its climax.

B. Geology and Relief

Asia presents a great variety of relief forms generally of an incomparable scale. The open ancient landscapes of the plateaus of Arabia and India merge almost imperceptibly with the youthful alluvial plains of the Tigris-Euphrates and the Indus and Ganges where the deltas of mighty rivers continually extend the land area. Above the plains rise abruptly the flanks of the youngest and most vast mountain system, which borders in its turn the high plateaus, block mountains and basins of the "roof of the world." Northward, high Asia gives way to the broad sweep of lowlands and low plateaus which extend from east Siberia to the Atlantic. To the east great spurs, between which the diligent rivers have built up the flat alluvial plains now teeming with humanity, reach toward the Pacific.

For more detailed treatment of geology and relief, Asia may conveniently be divided into eight regions: (1) the Arabian massif and plains of Iraq; (2) peninsular India and the Indo-Gangetic plain; (3) the mountain belts of Turkey, Caucasia, Iran, Afghanistan; (4) the Himalayan system from Baluchistan to Burma; (5) central Asia; (6) the lowlands of Asiatic U.S.S.R.; (7) the Pacific borderlands; (8) the island arcs.

Arabian Massif and Plains of Iraq.—Pre-Cambrian rocks are extensively exposed along the Red sea and in central Arabia. From Cambrian times onward marine strata have been laid down, Mesozoic and Tertiary being well represented. These formations, generally little disturbed, are arched and faulted west of the Jordan and slight rucking of the strata is found as the Alpine fold belt of Turkey, Iran and Oman is approached. There occur the important oil fields of the middle east. The dominant structural feature of the region is, however, the rift valley system of Tertiary age, to which the Red sea, Dead sea and Jordan valley belong. Vulcanicity accompanied the strong fault movements, producing the prominent lava flows that form the high ground in Yemen (up to 12,336 ft.), northern Hejaz (9,400 ft.) and southern Syria (5,938 ft.).

From its high western rim the Arabian plateau slopes gently to the plains of Iraq and the undulating coastlands of the Persian gulf. Seasonal watercourses abound and many features indicate

FIG. 1.—STRUCTURAL HISTORY OF ASIA

more humid climates of the past. Only the Tigris, Euphrates and a few Mediterranean rivers are perennial.

Peninsular India and the Indo-Gangetic Plain.—Stability has characterized the geologic history of the peninsula since early Cambrian times, though faulting, large-scale movements of the earth's crust and the outpouring of the Deccan lavas complicate its surface evolution. Over a great area the gently undulating landscape is composed of very ancient granites and gneisses above which rise abruptly occasional isolated granite hills. The larger masses of highland in the south, *e.g.*, the Nilgiri hills (8,640 ft.), and in Ceylon appear to be due to post-Jurassic upthrust.

A unique feature of India's structural evolution was the sinking of fault-bounded troughs and the accumulation therein of fresh-water deposits over a period lasting from about the close of the Carboniferous to the early Cretaceous. The most important area of these Gondwana rocks, in which thick coal seams occur, lies along the Damodar valley. Apart from evidence of marine Permo-Carboniferous limestone near Jabalpur, only the fringes of the peninsula experienced marine incursions, in Mesozoic and Tertiary time. In the northwest of the peninsula the eruption of the Deccan lavas in the late Cretaceous or early Eocene covered 200,000 sq.mi. with flat basalt flows.

The Western Ghats form the plateau edge to the west and stand 4,000 to 5,000 ft. above the Arabian sea. Eastward the plateau slopes gently to broad plains in Madras. A number of rugged hill groups toward the east reach 3,000 ft. but plains and broad valleys dominate the landscape. In the northeast the more extensive Chota Nagpur plateau reaches from 2,000 to 3,500 ft. and the Shillong plateau beyond the Ganges delta represents an outlier of the peninsula block. Across the north centre of the peninsula, the Tapti and Narbada rivers and the Satpura and Vindhya ranges form an important dividing zone, north of which the southwest-northeast-trending Aravalli hills gradually become submerged beneath the recent deposits of the plains.

The Indo-Gangetic plains are remarkable for their level surface broken only by steep river bluffs. Delhi, 1,000 mi. northwest from the Ganges' mouth, is 718 ft. above sea level. Toward the Himalayan foothills clays and silts give way to coarse gravels—the "bhabar" country.

Turkey, Iran and Afghanistan.—These countries with west Baluchistan are made up of numerous fold and block mountains enclosing broad basins, often with interior drainage. The Elburz (Mt. Demavend, 18,580 ft.) and Koppeh Dagh in north Iran run east in the Hindu Kush of northeast Afghanistan, while to the south lies the broader Zagros system with several peaks over 14,000 ft. and having a northwest-southeast trend through south Iran, branching into Oman and sweeping north in Baluchistan. The principal oil fields of the middle east are associated with the Zagros and its "ripple folds" against the Arabian massif. The two mountain systems enclose several saline basins, *e.g.*, Seistan, Lut, where also recent volcanic cones occur.

The simplest elements of the more complicated structure of Turkey are the Pliocene volcano, Mt. Ararat (16,945 ft.), from which the Anti-Taurus and Taurus run toward and along the Mediterranean coast, and the Pontic mountains along the Black sea. The fringing ranges enclose several basins on the Anatolian plateau, some containing bitter lakes; *e.g.*, Lake Tuz and Lake Van. Around Zonguldak on the Black sea lies an important Carboniferous coal field and elsewhere there are extensive chrome and manganese deposits. Modern earthquakes indicate the continuing instability of the region.

The Himalayas.—The influence of partly hidden extensions of the massif of southern India on the changes in direction of the fold systems of Tertiary age has been referred to above. The main 1,500-mi. chain of the Himalayas has generally five longitudinal divisions. Separating the system from the Tibetan plateau are the valleys of the upper Indus and Brahmaputra (Tsangpo), from which rise to the south the Great Himalaya with about 60 peaks over 24,000 ft., culminating in Everest (29,028 ft.). Nanga Parbat (26,660 ft.) and Namcha Barwa (25,446 ft.) mark the extremities of the range, south of which spreads a deeply dissected apron of spurs with summit levels of about 15,000 ft. The Lesser Himalaya comprise a number of ranges, sometimes over 12,000 ft. and enclose some basins, the largest being the vale of Kashmir. An abrupt descent follows to the Siwalik hills, with a maximum height of 6,345 ft., formed of coarse detritus brought down from the rising Himalayas in mid-Pleistocene times.

Central Asia.—The Tibetan plateau averages about 16,000 ft., rising in the Karakoram on the southern edge to 28,250 ft. in K2 (Godwin Austen). Heights of over 20,000 ft. are reached in the Pamirs and the west-east-trending Tien-shan, while several basins sink to about 9,000 ft.; *e.g.*, Tsaidam swamp in the Tsinghai province of China. The unique Turfan oasis lies 505 ft. below sea level. The range of altitude is more significant than absolute height above sea level. Many of the basins are enclosed drainage systems and those to the northeast, *e.g.*, the Gobi desert, have suffered much wind erosion.

Lowlands of Asiatic U.S.S.R.—This term is strictly relative

as the region includes the low central Siberian plateau, below 1,000 ft., between the Lena and Yenisei valleys. West of the Yenisei the unfolded Mesozoic and Tertiary deposits of the west Siberian plain stretch to the Urals which are conventionally regarded as in Europe. The surface is often marshy as in the Vasyugane swamps. To the southeast the Kuznetsk and Minusinsk basins, containing Paleozoic coal, form foothills to the Altai and Sayan ranges. The Kazakh uplands, averaging 1,000 ft., form the southern limit of the plain. There are a number of inland drainage basins, the climate being increasingly arid toward the Kirgiz steppe to the south, which includes the open plains of Turan east of the Caspian. The Syr- and Amu Darya rivers provide strips of irrigated cultivation. There are considerable tracts of sand, clay and alkali desert; *e.g.*, Kyzyl-Kum and Kara-Kum. Oil fields are exploited around the shores north of the Caspian.

Pacific Borderlands.—These include a variety of regions stretching from east Siberia through China to Malaya. East of the Lena, the Verkhoyansk and Cherski ranges rise to 8,200 ft. Kamchatka, with active volcanoes rising to over 15,000 ft., consists of two north-south ranges enclosing a basin. The relief of the Bureya highlands and Sikhote-Alin on either side of the Amur river is below 8,000 ft.

China is characterized by rejuvenated relief of fault blocks of Yen-Shanian orogeny and very young alluvial plains. Manchuria is a plain of erosion flanked by tilted blocks: the Greater Khingan, Jehol and Liaotung, the latter being cut off by the sea from the similar Shantung peninsula block. Korea is compounded of dissected plateaus and zones of mainly Mesozoic folding. The southeast China block is much faulted as is also the broad folded zone to its west. The P'o-yang and Tung-t'ing lake basins and the Hsi Chiang (or Si Kiang) valley occupy structural depressions in clays and slates. Westward two broad steps deeply dissected by valleys lead into the 6,000-ft. plateau of west Yünnan. Its spurs enclose the Red basin of Szechwan, to the north of which the Tsinling Shan, with rugged ranges up to 13,474 ft., forms a major divide across China.

The Ordos plateau, rigid since Permian times and covered with great thicknesses of undisturbed loess and older terrestrial deposits, forms the nucleus of northwest China. Loess redistributed by rivers clogs the valleys and has been carried down the Yellow river (Huang Ho) to form the north China plain. Both Yellow river and Yangtze plains are very young; lakes and alternative channels abound, and disastrous floods have been common.

The Yünnan plateau continues south of China into the Shan plateau of Burma and Indochina, deeply cut by the Salween and Mekong rivers. The highlands branch southward to enclose the deltas of the Chao Phraya or Mae Nam and Mekong. Rarely do heights exceed 10,000 ft. and in hilly Malaya the highest point is 7,186 ft.

The Island Arcs.—From Sumatra to Japan lies a belt of great instability. In Indonesia the evidence of volcanic chains, double island festoons and anomalous gravity values has been taken to indicate that orogeny is there in its infancy. A Mesozoic block including Malaya and west Borneo has probably been a buffer to Tertiary folding, and the Tertiary deposits include petroleum. The highest peaks are usually volcanic cones of which Java has several over 10,000 ft. In Japan faulting rather than folding is combined with vulcanicity. An outer, eastern rugged mountain zone on older folded strata cut by faults is distinguished from an inner western zone of younger block faulting and active vulcanicity. A deep rift in which rises the cone of Fujiyama (12,388 ft.) cuts across central Honshu. Plains of young alluvium, flanked by older gravels, occupy a relatively small area in this land of steep slopes.

C. Climate

The classic theory of the monsoons as explaining the climate of much of Asia has undergone radical revision in the light of the more intensive meteorological research into the dynamics of the upper atmosphere that took place during and after World War II. Among the most important factors influencing the climate of a place is its position in relation to the general planetary circulation of the atmosphere, upon which the distribution of high mountains and of land and sea masses has an effect. Local factors also have their effect, such as distance from and altitude above the sea and the configuration of the land surface.

As far as Asia is concerned, the planetary circulation consists of three elements:

1. The circumpolar vortex of the westerlies extending into the upper layers of the atmosphere, within which lies the jet stream, generally at a height of over 30,000 ft. and sometimes several hundred miles wide. Within the jet stream the velocity of air flow is much above that of the main body of the westerlies. According to G. T. Trewartha, the jet stream has an important regenerative and guiding effect on the depressions which follow beneath it. In summer the jet stream lies over the U.S.S.R. north of the mountains of central Asia and cyclonic disturbances tend to follow tracks west to east across central Siberia bringing rain to the steppes. In winter, with the southerly shift of the circumpolar vortex, the jet stream is caused to split in two by the highlands of central Asia, one branch passing south of the Himalayas and a weaker branch fluctuating in position north of the highlands. Over central China the branches converge to flow northeastward across Japan.

2. Equatorward of the westerlies there lies at the surface a belt of easterlies: the trade winds. These are strongest over the west Pacific ocean at all seasons, but are operative only in winter over the Indian ocean.

3. Air rising over the easterlies joins the general westerly whirl of the atmosphere at high altitudes. At the surface there is also a countercurrent, however—a belt of equatorial westerlies, normally quite narrow over the sea. It has been suggested by H. Flohn that this stream of air widens in summer to produce the so-called southwest monsoon over India and southeast Asia and presses eastward to meet the west Pacific trade-wind flow over China.

The climate of Asia can in large measure be described in terms of these three wind systems and the cyclonic disturbances that they generate through bringing into contact air masses of contrasting character, through dynamic causes due to air flow over the irregular surface of the land and through thermal causes due to the differential heating of the surface. The details of the climate may best be treated under the following regional divisions: Asiatic U.S.S.R., southwest Asia, India-Pakistan, southeast Asia and the far east.

Asiatic U.S.S.R.—With the exception of Transcaucasia, the Soviet Union's "greenhouse" sheltering south of the Caucasus, the whole of the U.S.S.R. lies exposed to influences from north and west. The lack of mountain barriers in this vast area stamps its climate with certain common traits: cold winters, warm to hot summers and low rainfall.

Siberian winters are notoriously cold and the lowest temperatures recorded in the northern hemisphere are almost invariably to be found there. The Siberian high-pressure system engenders calm, sunny weather as a rule and rarely can depressions break through bringing dreaded blizzards. Only the southern Caspian and Black sea coasts have January means above freezing. Summer follows winter with amazing rapidity. The Arctic ocean and large lakes tend to reduce temperatures locally, but south of the Arctic circle July means are over 60° F. and Verkhoyansk's record is 93°. In the central Asia republics July means of over 80° F. are found.

Only Transcaucasia, the middle Amur basin and Kamchatka have more than 20 in. of precipitation. Large areas in the central Asia republics and toward the Arctic circle receive less than 10 in., leaving a belt tapering eastward from the Urals with 10–20 in. Rainfall is generally concentrated in the summer months when frequent shallow depressions pass eastward across the steppes. Transcaucasia has rain at all seasons, while the fringe of the central Asian highlands receives most rain in winter. In the far eastern region a slight monsoonal effect brings late summer rain and polar frontal depressions pass parallel to the coast. In neither case, however, does precipitation extend far inland. There and on the Arctic coasts summer fog is prevalent.

Southwest Asia.—Despite the penetration of the Red sea and the Persian gulf, aridity is the keynote of this area, which lies between the Mediterranean and West Pakistan and south of the U.S.S.R. Most of what little rainfall the region receives is brought by westerly depressions moving in winter under the jet stream from the Mediterranean toward India. The summer is dry except in the areas bordering the Black sea, which enjoy convectional storms, and in the southern tip of the Arabian peninsula, which is high enough to extract some moisture from the monsoon air stream flowing toward India.

Temperature contrasts are very great. In winter the plateaus become extremely cold and there is widespread snow. Kabul has a January mean of 31° F., Tehran 34° and Ankara 28°, and the mean minima indicate even better the severity of winter: Tehran 26°, Ankara 17°, Mosul 32°. Everywhere, except perhaps on the southern Arabian coasts, temperatures may vary rapidly from day to day with the passage of depressions, in the advance of which warm air is drawn northward from the southern deserts, raising temperatures as much as 40°, to be followed by an equally sudden fall brought by cold northwesterly blasts in the rear. Only the coastlands of the Mediterranean (Beirut, January mean minimum 50° F.), the Persian gulf, Makran and, above all, the southern fringes of Arabia (Aden, January mean minimum 73° F.) can claim really mild winters.

Summer is everywhere very hot, tempered in the north by altitude (though by day enclosed mountain basins may be ovenlike) and elsewhere by winds, which though often dust laden help to make high temperatures bearable. Almost the whole of the region apart from Turkey and western Iran has daily maxima exceeding 100° F. in July. The slightly lower temperatures of coastal areas, *e.g.*, the Persian gulf and Aden, are much more uncomfortable because of the higher relative humidity.

India-Pakistan.—The seasonal rhythm of climate in the subcontinent is apparently linked to the alternating dominance of the winter jet stream and the equatorial westerlies. The northeast trade winds are a minor factor in winter. Depressions, some probably of Mediterranean origin, traveling along and developing in the zone of convergence beneath the jet stream, bring vital winter rainfall to northwestern districts. South of the jet stream subsiding air from aloft maintains winter drought over central India. The removal of the jet stream to north of the Himalayas in summer seems an essential precondition to the sudden inflow of moist equatorial air from the southwest, which brings heavy rainfall to the Western Ghats (Mahabaleshwar 261 in.), Bengal and Assam (Cherrapunji 428 in.) and the eastern Himalayas (Darjeeling 123 in.). Precipitation diminishes in the rain shadow of the Ghats (Bijapur 20 in.) and up the Ganges valley, becoming negligible in the Thar desert and farther west (Jacobabad 4 in.). In the northeast the main period of the rains is preceded by increasingly frequent storms from March onward. It is a popular misconception that the monsoon rains fall continuously for weeks. Rather they come with marked periodicity, rainless episodes of increasing length occurring as the season progresses and the distance from the sea increases. A notable feature of the rainfall is its variability from year to year, this being most pronounced in areas of low average precipitation.

With the reappearance of the jet stream south of the Himalayas in the autumn, rain-bearing air masses can no longer penetrate from the south and the dry season begins. Southeastern India, however, and northern Ceylon experience their season of maximum rainfall from October to December as the equatorial air masses retreat south, giving way to northeast trades over the Bay of Bengal. Tropical cyclones add to the autumn precipitation.

Temperature conditions emphasize the vast extent of the subcontinent and one can refer to a "continental" northwest and a "tropical" peninsular India. In the plains of the Punjab several slight frosts may be experienced each cold season, though day temperatures may rise into the 70s. The hot season brings excessively high temperatures to the same region, with mean June maxima over 110° F. in places. The arrival of the rains brings welcome relief by day, though night temperatures may remain in the 80s. The annual and daily range of temperature is much less in the lower Ganges valley and the peninsula. In the far south Trivandrum has a yearly range of 5° F. compared with 20° at Calcutta and 40° at Lahore, and a daily range of only 12° in January, *cf.* Lahore 29°.

Southeast Asia.—This area includes the broad peninsula lying between India and China, tapering southward into Malaya and the Indonesian archipelago. Except in the interior of the mainland, maritime and equatorial influences are all-important. Temperatures at sea level maintain a daily mean of about 80° F. in the archipelago. The annual range increases northward: Singapore 3°, Rangoon 10°, Mandalay 20°. Air flow across the equator alternates seasonally and rainfall regimes depend largely on aspect. Thus the coastal uplands of Vietnam lie across the path of the west Pacific trades in winter and with the northern flanks of the islands receive rain at this period. The equatorial westerlies of summer impinge most strongly on Burma, Thailand, South Vietnam and the south coasts of the islands. The Philippines and Vietnam also have much rain from late summer typhoons. Between the seasons of fairly constant air flow, Malaya and Indonesia are in the doldrums and calm thundery weather predominates.

Much of the archipelago and Malaya have rain at all seasons but on either side of the equator occur dry seasons characteristic of monsoon climates. From east Java to Timor the islands have a dry season during the southern winter. Northern Malaya has one month dry and the period lengthens northward: Akyab (Burma) has four months with under 2 in. in a total of 203 in. The dry season is accentuated in the "dry belts" of Korat (Thailand) and central Burma, where Mandalay, total 33 in., has only 0.8 in. between December and March.

The Far East.—China north of the Tsinling Shan has a severely continental climate, characterized by extremes of temperature and low rainfall. Central and south China and Japan by contrast have a humid temperate to subtropical climate. In winter the difference between these two major divisions is greatest; *e.g.*, January mean temperatures: Mukden 9° F., Peking 23°, Tokyo 37°, Hong Kong 60°. The southern branch of the jet stream in the westerlies is joined by the weaker northern branch over central China, and depressions intensify there and during their passage northwestward across the China sea and the Japanese islands. Some develop dynamically as passing lee depressions in air sweep across the Tsinling Shan from the high-pressure centre of northeastern Asia. The depressions draw moist air into central China and bring rain, while the north remains dry because of its outflowing air streams. Japan's winter rain and snow are heaviest on the west which is exposed to cold blasts from the mainland.

In summer China becomes the meeting ground of the equatorial westerlies and the trade winds. As in India, the removal northward of the southern branch of the jet stream is the signal for the beginning of the early summer *baiu* rains. Precipitation, heavy over south and central China (from 40 in. to more than 60 in. annually), decreases northward to less than 10 in. in the bend of the Yellow river. The coasts of southern China and southern Japan may suffer destructive typhoons from June to November. Because of its maritime position Japan has over 60 in. of rainfall except in the north. Unlike winter, summer temperatures are remarkably similar throughout the far east; *e.g.*, July means: Mukden 76° F., Peking 78°, Tokyo 78°, Hong Kong 82°.

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D. VEGETATION

Two major factors which determine the vegetation of much of Asia are the monsoon winds and the lofty mountains which intercept them. The seasonal alternation of the monsoons in the south and east causes an alternation of wet and dry seasons. In these regions there has developed a vegetation composed of plants which can reduce their activities during the dry season. This condition

parallels that in the north, where there is an alternation of warm or temperate and cold seasons. The central and southwestern portions of Asia for the most part can support only desert or steppe communities, because the surrounding mountains and the great distances from the seas prevent moisture-laden winds from reaching these areas. These general conditions are greatly altered in various parts of the continent because of local conditions and so give rise to a great diversity in the vegetation of Asia.

The flora of northern Asia is essentially similar to that of northern Europe and is composed largely of the same genera. Indeed, many species are circumpolar in their distribution. Some Mediterranean genera extend eastward across northern Asia Minor and on to the Himalayas, and a few elements reach as far as China. The deserts of interior Asia are continuations of the desert areas of Africa and Arabia with much the same types of plants; many of the genera are found throughout.

The vegetation changes somewhat toward central Asia in accordance with the change of climate from the hot and dry conditions of the southwest to the alternate extremes of hot summers with cold nights and cold winters at the high altitudes and latitudes of Tibet, Chinese Turkistan and Mongolia. These deserts lack such distinctive plants as the succulent cacti of the new world and the peculiar euphorbias which are characteristic of the drier parts of Africa.

Temperate and subtropical eastern Asia has the richest flora of any similarly located region of the world. Although the region is controlled by the alternating monsoons, great floral diversity results from variations in the configuration of the land and its range from the uniformly hot climate of the tropical zone northward into latitudes where severe winters prevail. This flora has many elements in common with the Himalayan and Indo-Malayan floras and shows striking relationships with the flora of eastern North America. There are also many genera and even families which are unique to this area.

FIG. 2.—MAJOR VEGETATION REGIONS OF ASIA

Southern and southwestern Asia has a rich tropical flora reflecting the generally abundant summer rains and mild to hot climate. The vegetation of India is composed of somewhat different floral elements from that in Indochina, the Malay peninsula and the Malay archipelago. They are differentiated as the Indian and the Indo-Malayan floras respectively. Especially in the southeastern part of the Malay archipelago there are many representatives of the distinctive Australian flora.

Northern Asia.—The combination of low humidity and severe winters along the arctic margin of the continent results in a scanty low vegetation known as tundra. The vegetation of the plateau region beginning east of the Yenisei river and reaching to the Stanovoi mountains forms the great tundras of Siberia, composed of low, flowering plants, such as sedges, dwarf birches and willows, with numerous mosses and lichens. The area is better drained and the winters are even more severe than they are toward the west. Forests of small trees occur in the lower and more sheltered parts with the tundra stretching southward on the ridges. Farther south occur distinctive forests or taigas, often swampy, which extend to the coniferous forests and meadows of the Siberian highlands in the general vicinity of Lake Baikal.

South of the swampy forests and meadows of northwestern Asia are found the grassy steppes of Siberia. They are best likened to the Great Plains of the western United States and extend as similar formations into European Russia. They gradually give way toward the south to the desert formations of Turkistan. Eastward the steppes extend far into Dzungaria and across northern Mongolia, ascending the highlands of Siberia. There the grass grows longer and makes better pasturage.

Northeastern Asia.—In this area high mountains intercept some of the most severe northern winds and allow the better saturated winds from the Pacific to exert a more benign influence on the climate. Hence a more luxuriant flora of a cold-temperature nature is found. It is composed largely of the same genera as occur in Europe and northern North America. Below lichen moors on the edge of the northern plateau in the Okhotsk region are dwarfed forests of hardy northern trees with coniferous forests at the lower levels. Tundra outliers are evident along the coast, but the deciduous forests of farther south are lacking. In Amur and the maritime provinces of Kamchatka, Sakhalin and Hokkaido extensive deciduous broad-leaved forests may be found interspersed with coniferous forests, especially at higher altitudes. Throughout the area are distinctive north temperate meadows with a varied flora, especially noteworthy being tall umbellifers.

Eastern Asia.—This region extends from Manchuria to Indochina and from the edge of the Tibetan plateau to the Japanese islands. The temperate deciduous forests of farther north reach down to the Shantung plain and give way toward the west to the desert vegetation of Mongolia. Oak, elm, ash, walnut and many other trees are found. Some hardy bamboos survive in Korea. Mongolia is the eastern end of the central Asiatic desert region and owes its dry condition to the inability of the summer monsoons to penetrate far inland because of the mountain chains that fringe

its southern and eastern borders. The better, though by no means abundant, vegetation of the loess region, which lies below the Yellow river and north of the mountain ranges extending east from Tibet, is the result not primarily of greater precipitation, but of the greater water-holding capacity of this richer and finer soil. Central China, comprising largely the Yangtze valley and including most of the Yünnan plateau, contains much of the rich and distinctive warm temperate flora which characterizes eastern Asia. A similar type of flora is also found in central Japan. This central China area is cut off by mountains from the severe northern influences and is bathed by summer monsoons from the China sea. The irregular weather of the northern part frequently results in droughts which profoundly affect the vegetation and the conditions of human life. The southern portion of this middle area contains a larger proportion of more southern plant forms, such as broad-leaved evergreen trees—laurels and banyans—which are absent in the north. Members of preponderantly tropical families such as the tea (Theaceae) and mahogany (Meliaceae) are also found. The natural vegetation throughout much of China has been highly altered during centuries of human exploitation by a dense population. In the west, bordering the high interior plateau, remain unexploited forests, passing from temperate deciduous trees upward through various zones of coniferous forests to dense rhododendron thickets below rich alpine meadows with primulas, poppies, asters, etc. Living trees of the dawn redwood (*Metasequoia glyptostroboides*), previously known only by fossil specimens, were discovered in 1945 in a few moist valleys of central China. The subtropical vegetation of southern China extends northward along the shore of the China sea east of the coastal mountain range as far as Chekiang province, and on to Formosa and southern Japan. Apparently much of the lower land once supported tropical or subtropical evergreen rain forests, which may still be found on Hainan. There now exist largely bare deforested and grass-covered hills with at best a meagre secondary type of savanna forest.

Southeastern Asia.—The continental portions of this region have a tropical climate and are wholly monsoon controlled. The monsoon type of tropical deciduous forest is found at its best at medium altitudes. Teak is one of the principal components and Dipterocarpaceae (*q.v.;* a family of timber- and resin-yielding trees) abound. These forests are limited below by evergreen lowland forests which result from a greater soil saturation, and at higher altitudes by evergreen rain forests. The mountain ranges that intervene between the great rivers which diverge from the narrow gorges of western Yünnan cause diverse conditions. The Malay peninsula is covered with dense tropical rain-forest jungles, reflecting the higher humidity and greatly lessened influences of the dry monsoons. There the vegetation is composed very largely of wholly tropical genera and families. Especially noteworthy are palms, rattans and tropical orchids and members of the Leguminosae, Euphorbiaceae, Rubiaceae, Annonaceae, Melastomaceae and Moraceae (*qq.v.*). The Malay archipelago and the Philippine Islands have a fairly homogeneous tropical flora diversified by altitudinal changes in climate with generally drier types of vegetation on the sheltered sides of the islands, which are more or less monsoon controlled. Certain mountain ranges extend above the tree limit and show a floristic similarity to the eastern Himalayan region. There is a generally decreasing humidity with less luxuriance of vegetation eastward from western Java.

Southern Asia.—High-mountain and temperate floras predominate in the Himalayas beyond the maximum influence of the monsoons. In this area are found forests of oak, characteristic conifers, rhododendrons and rich mountain meadows, extensions of the vegetation of far western China but with significantly different species. In the eastern Himalayas and Assam occur some of the heaviest rains and densest evergreen rain forests in the world. The vegetation varies with increasing altitude, beginning at the coast with rich swampy jungles and ending in mountain meadows and shrubby stony slopes around 16,000 ft. In a large part of India the more or less prolonged dry season results in a tropical deciduous savanna (parklike) type of forest, of which teak and *Shorea robusta* are prominent members. The vegetation in many parts of India is as highly altered by exploitation as it is in central China. Its original character can only be surmised. Peninsular India has a dry interior plateau with a semidesert type of flora rich in thorny trees and shrubs, especially acacias. More luxuriant forms of vegetation occur in the dissecting valleys, where water is more abundant. There the sandalwood tree is at home, although it was probably introduced long ago from the Malay islands. The Malabar coast, a very humid strip backed by the highest mountains (8,800 ft.) south of the Himalayan chain, contains evergreen rain forests with genera and families of plants scarcely represented elsewhere but with some elements in common with the Malayan region. Much of the east coast of the Deccan peninsula has a semievergreen flora with a considerable proportion of thorny species. The estuaries on both coasts, as well as on the other shores of the Bay of Bengal, have extensive mangrove swamps.

Ceylon should naturally be covered with forests, but there are now extensive areas of savannas, grasslands and fernlands of secondary origin. The western Himalayan flora is less rich than the eastern and lacks many of the tropical and certain of the temperate genera found in the latter. It includes, however, some European genera, principally representatives of the Mediterranean flora. Thus the deodar (a cedar) is found there, but larch, common in the east, is lacking. The plain of the northwestern part of the Indian subcontinent is dry and desertlike, with a corresponding flora. It is, indeed, only an arm of the great arid region of southwestern Asia. Its dryness is mitigated by extensive irrigation from the snow-fed Indus river.

Southwestern Asia.—Most of this area from Asia Minor and Arabia to the western margin of Tibet and the Kirgiz steppes is desert or steppe, except where the mountain ranges are high enough to intercept the more northerly winds and rob them of their meagre moisture. Where the larger rivers, such as the Tigris and Euphrates, traverse broad valleys the desert can be made to grow productive crops.

The flora of Arabia is poor in the number of species, and plant communities consist of large numbers of plants of only two or three species. They are strikingly pale green, gray or even whitish.

The Mediterranean flora of characteristic gray-green aspect, such as the olive and evergreen oak, stretches eastward from the shores of Asia Minor, especially along the well-watered northern slopes of the Black sea and on across northern Iran and the southern Caspian coast to Afghanistan and the western Himalayas. The mountains likewise bear coniferous forests of distinctive species.

Northern Iran is a better watered region where deciduous forests occur, as in Europe, but they are composed of a larger number of species. An extensive growth of box scrub is found at higher altitudes in certain places. The chief characteristic of the Iranian flora is the preponderance of thorny and prickly plants, of which more than 500 species have been counted, various kinds of *Astragalus* being among the most noteworthy. The sand wastes and salt tracts in the desert plains support characteristic vegetation, as tamarisk bushes, saltbush and wire grass. Date palms, however, occur in the oases.

The flora of Russian Turkistan reflects the cold desert conditions which prevail in this plain, cut off by high mountains on the east and south. One of the principal desert plants is the saxaul of the Chenopodiaceae, a family especially well represented in the desert vegetation of inner Asia. Vegetation sufficient to support human life is confined to the vicinity of the two rivers which flow from the mountains into the Aral sea and to the strips along the mountains where irrigation has permitted the growth of cities and centres of culture.

In the mountainous highlands of Russian Turkistan occur coniferous forests of an open parklike character, bordered above and below by grassy meadows. Flocks come there when the heat of summer dries up the pastures lower down.

Central Asia.—The vegetation of this high and dry plateau, which is divided by mountain chains into several basins, is very meagre. The great height of the plateau and its northern location result in extremes of daily and seasonal temperature, so that the plants which survive are of the hardiest types. The vegetation is arranged roughly in concentric zones about the most sterile sandy wastes and salt tracts. Extensive swamps occur, backed by better-

drained grasslands and thin scrub formations. The streams are often bordered by willows, poplars and elms. Eastern Tibet is partly grassland. Toward the northern side of this plateau the vegetation is composed of more northern elements, but in the south there are more genera and species related to the Himalayan flora. Characteristic mountain forests are found in the Pamirs, where the mountains converge toward the west. (W. B. T.)

E. Animal Life

It is obvious that the animal life (fauna) of a large continent such as Asia, ranging from inside the Arctic circle in the north to well into the tropics in the south, and from the arid Arabian regions in the west to the rain forests of the Malay archipelago in the east, must be very diverse. If climate were the only factor controlling the distribution of animals, a gradual change of the fauna from north to south would be expected. However, the Himalayas, stretching from west to east, form a barrier which prevents many northern animals from dispersing southward as well as many southern animals from extending their range northward.

The part of Asia north of the Himalayas, Iran, Asia Minor and Israel belong to what is called in zoogeography the Palearctic region. This region includes the whole of Europe and the Mediterranean countries of Africa. Asia south of the Himalayas is called the Oriental or Indian region. The boundary between the Palearctic and the Oriental regions east of the Himalayas is not well marked, as there the mountain chains often have a north-south trend, facilitating instead of preventing the migration of the Palearctic fauna southward and of the Oriental fauna northward.

Palearctic Region.—The Palearctic fauna of Asia is by no means uniform. Distinction can be made between a tundra fauna in the north, followed southward by that of the taiga, the belt of coniferous forests bordering the tundra to the south, which again merges into the steppes with a fauna of their own. In the tundra the deeper soil remains frozen the whole year round, hence burrowing animals cannot live there and, as the tundra is partly free from snow only during the short summer, conditions for life are poor. Most of the animals, such as reindeer, arctic hare, arctic fox and wolf, occupy this region in summer only and migrate southward in autumn, but the lemmings stay there and remain active under the snow, feeding on the buried herbage. Hibernation, as is the rule for many animals in countries with a cold winter, is impossible in the tundra, for the short summer does not allow the necessary accumulation of food reserve in the body.

Birds also desert the tundra in winter but here too there is an exception—the willow grouse and the ptarmigan live in tunnels in the snow, feeding on berries. During the summer birds are numerous. Many species of waders which in Europe are known as migrants only, such as the gray plover, sanderling, knot and several kinds of sandpipers, breed there, feeding principally on the mosquitoes which occur in the wet parts of the tundra in enormous numbers. These insects also form the staple food of the passerine birds that breed in the tundra, such as the snow bunting and the Lapland bunting. Peregrine falcons, rough-legged buzzards and skuas prey on these smaller birds, but principally on lemmings. Several kinds of geese and ducks, arctic tern and black-throated and red-throated divers occupy the moist parts of the tundra.

The taiga fauna is much richer than that of the tundra. This is the haunt of the brown bear, wolf, glutton, otter, ermine, sable, lynx, elk, forest reindeer, hare and several kinds of squirrels. Among birds, capercaillie, black grouse, hazel hen, black woodpecker, greater and lesser spotted woodpeckers, three-toed woodpecker, pine grosbeak, crossbill, siskin, redpoll, red-spotted bluethroat, rubythroat, redwing, fieldfare, nutcracker, Siberian jay and many others inhabit these forests, and where marshes and pools occur the terek sandpiper, oyster catcher, green and wood sandpipers and several other waders may be found.

The rivers of northern Asia are inhabited by many fresh-water fishes which are common in European inland waters and, besides, by several kinds of sturgeons, among them the sterlet. Lake Baikal has a peculiar fauna, including many native species of sponges, worms and crustaceans and a native species of seal.

The fauna of the steppes differs as much from that of the taiga as that of the tundra. There many burrowing rodents occur such as jumping mice or jerboas, marmots and piping hares (*Ochotona*). The large grassy plains are the home of antelopes. Typical birds are the bustards, quails, sand grouse and the red-legged hobby. Hoopoes and rollers are common locally, and where the banks of rivers offer convenient nesting grounds, bee eaters and the common sand martin may be found. Enormous reed beds lie along the courses of the great rivers, and these are inhabited by waterfowl of many kinds, and also by a locust. Certain conditions give rise to a migratory phase in these locusts when they swarm out in incredibly large numbers and start their devastation of crops.

The mountains and the plateau to the north of the Himalayas have a mountain fauna which partly reaches the Himalayas proper. Many kinds of wild sheep and goats live there. Tibet is the home of the yak.

The eastern part of the Palearctic region—Manchuria and eastern China—has several peculiar kinds of deer. The giant panda inhabits parts of China bordering Tibet; the lesser panda is a Himalayan animal. From the wastelands of the higher Himalayas came many legendary accounts of the "abominable snowman" (*q.v.*).

The large rivers of China have a rich fish fauna among which *Psephurus gladius* from the Yangtze and Yellow rivers is of interest, as it is one of the two survivors of an otherwise extinct family, the other being the paddlefish (*Polyodon spathula*) of North America. Another fresh-water animal, its nearest relative living in North America, is the giant salamander (*Megalobatrachus*) from Chinese and Japanese waters.

The Japanese fauna has many species identical with or closely allied to continental Palearctic species, but also peculiar species, such as a monkey allied to the Gibraltar monkey and a mountain goat allied to the serous (*Capricornis*) from the Himalayas and western China.

The fauna of Asia Minor (*q.v.*) is much like that of other Mediterranean countries but Israel, Syria and Arabia have an African element in their fauna, such as a species of coney (*Procavia*) and, in Lake Tiberias and the Dead sea, fishes of the African genus *Tilapia*.

Oriental Region.—For its greater part the Oriental region is situated inside the tropics. The northwestern part is dry and partly even desert, where the fauna is poor. The northern part, south of the Himalayas, has dry, cool winters and very hot, wet summers. In the southern part of the Indian peninsula and in the southeastern peninsula (Thailand, Indochina and Malaya) and in the Malay archipelago the temperature is nearly constant, seldom rising above 30° C. (86° F.). These are the regions where tropical rain forests prevail. Monkeys are common, but apes are found only in the rain forests, being represented by gibbons in Assam, Burma, the southeastern peninsula and the Greater Sunda Islands, whereas the orangutan is restricted to Sumatra and Borneo. Among carnivores the lion is now confined to the Gir forest of the Kathiawar peninsula, where it is protected. The tiger ranges from the Himalayas to Sumatra, Java and Bali. It is absent from Borneo and from Ceylon. Panthers range all over the Oriental region, but have never been found in Sumatra. Civets and mongooses are numerous; the latter do not extend their range so far to the southeast as the former, some species of which even inhabit the Moluccas. Among badgers the ratel (*Melivora*) lives in the hilly districts of peninsular India but its range goes as far westward as Israel. Jackals are plentiful in India; the striped hyena is confined to drier parts. Both are absent from the eastern part of the Oriental region. Flying and ordinary squirrels are common in forests and woodland. The gaur (*Bibos gaurus*) is an inhabitant of the larger hill forests of India and Burma, the banteng (*Bibos banteng*) lives in the lighter forests of Burma and south to Borneo and Java, but it is absent from Sumatra. The most common antelope is the black buck which may be found in bushes and cultivated plains all over India, except the Malabar coast. The nilgai (*Boselaphus tragocamelus*) and the four-horned chousingha (*Tetracerus quadricornis*) occupy the hilly regions south of the Himalayas. There are several species of deer in the Oriental region. The musk deer lives in the pine zone of Kashmir,

Nepal and Sikkim; the sambar deer and its allies are distributed practically over the whole of the region; the barking deer also has a wide distribution, ranging northward into China. Typical beasts are the chevrotains (*Tragulus*) and wild boars are widely distributed. The Indian one-horned rhinoceros is at present confined to Nepal and Assam; the Javanese rhinoceros, too, formerly had a wider distribution but its range is now restricted to Malaya, southern Sumatra and western Java, and the two-horned rhinoceros ranges from Burma to Sumatra and Borneo. The Indian tapir is an inhabitant of dense forests in southern Tenasserim, Malaya and Sumatra. The Indian elephant can be found in suitable places throughout the Oriental region, including Ceylon and Sumatra. Scaly anteaters or pangolins are characteristic, but occur also in Africa.

Among the many birds which inhabit the Oriental region, game birds play an important part. The Indian peacock is met throughout India, whereas another one is restricted to Java. Numerous species of pheasants live in the forests of Burma, Thailand, Indo-china, Malaya, Sumatra and Borneo. Jungle fowl are found only in the Oriental region. Pigeons occur in great variety, but the number of species of parrots is small as compared with that of other tropical regions; the most conspicuous one in India is the rose-ringed parakeet, replaced to the east by the moustache parakeet. Water kingfishers as well as wood kingfishers are represented by many species. Hornbills, although not restricted to the Oriental region, show their greatest development there. The Indian hoopoe is rather common in India but is only met as a migratory bird in the southeastern part of the Oriental region. Among cuckoos the brain-fever bird is well known. Eagles, ospreys, falcons, hawks, kites and buzzards all occur, and in the western part vultures are numerous and can be found even in towns. The forests are inhabited by many species of woodpeckers. The barbets are characteristic, the best-known being the coppersmith bird. Bee eaters and rollers are common in India, but whereas the former can be found as far as the Malay archipelago and beyond, rollers are absent from the southeastern part of the Oriental region but reappear again in Celebes. The passerine birds are too numerous to survey at length. The house crow, the Indian grackle and the common mynah are familiar birds in India. Drongos, flycatchers, bulbuls, tailorbirds, orioles and many others are widely distributed and broadbills (Eurylaimidae) are typical birds. Many passerines, such as swallows, pipits and wagtails, have both resident and migratory species and the same can be said of many plovers, gulls, terns, ducks, storks and herons. Among the last named the cattle egret is a common bird in suitable localities all over the Oriental region, whereas spoonbills, cranes and gulls are confined to the western part.

Of the crocodiles the gavial is restricted to the large rivers of northern India, a species of an allied genus is found in Sumatra and Borneo and the mugger and the estuarine crocodile have a wider distribution. Fresh-water turtles and land tortoises are well represented. Lizards are numerous, including geckos, skinks and monitors, and flying lizards (*Draco*) are typical of the region. Chameleons are chiefly African, but one species is found in peninsular India and Ceylon. Snakes are numerous too, among them the poisonous krait, cobra and Russell's viper. Frogs and toads belonging to several families are abundant. True tree frogs (Hylidae) are absent, but some species of other families have taken to an arboreal mode of life.

The fresh-water fish fauna of the Oriental region is rich. The carp and catfish families have many native genera and species. The labyrinth fishes, to which the climbing perch and the gurami belong, and the spiny eels (Mastacembelidae) are characteristic of this fauna, although a few species live in Africa.

Insects, arachnoids, mollusks and other invertebrates inhabit this region in great numbers. The large and gorgeous bird-winged butterflies (*Ornithoptera, Troides*), allied to the well-represented swallowtails, are typical, although they occur in the Australian region as well. Almost all known families of scorpions are present. Among land shells the absence of Helicidae, common in the Palearctic region, is noteworthy. Their place is taken by other forms, such as *Hemiplecta,* and by operculate land mollusks.

(L. F. De B.)

II. NATURAL RESOURCES

Stretching from near the north pole to south of the equator, possessing some of the driest as well as the wettest regions of the world, the coldest as well as the hottest, and embracing rocks of every age and type, Asia has natural resources which are understandably varied. Its soils include the alluvium of the teeming rice-growing deltas of the monsoon lands, the arid expanses of southwest Asia and West Pakistan where snow-fed rivers enable the desert to bloom, and the fertile black earths of the Russian steppes. In mineral resources Asia holds an enviable position. Reserves of almost every important mineral occur and much of its wealth has yet to be surveyed and developed.

For convenience Asia can be divided into six major regions, each having some degree of homogeneity whether of culture, po-

FIG. 3.—PRINCIPAL LAND-USE REGIONS OF ASIA

litical regime or state of economic development. These regions are: Asiatic U.S.S.R.; southwest Asia (including Afghanistan); India-Pakistan; southeast Asia with Indonesia and the Philippines; China (including Tibet and the inner provinces and Formosa) with Mongolia; and Japan and Korea. It should be noted that information regarding resources in the U.S.S.R. and China comes mainly from government sources and can rarely be checked independently.

Asiatic U.S.S.R.—The great size and climatic variety of this region are reflected in the range of soil types. Tundra soils, peaty and overlying a frozen subsoil, occur along the Arctic coast and more extensively east of Lake Baikal. Podsols are developed over great areas in Siberia, often sandy and marshy in the west Siberian lowland, sometimes stony on the central Siberian plateau. Some podsols lie on permanently frozen subsoil in northeast Siberia. Gray podsolic forest-steppe soils mark the southern limit of the podsols and the beginning of the unleached pedalfer soils in the chernozem (black-earth) belt which extends in a narrowing zone from the southern Urals east to the Ob river and then in isolated patches close to the southern frontier of the U.S.S.R. These are important agriculturally; *e.g.*, Minusinsk steppe and areas in the upper Angara valley, and near Chita farther east. With increasing aridity the chernozem gives way southward to chestnut soils in the Kirgiz steppe and then to brown desert-steppe soils with extensive tracts of sandy desert. On the Caspian coast are areas of salt marsh and solonchak (saline soils). In Transcaucasia there are dark brown podsols developed under moister conditions and a small patch of subtropical red-yellow earths on the Black sea coast.

Water resources for irrigation are of particular importance along the Syr- and Amu Darya rivers in Soviet central Asia. Rivers have been harnessed for hydroelectric power at several stations in the same region and in Transcaucasia, but the greatest potential probably lies in the rivers of southern Siberia. Oil and coal are the main sources of energy, however. There are oil fields on the eastern and northern shores of the Caspian near Krasnovodsk and along the Emba river. The Fergana valley field in central Asia is of some importance, and small fields are worked in the Lena basin (Yakut Autonomous Soviet Socialist Republic) and on the island of Sakhalin. Coal is of more immediate industrial value. The Kuznetsk basin in west Siberia is the Soviet Union's second in production and supports a major industrial region. The Karaganda field in Kazakhstan provides coking coal for metal industries in the Urals. In east Siberia the Irkutsk field and in the far eastern region the Bureya and Vladivostok fields are of value to local industry and to traffic on the Trans-Siberian railway. Lignite deposits in the central Asia republics and west Siberia are of minor significance but vast coal fields are thought to underlie the Tunguska and Lena basins.

Other mineral resources are considerable, even if the varied wealth of the Urals is held to be conventionally in Europe. The Soviet Union's principal source of uranium is in central Asia at Tuya-Muyun. Iron ore is mined in the Kuznetsk region and at Khabarovsk, both areas supporting iron and steel production. Of the ferroalloys, manganese is found in the Kuznetsk basin and in Kazakhstan, which also has large chrome deposits, cobalt and molybdenum; the latter occurs in several localities east of Lake Baikal. Tungsten is mined in southern Siberia, vanadium in the Kirghiz A.S.S.R. Nonferrous metals are widely distributed and few are unrepresented. Kounradski on Lake Balkash is a major copper producer and there are half a dozen other mines in Kazakhstan, central Asia and west Siberia. Tin is found near Chita, east Siberia. The Kuznetsk basin has the Union's main lead-zinc ore complex and more is mined in Kazakhstan and in the far eastern region. Nickel is mined at Norilsk within the Arctic circle. Aluminum minerals are found at Akmolinsk (Kazakhstan) and in the Kuznetsk basin. The Lena valley is probably among the world's chief sources of gold. Other minerals worthy of note are mica, asbestos, mercury, beryllium and silver.

With such a plethora of resources, it is not surprising that industry has developed rapidly at a number of centres, especially under the stimulus of wartime necessity when much of the U.S.S.R.'s European industry in the Donets basin (Donbas) and elsewhere was overrun by the Germans. However, production is still secondary to that of the European part of the U.S.S.R. The Kuznetsk basin is important for heavy industry of many kinds but engineering is widespread in towns along the Trans-Siberian railway and in Soviet central Asia. Textile industries are concentrated in the latter area and in Transcaucasia but are also found in the Kuznetsk basin, Irkutsk and in other large towns.

Of all the countries of Asia the U.S.S.R. probably has the greatest area of productive forest, almost all of it coniferous softwood. The taiga forest stretches across the whole of Siberia, flanked by the steppe grasslands to the south and by the bleak tundra strip to the north. Forest exploitation is mainly along the Trans-Siberian railway and navigable rivers accessible to it or, like the Yenisei, penetrable from the Arctic sea during the brief summer. Lumbering is important also in the far eastern region in the vicinity of Vladivostok.

Agriculturally, as industrially, Soviet Asia is something of a colonial territory compared with its European counterpart and still contains virgin land suitable for development. The black-earth belt, especially the Barnaul steppe, is one of the Soviet's surplus grain areas. Wheat, rye and oats (the latter notably in east Siberia where the growing season is short) are the food grains. Cultivation is generally extensive rather than intensive. Projects for increasing agricultural production by cultivating the virgin steppelands have concentrated attention on the chestnut-soil belt on the semiarid southern margins of the black earths. Irrigated cotton is the main industrial crop in Soviet central Asia and Transcaucasia, sunflowers for oil in the black-earth belt and some flax on its northern fringe. The drier steppelands support sheep and goats, as do mountain pastures, while cattle are associated with the agricultural areas and reindeer herding with the tundra and more open taiga. Grapes grow well in Transcaucasia and in irrigated gardens in central Asia, and the sheltered subtropical western corner of Transcaucasia has a small area of tea plantations.

Southwest Asia.—As most of this region can be regarded as semidesert and desert, except for its northern and western fringe, water resources are of the utmost importance to agriculture and pastoralism. Apart from Turkey, where the need is less pressing, water resources are used very intensively. Well over half the agricultural area of Iraq is irrigated by the Tigris-Euphrates system, while in Iran the irrigated area comprises lands in a great number of internal drainage basins. Syria, Lebanon and Israel irrigate from 12% to 20% of their cultivated land, and would include more if water were available. Long summer drought causes river regimes to be very irregular, militating against their use for power production. Syria (Yarmuk river) and Turkey generate hydroelectric power on a small scale.

The region is fortunate however in its resources of oil and coal. Turkey, with little oil, has a valuable coal field supporting industry around Zonguldak. Iran mines coal near the Caspian coast, and Afghanistan north of Kabul. Oil is of immense importance but chiefly as a source of foreign exchange. Iran and Iraq have extensive oil fields in the foothills of the Zagros mountains but the more recently developed fields on the Arabian shore of the Persian gulf in Kuwait, Bahrein, Qatar, etc., are even more productive. The countries on the Mediterranean coast have neither oil nor coal.

Turkey is most fortunate in possessing a variety of minerals. Iron ore from Divrigi is smelted at Karabuk close to the coal field; manganese is found at Eregli and on the Mediterranean coast. Turkey ranks first in world production of chrome, of which Afghanistan has small reserves. Copper is mined at Madan (Turkey) and a little gold in Saudi Arabia. The rest of the region is poor in metalliferous minerals but among nonmetals mention should be made of the Dead sea potash, sulfur in Turkey and phosphate rock in Jordan. As, however, much of southwestern Asia has been little explored it is quite possible that further resources will come to light.

The countries bordering the Mediterranean have about one-fifth to one-quarter of their area under cultivation but eastward in Afghanistan the proportion falls to under 2% and is negligible in Saudi Arabia. Much uncultivated land is of value as grazing for sheep and goats and seminomadic pastoralism is the way of life

over wide areas of semidesert. Turkey and Syria, with agriculture supported by rainfall to a large extent, and Iraq with its irrigated plains normally export a surplus of agricultural products, notably wheat. This is the main food crop, but barley takes first place in Iraq and Israel. Maize and rice are also grown, the latter as an irrigated crop in Iraq, Turkey and on the Iranian shores of the Caspian sea. Turkey, Iran and Israel grow sugar beet but cotton is a more important industrial crop, especially in Turkey, Syria, Iran and Iraq. The cotton-spinning industry is established in a number of centres in Turkey, Syria, Lebanon, Israel and Iran and in the capital cities of Iraq and Afghanistan.

Citrus fruits are Israel's principal export, important too in Lebanon and Syria, while Iraq produces four-fifths of the world's dates. The latter grow in Arabia wherever water is available. Grapes are grown on a large scale to be dried as raisins in Turkey and Iran. Dried figs are exported from Turkey, where tobacco is locally important, and olives are grown on the Mediterranean coastlands. The climate of the region is against the rapid growth of forests which are extensive only in the better watered mountains of Turkey and Iran, particularly around the Caspian.

India-Pakistan and Ceylon.—An authoritative soil survey of India-Pakistan has yet to be made. The Indian states of Rajasthan, Uttar Pradesh and Punjab, with the whole of West Pakistan, have mainly dry steppe soils with a saline tendency toward the margins of the Thar desert. The eastern part of the Ganges valley has prairie soils giving way to young alluvial soils in the delta. Over most of peninsular India red soils are developed on Archean rocks while the Deccan lavas give rise to the characteristic black sticky regur. Laterites are found capping the Western Ghats and on parts of the Bastar hills and Chota Nagpur plateau. The Shillong plateau and some "older" alluvium in Bengal bear red-yellow soils best described as lateritic.

To the peasant agriculturalist the workability of the soil, its water-holding qualities and the possibilities for irrigation are more immediately significant facts than those concerning its chemistry and genesis. The soils of the Indo-Gangetic plain and of the more restricted valley plains and deltas of the peninsular rivers are thus agriculturally of outstanding importance. Except on the moisture-retentive regur soils, agriculture on the uplands is generally poor and of very secondary importance. The concentration of rainfall in the summer months, followed by three to six months of drought, emphasizes the importance of irrigation. There is hardly a corner of the subcontinent that would not benefit from an assured all-season water supply, but this has only been attempted in the northwest in many areas of which agriculture would otherwise be impossible. The great rivers rising in the Himalayas and fed in the dry season by melting snows bring life-giving water to the plain of the Indus and its tributaries and to the Ganges system. Their waters have been extensively controlled and utilized for irrigation. In some saline-soil areas in the Indus basin seepage of water from canals and overirrigation have caused alkali efflorescence rendering the land unusable. The regime of the peninsular rivers, lacking snow fields as a dry-season reservoir, is highly variable. Many of them dry up just when their waters are most needed and the major existing irrigation systems distribute floodwater rather than storing it for dry-season use. There and in Ceylon there are numerous crudely embanked shallow tanks storing floodwater, but they rarely outlast the dry season and command only small areas. Some large multipurpose river-development schemes were in hand in the mid-20th century to increase the irrigated area. Innumerable wells by which ground water can be brought to the surface supplement canal irrigation in the northern plains. These are most important in the submontane belt in the Punjab and Uttar Pradesh, but deeper modern tube wells are increasing in number on interfluves beyond the command of canals. All told, about 10% of the area of India-Pakistan is irrigated, more than half of this by canals.

The rivers of the subcontinent are of great value as sources of hydroelectric power. The abrupt descents of the Western Ghats, Nilgiri and Cardamom hills have been so utilized for several years but the potential of the Himalayan rivers has been relatively neglected, Malakand and Mandi being for long the only stations. Since attaining independence, India, Pakistan and Ceylon have set about developing hydroelectric resources to feed new industry. In West Pakistan the Jhelum river has been harnessed and an ambitious multipurpose scheme is at Warsak on the Kabul river. In East Pakistan the Karnafuli river project is designed to produce 80,000 kw. India's schemes are mostly designed to control floods and to provide irrigation water at the same time as power. The Bhakra-Nangal project on the Sutlej river is one of the biggest constructions, but others have been completed on the peninsular rivers, *e.g.*, Damodar, Mahanadi, Tungabhadra (tributary of the Krishna), and in Ceylon the Gal Oya. In these schemes water storage over the dry season is a major problem.

India's coal resources are relatively abundant compared with those of Pakistan. They are concentrated in the northeastern part of the peninsula, in the Damodar valley particularly, where there are limited reserves of coking coal. In Assam and West Pakistan there are poor-grade, mainly Tertiary coals. Petroleum is found in the Digboi field of Assam (insufficient for India's needs) and in the Attock field of West Pakistan. Intensive search has failed to reveal further major oil fields but there have been important finds of natural gas in both West and East Pakistan.

India's reserves of iron ore, mainly high-grade hematite, and manganese are among the greatest in the world. Both minerals are found in the northeast part of the peninsula. West Pakistan has some inaccessible iron ore in Chitral and its only significant minerals are chromite in Baluchistan, rock salt, alum, gypsum and salts of magnesium and potassium, all in the Salt ranges. India is endowed with a variety of nonferrous metalliferous minerals: copper, lead, chromite, gold and bauxite are all worked in various parts of the peninsula. Salt is mined in Rajasthan but much is evaporated from sea water in Bombay and Madras states. India's production of mica from Chota Nagpur amounts to about 80% of the world's supply. Important deposits of the "atomic" mineral monazite are worked in Kerala. Ceylon lacks coal and oil and is very poor in other minerals also.

Between 50% and 60% of the subcontinent is cultivated, agriculture being the mainstay of the population. Rice, millets (bajra and jowar) and wheat are the staple food crops. Rice is dominant in areas of good rainfall (60 in. and higher), notably in Bengal, Assam and Orissa, the west coast of the peninsula and in Ceylon. On the east coast deltas, in Madhya Pradesh, Uttar Pradesh, and to some extent in Bihar, rainfall is commonly supplemented by irrigation, while in West Pakistan rice is grown irrigated in a near-desert climate. Drought-resistant millets are favoured in peninsular India but are also grown as an insurance crop in drier parts of the Ganges plain. Wheat, grown in the cool season, is the food crop of West Pakistan, the Indian Punjab and western Uttar Pradesh and is of some importance on the Deccan lavas. Various pulses and oilseeds are widely grown. Jute is confined to East Pakistan and adjacent West Bengal. Cotton is irrigated in West Pakistan but rain fed on the regur soils of the Deccan. More restricted in their location, but important in the export trade, are plantation crops. Assam, West Bengal, Sylhet (East Pakistan), south India and Ceylon have extensive tea gardens. Rubber is grown in Kerala and Ceylon; coffee in Mysore.

Pressure of population has caused the replacement of much original forest by agriculture or scrub jungle used for grazing, and productive forests are mainly limited to sloping areas. Even there, as in Assam, East Pakistan, parts of the Western Ghats and Ceylon, shifting cultivation prevents the optimum utilization of forests. The middle slopes of the Himalayas in the drier west bear valuable pine and deodar forests, while in the east are broad-leaved evergreen species with much bamboo, especially as secondary growth up to about 9,000 ft. Sal forest is dominant in the Siwalik hills and over the northeast of the peninsula. The Western Ghats and the hills bordering Burma have tropical evergreen and semievergreen forests including valuable teak, while the Sundarbans on the tidal fringe of the Ganges delta is a region of dense mangrove forest.

Except in India's heavy industrial region between Jamshedpur, the Damodar valley and Calcutta, and in the cotton textile dis-

FIG. 4.—PRINCIPAL MINERAL-PRODUCING AREAS OF ASIA

trict stretching north from Bombay to Ahmedabad, manufacturing is generally scattered. Calcutta shares the jute industry with the East Pakistan towns of Narayanganj, Khulna and Chittagong. Many large towns have textile industries and miscellaneous manufacturing often based on agricultural raw materials, foodstuffs, leather, etc.

Southeast Asia and Indonesia.—This region displays considerable soil contrasts ranging from the excessively leached lateritic soils of upland equatorial areas to the dry soils of central Burma. As far as man's utilization of the region is concerned, by far the most important soils are those developed on the alluvium of the several great and many minor delta plains. Next to these young alluvial areas the most productive soils are associated with basaltic lavas, widespread in Java and of some significance in South Vietnam. The more common acid igneous rocks and arenaceous sedimentary material generally give rise to soils poor in inorganic plant nutrients.

Mineral resources, exploited for export rather than for internal industrial development, fall into two main groups: the metalliferous minerals of the structurally older blocks of the Shan plateau, Malaya and southwest Borneo, and the petroleum fields of the belt of Tertiary folding surrounding this older core. The only important coal field is in North Vietnam, where anthracite is found, but Malaya, Sumatra and Borneo have minor deposits. From a global viewpoint oil is more significant. There are productive fields in Sumatra, Java and Borneo and in central Burma. Malaya and the Philippines have iron ore but there is no heavy industry in the region and the ore has been used in Japan. North Vietnam, Malaya, Java and the Philippines are minor producers of manganese. Ores of nonferrous metals, particularly tin, are of greatest importance. Malaya and Bangka-Billiton (Indonesia) rank first and third as world tin producers, Thailand was fifth and Burma was eighth; North Vietnam is also a producer. The Burmese centre of Bawdwin mines lead, zinc and nickel. Chromium is found in the Philippines (fourth world producer) and North Vietnam; bauxite and titanium in Malaya; the phosphate deposits of Cambodia have not been developed. The Philippines has a number of gold-mining districts but elsewhere, in Malaya, Sumatra, Thailand and South Vietnam, output is less important.

A major drawback to industrialization in the region is the lack of power installations. Water-power potential is considerable on the many rivers, great and small. The Mekong river could be harnessed to supply Laos, Vietnam, Cambodia and Thailand with electricity but capital funds and an assured market are lacking. Some hydroelectricity is generated in Malaya and Java but most of the small output of power comes from thermal generators in the major cities. Manufacturing regions do not exist, the principal industries being concerned with the processing of raw materials for export. Singapore smelts much of the region's tin ore. Java has a number of sugar mills. Textile industries making cotton goods for local markets are established in Burma, Thailand, Indonesia, the Philippines and North Vietnam.

Forests are relatively abundant in the region compared with the densely populated neighbouring countries. Burma and Thailand have valuable teak forests but the equatorial hardwoods of Malaya and the archipelago are little developed. Shifting cultivation with its periodic burning of the vegetation is responsible for reducing the quality of the forest cover in many areas, notably in Laos, Vietnam and Borneo.

The predominant agricultural activity is rice farming on the alluvial lowlands. The deltas of the Irrawaddy (Burma), Chao Phraya or Mae Nam (Thailand) and Mekong (South Vietnam) have long been major producers of rice for export, while in the Red river delta of North Vietnam and in Java rice cultivation has been even more intensive to support high densities of rural population. In Java and the Philippines hillsides have been terraced to grow rice and there are carefully tended systems of water control. Irrigation supplements rainfall in the drier parts, *e.g.*, central Burma and the Korat plateau of Thailand, and inundation canals are found on all the major river systems. Adequate storage provision has yet to be made for dry-season irrigation. Among the most important field crops after rice are tobacco (grown in all countries of the region but especially in Java), sugar cane (Java and the Philippines), soybeans (Java) and peanuts (Java and central Burma).

Plantation crops are of great importance. Malaya and Indonesia together grow most of the world's natural rubber and some is grown in South Vietnam and Thailand. The Philippines has a near monopoly of the abacá (manila hemp) trade and leads Indonesia and Malaya in copra production. The oil palm is increasingly popular in Malaya and Sumatra, which seek to diversify their plantation economy, while tea is a minor product of Java.

China and Mongolia.—About two-thirds of this region consists of the high plateaus and mountains of central Asia, much of it steppe and semidesert, where nomadic peoples rear sheep, goats and horses, exporting livestock and animal products, *e.g.*, hides, wool, etc., to lowland China and the U.S.S.R. Cultivation of

grains, mainly wheat, millets and barley, is restricted to irrigated strips along streams issuing from the mountains. Little is known of the mineral resources of this vast area but Mongolia mines some coal, iron, gold and nonferrous metals and oil fields are being developed in the Chinese provinces of Sinkiang and Kansu and in the Tsaidam basin in Tsinghai province. Mongolia has some engineering industries at Ulan Bator but is very dependent on U.S.S.R. manufactures. Urumchi (Sinkiang) and Lan-chou (Kansu) have textile mills. There are mountain forests in west Mongolia and Tibet but inaccessibility prevents their being of economic importance.

By contrast, eastern China with Manchuria has considerable resources. There are two principal soil types: brown podsols in north China grade inland with increasing aridity into chernozems developed on loess, while China south of the Tsinling Shan has the more tropical podsolic red earth. The north-south contrast is due basically to climatic differences which are also brought out by agricultural differences. In the north, wheat with drought-resistant millets and kaoliang, barley and soybeans are the principal food crops but the south and Formosa are dominated by rice. Soybeans incidentally are also a valuable industrial crop of which Manchuria produces a surplus. Along the Yangtze valley the rice and wheat regions overlap. Maize in the north and in Szechwan is a minor crop. The chief industrial crops are cotton grown widely in the north China plain and the middle Yangtze, and tea from the south China hills and Formosa. The tung-oil tree is of some importance in the south but the main sources of vegetable oils are sesame in the north China plain and rapeseed in Szechwan and central China. China leads the world in tung oil, sesame, rapeseed and soybean production. Peanuts, also in the north China plain, are another source of oil. The subtropical south China coast lines and Formosa grow sugar cane. Tobacco, for which China is second only to the U.S. in output, is grown extensively but particularly in Szechwan and the north China plain. Citrus fruits thrive in the south and in Formosa but rarely on a commercial scale.

Although large irrigation works were under construction by the middle of the 20th century on the Yellow river to protect the dry north from both flood and famine, small irrigation schemes command much of the cultivated land in south China. Everywhere farming is intensive and primarily for subsistence, though less so in Manchuria, an area of relatively recent agricultural colonization, where it is more commercialized. Intensive land use for agriculture and the demand for fuel and for grazing land has led to deforestation, until little real forest remains and that is confined mainly to the Tsinling Shan, the southern hills and the mountains bordering on Tibet and Burma. The mixed forests on the Greater and Lesser Khinghan ranges in Manchuria are, however, probably of greater economic significance.

China has long been recognized as possessing considerable hydroelectric power potential, particularly in its great rivers, the Yangtze and Yellow, and in the well-watered mountains of eastern Manchuria and southern China. Among important schemes completed or in hand in the 1960s were the Ta-feng-man (Sungari river) and Shui-feng (Yalu river) in Manchuria, and San-men on the Yellow river. There are also stations on the Yangtze near Chungking, on the Min river in the southeast and in Formosa.

Coal is likely to be of far greater value to China's industrial development, and China ranks second in estimated reserves of bituminous coal, including some good coking grades. Hardly a province lacks coal but the main field lies in the northwest in the provinces of Shensi, Shansi and Honan, a field comparable in extent with the American Appalachian field. Southern Manchuria and northern Hopeh have the largest production, but rapid development is taking place in Shansi. Of the southern coal fields the most extensive is in Szechwan. The principal iron-ore mines are in Manchuria near An-shan and Pen-ch'i. Other sources are Hsüan-hua or Suanhwa (Hopeh), T'ang-shan (Shantung), Ta-yeh and Ch'i-chiang (Kikiang) on the Yangtze near Hankow and Chungking respectively, and near Pao-t'ou in Suiyüan. The precise state of development of mining and manufacturing in China is not known. In certain key nonferrous metals China holds an important position, notably in tungsten and antimony, both mined in the south. Tin occurs in Yünnan, manganese in south central China, copper in Formosa and Manchuria, vanadium in the north, lead and zinc in the south and in Manchuria; generally, all these resources are on a small scale. Shantung, south Manchuria and Hainan have bauxite and Kiangsu produces some rock phosphate. Manchuria has a large output of magnesite, asbestos and gold, while gold and mercury are found in the south China hills. Mineral salt is obtained in Szechwan but much comes from evaporation of sea water.

With such a range of resources it is not surprising that despite a late start China is developing rapidly as an industrial power. Heavy industrial regions are concentrated in the north around An-shan, Pen-ch'i, Mukden, Harbin and Dairen in Manchuria, at Hsüan-hua northwest of Peking, inland at Pao-t'ou, at Wu-han on the middle Yangtze, at Chungking and at Shanghai. There is an increasing tendency for manufacturing districts to grow inland, especially near the major coal fields, but the textile and other light industries are still located mainly in the coastal cities such as Shanghai, Canton, Tientsin and Tsingtao, though important new centres inland include Cheng-hsien (Cheng-chow), Sian and Ch'eng-tu.

Japan and Korea.—These areas are alike in having rugged terrain and restricted development of plains. Soils are generally podsolic, tending to subtropical red in southern Japan, but agricultural methods are so intensive that water-holding capacity is of more importance than soil chemistry. Rainfall, especially in Japan, is adequate for plant growth but the traditional popularity of rice as the mainstay of farming makes irrigation important as a means to maximum yields. Only in North Korea is rice displaced by millets and wheat as the main food crop, though in South Korea barley is quite important; wheat and barley are becoming more popular in Japan as second crops after rice, and oats is a main crop in the cooler north in Hokkaido, though rice is grown there too. The principal commercial crops are cotton in Korea, mulberry trees (for silkworm fodder) and tea in southern Japan. Apples and pears grow in eastern Korea and northern Japan, citrus fruits and tobacco in the subtropical south.

In Korea mineral wealth includes low-grade iron ore, anthracite, tungsten, beryllium and lead-zinc in the north, molybdenum and some tungsten in the south; gold and fluorspar are also mined. Hydroelectric power is generated particularly in the north along the Yalu river. The main industries are cotton textiles in the south, rayon in the north using local timber resources. The north also had heavy metal and chemical industries, though these were interrupted during World War II and the Korean war.

Japan, after the U.S.S.R., is the most industrialized country in Asia but depends much on imported raw materials to supplement its own resources. It possesses several coal fields, the chief being in Hokkaido and Kyushu, and has a small output of oil from fields on the west coast of Honshu and Hokkaido. Water power is highly developed, the wet climate and mountainous relief there being an advantage, especially in central Honshu. Vulcanicity ensures the country an abundance of sulfur and pyrites, but except for widespread copper, and some chrome in Hokkaido, the great variety of the mineral resources are quite inadequate for Japan's industries. Thus it has a little iron ore, manganese, tungsten, lead zinc, tin, mercury, gold and silver.

Manufacturing is concentrated in a belt of cities extending from Tokyo west-southwest through Nagoya to Kōbe-Osaka on the shores of the Inland sea and the industrial cluster of northern Kyushu centring on Yawata and ending at Nagasaki. This belt includes both heavy and light industry. Outside it there is manufacturing on the Hokkaido coal field at Muroran and at Kamaishi on the iron-ore field in north Honshu. Heavy industry includes shipbuilding, heavy engineering, vehicles and chemicals, but Japan is better known in foreign markets for its textiles. Utilizing its own timber resources, Japan produces cellulose rayon and newsprint and has been an important supplier of cement to south Asian countries.

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III. ANTHROPOLOGY

In this section the word anthropology is used to cover two aspects of the science of man. The first is cultural and depends on social inheritance or nurture; the second is physical and depends on biological inheritance or nature. Both may be affected by environment in the widest sense of the term. The study of culture is the province of archaeology, ethnology, social anthropology and linguistics. The archaeologist traces the spread of past cultures from what is left of their tools and other implements and art forms. The ethnologist does the same by comparing the cultures of present-day peoples. The social anthropologist studies the social institutions and related beliefs of peoples. The linguist, in establishing the relationships between languages, makes possible inferences about the previous connections of their speakers.

A major aim of the anthropologist is to reconstruct the biological and cultural history of mankind at all times and in all places. As documentary evidence is available to him for only a small number of cultures (and then is often confined to the most recent period of their existence), to fill in the blanks in space and time he draws upon the findings of paleoanthropology, anthropography, archaeology, ethnology and linguistics. Any discussion of Asia as an anthropological unit divorced from adjacent areas is necessarily artificial. Europe is properly only a western peninsula of Asia; Africa is linked with Asia at the isthmus of Suez; the American mainland may be seen from the eastern cape of Siberia; and the islands of Indonesia and Melanesia lead like steppingstones from southeastern Asia into Australia and Polynesia. As a result of this geographical propinquity the peoples of Europe, Africa, America and Oceania show, in varying degrees, physical, linguistic and cultural affinities with those of Asia. Within itself, moreover, Asia contains the widest variations in physical types and cultures of all the continents and a diversity of languages apparently exceeded only in the Americas. The intensive anthropological study of Asia is, however, only beginning. In proportion to its area and population, less anthropographic, linguistic and ethnographic research has been done in Asia than in any other continent. The consequent paucity of evidence permits only tentative generalizations. (J. C. Tr.)

A. Ethnology and Languages

The cultures of Asia may be grouped into six major areas, each of which occupies a more or less distinctive natural habitat. These culture areas are as follows:

1. Northern Siberia, comprising the treeless tundra of the northern coasts and lowlands and the forest zone or taiga. The basic subsistence pattern is fishing, the hunting of land and sea mammals and reindeer breeding. Social organization and technology are relatively simple.

2. Interior Asia, comprising the steppe zone, a transition zone of steppe-forest in the north, a central steppe-desert system and highland. This generally arid region includes Sinkiang or Chinese Turkistan, Russian Turkistan, Tsinghai province and northern Kansu, Outer and Inner Mongolia, parts of southern Siberia and Tibet. The traditional economy is nomadic pastoralism, with enclaves of farming where water is made available. Hunting is a subsidiary means of getting food, clothing and shelter. Some of the peoples of Turkistan depend on both herding and farming.

3. East Asia, comprising China proper, Japan and Korea. The territory of China within this area is that within the Great Wall, or monsoon China. Intensive agriculture is the predominant means of subsistence; peoples who live by other means are few and scattered. Manchuria is a crossroads of the Siberian, east Asian and interior Asian zones in both culture and natural environment.

4. The Indian subcontinent, comprising India, Pakistan, Ceylon, Nepal, Bhutan and Kashmir. The cultural range, like that of terrain and climate, is great. The predominant culture is Indic but variations are found in Pakistan, which is Moslem, in Buddhist Ceylon and among various indigenous tribes.

5. Southeast Asia, comprising the peninsular states of Burma, Thailand, Malaya, Laos, Cambodia and North and South Vietnam. Cultural relations there have not been as clearly defined as in the other areas. The broad cultural range within this wet, tropical region includes primitive groups with simple technology and social organization who live by fishing, hunting and collecting wild plants, as well as civilizations with intensive agriculture, fairly advanced technology, complex social and political organization and literary traditions.

6. Southwest Asia, comprising Afghanistan; Iran; the Arab states of Saudi Arabia, Syria, Iraq, Jordan, Lebanon, Aden protectorate, Yemen, Kuwait, Bahrein and Oman; Israel; and Turkey. Much of the region is desert; among the few well-watered zones are the "fertile crescent" (in James H. Breasted's phrase) region of northern Iraq, Lebanon and Syria, extending to northern Israel, and parts of the coast of Turkey. The Islamic people predominate save for the Israeli enclave, the Christian communities of Lebanon and minor sects. All the main branches of Islam are centred in the area. The inhabitants are predominantly agricultural but a significant portion of the populations of the Arab countries, Iran and Afghanistan are nomadic pastoralists and some groups combine cultivation and herding.

The cultures and languages of these six areas will be discussed in order.

Northern Siberia.—The indigenous inhabitants of central and northern Siberia fall into three main linguistic stocks: Uralic, Altaic (*q.v.*) and Paleo-Asiatic. The Uralic-speaking peoples include the Samoyed, Ostyak (Khanty), Vogul (Mansi) and Selkup in western Siberia and the Yukaghir of northeast Siberia. The Uralic groups are small; the largest of them, the Nenets of the Samoyed and the Khanty, each numbered fewer than 20,000 in 1926. Others range from a few hundred to a few thousand in size.

The Altaic stock is represented by two families in the area, the Tungusic and the Turkic. The most numerous of the Tungusic peoples are the Evenki and Eveni (Lamut). In addition, there are a number of small groups (Negidal, Udege, Oroki, Orochon, Olchi and Nanai or Gold) in the Amur river region in southeastern Siberia and northern Manchuria. There are two Turkic-speaking peoples, Yakut and Dolgan. The Yakut have moved north into the Siberian forest over a long period, primarily from the forest-steppe of southern Siberia, but also from east Asia. In Siberia they combined with indigenous peoples. The Yakut are by far the most numerous of the native peoples of Siberia, with a population of about 300,000. Their economy is chiefly the breeding of horses, cattle and, in the extreme north, reindeer. The Dolgan are a small group who are in the main Tungusic clans become yakutized.

The Paleo-Asiatic peoples form a residual category with no intrinsic unity other than membership in the north Asian cultural area and a generalized cultural resemblance. In northeastern Siberia they include the Eskimo, Chukchi, Koryak, Kamchadal (Itelmen) and Gilyak (Nivkhi). The genetic relationship of the Chukchi, Koryak and Kamchadal languages is well established. A suggestive hypothesis needing further exploration is the Eskimoan-Chukchian connection. The Gilyak have no known relation to the other northern peoples. The Ket (Yenisey-Ostyak) of western Siberia is a small remnant group unrelated to any of the others. Most of the groups number in the hundreds; the largest, the Chukchi, numbered about 12,000 in 1926.

The arctic and subarctic peoples share a number of traits in their technology, house types, clothing, food getting and religion. Their physical type is northern Mongoloid. The northerly habitat has played a central role in the formation of the material culture; the rigours of climate have limited the cultures to certain types. These boreal peoples place heavy reliance on furs and pelts for clothing and shelter. The dog is domesticated there as it is throughout Asia. None of these groups is limited to a single source of livelihood. The Chukchi are divided into two groups, the Maritime Chukchi, whose main subsistence base is the hunting of sea mammals and fishing, and the Reindeer

Chukchi, who depend on reindeer milk and meat for food and obtain clothing and shelter from the pelts and hides. The Evenki, the largest Tungusic tribe, are divided into sedentary and nomadic groups that live chiefly by hunting and fishing and by reindeer breeding, respectively. Some of the nomadic Evenki who live in the vicinity of the Mongols of southern Siberia (Buryat A.S.S.R.) and Outer Mongolia raise herds of horses and cattle. The Samoyed also have double-faceted economies.

The most widespread religion of the north Asian peoples is shamanism (*q.v.*), the basis of which is the establishment of close relations between the chief practitioner, the shaman, and a spirit. In invoking the spirit, the shaman induces a trance state through autosuggestion or narcosis. Shamans preside over religious rites and act as healers and seers. The basis of their supernatural powers is their intimacy with their spirits.

With the exception of the Yakut, who alone have traces of a past aristocracy, the social organization of these peoples is simple. They live in the forests and tundra, banding together in small camps or settlements. They have no writing, and their history prior to the 17th century must be pieced together from the few hints afforded by the archaeological record and oral traditions.

Russians moved into the area in large numbers from the 17th century on and have effected profound changes in the life of the indigenous peoples. (*See* CHUKCHI; GILYAK; KORYAK; OSTYAK; SAMOYED; TUNGUS.)

Interior Asia.—The indigenous populations of interior Asia are Mongols, Turks, Tibetans and Tajiks. Chinese are settled in Inner Mongolia, Sinkiang and Russian Turkistan. Their habitat, the steppe zone of Asia, extends from the mountains of western Manchuria to the Caspian sea.

Speakers of modern Mongol dialects are divided into three branches, eastern, western and northern. The eastern Mongols have their main seat in Inner and Outer Mongolia. The Khalkha Mongols dwell in Outer Mongolia; the Chahar, Ordos and others, forming the largest number of Mongol peoples, live in Inner Mongolia. The western Mongols or Oyrats live in the western parts of Outer Mongolia, Sinkiang and in the north Caspian plain, where they are known as Kalmucks. The Buriats, or northern Mongols, live in the vicinity of Lake Baikal in southern Siberia. There are small groups of Mongols speaking archaic dialects; the Monguor of Kansu, the Dagurs of the Amur river region and the Mongols of Afghanistan. (*See* BURYAT AUTONOMOUS SOVIET SOCIALIST REPUBLIC; MONGOL.)

Among the Turks, the Uygurs live in Sinkiang, Altai Turks in the Altai mountains and a number of small Turkic groups in southern Siberia, from the Tuva Autonomous Region to the Ural mountains. These are the Hakas, Tuvinians and Shori and others, whose names are taken from their locality, such as the Baraba Turks. There are a few peoples of Samoyedic origin who have become turkicized. Among these last are the Motor (Mator or Koybal) and Karagas (or Tofalar). In Russian Turkistan, the chief Turkic groups are the Kazakh, Kirgiz, Uzbek, Turkmen and Karakalpak. A small number of Kazakhs live in Sinkiang. Finally, a group of Turks known as Saryg ("yellow") Uighur (Uigur or Yogur) live in Kansu. In western Mongolia and in the Altai there are small groups of turkicized Mongols and mongolized Turks. (*See* TURKIC PEOPLES.)

The Mongols and Turks have both moved far to the west in a number of waves during the past 2,000 years. The Kalmuck Mongols have inhabited the north Caspian plain from about 1600. The Turks have moved west and south where they encountered the Iranian Tajiks, the prior inhabitants of what is now southern Turkistan. (*See* TADZHIK SOVIET SOCIALIST REPUBLIC.)

The Tajiks are a sedentary agricultural people. The Mongols are nomadic pastoralists by tradition, as are the Kazakhs, Kirgiz, Turkmen, Karakalpak, Altai Turks, Uzbeks and others of the Turkic peoples mentioned. The Uighur of Sinkiang farm the oases of the arid Chinese province; the once nomadic Uzbeks have taken up farming in the close neighbourhood of the Tajiks in recent centuries. Turkic pastoralists had a minor traditional dependence on farming, which is now of major importance.

The pastoralism of north Asia is simple; it is focused on the reindeer, except among the Yakut, who brought in cattle and horses from the south. The southern complex could not be maintained and all native pastoralism except reindeer breeding has declined in recent centuries. The pastoralism of interior Asia, by contrast, is more highly developed, involving herds of sheep, goats, cattle and horses. In the steppe-desert of interior Asia camels form as much as one-sixth of the herds; in the highlands the yak and a yak-cattle hybrid are raised; in the southwestern parts of the area (Uzbekistan, Turkmenistan) the donkey and the mule play a prominent role.

The agriculture of the Uighur, Tajiks and Uzbeks is intensive, with irrigation. The aridity of the steppe region limits farming to a few oases and river valleys, notably the oases around the Tarim basin of Sinkiang and the Fergana and Zeravshan valleys of Russian Turkistan. There, through careful use of water supplies, high yields of food grains and cotton are achieved. Agriculture is a supplementary source of subsistence for the Kazakhs, Turkmen and other Turkic nomads who cultivate small plots near their winter encampments. There is a small amount of farming on the slopes of hills and mountains, utilizing the seasonal floods of the melted snow. This form of agriculture, locally called *bugara*, is highly uncertain.

The Mongols had little farming in the past; considerable development of agriculture in Inner Mongolia followed Chinese settlement and influence. The Kazakhs, Kirgiz and other Turkic peoples have been settled in collective farms in the Soviet Union the change effected by official policy; but longer-range factors also influenced the change-over from pastoralism to agriculture. Chinese and Russian farmers moved into the steppe zone from the mid-19th century and settled in those lands with the best agricultural potentialities. These are at the same time the richest grasslands. The nomads were thrust back on the more arid wastes, which are their own reserves. The herders had to take up farming because of population pressures and limits on soil utilization as well as political policy. Farming is a more efficient basis of subsistence because it can support more people per acre than herding.

The Monguor of Kansu have been greatly influenced by Chinese culture. Their farming and social organization are Chinese and their political system has long been part of the Chinese system.

The Mongols have been Buddhist since the days of their great empires in the 13th century; of greater relevance to the present is their second conversion in the 16th century. The Turks are Sunni Muslims. (*See* BUDDHISM; ISLAM.) In both cases, the religions of higher culture origin have been combined with indigenous shamanist cults.

The organization of these peoples is complex. They have had a long tradition of hereditary nobility. Slavery was practised on a minor scale. The kinship system is based on patrilineal descent; family authority is vested in the patriarch; the son lives with the father in a common camp. The political institutions were evolved to a considerable degree but lacked stability during imperial times. However, the steppe peoples developed sporadic empires during the past 2,000 years, achieving a climax under the Mongol leader Genghis Khan and a second climax under the Ottoman Turks. These empires joined in a political unity herdsmen and farmers who had a crude sort of economic integration. Numerous smaller political enterprises preceded, accompanied and followed the empires of world-historical importance. The kin groups combined into great political entities and in the process of expansion their pattern of differentiation into social classes was evolved. Thus political and kinship structures are historically interrelated.

The common genesis, subsistence base and social organization of nomadic pastoralism, the common polity and the development of historical processes make the steppe Turks and Mongols into a cultural unity. The geographic features of aridity and interior drainage have made their impress on the cultures of the region. The aridity limited the areas of agriculture; the lack of waterways caused the development of overland trade routes between the Mediterranean and the far east.

Tibet is a specialized subarea in interior Asia. The main features of the region extend into the Tibetan highland; nomadic

pastoralism is as important as agriculture. The herds are composed of sheep, goats, yaks, cattle and horses. There is no intensive agriculture; farming is poorly developed, although sedentary. Tibet is the avenue whereby Buddhism was introduced into interior Asia. In southern Tibet, near the Indian border, animism is dominant. Elsewhere, in addition to the native Lamaism (mo-

FROM NORTON GINSBURG (ED.), "THE PATTERN OF ASIA," ENGLEWOOD CLIFFS: PRENTICE-HALL, INC. © 1958

FIG. 5.—MAJOR LANGUAGE GROUPS OF ASIA

nastic Buddhism), is found the Bon faith, a form of shamanism. Tibet is a theocracy in which the chief of state is believed to be a reincarnation of the Buddha and is the chief of the religion. The nomads of Tibet are patrilineally organized. A feature of Tibetan marital practices is a form of polyandry, the marriage of a woman to two or more brothers.

East Asia.—East Asia is an agricultural region: the Chinese have the largest number of peasants in the world. The densities of population in parts of China, such as the coast near the mouth of the Yangtze river, are among the highest in the world. Intensive exploitation of the soil is a necessity for the immense population, which occupies an area not much larger than continental United States. Agriculture is based on a complex organization of water resources by dams, dikes, ditches, canals, reservoirs for flood control, irrigation and conservation. Land falling under the water-conservation effort was about one-fifth of the cultivated area in traditional China. In the late 1950s it was nearly half the cultivated area. Political control in China rested on water control by the rulers.

China is relatively homogeneous in population; the Chinese spread over their present territory in historic times by their march to the tropics. In consequence, China is 94% Chinese. There is considerable linguistic and cultural diversity but at the same time solidarity through sharing of the symbolic value of Han nationality.

Rice cultivation dominates in the south and wheat in the north; the Yangtze valley is a transitional zone. The sweet potato has gained increasing importance in the south, where conditions for cultivation are favourable. The Chinese parts of interior Asia—Mongolia, northern Kansu, Tsinghai, Sinkiang and Tibet—have agriculture mainly in oases and protected valleys. In China proper there is little pastoralism. Whereas in Outer Mongolia there are about 30 head of stock per person, in China there is only one head of stock for every two or three persons. Animals bred for work and used only secondarily for food include the water buffalo in the south; the donkey, horse and mule in the north; the ox in the north and south. The pig is raised for food, hides and bristles; sheep and goats are raised for meat, hides and wool.

China, aside from the peoples of interior Asia and Manchuria, has a number of less numerous peoples scattered through the country. Some of them have been displaced and some absorbed in the course of the Chinese movement southward. These peoples are part of the Sino-Tibetan-Burman-Thai stock. The most important are Thai-speaking peoples in southwest China, chief among these the Chuang of Kwangsi, the largest non-Han nationality of China, numbering about 7,000,000. They are rice farmers, like the Thai peoples in southeast Asia. Also inhabiting the mountainous region of southwest China are the Puyi, Nung, Sha, Sishuang and Tehung; these are less numerous Thai peoples related to the Chuang. More distant linguistic and cultural relatives are the T'ung, Shui and Maonan of south China, and the Li peoples of the mainland and Hainan Island. The Yi and Kachin of Burma and adjacent China and the mountain-dwelling Miao and Yao peoples of central China are members of the same speech stock. (*See* also THAI PEOPLES.)

Typical are the Payi of the Tibetan-Burman group, in the valleys of the upper Mekong and the Salween in the Burmese-Yünnan border area. They live by rice agriculture and stock raising; the buffalo is used as a draft animal. They share traits with the Burmese in following the Hinayana or Lesser Vehicle (southern) branch of Buddhism; on the other hand, they are strongly acculturated to Chinese ways; *e.g.*, in burial customs. The Tibetan-Burman-Thai groups are an earlier population whose areas have been considerably restricted by Chinese southward movement.

Japan shares a number of traits with China, including a high rural population density, the careful management of resources and the terrace-rice agricultural system found throughout Japan and in parts of China (*e.g.*, the Szechwan basin). The intensive exploitation of the land means low development of stock breeding. Horses and cattle are few, and are used as work animals. Hogs are of greater importance for food, as in China. Other than the grains, the chief source of food comes from the sea, and a number of fishing techniques of wide Pacific distribution are found in Japan, such as employment of the harpoon, the fish spear (used through the ice) and various fishhooks. Japan shares with China the use of birds in fishing. A number of features of social organization and religion also bring China and Japan together.

The Japanese have a relatively homogeneous culture, combining traits of indigenous, Chinese and Pacific-wide distribution. The population and culture of Japan are virtually all Japanese. In the extreme north of Japan, and on Sakhalin and the Kuriles, are a small number of Ainu (*q.v.*), a non-Japanese people who are not placed with certainty with respect to linguistic, cultural or physical type. They are probably responsible for introducing a number of arctic traits into Japanese culture; they are possibly related to the Gilyaks and to the Japanese linguistically.

The neighbours of the Japanese to the south are the Ryukyu islanders. The Ryukyuans are related to the Japanese in language; they appear to have preserved a number of archaic Japanese features and have adopted the Japanese script and Buddhism. The culture of the islands reflects certain southerly connections of the archipelago generally, in the preparation of wine for religious ceremonies by chewing rice kernels, in tattooing and in the construction of houses on piles.

Korea is the third main member of the far eastern culture area. Much of the material culture, such as house forms and settlement patterns, are of Chinese derivation; moreover, Korea has been the avenue of transit of a number of traits from China to Japan, among them stock breeding, musical instruments, large portions of the vocabulary and certain aspects of Buddhism. The Chinese system of writing has been reworked both by Koreans and Japanese to transcribe their own languages. The three languages are genetically independent. Outside their native country Koreans have settled in neighbouring parts of Manchuria; there is also a large Korean colony in Japan.

Korean civilization, which covers two millenniums, is a combination of indigenous traits and long-term Chinese influence. Until the early 20th century Koreans maintained such forest traits as tiger hunting with the use of imitative calls, spears, lances and trained dogs.

Manchuria is the homeland of the Manchus of the Tungusic family of the Altaic stock. They have strong north Asian connections. The Manchus formed the last conquest dynasty of China, 1644–1912, in the course of which most of them became thoroughly sinified. Only a few remnant groups scattered in Manchuria and a few colonies in Sinkiang kept apart from the process of absorption by Chinese culture.

Manchuria has been the arena of a combination of steppe and northern forest elements. The Manchus, of northern origin adapted the Mongol script and politico-military organization which they put to their own use in the conquest of China. Chinese culture traits were early introduced into the area. Manchuria has been settled during the 19th and 20th centuries by Chinese farmers, a movement comprising one of the greatest mass migrations in history.

There are a number of common features of social organization in east Asia. Kinship is generally reckoned in the paternal line among the Chinese, Japanese and Koreans. A system of patrilineal clans identified by name forms the basis of the traditional society. The veneration of eminent ancestors is found through the area, and is the focus of a number of cult practices: ceremonial offerings, prayers, sacrifices. In China and Korea there is a strong tradition of exogamy on the basis of family names. By tradition the typical, extended family is composed of several generations of kin; married sons remain with the parents together with their families, provided the family lands can support them.

The religious picture is exceedingly complex. Ancestor worship has been mentioned, together with family and clan temples and cults. In addition, shamanism is widespread. Taoism (*q.v.*) has a long history in China and Korea; Confucianism (*q.v.*) has had a great influence both in China and in neighbouring countries. Buddhism, introduced into China from India during the T'ang dynasty, has been long and deeply rooted in Korea and Japan. The dominant form is northern Buddhism, the Mahayana or

Greater Vehicle. However, there are Hinayana areas in south China. The cult of the emperor and the state traditionally was given a focus in the religions of the area: Confucianism (to the extent that it is a religion) in China and Korea; Shintoism in Japan.

The Indian Subcontinent.—This region is predominantly agricultural; certain areas, such as the delta areas of East and West Bengal (East Pakistan and India), achieve densities of population no lower than the Yangtze valley. These are regions of intensive rice and fibre plant (cotton, jute, hemp) cultivation; irrigation and water technology generally are well developed. Much of the northwest of the subcontinent is desert. The summer monsoon brings needed rainfall, failing which India is subject to drought and famine. The great mountain ranges of the north form a natural limit correlative with that of the Indian cultural pattern.

Within the broad frame of cultural and natural unity of the region there is vast diversity which was emphasized by the partition of the subcontinent in 1947 into the two states, Hindu India and Muslim Pakistan. The cultural divisions within Hindu India are complicated by the caste system (*see* CASTE [INDIAN]).

The present population of the Indian subcontinent has been formed out of the union of Indo-Aryan invaders of the 2nd millennium B.C. with the indigenous peoples: Dravidian, Munda or Kol, Sino-Tibetans and a number of smaller groups. The population of India is second in size only to that of China; the rural population predominates over the urban in a ratio of 5 to 1, only slightly less than in China. The degree of urbanization of Pakistan is about on the level of China.

The ethnic diversity of India is far greater than that of any of the far eastern countries. In India after the partition there remained four chief linguistic-cultural constituents: Indo-Aryan, Dravidian, Munda and Sino-Tibetan (*see* INDIAN LANGUAGES).

1. Indo-Aryan. These peoples, who appeared for the first time in India during the middle of the 2nd millennium B.C., are settled chiefly in north India. They are divided into a number of subgroups on the basis of provincial, linguistic and caste differentiation. The principal linguistic divisions are west Hindi, centred near Delhi, and Urdu (a dialect of west Hindi with numerous Persian, Arabic and Turkic loan words); east Hindi, with its four chief dialects, Bihari (in Bihar), Oriya (Orissa), Bengali (East and West Bengal) and the Hindi dialect of Assam. In the west, Gujarati, Rajputani, Sindhi and Punjabi are the main languages of the Indo-Aryan family.

Together with the neighbouring Iranians, the Indo-Aryans form the Indo-Iranian grouping of the Indo-European linguistic stock. The Baluchis, who live partly in Iranian and partly in Pakistani Baluchistan, belong to the Iranian group. The Kafirs, who live partly in Afghanistan and partly in Pakistan, belong to a group of their own, which, according to the Norwegian linguist G. Morgenstierne, branched off from Indo-Iranian at a time when both language groups were closer together than they are today; the Kafir and closely related Dardic languages, including Kashmiri, and the dialects of the Northwest Frontier (Chitral), Gilgit, etc., are closer to the Indic than to the Iranian language family. The Gypsy language belongs to the Kafir-Dardic-Northwest linguistic group. The entire group numbers from 200,000,000 to 250,000,000 speakers.

2. Dravidian. The speakers of this language family are primarily in south and central India and on northern Ceylon. Tamil, Telugu, Malayalam and Kanarese (Kannada) are the chief Dravidian languages of southern India; Tamil is dominant in northern Ceylon. Related to Kanarese are Tulu, Kodagu and the languages of the Toda and Kota tribes. Dravidian languages of central India are Marathi, Gond, Kui, Oraon, Malto and Kolam. These once occupied a larger region than they do today through the expansion of the Indo-Aryan languages. Far to the northwest, in Baluchistan, are found the Brahui, Dravidian speakers who suggest a once far wider distribution of the Dravidian tongues. There are one-third to one-fourth as many Dravidian as Indo-Aryan speakers.

3. Munda or Kol. Their main distribution is in Bihar (the Chota Nagpur district), Madras and Madhya Pradesh. Their linguistic affinities lie to the east, with the Mon-Khmer peoples, forming the Austro-Asiatic linguistic stock. The agricultural Santal are the largest group of the Munda family; to this family belong the Karmali, a caste of ironworkers; the Mundari proper and a number of others: Birhar, Koda, Kurku, Kharia, Patua, Ho, Sabara and Gadaba. The Nicobar islanders are Austro-Asiatic (their exact placement is still under debate); the Khasi of Assam are of the Mon-Khmer language family of the Austro-Asiatic stock.

Some of these peoples have introduced a Negroid element into the physical types of India. A number of them, like the Birhar, are forest dwellers; others have special occupations, like the Karmali, noted above, and the Koda, who are road workers. They are *in toto* far less numerous than the Dravidian peoples.

4. Sino-Tibetan. In the Himalayan districts of India and in neighbouring Bhutan the great majority of the people are Sino-Tibetan speakers. North and east of Kashmir are the peoples of Baltistan, Ladakh and Lahul who are related to the Tibetans in language; in Baltistan or Little Tibet are islamized Tibetans, the only ones so converted. The population of Nepal is Tibetan speaking. Also in the Sino-Tibetan family are the Lepcha of Sikkim and the Bhutani, Bhotia and Lhopa.

In the western Himalaya region are found smaller groups which are unrelated to their neighbours, such as Burushaski; R. Bleichsteiner has suggested that their morphology is reminiscent of languages of the northeast Caucasus. In Assam are a number of peoples who live by hunting and slash-and-burn agriculture. These were related by B. S. Guha and, following him, S. K. Chatterji to a Negrito folk once widespread in India. Negritos (*q.v.*) were found in the Andaman Islands; they have left traces of their physical type in Cochin and Travancore (south India) and in eastern Bihar (northeast India). For the most part they have been absorbed by later arrivals.

The traditional Indian extended family was undergoing change in the 20th century, being in part replaced by a family with only one conjugal pair. The Indian rural scene through most of the country is built around villages which are nucleated or grouped and led by headmen. However, in Travancore-Cochin and west Madras, houses tend to be dispersed rather than grouped. The nonnucleated village has a wide, if sporadic, distribution in north Persia and in both east and west Turkistan. There, agricultural populations, often numbering several thousands, may aggregate in formless masses with no perceivable pattern or clustering. Nonnucleated villages are governed at the district rather than the village level.

Marriage in Hindu India follows caste endogamy; an important variant is the practice of hypergamy, the "upward" marriage of women. The patriline is the standard mode of descent; however, the Dravidian Nayar of Malabar and the Vedda of Ceylon are well-known matrilineal groups. The Toda have double descent and practise polyandry. Matrilineal organization is widespread in south India among the non-Indo-Aryans; *i.e.*, the Dravidian and Munda peoples. Likewise the christianized Khasi of Assam have a strongly matrilineal organization. Inheritance among these peoples follows in the maternal line and residence is matrilocal. On the other hand, the Dravidian Baiga, Bhuiya, Coorg, Gond and Reddi were classified as patrilineal and patrilocal by G. P. Murdock.

The religious systems of India are complex (*see* HINDUISM). Variation of the dominant Hinduist creeds is multiplied by caste cults. Islam is the official religion of Pakistan; there the Sunni doctrine predominates, but there are also Shi'ite and Ismailian peoples. Buddhism, which had its historical foundation in India, spread far beyond to other Asian countries, but has only a small number of members in India proper. Jainism is an early independent offshoot of Hinduism. The Parsis are Zoroastrians and dualists in belief. The Sikhs have their own monotheistic religion, which was a 15th-century Indic response to the Islamic incursion in the Punjab. There are small Jewish and Christian colonies of great antiquity in the south of India.

Ceylon is closely related to the Indic cultural area. The chief

population is Sinhalese, an Indo-Aryan people. The Tamils have settled in the north of Ceylon, reversing the age-old pattern of movement, since it is the Indo-Aryan which gave way. The Sinhalese of Ceylon are Hinayana Buddhist. However, Sinhalese also form the chief population of the Maldive Islands, where they are Muslims. The Laccadive Islands, off the west coast of India, are inhabited by Malayalam-speaking Muslims.

Southeast Asia.—This is an area which exhibits indigenous features, but which has also been subject to long-term and profound acculturation with India and China. It is the least clarified of the main cultural areas of Asia. There are three main linguistic stocks: Mon-Khmer, Sino-Burman-Thai and Malayo-Polynesian. The Mon-Khmer languages include Mon, Cambodian, Kha, Moi, Wa, Khasi and Garo; the Sino-Burman-Thai languages include Thai or Siamese, Laotian (Lao), Miao, Yao, Li, Yi, Kachin and Chuang; Malayo-Polynesian includes Malayan and Moi (as distinct from Mon-Khmer Moi). There are also isolated languages, whose presence may antedate the distribution of the larger stocks on the peninsula. These are spoken by small, relatively primitive groups who inhabit the forests and live by hunting and gathering plants: Yumbri of the Thailand-Laos border area; Senoi and Semang of Malaya; "Sea Gypsies"—Orang Laut and Bajau of Malaya and Indonesia, and Salon (Selong) and Mawken of Burma. Semang is a collective designation for a group of Negrito tribes of Malaya. The Negrito peoples are a distinctive type, small in stature, with a relatively homogeneous culture. They are widely distributed in the Philippines, the Molucca Islands, the Andaman group, and on the mainland in Malaya and Thailand. It is evident that the Negrito, both as a physical type and as a culture, once had a wider distribution than today. Their economy, social organization and technology are simple.

The Sea Gypsies are not a homogeneous cultural group. The Mawken have two divisions, one in close symbiosis with Malayans and Chinese of the region, the other in isolation. They live by the products of the sea. H. A. Bernatzik described their fishing as of simple technology. They have neither nets nor stakes, but fish with the spear and harpoon. The people live on boats, in extended families; a group of boats forms a community. Shamanism is reported among them.

The agricultural peoples are of two kinds: those with highly developed, intensive agriculture, with irrigation, fertilizer and the plow; and those with hoe or digging-stick agriculture. Rice is the main crop of both the advanced and the simple technologies. The simpler agriculture, lacking irrigation or fertilizer and usually carried on in poor, upland soil, is impermanent. Fields are frequently abandoned for long periods by the Miao, Yao and some Karen and Kachin. Those Karen and Kachin who live in the valleys use the plow. All the simpler agricultural peoples do some hunting, gathering and fishing.

The Burmese, Thai, Malay, Cambodian, Laotian and Vietnamese peoples have a high cultural development. They share a complex combination of indigenous traits with a heavy overlay of Chinese and Indic influences. The Malays, a large proportion of Indonesians and a small part of the population of the Philippines are Muslims. In addition to profound influences on the material and spiritual culture of southeast Asia, India and China have both contributed large numbers of migrants in recent centuries who form a major part of the commercial urban as well as some of the rural populations of the area.

City life and commerce, state organization, agricultural technology (irrigation, the plow, the cart, sericulture) are related to India and China. Taoism, Confucianism, Buddhism are omnipresent among the shamanist and Muslim peoples; Christianity has spread among the Karen.

Southwest Asia.—This region is remarkably homogeneous in its geographic features and in the dominant religion of the area, Islam. The Islamic religion is divided into two main branches, the Shi'ite, centred in Iran, and the Sunni, centred in Arabia. A third branch, Khawarij, in eastern Arabia, has little numerical importance. While Islam is the dominant religion in southwest Asia, there is a large Jewish population in Israel and there are significant Christian communities in Lebanon and Turkey.

There are three chief ethnic and linguistic components of southwest Asia: Semitic, Iranian and Turkic. The Semitic peoples are primarily the Arabs. Arabic is divided into a number of dialects in southwest Asia, the chief of which are those of the Arabian peninsula, Syria and Lebanon, and Iraq (*see* ARABIC LANGUAGE). Small groups of Arabs, both farmers and nomads, also live in southwest, central and eastern Iran. Arabic, both classical and modern, belongs to the southern branch of the Semitic family. There are scattered groups of Syriacs or Aysors in Syria, northwestern Iran and northern Iraq. Syriac is related to Aramaic of the northern branch; Hebrew is classified in the western branch of the Semitic stock (*see* HEBREW LANGUAGE). These tongues are not mutually understandable; however, there is a tendency toward uniformity among the Arabic dialects. (*See* also SEMITIC LANGUAGES.)

The Iranian speakers in the area are divided into two chief groups: west Iranian or Persian and related tongues; and east Iranian or Pashto (Pushtu), the official language of Afghanistan, and related tongues (*see* IRANIAN LANGUAGES). Persian, or Farsi, is the common and official tongue of Iran; its close linguistic relatives are Lur, Bakhtiari, Kurdish and Baluchi. Various dialects of Persian are spoken in Soviet Tajikistan, Afghanistan and in parts of Iraq. The Lur and Bakhtiari are mountain peoples of western Iran who speak a distinct language closely related to Farsi. The Kurds inhabit parts of eastern Turkey, northern Iraq and northwestern Iran. The Yezidi live in Kurdistan and speak Kurdish but have a religion which combines Muslim and Christian with other elements.

The Lur and Bakhtiari are partly agricultural and partly pastoral. They have developed agriculture significantly only during the 20th century, largely because of economic and political pressure from without. The Baluchi of southeastern Iran and neighbouring parts of Afghanistan and Pakistan are primarily herdsmen; Persian farmers live among them.

Gilak, spoken in northwest Iran, is related to Farsi. The Gilak are a mountain people with well-developed agriculture and practise some stock raising.

Talysh is an Iranian tongue, related to Kurdish and spoken in the Caucasus mountain districts of the Soviet Union and in the Caspian district of Iran.

Eastern Iranian languages related to Pashto include those grouped under the name Mountain Tajik or Galcha. These languages are spoken in the Pamirs by highly isolated communities, many of them of the Ismailian sect of the Shi'ites.

Pashto is the language of the Pathan of Afghanistan. The Pathans have a mixed agricultural and pastoral economy, like the Lur and Bakhtiari. Tajik (west Iranian)-speaking farmers live among them. The Mountain Tajik (east Iranian) also have a mixed economy. Irrigation is a necessity for agriculture throughout the region.

The Kafirs are an indigenous population of the Hindu Kush mountains, whose language has affinities to Indic and to Iranian. They were a mountain folk, converted to Islam in the latter part of the 19th century. Their pre-Islamic religion, still practised in distant and inaccessible parts of their country, is a dualist one: a good deity, Imra, is counterposed to an evil deity, Yush. Their closest linguistic kin is the Dardic group of languages.

The third major population in southwest Asia is composed of the Turks, most of whom have moved in during the last 1,000 years (*see* TURKIC PEOPLES). Those of Turkey are the largest numerically in this group. The Anatolian Turks are almost entirely given over to farming or to urban life; pastoralism is practised only by a few groups of Turks in the southeast. For the most part stock breeding is carried on by communities whose basic subsistence is agriculture. Azerbaijani Turks live in northwest Iran and in the contiguous Soviet Azerbaijan. They are an agricultural people, with secondary support from stock raising. The Turkmen of northeast Iran and north Iraq, originally a pastoral nomadic group, became largely agricultural and in part urbanized. The Gashgais of southwestern Iran are primarily pastoral nomads; a small proportion in western Iran are sedentary farmers. Uzbek farmers live in Afghan Turkistan, that is, the

low steppe-desert region near the Soviet frontier.

The Hezara of Afghanistan are a problem apart. By origin Mongols and nomadic pastoralists, they have become Persian-speaking farmers and urban dwellers. Only small groups in northern Afghanistan still retain the Mongol speech, which is heavily iranized. The Hezara are to this extent similar to the Manchus; in the process of conquest both took over the tongue of the conquered people and the local culture generally, save for tiny isolated enclaves.

Aside from these principal ethnic and linguistic groupings, there are a number of smaller groups. Armenians are Christians living in the Armenian S.S.R. and in nearby regions of Turkey. They are outstanding traders and comprise a considerable urban element throughout the area. Jews, aside from those resident in Israel, live in the cities of the middle east and have a role comparable to that of the Armenians in commerce.

The traditional family organization of southwest Asia is predominantly of extended type, patrilineal and patriarchal throughout the area. However, as urbanism develops, and as traditional folkways give way to modern, the family is changing in form to a nuclear or conjugal type in the cities and urban fringe. Nomadic groups such as the Arab Bedouin and Baseri, the Turkic Gashgai and Iranian Baluchi have retained a traditional family and social organization. The peoples with a mixed economy—Bakhtiari, Lur, Turkmen, Kurd, Kafir—have experienced a transformation in social organization. The Arabs of the oil territories in Kuwait, Bahrein and Saudi Arabia and the Persians and Arabs of Iranian Khuzistan have been transformed to an even greater degree. The continuation of traditional society may be found in enclaves such as Baluchistan that remain apart by reason of geographic inaccessibility or lack of significant raw materials.

Cultural Focuses.—The cultures of eastern and northern Asia are focused in China, in which the highest cultural development in the area was attained. Proceeding north from China, the cultural units become steadily smaller and the number of communities in a culture and population density decrease. To the north of the Chinese are the Mongol nomadic herders; to the west are the Turkic.

There is little difference between the steppe nomads and the sedentary Chinese in complexity of social organization; each culture area has a complex social stratification and proliferous specializations—economic, political, religious. The difference between the two groups appears to lie in the durability of institutions employing the various specialists. The Chinese and the nomads have many elements in common but the former have had metallurgy, writing paper, textiles, urbanism for a longer time and continuously.

The forest area contains still simpler peoples, measured by these criteria. The populations are smaller, and their densities significantly lower than those of the Turks and Mongols of the steppes. The largest indigenous population, the Yakuts, are historically recent in the area.

The forest economy is simpler than that on the steppe. Instead of raising variegated stock, forest dwellers have but one domestic herd animal, the reindeer. The Yakut have had horses and cattle but their stock are fewer both in absolute numbers and per capita. Moreover, their social institutions are simpler. Nowhere are there permanent social stratifications. However, the Tungusic and Samoyedic peoples live in kin villages which in turn have broader relationships traced in the paternal line. They are without writing of their own and have few specialized occupations other than that of shaman.

The tundra peoples are simpler yet. Their population sizes and densities are small, at the lower limit of the population sizes and densities of the taiga folk. They move in small bands which do not trace kinship with other groups and live mainly by fishing and hunting, which are supplementary sources of subsistence for the taiga and steppe peoples.

The cultural topography of eastern and northern Asia may be represented by a downward gradient from south to north. Westward from China is the arid zone of Turko-Mongol pastoral nomadism with enclaves of oasis farming. There are pockets of primitive hunters in the vicinity of the mountain lakes of Tsinghai and Sinkiang. South from China is an area of long and profound Chinese influence combined with indigenous and Indic traits.

Indic culture has achieved as dominant a position in south Asia as Chinese culture in east Asia.

There are two continent-wide networks of religious institutions. Southwest Asia has been the centre from which Islam spread to Pakistan, Turkistan, China, Indonesia, Malaya and the Philippines. Thus there is a great network of religious practice and doctrine in central, east and southeast Asia, whose historical and ideological focus lies in southwest Asia.

A religious institutional network has also spread from India. Ceylon, Burma, Thailand and parts of the Indochinese peninsula belong to the southern Buddhist tradition; Tibet, Mongolia and, to a considerable extent, China, Japan and Korea belong to one or another branch of northern Buddhism.

Aside from these, Taoist and Confucian influences may be perceived in the countries of Indochina. Christianity has had a sporadic but ancient distribution in Asia. The culture areas of Asia have been brought into various unifying combinations by the spread of religious institutions.

At different times in the history of Asia there have arisen a number of political enterprises which have brought together different cultural worlds in various combinations, such as the Chinese, Indian and Persian empires.

The Mongols and Turks have, during the past 2,000 years, created empires that temporarily combined all or parts of the steppe with all or parts of China, India and southwest Asia. The political and military framework within which the empires were formed was at the same time an economic framework. The movement of agricultural products from China to the steppe and of pastoral products from the steppe to China has been accomplished by trade, conquest, raiding and tribute collection. The economic interchange has formed a great institutional net, bringing together interior Asia and China and, to a lesser extent, south and southwest Asia.

Trade moved across Asia between Byzantium, Persia and Syria on the one side and China on the other along the "silk road" in ancient and medieval times. The Chinese have also traded with north Asia. Han artifacts have been excavated in Yakutia. India has had a long tradition of trade with southeast Asia. Economic, religious and political movements have spread from India to Burma, Thailand and Indochina, where a number of states have been formed with characteristic Indic institutions; these are the hinduized states of Indochina.

Agriculture is intensive—plow cultivation with fertilization and irrigation—in the high cultures of Asia. More primitive agriculture is practised in the uplands of southeast Asia and in adjacent parts of India and China. There the digging stick replaces the plow; fertilization and irrigation are little known and agricultural sites are changed in a steady round.

Nomads may be differentiated by their characteristic tents or house types. The nomads of southwest Asia live in black cloth tents. Altaic nomads of interior Asia live in felt tents on a lattice frame. The reindeer herdsmen to the north live in tents of larch, birch or other bark, or hides and skins, in wooden huts or semi-subterranean earth and wood houses.

Most hunting, fishing and food-gathering peoples of southeast Asia and Siberia traditionally live in isolated, relatively self-sufficient communities. Even groups bearing the same name, such as the Chukchi, divided as they are into hunting and herding branches, have little interdependence. Specialization and interdependence between herders and farmers throughout the rest of Asia is more highly developed.

For related material on the peoples of Asia, consult articles on individual countries (CAMBODIA; TIBET), regions (ASIA MINOR; LAPLAND), tribal and ethnic groups (MALAY; PATHAN), languages (FINNO-UGRIC LANGUAGES; THAI LANGUAGE) and religions (ARMENIAN CHURCH; TIBETAN BUDDHISM).

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B. Physical Anthropology

It is convenient to consider physical anthropology (1) from the standpoint of paleoanthropology, which concerns itself with the study of the fossil remains of man and his nearest relatives in the animal kingdom; and (2) from that of anthropography, which deals primarily with measurements and other records of contemporary human populations. The evidence of paleoanthropology and anthropography may throw much light on the origins, migrations and histories of the physical types represented in a given area.

Fossil Man and Other Primates.—The Asian continent was undoubtedly the scene of a large-scale dispersal of early members of the natural order to which man belongs, the Primates; yet a supposed corollary of this event or series of events, that he also emerged there, has been generally abandoned in favour of his probable origin in Africa—a return to Charles Darwin's views of the 19th century. Nevertheless, Asia is the home of the only surviving genus (*Tarsius*) of the tarsiers, small nocturnal primates (about the size of a newborn kitten) nowadays confined to Borneo, Celebes and the Philippines, the fossil remains of which are of great importance in the study of man's remote ancestry.

Several tarsierlike creatures existed during the Paleocene and Eocene periods of the Tertiary epoch in North America and during the Eocene in Europe. A widely held opinion is that one of these gave rise to the catarrhine primates, namely, the old world monkeys, the tailless or anthropomorphous apes and man. Fragments of jaws and teeth of Upper Eocene age from Burma have been given the generic names *Pondaungia* and *Amphipithecus*, while the forms they represent are thought by some students of primate phylogeny to mark a stage in the transition of primitive tarsioids to catarrhines. The U.S. paleontologist George Gaylord Simpson considered them to be possible apes of uncertain affinities.

The extinct great apes belonging to the genera *Dryopithecus* (also European), *Sugrivapithecus* and *Bramapithecus*, whose remains have been recovered from Pliocene horizons in the Siwalik foothills of the Himalayas, are clearly too specialized to be accepted any longer as man's potential ancestors; but claims that the Lower Pliocene *Sivapithecus* (to which the Upper Pliocene *Ramapithecus* may be allied) of western Pakistan, Kashmir and northern India could be placed in the direct line of human descent were made by Guy E. Pilgrim in 1915 and 1927. In 1953 L. S. B. Leakey suggested that an African species of *Sivapithecus* from the Lower Miocene beds of Kenya might be a true representative of the stock from which man arose. Some enigmatic primate molars of enormous size sold in 1935 and 1939 as "dragon teeth" by Chinese pharmacists in Hong Kong and Canton to G. H. R. von Koenigswald, who proposed the genus *Gigantopithecus* to receive them, cannot be definitely assigned either to a great ape or to any member of the human family, the Hominidae. (Indirect evidence points to their having come from Middle Pleistocene deposits in Kwangtung and Kwangsi in southern China.)

There are no misgivings about the Lower and Middle Pleistocene remains (called *Pithecanthropus* or Java man) discovered at various sites in Java over the half century 1890–1941, or about those of Peking man or *Sinanthropus*, of Middle Pleistocene date, found at Chou-k'ou-tien near Peking during the 1920s and 1930s. Their owners were not only certain hominids but should, by the ordinary canons of zoological classification, be included generically in *Homo* (*see* Man, Evolution of).

Java man and Peking man (the best inclusive terms to use at the moment) stood upright and had low flat skulls of about 1,000-c.c. capacity in adult males—the average for present-day European men is 500 c.c. higher—with the greatest breadth as far down as the level of the ear openings, continuous bony bars above the orbits and across the occiput, a constricted frontotemporal region and mandibles lacking any chin projection. No artifacts can be directly associated with Java man, but Peking man made tools from stone and bone and knew the use of fire. Java man is represented by the parts of half a dozen craniums. Peking man was represented by more than twice as many, but the whole of the Chou-k'ou-tien material disappeared at the time of Japan's entry into World War II. The rest of the fossil hominids from Asia not of the species *Homo sapiens* are Upper Pleistocene in date.

Eleven or twelve fragmentary calvariae or brain cases, found with two shinbones at Ngandong on the Solo river in central Java in 1931 and 1933, constitute Solo man or, according to the original description, *Homo* (*Javanthropus*) *soloensis*. In appearance they resemble the skulls of Java and Peking man but have rather larger capacities. The human remains excavated in caves near Taghba on the Sea of Galilee in 1925, in the Mt. Carmel range near Atlit (Athlit) between 1929 and 1934 and in the Jebel Kafzeh near Nazareth during 1933 and 1934 belong to Neanderthal man. F. Clark Howell in the U.S. held that *Homo sapiens* evolved from Mt. Carmel and similar groups. This thesis was opposed by Henri V. Vallois in France, Gisela Asmus in Germany and others, who would seek our ancestry in a more generalized human form. The skeleton of a child aged about nine, discovered in the Teshik-Tash cave near Samarkand, Uzbekistan, in 1938 marks the eastern limit of Neanderthal man's distribution.

Distribution of Physical Types.—The single existing species of mankind, *Homo sapiens*, is polytypic and may be divided into four or five major racial groups or varieties, each composed of a number of races or subvarieties. Certain physical features tend to be constant within a particular major group and the average values of others distinguish its constituent races. These are the familiar anthropometric and anthroposcopic characters and to them may be added the discriminating powers of the various blood-group systems. Relative to the vast size of Asian populations, the data on their blood groups, apart from those of Japan and Indonesia, are meagre. Of the ABO and MNS systems, the high frequencies of the B gene, especially in Pakistan, northern India and central Asia, are probably adaptive, as are those of the M gene in southern Asia. A is often less abundant than B, and O loses its otherwise almost universal predominance. Eastern Asia, like Europe, has only a slight excess of M over N; and S, rare in China, is common in India Of the respective Rhesus and Duffy systems, CDe (R_1) becomes increasingly predominant from west to east, and Fy^a has a very high frequency.

Of the Mongoloid, Caucasoid, Australoid, Negroid and Khoisan major groups, all but the last, which includes the Bushmen, Hottentots and Sandawe of Africa, have Asian representatives. The majority of the inhabitants of Asia, however, are Mongoloids, who occupy most of the northern, central and eastern parts of the continent with outliers in Europe (Kalmucks and Samoyeds), Oceania (Micronesians and Polynesians) and the new world (Eskimos and American Indians). The Mongoloid races in Asia are the Mongolian, divided into Aralian, Tungusian, Sinian and Pareoean subraces; the Himalayan, with two main branches; and the Indonesian. The European or Caucasoid peoples in Asia from west to east and north to south are the Uralic (Voguls and Ostyaks) between the Urals and the Ob basin; the Ainu (*q.v.*), in Sakhalin and Hokkaido, Japan, and one of the nearby Kuriles; the Pamirian, from Anatolia to Sinkiang; the Mediterranean, with one subrace, the Heberian, in the Levant and Arabia, and another, the Caspian, in Iran, Afghanistan, western Pakistan and the Indo-Gangetic plain; and the Dravidian or Chersiote of peninsular India and Ceylon.

The only Australoid type in Asia is the Veddian, whose members are sometimes known as pre-Dravidians or proto-Australoids.

It comprises the Vedda of Ceylon and the Kadir, Kurumba, Paniyan and Irula of southern and the Bhil, Gond and Chenchu of north central India. Small pockets of Veddoids have been identified in Baluchistan and in the Hadhramaut and Yemen in southern Arabia. Asian Negroid groups are wholly pygmies of Negrito race who as a rule inhabit refuge areas. They include the Andaman islanders, the Semang of the Malayan jungles and the mountain-dwelling Aeta of the Philippines. In southern India the Kadars and the Pulayas display attenuated Negritoid traits, which recur in eastern Sumatra.

If the Malay archipelago is excepted, the continent can be separated into two main anthropological regions to the north and the south of the Himalayas. The presence of the Ainu at the periphery of the first suggests that they are descended from a Caucasoid race living on the mainland, probably south of the Amur river, toward the end of the last glaciation. The Tungus, who divide the Ainu from the Uralics, are the most specialized of the Mongoloids and show the results of adaptation to extreme cold. In the second region Negritos seem to have been succeeded in turn by Australoid and Caucasoid peoples to the west and by Australoids and Mongoloids farther east. It is also possible that links exist between the Dravidians of India and the Somali of the horn of Africa.

See also ANTHROPOLOGY: *Physical Anthropology;* MAN, EVOLUTION OF; RACES OF MANKIND; and articles on the individual countries.

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(J. C. TR.; X.)

IV. HISTORY

A. PREHISTORY AND ARCHAEOLOGY

The Near East.—After about 1930 the chief attention of near eastern archaeologists turned from the capital cities of the ancient world, like Bogazkoy (Turkey), Ur (Iraq) and Susa (Iran), to the frontier regions between early civilizations. One such district is the plain of Cilicia, in southern Turkey, where J. Garstang's excavations at Mersin and those of Hetty Goldman at Tarsus illustrated the relations between Anatolia and Syria in prehistoric times. Another is the Amuq plain by the bend of the Orontes river, where Sir Leonard Woolley's work at Atchana revealed the culture of a rich Hittite dependency, in close contact with Mesopotamia, Egypt and the Mediterranean world. Nearby, his excavations at El-Mina at the mouth of the Orontes shed much new light on the trading contacts between the Aegean and the east in the early colonizing period of the 8th century B.C. This, together with the conclusions of the joint expedition from the British School at Athens and the University of Ankara to Old Smyrna, led to a careful review of Phrygian and Urartaean evidence and a revision of former views on the origins of the oriental elements in the art and civilization of early Greece.

In Syria important work was done by Claude Schaeffer at the coastal site of Ras Shamra. This was a very cosmopolitan centre in the 2nd millennium B.C., to judge from the wide variety of languages used on its clay tablets. Some of these were inscribed in a unique alphabetic cuneiform script.

At Kultepe, the ancient Kanesh, near Kayseri (Caesarea Mazaca), T. and N. Ozguc opened the *karum* or commercial suburb of Assyrian merchants, which flourished at the time when the Hittite civilization was taking form; while at Karatepe in the Taurus mountains, the headquarters were found of a small neo-Hittite kingdom of the 8th century B.C., among whose relics was a bilingual inscription in Phoenician and Hittite hieroglyphic, which made possible great advances toward the complete deciphering of the latter enigmatic script. The mound of Beycesultan near Civril, toward the western frontier of the Hittite realm, was opened in the spring of 1954 by the British Institute of Archaeology at Ankara. In the central Anatolian plateau, a series of excavations conducted by the University of Ankara illuminated the culture of the Stone Age and Copper Age. The most important single recent discovery in this region was that of the royal graves at Alaca Huyuk, opened by the Turkish Historical society. Their rich contents proved that a high civilization throve on the plateau in pre-Hittite times, in the middle of the 3rd millennium B.C.

An expedition from the University of Cincinnati made a careful check of the stratigraphy at Hissarlik. A brief but important Anglo-Turkish deep sounding at Polatli in 1949 provided a useful continuous stratification in a district between the full excavations at Alishar and Kusura. The art of the Phrygian kingdom was illustrated by the remarkable wall paintings uncovered by the Turkish Historical society in the fortress of Pazarli, while remains of the Phrygian capital itself, at Gordium, were in part uncovered by a party from the University of Pennsylvania (Philadelphia) museum, and those of the Midas City by an expedition from the French Institute of Archaeology at Istanbul.

The British School of Archaeology in Iraq, under the direction of M. E. L. Mallowan, turned its main attentions to the Assyrian levels of the mound of Nimrud at Nineveh. Comparable Assyrian material was recovered at Sultantepe near Urfa by the expeditions of the British Institute of Archaeology at Ankara during an exploration of the monuments of Harran and the surrounding country. Throughout the fertile crescent and neighbouring regions, much attention has been given to the search for the earliest traces of settled Neolithic civilization. These were found in deep diggings at Mersin, at Jericho, at Khirokitia in Cyprus and at Hassuna and the Jarmo cave in Iraq.

In Iran, Afghanistan and Baluchistan stratified excavations are very rare. The chief are those at Siyalk in central Iran, at Hissar in the southern foothills of the Elburz and at Geoy Tepe in Azerbaijan. The main problems there concern the links between Mesopotamia and the Indus valley, and the relative chronology of the plateau and the great river valleys. Contributions to these studies were made by the explorations in Baluchistan in 1950–51 by a party from the American Museum of Natural History in New York, and by the deep sounding by J. M. Casal at Mundigak near Kandahar in Afghanistan. Apart from researches in prehistoric strata, French archaeologists in Afghanistan, who by an agreement of 1922 were given special opportunities for work in that country, explored widely for remains of the Bactrian Greek civilization; and in 1951 at Surkh-Kotal in Bactria began excavations of a 2nd-century A.D. temple with a fragmentary inscription in Greek characters.

Modern work in Arabia has included explorations of the tumulus fields of Bahrein and Hasa; several reconnaissances in Yemen, the chief of which was that from Egypt, published by Ahmed Fakhry; and extensive journeys in search of epigraphic material by G. Ryckmans.

In the Syrian desert, ordinary methods of ground exploration were supplemented by the use of aerial photography in the study of the archaeology of the eastern Roman frontier. Père A. Poidebard pioneered this work in Syria, and it was continued in Iraq and Jordan by Sir Aurel Stein in his last major journeys, of 1938–39.

In Jordan in 1947 there appeared the first of the Dead sea scrolls, manuscripts in Hebrew and Aramaic of books of the Old Testament and other works probably compiled by the Essene sect in the 1st century A.D. Later protracted searches in the caves about Khirbet Qumran produced further documents.

In addition to various sections under ARCHAEOLOGY, *see* ASIA MINOR: *Archaeology*; BABYLONIA AND ASSYRIA; CILICIA; DEAD SEA SCROLLS; HITTITES; MESOPOTAMIA; PHRYGIA. Also consult MERSIN, URARTU and other ancient sites; and articles on the various countries.

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(WM. C. B.)

India and Greater India.—In India, improvement in archaeological method resulting in increased knowledge makes it possible to present an almost complete narrative from earliest times.

Stone tools of the Paleolithic period have been found distributed all over India. In the north some of these are associated with river terraces corresponding with glacial and interglacial periods. Similar aggradation and downcutting of river valleys is produced

by the dry and wet periods of the south, where tools have been found in cemented gravels and pebble or gravel conglomerate, the most complete range of tools, from Clactonian types to microliths, in one section being that at Khandivli near Bombay.

Hunting, food-gathering Mesolithic peoples, who used microliths to point and barb their arrows and as knives and scrapers, were as widespread as their Paleolithic predecessors. In forest areas this cultural stage with its use of microliths persisted to the early centuries A.D. or even later. In the valley of the Son river and the Mahadeo hills and at Singhanpur, rock paintings, physically associated with microliths, have been compared with Paleolithic paintings in Europe: actually the majority are of the early historic period and none is earlier than 1000 B.C. At Kile Gul Muhammad near Quetta a Mesolithic settlement having mud-walled huts but no pottery was found, and it is in such communities that the approach to the Neolithic, food-producing stage is observed. The Neolithic period in India is the hardest to determine, depending mainly on the advance in agriculture to make its evidence apparent. Digging-stick cultivators would show no change in material possessions from those of the Mesolithic food gatherers. Hoe cultivation, possibly with terracing, needs stone hoes and slash-and-burn cultivation needs axes. By far the greater number of ground and polished stone axes have been found in the east and south. Excavations in Brahmagiri in northern Mysore and at other sites have shown that the use of such axes persisted to the 2nd century B.C. The first settlement at the megalithic site of Burj Hama in Kashmir is of a stone-ax-using people, not necessarily connected with the megaliths.

The small amount of copper found at some stone-ax sites hardly justifies their being classed as Chalcolithic, or copper- or bronze-using, and this applies to some extent to the peasant farmers of Baluchistan. It would appear also that up to the end of the 4th century B.C. the cultural progress of greater India followed the same pattern and that a Neolithic mode of life, of which highly polished stone axes and tanged stone adzes were the highest achievement, persisted until influenced by India and China at about that time. In the hill valleys of Baluchistan, from the Iranian frontier on the southwest to the Zhob on the north, many sites have been discovered—the settlements of early peasant communities whose remains are mostly a succession of painted pottery industries. Handmade pottery, as shown by the sites of Rana Ghundai in the Zhob and Kile Gul Muhammad, was followed by wheel-thrown painted pottery of Kechi Beg-Amri type, so-called after sites near Quetta and in Sind. This is the earliest ware of this type and its makers arrived from Persia after the breakup there of the painted-pottery cultures, between 2800 and 2600 B.C. Both near Quetta, where it appears with Late Kechi Beg, and in Sind, associated with Middle Amri, is an industry known as Togau ware which is also associated in Sind with very early Nal industry types, and as these and Amri ware overlap the appearance at about 2600 B.C. of the Harappa culture pottery, a basis for approximate dating has been obtained.

Various cultures, largely represented by their pottery, fill the period between 2600 and 1800 B.C. when they were all swept away by invaders from the west. The most important of these is the Kulli culture, widespread throughout southern Baluchistan, having metallurgy as highly developed as that of the contemporary Harappa culture and a painted ware with motifs deriving both from India and Persia. Of the Nal-Nundara culture much less is known. There are definite contacts with Amri in its earlier stages, but the site of Nundara has not been excavated and the Nal cemetery seems to have been used during a period when that site was deserted, between the disappearance of a Kulli occupation and the establishment of a Zhob settlement.

In the Zhob, communities with bichrome pottery of Amri type were ultimately displaced by a people who spread from Periano Ghundai in the north and who took over on all sites southward to that of Nal, bringing their characteristic black-on-red pottery and mother-goddess figurines with them. It was this people and those of the Kulli culture who were in occupation when the period of invasions started.

In the Indus valley the peasant communities were succeeded by an urban civilization, the Harappa culture, which suddenly appears complete with all its cultural characteristics fully developed. The area affected by this culture was considerable, the two chief cities, Harappa in the Punjab and Mohenjo-Daro in Sind, being 350 mi. apart. Its outstanding features are the high level of town planning, the developed system of drainage and sanitation and the measure of civic control which these imply, unique at that remote period. The dating proposed in the mid-1950s to cover the known development of this civilization was from 2500 to 1500 B.C.

The granary at Mohenjo-Daro and the coolie lines, granaries and grain-pounding platforms at Harappa show that the economic basis was large-scale agriculture. The metallurgy of this people was well developed. The processes of raising and sinking to make deep and shallow bowls, that of lapping for joins and the cire-perdue method of casting were known, but the majority of objects were hammered from rods or cut from sheet metal. Bitumen, which was obtained locally, was used to calk the great bath at Mohenjo-Daro. Cotton clothing was worn, sometimes decorated with embroidery or appliqué cloth. Wheeled transport and a system of weights and measures completes the picture of a civilized community. A vast number of steatite seals were unearthed displaying a line of script and a picture, usually an animal, the ox, elephant, tiger and rhinoceros predominating. The undeciphered script seemed to be a syllabary of stylized pictographs produced arbitrarily as the result of a knowledge of writing. Terra-cotta figurines have been found in great numbers, the majority being oxen; male and female figures may be either deities or votaries, and clay carts and some of the animals were probably toys. Large quantities of plain mass-produced wares and fewer slipped and painted black-on-red jars represent the household pottery of the Harappans. At the two principal sites the presence of a fortified area argues for citadel rule. The culture was Chalcolithic in character, copper and bronze being supplemented by a profusion of cherty flint blades which were the normal utility knives.

After 1942 there was a great increase in knowledge about the "dark age" period, from the ending of the Harappa culture to the invasion of Alexander the Great. In the northwest, invaders, having with them an increasing Aryan element and who buried their dead en route on the Shahi tump mound in Baluch Makran, occupied small towns in Sind, their remains being called the Jhukar culture. Similar invaders also seized Harappa where their burials have been unearthed. Polychrome ceramic industries such as that of Trihni in Sind spread also over the Zhob between 1400 and 1200 B.C. In northern India the first evidence for the appearance of iron is the arrival of a people in Baluchistan from Persia, who between 800 and 450 B.C. spread from Persian Makran to the Zhob. They were horse riders who buried their dead in cairns and used iron.

Excavations at Ahichhattra (Ramnagar; 1940–44) and Hastinapur (1950–52), sites of the historic period, produced ceramic industries which stretch back to meet the early wares of the northwest. Northern black polished ware found throughout northern India dates back to 400 B.C., and stratified below this appears a painted gray ware which would start at about 650 B.C. Associated with this, but possibly originating about 200 years earlier, is an ochre-washed ware that can be linked with the copper hoards of the Ganges valley, containing swords, daggers, harpoons and axes, which previously had no archaeological context. In south India an iron-using people who buried their dead in a variety of fashions notably in megalithic tombs, succeeded, during the 6th to 2nd centuries B.C., a Neolithic people who had as their equipment ground and polished stone axes and microliths.

See also ARCHAEOLOGY; INDIA-PAKISTAN, SUBCONTINENT OF; INDIAN ARCHITECTURE; INDIAN ART; INDUS CIVILIZATION.

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Camels watering in the desert near Al Jawf between the Syrian desert and the central Arabian peninsula

Mt. Demavend, northeast of Teheran in northern Iran, an extinct volcano in the Elburz mountains

Upper Euphrates in the Turkish highlands west of Erzurum. The Euphrates is the largest river in western Asia, rising on the Armenian plateau, flowing southeast to join the Tigris and emptying into the Persian gulf

Hills and fertile valley in the region of the Helmand river, southwest of Kabul, Afghanistan

Cedars of Lebanon growing on the slopes of the Lebanon mountains which extend almost the entire length of the country parallel to the Mediterranean coast

PHYSIOGRAPHIC REGIONS OF ASIA: ARABIAN MASSIF, TURKEY, IRAN AND AFGHANISTAN

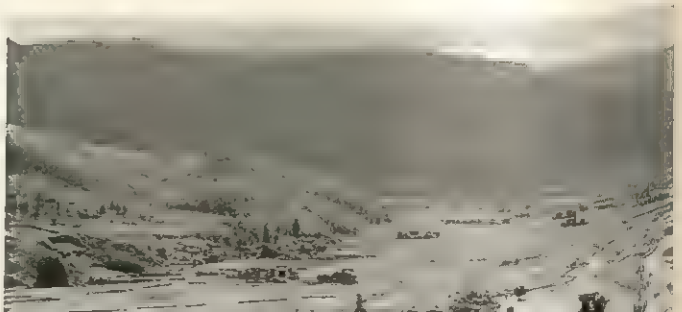
BY COURTESY OF (TOP LEFT) STANDARD OIL COMPANY (N.J.); PHOTOGRAPHS, (TOP RIGHT) JOE COVELLO FROM BLACK STAR, (CENTRE RIGHT) MARC RIBOUD—MAGNUM, (BOTTOM LEFT) AFGHAN INFORMATION BUREAU, LONDON, (BOTTOM RIGHT) MANOUG FROM YERVANT SARRAFIAN, BEIRUT

ASIA

Mt. Everest, situated on the border of Nepal and Tibet in the Great Himalaya. Ascending to a height of 29,028 ft., it is the highest mountain in the world

A valley within the Himalayas in Kashmir in the north of the Indian subcontinent, dominated by extremely high mountains, picturesque river valleys and forests

Bullock cart at the edge of a tank at Gundlupet, south of Mysore in the southern tableland of the Indian peninsula, an area of extensive plateau



Paro, one of the broad, fertile valleys of Bhutan which interrupt the succession of extremely high mountain peaks of the eastern Himalayas

PHYSIOGRAPHIC REGIONS OF ASIA: INDIA AND THE HIMALAYAS

PHOTOGRAPHS, (TOP) CENTRAL PRESS PHOTOS, (CENTRE RIGHT) J. ALLAN CASH—RAPHO GUILLUMETTE, (BOTTOM LEFT) CAMERA PRESS—PIX FROM PUBLIX, (BOTTOM RIGHT) WIDE WORLD

Camel caravan crossing the Gobi desert between Lan-chou, Kansu province, and Pao-t'ou, Inner Mongolian Autonomous Region, China. One of the world's largest deserts, the Gobi is an elongated shallow depression within the Mongolian plateau

Glaciers in the Tien Shan, one of the great mountain systems of central Asia extending about 1,500 mi. from Samarkand, U.S.S.R., to the Kansu border, China

K2 (Mt. Godwin Austen), the second highest mountain in the world, rising to a height of 28,250 ft. in the Karakorum range, northeastern Kashmir

Dolomite rock formations along the bank of the Lena river, U.S.S.R., which flows from the Baikal mountains, East Siberia, to the Arctic ocean

Lu Shan, a wooded massif rising to a height of 4,500 ft. above the plains and mountains south of Chiu-chiang, Kiangsi province, China

PHYSIOGRAPHIC REGIONS OF ASIA: CENTRAL ASIA

PHOTOGRAPHS, (TOP LEFT, BOTTOM RIGHT) EASTFOTO, (TOP RIGHT, BOTTOM LEFT) SOVFOTO, (CENTRE RIGHT) ARDITO DESIO

Koryakskaia volcano, one of a series of volcanoes along the east coast of the Kamchatka peninsula, Russian S.F.S.R.

Transporting logs down the Yangtze, the longest river in China. 3,600 mi. in length, it traverses China from east to west, linking the interior to the East China sea

Woman taking a buffalo to water in the Mekong river near Vientiane, Laos. Originating in the Tibetan highlands, the 2,500-mi.-long river flows through China, Thailand, Laos, Cambodia and Vietnam

View of the Barisan volcanic mountains along the coast of Sumatra, seen from the coast of Java looking across the Sunda strait, Indonesia

Fujiyama, the highest peak (12,388 ft.) in Japan, in the central Honshu group which is one of seven volcanic chains in Japan

PHYSIOGRAPHIC REGIONS OF ASIA: THE PACIFIC BORDERLANDS AND ISLAND ARCS

PHOTOGRAPHS, (TOP LEFT) SOVFOTO, (TOP RIGHT) HENRI CARTIER-BRESSON—MAGNUM, (CENTRE RIGHT) NICOLAS TIKHOMIROFF—MAGNUM, (BOTTOM LEFT) AVA HAMILTON, (BOTTOM RIGHT) BURT GLINN—MAGNUM

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The Far East.—The earliest traces of human activity in Asia have been found in limestone hills at Chou-k'ou-tien, about 30 mi. S.W. of Peking. In the 1920s excavations there led to the identification of a new type of fossil man, *Sinanthropus pekinensis*, from an unusual molar tooth. Later W. C. P'ei discovered the primitive skulls, hearths and roughly chipped stone implements. Excavation at the site continued until 1939 and was later resumed by the Chinese Academy of Sciences. The crude tools are distinct in shape and method of manufacture from the hand axes characteristic of the Lower Paleolithic, but they are of comparable antiquity, perhaps about 400,000 years old (*see* MAN, EVOLUTION OF: *Pithecanthropus*). Cultures corresponding to the Middle Paleolithic of Europe, with Mousterian-type tools, had not been found farther east than the Crimea, the Chusovoy valley in the Urals and the Abkhazia district of the western Caucasus by the mid-1950s. The great expanse of Asia to the east had yielded no cultural remains between Chou-k'ou-tien and a period corresponding, at the earliest, to the later Upper Paleolithic of Europe and to the terminating millenniums of the Pleistocene or Ice Age.

Southern Siberia has been relatively well explored by archaeologists. On the Angara river near Irkutsk (Verkholenskaya gora) and in the Yenisei basin (Krasnoyarsk *kray*) are found traces of a flint- and bone-using culture somewhat resembling the Magdalenian and Solutrean of Europe, with pressure-flaked flint points and bone harpoon heads, but lacking the developed art of the west. These cultures are perhaps 10,000 or 15,000 years old. Later the stone tools of eastern Asia include many tiny parallel-sided blades with little secondary trimming, intended for mounting in series. These microliths also echo the European and north African development but lack the geometric shapes which appeared in the west. The microlithic cultures lasted long, for in Siberia, Mongolia and Manchuria they are often found combined with Neolithic elements in the shape of polished or partly polished stone axes, crude handmade pots with rounded or pointed bottoms and small triangular arrowheads. At Ulan Khada on Lake Baikal a layer containing the Neolithic additions was found stratified over another, similar but for the absence of the Neolithic types. With the advent of pottery and stone polishing, probably about 3000 B.C., these cultures are termed Neolithic, although they knew nothing of farming or cattle raising. For food they relied on hunting, assisted by a domesticated dog. Some of their pottery is decorated with the impressions of cords and notched sticks and is thereby related to a broad tradition diffused across Asia from northwest Europe to Japan and even to North America. Microlithic stone industries are known from Sjara-osso-gol in the Ordos region of northwest China, and in Manchuria at Djalai-nor and Ku-hsiang-tun. At Lin-hsi in Manchuria and Singer in Sinkiang the microliths were mingled with Neolithic elements.

The northern belt of cultures described above reaches to the sea in Kamchatka. To the south lies the cradle of the High Bronze culture of protohistoric China, based on the easy agriculture of the Yellow river valley. The Neolithic cultures which preceded the Bronze Age in this area are much more advanced than the Mongolian Neolithic and their origins seem to owe nothing to it. The southernmost zone, comprising south China, Indochina and the great islands, also possessed a distinct pre-Bronze tradition. In the Tongking province of Indochina the excavated site at Hoabinh had only small chipped stone tools unlike anything found in the north, while Bacson produced an individual kind of stone ax, polished only on the edge, and some rough pottery with impressed decoration. But in the south investigation had not gone far at mid-20th century. Over the whole of the area are found rectangular polished stone axes, sometimes like the northern ones. Their distribution overlaps but does not coincide with the distributions of quasi-cylindrical and shouldered axes. In the southern coastal provinces of China the rectangular axes are found associated on surface sites with corded pottery. The use of stone in the southern zone continued into historical times.

The painted-urn culture of Kansu, the westernmost of the three Neolithic traditions of the central zone of China, was first investigated by Andersson in its numerous cemeteries around Lan-chou. The large, handmade, necked urns accompanying the extended earth burials are richly painted with formal patterns in black, red and purple. These splendid vessels resemble those found at Anau in Turkistan and in the Tripolye culture of south Russia, but not closely enough to warrant a direct cultural affiliation. Their ancestry is mysterious; there are no linking sites in the intervening territory. Andersson went on to discover the Painted Pottery Neolithic now called after the type site at Yang-shao-ts'un in Honan province. The techniques of painting and some simple geometric decoration link the Yang-shao Neolithic (which is now known from many sites in Honan) with the Kansu culture, but there was no evidence showing their exact relation in time and space. The third Neolithic culture of central China is called Lung-shan, after the type site in Shantung province discovered by K. T. Wu. It is characterized by a fine burnished ware in wheel-turned vessels of angular outline; abundant gray pottery; rectangular polished stone axes; walls built of compressed earth; and (at the type site) by a method of divination in which heat was applied to the shoulder blades of cattle, the resulting cracks giving the augur his clues. This Black Pottery culture is traced in eastern and northern Honan, in Anhwei and as far as the Kwangtung peninsula in the northeast. Its gray ware resembles that found on numerous unexcavated sites associated with raised-earth platforms in south central China. With the Yang-shao culture it shares the vessel with three baglike feet called *li*, which is characteristic of the Neolithic of central and northeast China and is not found elsewhere.

The Bronze Age of central China is known from excavations near An-yang in northern Honan on the site of the capital of the later kings of the historical Shang or Yin dynasty. The occupation covered the period stated by the literary tradition to extend from 1402 B.C. to 1122 B.C., dates considered by some scholars to give too short a period to this dynasty, which is now thought to extend from 1523 B.C. to 1027 B.C. (For an account of the contents of this rich culture and its paramount significance for the later history and art of China, the reader is referred to the articles ARCHAEOLOGY and CHINESE SCULPTURE. Here only some points of special archaeological interest are mentioned.) The most striking material achievement of the culture is its ritual vessels of bronze reflecting aspects of a primitive religious lore. The technique is unsurpassed in the bronze art of the ancient world. Excavation

revealed hundreds of storage pits; two large building foundations of rammed earth surrounded by the graves of human sacrificial victims; burials of complete chariots and great royal shaft tombs at which human victims had been immolated by the score. Thousands of inscribed tortoise shells and scapulae used in divinations have thrown light on religious and other affairs of the Shang dynasts and furnished unexpected corroboration of the majority of royal Shang names recorded in historical texts.

The general pattern of this Bronze Age civilization is familiar from excavations in the near east, at Ur and elsewhere, but there is nothing to support the idea of transplantation of a culture from the west into central China. That the roots of the An-yang culture go deep in China itself is shown by its links with the preceding Neolithic. Yet in China no more primitive version of Bronze Age culture has been discovered.

Bronze metallurgy seems to have arrived suddenly and to have been applied to forms already evolved in other materials. The characteristic weapon, the *ko* halberd, is undoubtedly a Chinese invention. The only type owed ultimately to the west is the socketed ax, of which very few were found. Versions of the *ko* occur in the little-known Dong-son culture of southwest China and Indochina, and in the Karasuk bronze culture of the Minusinsk basin of southern Siberia. From the latter region animal-headed bronze knives of Siberian type were imported into China. The rise of the Karasuk culture coincided with the appearance in southern Siberia of a Sinid people who may have been driven from the northwest march of the Shang state by military pressure.

Japan had no share in the spread of bronze metallurgy and weapon types from the Shang centre, and was hardly acquainted with the use of metal before the beginning of the Christian era, when iron had been in use in addition to bronze for about three centuries on the mainland. The introduction into Japan of Neolithic culture, with the use of polished and chipped stone tools and pottery decorated with the impressions of cords, shells and wooden stamps, may, however, be almost as early as the appearance of the Neolithic on the mainland of east Asia. It is interesting to note that the influences discernible are from the northern and southern zones, and that no connection with the early cultures of central China is apparent.

See also ARCHAEOLOGY; INDIAN ARCHITECTURE; INDONESIAN ARCHAEOLOGY AND ART; and articles on individual countries, such as BURMA; CAMBODIA.

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B. EXPLORATION

Little of Asia remains hidden from the sight and knowledge of man, but for centuries the broad belt of deserts and mountains from Arabia to eastern Siberia has attracted explorers by its very inaccessibility and by the secrets it offers of past civilizations, climates and landscape evolution. Modern exploration is rarely concerned with venturing into the unknown, but rather with the scientific investigation of the little known.

Early Period.—Europe's knowledge of Asia in classical times was derived mainly from contact with traders. The salt of northern India and that of Palmyra, traded between Syrian ports and the Persian gulf, were known before Alexander's day. Silk was imported at Cos before classical times, and knowledge of its cultivation spread westward from China through central Asia and Persia. Chinese pilgrims journeyed in Turkistan from the 5th century. The advancing Mongols in the later middle ages drew attention eastward. Franciscan friars made early journeys: Joannes Carpini (*q.v.;* 1245–47) and William of Rubruquis (*q.v.;* 1253–55) in central Asia. Giovanni di Monte Corvino (*q.v.*) was created archbishop of Peking in 1307. The travels of the brothers Polo to the court of Kublai Khan and their hearsay descriptions of the farther east added greatly to contemporary information. (*See* POLO, MARCO.)

19th and 20th Centuries.—Colonial expansion engendered exploration for its own sake, and the unknown heartland began to yield its secrets to travelers and surveyors. Father Évariste Huc (*q.v.*) crossed the Ordos and Koko Nor, reaching Lhasa in 1846. Nikolai Przhevalsky (*q.v.*) crossed the Gobi and mapped the sources of the great southeast Asian rivers in 1870–73. British Indian and Russian military surveyors filled in much detail in central Asia in the last quarter of the 19th century. The names of Sir Francis Younghusband (*q.v.*) in Tibet and Sven Hedin (*q.v.*) in Persia, Turkistan, the Pamirs and Tibet stand out, the latter discovering ancient cities apparently dependent on rivers and ground water more plentiful than at present. Sir Aurel Stein (*q.v.*) continued this work into the 1940s.

Modern exploration has become increasingly scientific, though the urge to climb the world's highest peaks has been a powerful stimulus. Ellsworth Huntington (*q.v.*) in the Tien-shan and Altai (1903), the Filippi expedition in the Himalayas and Karakorum (1913–14) and later researches, *e.g.*, Hellmut de Terra in Kashmir and Tibet, have sought to unravel the climatic changes from Pleistocene times, Stein, Hedin and others contributing archaeological detail. Workers, particularly in the Tibet-Himalayan field, became numerous in the 20th century. The conquest of Everest (1953) by a team led by Sir John Hunt crowned the efforts of three decades. Among other important researches may be mentioned F. Kingdon Ward's work on the China-Burma border, F. von Richthofen (*q.v.*) in China, R. C. Andrews (*q.v.*) and later R. D. F. Schomberg in Chinese Turkistan, P. A. Kropotkin (*q.v.*) and Baron E. von Toll (19th century) and V. A. Obruchev (1926) in northeastern Russia. In southwestern Asia, archaeological excavation dominated (*e.g.*, Sir Leonard Woolley's work in Iraq), but pure exploration of southern Arabia was continued by Bertram Thomas, H. St. John Philby and W. P. Thesiger, while the geologists G. M. Lees and J. V. Harrison worked in Arabia and Persia. (B. L. C. J.)

C. SUMMARY OF GENERAL SOCIAL-ECONOMIC AND CULTURAL HISTORY

Asia is a geographical, not a historical, concept. Civilizations, great and small, have arisen in Asia in history and have interacted one on the other, but their span in both space and time has prevented the emergence of anything like an Asian culture. Turks, Indians, Chinese and so on differ in many important points, and the term Asian, Asiatic or oriental is a mere convenience. The history of Asia to be intelligible must therefore be broken down into its component parts. In the 20th century a sense of Asianism, as Asian consciousness, emerged, rather as a reaction to European and western dominance.

The Pacific ocean has limited the spread of Asian peoples to the east, but on the west the borders commonly assigned to Asia are somewhat arbitrary. The Urals mark no real division of peoples and in both the Greek and Turkish empires, for example, Asia Minor has been as much connected with Europe as with the lands to the east. However, the Urals, the eastern Mediterranean sea and the Sahara desert may roughly be taken as marking historically the western limits of Asia. It may be noted that, in a narrow sense Asia was the name of the first Roman province east of the Aegean formed in 133 B.C. By the reorganization of Diocletian this Asia was broken up into several smaller provinces, one of which, with its capital at Ephesus, retained the name of the original province.

Religions and Major Influences.—The great religions of the world—Buddhism, Christianity, Hinduism and Islam—and others of considerable importance, such as Judaism, Parsiism and Taoism, all arose in Asia. However, Christianity, though Asian in origin, has expressed itself most fully in Europe and the west, and its most important forms owe little to Asia. It has made little progress to the east of Asia Minor, and the great Christian missionary effort in southern and eastern Asia from the 16th century onward made only modest headway. Although in earliest times the Nestorians penetrated to India and China, they never had anything like the success which attended Buddhism and Islam. Yet Buddhism and Hinduism never produced much impression west of India, and Islam later was alike rejected by Christian Europe and Hindu India.

The history of Asia in the past 2,500 years is primarily the result of the interaction of five main influences: (1) Chinese; (2) Indian; (3) Islamic; (4) European; including Russian; (5

central Asian. Of these, the first four represent different kinds of civilization. The fifth has little originality but has been of significance in affecting the distribution of peoples and of political power.

China has molded the civilization of eastern Asia including Japan, Korea and Annam and has been a primary influence on Mongolia, Tibet, Thailand, Cambodia and Burma. Wherever Chinese influence exerted itself, it introduced Confucianism, a distinctive style of art and, above all, the Chinese script.

Indian influence has mainly expressed itself through Hinduism and Buddhism. These are not merely religious in nature but have carried with them Indian art and literature and often an Indian alphabet, as in Tibet, Java and Cambodia. Indian influences have affected the peoples of central Asia and of southeast Asia, including Malaysia and Indochina. Buddhism spread into China and Japan, but Indian culture on the whole has itself been little affected by Chinese art, literature or ethics.

Islam spread widely in all directions from its original home in Arabia. It subjugated the near east, in which it is still the principal religion, also eastern and northern Africa. It spread for a time into eastern Europe and Spain. In the other direction it got a firm hold in the northwest and northeast of the Indian subcontinent, and the state of Pakistan now covers these two areas. Beyond India it reached the Malay archipelago where it submerged earlier Hindu influences. Through central Asia it reached and affected China, but it gained no foothold in Japan and Indochina. Islam, like Buddhism, took with it everywhere a special style of art and culture. It was usually accompanied by the use of the Arabic alphabet and the vocabulary of this language forms a large part of the languages of the Muslim peoples.

Central Asia has been the region into and through which these various powerful influences have been projected. Archaeological excavations have shown that early in the Christian era there flourished in the Tarim basin small states, such as Khotan and Kucha, which possessed a mixed culture comprising Chinese, Indian, Iranian and even Greek elements. Buddhist, Christian and Manichaean edifices have been found as well as libraries in many languages, two of which were previously unknown. Through central Asia Greek influences and later Islam penetrated India, and Buddhism passed from India into the far east and into parts of southeast Asia.

The various tribes of the area have no common name. Linguistically they fall into several groups such as Turks, Mongols and Huns and, in the face of difficult communications and terrain, only occasionally did several of the groups come together in one state. In history, central Asia has acted rather like a sponge, absorbing pressures and sooner or later transmitting them. Time and again these pressures have produced invasions of the peripheral regions and in the Christian era the following may be mentioned: the early invasion of Europe by the Avars, Huns and Bulgarians; the conquest of north India by the White Huns; the conquest of Russia by the Mongols; the conquests of Timur; the conquest of Asia Minor and eastern Europe by the Turks; the invasion of India by the Moguls; the conquest of China first by the Mongols under Kublai and later in the 17th century by the Manchus.

The Ancient Near East.—This term is a historical concept, denoting the extent, in space and time, of the earliest civilized societies. Through archaeology, it is known that in this area the change from food gathering to food production first began and that the diffusion of agriculture, not only in the knowledge of grains but also in the technique of harvesting, took place. Toward the 3rd millennium B.C. the emergence of river-valley civilization in Mesopotamia and Egypt set this area apart from the peasant cultures of the rest of Asia and Europe. The cradle of Mesopotamian civilization was the southernmost part of the Tigris-Euphrates valley, and there the first cities arose. As is known from the remains of their pottery, the earliest settlers of this marshy plain had descended from the highlands of southwest Persia. These peoples were probably Sumerians, speaking a very remarkable language which has not been brought into relation with any known tongue. Physically they belonged to the Mediterranean group of peoples. The high civilization of the Sumerian south penetrated the Semitic-speaking peoples of the middle regions of the valleys, whence arose the Akkadian (Accadian) dynasty under the ruler Sargon. The Akkadians finally absorbed the Sumerians, and out of this mixture emerged the state of Babylon under Hammurabi, the lawgiver, in the 18th century B.C. But the epics and books of wisdom of the Sumerians remained the classical texts of both Babylonians and, later, Assyrians. The Sumerian civilization had invented writing, at first as a practical requirement of the organization of their temples. They used pictograms, later supplemented them with phonetic signs. The form of the society which built the earliest cities has been called theocratic socialism. Its basis was a well-balanced mixed economy in which agriculture, stock breeding and hunting existed side by side. Through the export of rugs and textiles, weapons and jewelry, the influence of Sumerian civilization permeated the whole of the ancient near east.

The Babylonian state collapsed before invaders, the Kassites, from Elam, who controlled Babylon for five centuries. They adopted the civilization and Semitic language of their subjects. The Hittites, who first invaded Babylonia about 1595 B.C., created a considerable empire covering northern Syria and the greater part of Asia Minor in the 14th century B.C. In the archives found at their capital, eight languages are represented, including Sumerian and Akkadian. Subsequently the Assyrians, who seem to have been an offshoot of the Babylonians using almost the same language, asserted themselves and in the 11th century B.C. became the chief power. Their empire gradually broke up, finally succumbing before the Medo-Persian power at the close of the 7th century B.C. Babylon itself was taken by the conqueror, Cyrus, in 539 B.C., but its culture and religion continued to exercise great influence long after the Persian conquest.

In Egypt the cultural continuity was even stronger than in Mesopotamia, and there was never any change corresponding with the displacement of Sumerian by Akkadian in Mesopotamia. Whereas that land was dotted with autonomous cities, Egypt began in the upper reaches of the Nile valley as a royal domain which extended to cover the whole valley and to found a 1st dynasty about 3100 B.C. The administration and major activities of society were centralized to an extreme degree and it was accepted that in the person of Pharaoh, the living king, a god had taken charge of the people. With relatively minor breaks the established order continued for many centuries, Egyptian influence at times reaching eastward to the upper Euphrates. Up to about 1200 B.C. the history of the ancient near east had passed through two main phases, the emergence of the first great civilization in Mesopotamia and Egypt and subsequently the gradual spread of that civilization to the periphery. About 1200 B.C. new waves of invaders broke into Asia Minor and the Levant destroying the Hittite empire and disrupting Egypt, and after this the creative power of the near east waned. Its main achievement was in the consolidation of acquired knowledge. From this period the centres of power move both to the west and to the east of Egypt and Mesopotamia.

As has been seen, Persian power in the 6th century B.C. destroyed the Assyrian empire and in 539 B.C. captured Babylon and created the Achaemenid empire. The Persians, with whom the Medes are often coupled, appear to be Aryan in origin, their language and religion offering remarkable analogies to those of the early Hindus in India. These two peoples appear to have had a common origin in central Asia. The Achaemenid power at its greatest extended from the Oxus and Indus in the east to Thrace in the west and Egypt in the south, but it fell before Greece after lasting for more than 200 years. Darius and Xerxes were repulsed in their efforts to subjugate the Greek peninsula and Alexander the Great conquered their successor, Darius III, in 331 B.C. But the greater part of the empire continued to exist under new masters, the Seleucids, as a Hellenistic power which was of great importance for the dissemination of Greek culture in the east. About the same period (227 B.C.–A.D. 226) the Parthian empire arose under the Arsacids in Khurasan. The Parthians were probably a Turanian tribe who had adopted Persian customs. At one time their power stretched from India to Syria. They withstood the Romans but succumbed to the Persian dynasty of Sassanids who ruled for about four centuries, establishing the Zoroastrian faith as their

state religion and maintaining an equal conflict with the eastern Roman empire. But in the 7th century A.D. their power was overwhelmed in the first rush of the Mohammedan conquest which established Islam in Persia and in the neighbouring lands.

India.—The subcontinent of India is divided from the rest of Asia by the Himalayan mountain ranges. This has by no means kept India in isolation but it has resulted in the growth over a period of two to three millenniums of a Hindu civilization which in many of its aspects is unique. Archaeologists have unearthed the remains of a city civilization on the upper Indus valley which appears to have flourished in the 3rd millennium and to have had affinities with Sumerian civilization, but its inscriptions cannot yet be read and its history is still unknown.

Hindu civilization came about in the 1st millennium B.C. as a result of the intermingling of Aryan and pre-Aryan cultures. Entering India sometime between 1800 and 1500 B.C., the nomadic Aryans settled in the northwest, thence gradually during the 1st millennium B.C. encroaching eastward on the pre-Aryan peoples in the Ganges valley and producing a multiplicity of settled states and a fusion of cultures. Society came to be dominated by a hereditary priestly class of Brahmans. Political multiplicity is a characteristic of India's history and the occasions on which most of the subcontinent was united under one rule were few and relatively brief. Such periods occurred during the Mauryan rule of Asoka in the 3rd century B.C., the Delhi sultanate in the 13th and 14th centuries A.D., the Mogul empire of the 17th century and British rule in the 19th century.

India lacked a common political consciousness probably because its social consciousness had developed so strongly. The Indo-Aryan culture of the northern plains spread across the southern part of the peninsula during the second half of the 1st millennium B.C. and the Dravidian peoples of the south (Tamils, Kanarese, etc.) were at one with the north in accepting Hinduism and the caste system, a division of the population into groups, based partly on race, partly on occupation. In Hinduism, India cradled the oldest surviving world religion. India's greatest achievements lie in the intellectual and cultural field, and its religious and philosophical systems and Sanskrit literature stand among the finest achievements of the human mind. From the 4th century B.C. two scripts were in use—Kharosthi in the northwest and the more important Brahmi elsewhere. From the latter regional modifications developed not only for India but also for central and southeast Asia. Indian grammar, law, architecture, sculpture, painting, music, arts and crafts, such as metal casting, enamel work, jewelry, ivory and wood carving, were highly developed. In India the invention of calculation on a system of nine digits and zero took place. Indian art and science grew directly from its religions and philosophies.

In the main this was a Brahmanical achievement, but in the 6th and 5th centuries B.C. various reactions to Brahmanism began, the most important being the doctrines of Gautama the Buddha, which in the form of Buddhism grew into one of the greatest religions in the world. For many centuries the intellectual development of the Hindus depended mainly on the interaction of Buddhism and Hinduism, but Buddhism was finally absorbed and disappeared in India. But it proved acceptable on the frontiers and spread far and wide. Ceylon was converted. In the northwest it crossed the passes into Afghanistan and moved along the trade routes through Turkistan into China, bearing with it in literature, sculpture and painting, material forms of Indian culture. It passed into Korea and Japan, gradually adapting itself to its new environments. In the 7th century A.D. Buddhism was imposed on Tibet, and that country remains a stronghold of the faith, which there takes the form of Lamaism. To the south, in the early centuries of the Christian era, Buddhism followed the trade routes across the seas to southeast Asia and as a result mixed cultures sprang up in which Indian influences are discernible. In this direction, unlike the movements to the north, Hinduism also followed Buddhism, and petty Indianized kingdoms in Burma, Thailand, Malaya, Indonesia and Indochina were set up and a movement of traders, scholars and travelers took place. Some of the greatest surviving architectural creations in the Indian world, for example, Borobudur and Lara Djonggrang in Java and Angkor Wat in Cambodia, were conceived and built in southeast Asia. The kingdom of Champa in Indochina marked the farthest reach of Indian culture. There it came directly into contact with Chinese civilization which had molded the adjacent empire of Annam. Champa was overrun by Annamite armies in the 15th century A.D.

In general, the contacts between India and the west took place on the material plane. Trade, for example, between the Roman empire and southeast Asia via south India was considerable even in the early centuries of the Christian era. On the whole, western Europe was little affected by India until the end of the 18th century.

Southeast Asia.—The peoples of this extensive region belong to many races, of whom the first with a determinable history were the speakers of the Mon-Khmer languages still used in Pegu and Cambodia. Early in the Christian era Indianized kingdoms were established in Cambodia and in Champa. The Burmese, who are linguistically allied to the Tibetans, entered Burma from the northwest. By the 16th century A.D. Burma had become a united kingdom. The Thais or Siamese, who speak a language of the Chinese type but use an Indian alphabet, infiltrated from southern China and took power in Thailand in the 13th century A.D. The Annamites and Malays are discussed above. All these peoples have been closed about by the cultures of India and of China, and the higher elements of their civilization have been taken from these two primary sources.

China, Japan and East Asia.—Chinese civilization appears in northern China in the latter half of the 2nd millennium B.C. The discovery at An-yang in Honan province in 1899 of thousands of bone fragments, many of them inscribed, has confirmed the existence of the Shang dynasty (*c.* 1523–1027 B.C.), which previously had been thought to be legendary. Early Chinese civilization grew in the Yellow river plain extending southward toward the Yangtze and westward and northward along the Wei and Fen valleys in Shensi and Shansi provinces. During the Chou dynasty (1050–256 B.C.), the great formative age of Chinese civilization, the intervening areas populated by groups of a lower culture were conquered and absorbed.

In Han times (202 B.C.–A.D. 221) the centre of Chinese culture was still in the north but by the Sung dynasty (960–1279) the Yangtze valley began to outweigh the north in population and importance. Chinese expansion to the north, which reached the steppelands during the Chou dynasty, was much slower and it came to a halt on the steppe, among the nomadic herdsmen, where the Chinese system of settled agriculture could not be applied. This conflict between two ways of life resulted in the building by the Chinese of a series of defensive walls, finally linked together by the Ch'in dynasty into the Great Wall.

Korea and Annam came under Chinese dominance in the Ch'in-Han period, but the former broke free again in the 4th century A.D. and the latter in the 10th century. Both absorbed Chinese culture. On the other hand, Japan, which was a united power by the 4th century A.D., never came under Chinese rule. However, Japan received the first elements of higher culture from China through Korea and in later times Japan set itself with determination and success to absorb Chinese culture.

In early historical times in China, society was dominated by a hereditary ruling class whose religion, involving the cult of heaven and of the family and clan, was not shared by the masses. The rulers were the custodians of the written language and of the traditions, and the scholars among them gradually formed during a period of political troubles a system of ethics and political theory which the philosopher Confucius preserved and transmitted to posterity. These thinkers, moreover, had evolved the rational ethical ideal of the ruler, the "son of heaven," holding the mandate of heaven but not himself divine and capable of being replaced if his conduct betrayed his position. Theirs, too, was the ideal of the supremacy of learning and of the scholar-ruler which became the accepted standard of the mandarin administrators of imperial China.

Many centuries passed, however, before the ideal of government through bureaucracy, selected on the basis of learning, reached its

fulfillment. Not until the T'ang dynasty (A.D. 618–906) was the examination system, through which the mandarins were selected, functioning fully. This administrative system undoubtedly provided the backbone of the remarkable political continuity of the Chinese empire and helped to strengthen the ideal of political unity, "all under heaven," which was throughout a feature of Chinese political theory. The actual achievement of unity under the Ch'in dynasty (221–207 B.C.) set the standard for the following 2,000 years, a unity which persisted through about 20 successive dynasties. Different as was the empire of the 19th century A.D. from that of the Ch'in, it had in fact undergone no major political revolution in the interim. Rebellions might take place, provinces might break away, rulers might change or be changed, but the system persisted.

China's artistic achievement, like its ethical and political system, was greatly influenced by the scholar bureaucracy. This is especially true of those arts that were based on the written character, whether in the form of literature or calligraphy or a great deal of Chinese painting. But the main stream of Chinese culture was also affected from the outside. New ideas, especially in the early centuries of the Christian era, entered freely from India and the Iranian world. Of these Buddhism was much the most important, competing with Confucianism for the allegiance of the upper classes, deeply penetrating the later Taoist religion and providing a pattern for the organization of the Taoist Church. With Buddhism, too, came a deep influence on all Chinese art.

An outstanding characteristic of Chinese civilization was its inventiveness which produced, among other things, paper, printing, gunpowder, the mariner's compass, the sternpost rudder and the wheelbarrow. Chinese silks, ceramics, jades and bronzes early found a market in other parts of Asia and in Europe. The expansion of the Former or Earlier Han dynasty (206 B.C.–A.D. 8) into central Asia opened up a major caravan route through Turkistan which for centuries provided a link with the Roman world. China's relations with the nomad peoples affected the movements of peoples throughout central Asia, from time to time creating repercussions in the near east, in Europe, in northern India and Iran. By the 2nd and 3rd centuries A.D. a southern sea route was opened from India and the west around Malaya to Annam and south China; and by these land and sea routes trade and travelers passed freely. After the rise of Islam in the near east, trade by sea flourished and Arab ships were to be seen at Canton and Chinese junks in the Persian gulf.

In the 8th century the caliphate and the T'ang empires came into direct land contact and conflict (A.D. 751). Overland contact, interrupted from time to time by the pressures of the steppe peoples was maintained from this time until the 13th century. Then a sudden major outburst of the Mongols created for a short period a single empire reaching from south Russia to the Pacific, allowing Europeans for the first time to visit and write about China. The Mongol empire soon dissolved, but the legend of Cathay (*q.v.*) that was born in European minds lived on, and in the 16th century played its part in inducing the Portuguese to venture round the Cape of Good Hope and the Spaniards to cross the Pacific. Thus there came to the west a more detailed knowledge of Chinese civilization which in the 18th century created in Europe a craze for things Chinese. But by this time the Chinese Manchu empire was decaying, its administration rotting with corruption and its inspiration dead.

As seen above, Japan had early begun to assimilate Chinese culture and in A.D. 645 a deliberate and wholesale introduction of Chinese forms of government took place. But the administration remained subordinate to a number of great landed warrior families who fought among themselves for control of the country. The Fujiwara, the Taira and the Minamoto bore the brunt of the struggle, the latter emerging victorious and in A.D. 1192 establishing a dual system under which an emperor ruled in name while the real power rested in the hands of a hereditary military chief called the shogun. This system was carried on by the Ashikaga family (1336–1568) and the Tokugawa family (1603–1867). In the 16th century the Portuguese reached Japan and attempted to introduce Christianity. In the resulting ferment, ideas of conquest developed among a remarkable group of leaders, one of whom, Hideyoshi, organized the invasion of Korea. Death interrupted his plans and a reaction set in under his successor, Ieyasu, who decided on a policy of isolation. Christianity was forbidden and Japan was closed to foreigners, and it so remained until after 1854. The early history of Japan was chiefly remarkable for the single-minded way in which its people were able to close ranks and follow a set line of policy such as deliberately setting out to copy Chinese culture, adapting Chinese forms of government or shutting out the foreigner.

Islam.—The term Islam (*q.v.*) covers the peoples and states that accepted the faith and law of Islam and professed to live by them. Islam begins with the life and teaching of the prophet Mohammed in Arabia in the early 7th century A.D. The first Muslim state in Medina erupted in successive waves of conquest over Arabia into the fertile crescent and across Persia into central Asia. Its influence reached into China and northern Asia; at the same time it had also pushed westward across northern Africa to the Atlantic. Fresh impulses of conquest took Islam into southern Europe and through Spain into France. By sea first and then by land Islam was also carried into India, thence by sea again southeastward to Malaya and the East Indies. However, the heart of the Islamic world was and is the near and middle east. The caliphate under the Omayyads (Umayyads) of Damascus (661–750) and then the Abbasids of Baghdad (750–1258) became the principal power.

Wherever Islam was accepted it carried with it a sense of unity based on its strictly formulated faith and on its holy law which, despite much variation of custom over so vast a zone of conquest, remains a common ideal and pattern of belief and conduct for the whole Muslim world. Wherever it has gone it has taken its language, Arabic, which is the holy tongue of Islam, the language of the Koran and of the traditions of the Prophet. Almost all the languages of the Muslim world have borrowed heavily from Arabic and are written in its script. The art and architectural forms of Islam, too, are distinctive, proclaiming the unity of the Islamic cultural pattern. Through their military and political power, reinforced by their culture, the Muslims brought together two formerly conflicting worlds, the diversified Mediterranean tradition of the ancient near east, Greece and Rome and the rich civilization of Persia, a fusion which produced great scientific and philosophic developments. Islamic scholars preserved something of the heritage of Greek antiquity, which was later handed on to Christian Europe. Through the Arabs the Chinese art of paper-making and the Indian system of numerals reached Europe.

Arab power was explosive and quickly burned itself out and by the 11th century A.D. fissiparous tendencies produced a singularly complete collapse of the empire of which the European crusaders and traders in the 12th and 13th centuries took advantage by invading the near east. But the peoples on the periphery carried Islam with them. The khanate of the Golden Horde, which between 1241 and 1395 ruled from the Danube to the Urals, was a Muslim state as also were its successors in the Crimea, the Caucasus and the Volga. In the 14th century the islamized Ottoman Turks brought large areas of Europe under Muslim rule and created an Ottoman empire which lasted until 1922. Muslim dynasties ruled in Persia, and Islam was carried through central Asia in two main waves into north India by the Turks (1000–1526) and the Moguls (1526–1707). The Muslims never fully subjugated south India but their rule in the north under such rulers as Akbar and Shah Jahan was brilliant, both politically and culturally. But Hindu powers, especially western India, struck back at the Muslims in the 17th century, creating disorder and disrupting the empire. In these disturbed conditions European trading companies already established on the Indian coasts, especially the English and the French, were drawn in to compete for political supremacy.

Through trade Islamic influence had reached out in the 16th century from India to Malaya and Indonesia, peacefully overlaying Hindu culture in the main centres, though not in Bali.

The influence of Asia on Africa was until the 19th century greater than that of Europe. The ancient near east drew on the resources both in men and material of the regions beyond the

upper Nile valley. The ancient Abyssinian kingdom was founded by Semites from southern Arabia, and Islam penetrated both north and south of the Sahara across to west Africa. There was a continuous Arab migration to east Africa which founded a series of cities on the coast. There was also an ancient connection between India and eastern Africa, which was reinforced in the 19th century by Indian immigration.

The great civilizations of Asia spread out over immense areas. Although they were separated one from the other by distance and slow communication, their contacts were numerous and between them the cross-fertilization of ideas and material culture was extensive. They were slow growing and slow changing, based in the main on subsistence economies. Their upper classes, however, created an active trade in ideas and luxury goods and in each civilization developed a way of life, whether Indian, Chinese or Islamic, that was chiefly remarkable for its inner harmony. Each religion or ethical code formed a way of life for its peoples and all aspects of life served to express this. Nevertheless, that their ways of life were very different one from the other is to be seen, for example, in their respective attitudes to history. The Chinese regarded the writing of their own history as an important state function and a significant branch of literature. Official historians were regularly at work producing official histories of each dynasty. In this way the doctrines of Confucianism were perpetuated and the official record of the times was made to conform to the accepted doctrines. What man did in this life on earth was taken to be supremely important. The civilizations of the ancient near east and of Islam produced histories and chronicles justifying the ways of God to man and in the case of Islam seeking to show that a good Muslim would certainly be a good ruler or a good subject. What a Muslim did on earth was necessarily important. In striking contrast the Brahmans of India disregarded their own history. Consistent with their view of life, they did not regard the recording of man's practical activities as of any significance compared with spiritual issues. These differences illustrate the fact that oriental civilizations did not find uniform solutions to their problems.

Asia and Western Dominance.—At the close of the 15th century, that is, about a quarter of a century before the Moguls began to conquer northern India and a half-century before the last great dynasty of China (the Manchus) established itself, a Portuguese fleet under Vasco da Gama found its way around the Cape of Good Hope into Indian waters. While the Moguls went on to conquer the Indian mainland, the Portuguese made themselves masters not only of Indian waters but of all the eastern seas. Where they led, the Spanish, Dutch, French and English followed. Above all, trade was sought, especially in silks and spices, but various attempts were also made to spread Christianity, especially by the Portuguese, who had themselves felt the proselytizing impact of Islam in Europe and north Africa and were not reluctant to carry the fight to the east.

During the 15th to the 19th centuries Europe itself was changing rapidly. Nation-states, perhaps as a solvent of religious wars, were growing up. The foundations of a scientific, industrial and technological revolution were laid. Europe learned how to navigate the oceans, apply sea power, wield artillery, organize representative government, cultivate religious toleration and use money and credit in trade. Thus it was a supremely confident Europe that began to feel its way along the coasts of the traditional, slow-changing societies of Asia.

The Portuguese quickly established themselves in Goa and Macáo; the Spanish took the Philippines in 1565. The rivalries of Europe were extended to Asian waters and the Dutch evicted the Portuguese and consolidated a spice empire in Java and Sumatra, centring on Batavia. Between 1740 and 1805 the French and British on the coasts of India fought a severe struggle for supremacy, which the latter won, in the process being drawn into the vacuum which the collapse of the Mogul empire had created. During the 19th century British power easily spread across India to the Himalayas and the whole subcontinent and its peoples became a major field of British investment. To protect this, new British bastions of power were erected in Aden, Persia, Arabia, Burma and Singapore.

Meanwhile the French, pushed out of India and forestalled in Burma, established control over Cochin China, Annam, Tongking, Laos and Cambodia. The independence of Siam (Thailand) was preserved because of its buffer position between the British in Burma and the French in Indochina.

In the near east, the Ottoman empire was crumbling under internal stresses and external pressures. In 1882 the British took control of Egypt in order to safeguard the new route to India through the Suez canal (1869), and the French, who had already crossed the Mediterranean into north Africa, later found a foothold in Syria. The far east was to some extent protected by distance and the rivalries of the European states elsewhere, but in 1842 and thereafter China was forced to open some of its ports to foreign trade and residence and to accept treaty provisions giving a special position to foreigners, a status which was substantially maintained until the 1930s. Beginning in 1854, the United States opened Japan, under arrangements similar to those forced on China.

Meanwhile across central and northern Asia Russia was advancing by military force, political manipulation and colonization. By 1900 Russia was established on the Pacific coast, and both China and Korea were being threatened from land and sea.

The Recovery of Asia.—By this time the peoples and governments of Asia had begun to react to the impact of Europe. Their 20th-century history is largely the story of change looking toward recovery of full independence and political and economic modernization. Japan, a tightly organized, compact island state, moved first by again making a deliberate decision to acquire the material power and organization of the apparently superior power, this time the European. By 1894 the legal and judicial order had been modernized; a new school system had been created; the foundations for a modern economy had been laid; the military system had been modernized; and a constitutional system had been established (1889). These changes enabled Japan to negotiate revision of its treaties, establishing legal equality with the western states. Its new power also enabled Japan to defeat China in 1894–95 and Russia in 1904–05. These two wars enlarged Japan to include Formosa (1895) and Korea (1910) and gave it a position in Manchuria from which to move in empire building on the Asian mainland.

European domination in Asia, together with the introduction of "western learning" into Asian countries, gave rise to nationalist movements. Capitalist enterprise and higher-education policies in the Islamic world, China, southeast Asia and India had brought into existence a new intellectual and middle class, the members of which respected the scientific and industrial revolution of the west and wanted to emulate it. They sought to introduce into their several countries the political and economic institutions of the west, but at the same time to reject western political and economic supremacy. Everywhere in Asia nationalism and anticolonialism formed the co-ordinates of these movements. Although nationalism itself, together with the presence and dominance of European powers, tended to isolate the Asian countries into self-contained units, the individual nationalist movements interacted on each other. The victory of Japan over Russia and the early successes of the Chinese reform and revolutionary movements stimulated action elsewhere in Asia. The rise of the freedom movement in India encouraged similar developments in Ceylon, Burma and Indonesia. The revival of Islam in the near east after World War I stimulated Muslim consciousness in India and southeast Asia.

In China the first reaction to the western impact was anti-Manchu as well as antiforeign. The failure of the Boxer movement (1900) inaugurated a period of Manchu reform designed to avoid revolutionary change. Revolutionaries were, however, successful in replacing the dynasty with a parliamentary republic in 1911–12. The traditional provincialism, however, soon made ineffective the national parliamentary republic, although China as a state retained its identity against pressures both from the west and Japan. National political unity began to be re-established when the Nationalist party took over the government of China (1928). Concurrently with the nationalist phase of the Chinese revolution Marxist-Leninist ideas were introduced into China with the organization of the Chinese Communist party, affiliated with the Communist international. In the ensuing struggle the Nationalist

government maintained its ascendancy until 1949. The establishment of the People's Republic by the Chinese Communist party not only inaugurated the Communist phase of the Chinese revolution but also enabled Chinese and Russian influence to replace western in a number of peripheral areas.

In the Indo-British empire an effort was made by the British to establish forms of representative and responsible government. But the attempt to hand over power roused the self-consciousness of the Muslim and Hindu communities so that the subcontinent when freed in 1947 was also partitioned into two independent countries—Pakistan and India. Nationalism had been sufficiently strengthened in Burma and Ceylon during World War II so that Britain was obliged to concede independence by 1947. A new relationship with Malaya was similarly established a decade later, and in the late 1960s only Brunei and Hong Kong remained under British control. Other European imperial powers in Asia, weakened by World War II and the temporary overrunning of southeast Asia by Japan, in time yielded their positions. The Dutch gave way to the Indonesian nationalists in their colony (1949), and the French, by 1954, had been compelled to withdraw from Indochina. The United States fulfilled its promise to grant independence to the Philippines in 1946. The U.S. occupation of Japan was officially terminated by the peace treaty which became effective in 1952 but U.S. forces remained under the terms of a security treaty. Sustained U.S. military involvement in Korea (1950–   ) and later in southeast Asia were exceptions to the broad retreat of Western power from the Asian scene.

After World War II the idea of the nation-state was firmly planted in all Asian countries. Internal political and economic stability, however, had not always been fully established following independence. In the background the U.S.S.R., on the landward side, strengthened its grip on central and northern Asia, and the United States, on the seaward side, sought to fill the power vacuum left by the Japanese defeat in the Pacific. Communist China emerged as a major power opposing the U.S. and, from the early 1960s, publically divided from the U.S.S.R. In the near and middle east the Arab and Muslim states had regained or reasserted their independence, but they were small, weak and divided. Continuing hostility to the new Jewish state, Israel, after its proclamation (1948), as well as fear of European domination, served as an Arab bond of union. Turkey, which had become a republic in 1923, deliberately abandoned Islam as the state religion and under Mustafa Kemal Atatürk began to turn itself into a modern westernized nation-state.

Economic and social developments in Asia had not kept pace with the rate of political change. An enormous increase in population, especially in India, China and Japan, had occurred and, except in Japan, the masses were probably poorer at the close of the period of European dominance than they had been at the beginning. The disparity between the masses and their new, mainly middle-class rulers had become more glaring than ever and the new nations of Asia, though free, were neither secure nor stable. This situation opened the way for the introduction of the essentially European program of Communism in competition with western democratic capitalism. In short, the influence of the west had created revolution in Asia and had complicated, not simplified or clarified, the problems facing Asians.

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V. POPULATION

By the late 1960s, nearly 2,600,000,000 people, about 60% of the world's population, lived in Asia exclusive of the Russian portion. For the most part, this massive population is composed of village-dwelling, agrarian peoples, concentrated on the better agricultural areas where population densities are extremely high, and characterized by high fertility rates which are basic to high rates of natural

ADAPTED FROM GEORGE B. CRESSEY, "ASIA'S LANDS AND PEOPLES"; REPRODUCED BY PERMISSION FROM MCGRAW-HILL BOOK COMPANY, INC.

FIG. 6.—POPULATION DISTRIBUTION OF ASIA

increase, both actual and potential. Urban-industrial population concentrations, while important in Japan and a few other areas, are not characteristic and have had little effect upon the great mass of the Asian population.

Distribution.—The average population density of fewer than 100 persons per square mile for Asia as a whole (including the portion in the Soviet Union) is less than half the comparable figure for Europe. But an average is hardly descriptive of such a large and varied continent. In the north are several million square miles of sparsely populated subarctic tundra and forest lands, with permanently frozen ground and large areas of swamp. Central Asia, including Mongolia, the western half of greater China and Russian Turkistan, is an area of deserts, mountains and high plateaus, where dense populations are restricted to irrigated oases. Aridity applies a similar limitation to much of southwestern Asia from Iran to Turkey and Saudi Arabia.

In contrast to these large sparsely populated sections, Asia also contains the world's largest areas of densely populated agricultural land. In east, southeast and south Asia live 90% of the continent's total population on less than half (actually a third if west China be excluded) of its land area. The most populous areas lie in crescent-shaped monsoon Asia extending from West Pakistan to northern China and Japan. In most of monsoon Asia the climate is humid, tropical or subtropical, with a marked maximum of precipitation occurring in the summer. The rainfall regime and topographic influences result in a striking development of fertile alluvial flood plains and deltas along the lower courses of monsoon Asia's rivers, from the Indus in Pakistan to the Yellow river in north China.

In this large section of Asia the traditional and still dominant basis of livelihood is agriculture, with emphasis on irrigated rice wherever its cultivation is possible. Densities are extreme. Trewartha's maps show a minimum of 400 persons per square mile on the extensive alluvial plains of eastern China with densities in excess of 900 over large areas. Rural densities as high as 2,000–3,000 persons are revealed by detailed data for smaller areas in most countries of monsoon Asia. The occurrence of these alluvial lowlands sets the gross pattern of population distribution. But the lower densities in less-favoured areas such as south China (hilly terrain), parts of southeast Asia (poor soils) and peninsular India (less and more variable rainfall) should not obscure the fact that in these areas also agricultural populations press against the limits of available resources.

Monsoon Asia thus contains two of the world's three great masses of population, each occupying an area larger than Europe, with a higher average density and more people than any non-Asian continent. In east Asia is the largest of these masses with its demographic centre in eastern China, where more than 700,000,000 Chinese constitute the largest group of ethnically and culturally unified people on the earth's surface. The second major population mass is in south Asia with over 600,000,000 people in Afghanistan, Pakistan, India and Ceylon. Between these two masses is southeast Asia, more fragmented in form and more diverse in its demographic character. The densely populated areas on alluvial lowlands of the mainland and in Java, with its fertile volcanic soils, contrast with large areas of sparse population where infertile lateritic soils, rough terrain or the presence of endemic diseases inhibit intensive development.

Only in Japan, the most industrialized country in Asia, has urbanization reached western levels. About three-fifths of the Japanese live in official cities (*shi's*), and six major cities of more than 1,000,000 inhabitants have a total population in excess of 16,000,000. Elsewhere the large Asian city has usually been a port or an administrative centre developed as a result of western influence and epitomizing the duality that characterized the economy, especially of colonial territories. After World War II the withdrawal of colonial control was accompanied by a rapid growth of cities. The number with populations of at least 1,000,000 increased from 13 in 1935 to 31 at mid-century, with comparable increases in the number and population of smaller centres. However, the development is too recent to have altered very much the numerical and cultural dominance of the rural and village populations.

Population Trends.—For centuries the high birth rate of Asia's population has been associated with intensive rice culture, cohesive village life and family-centred social organization. Demographers hold that the population increase which quintupled the population of Asia in the period 1650–1950 was largely due to decrease in the death rate, while birth rate and the underlying conditions affecting it remained relatively unaltered. After World War II the use of modern insecticides and antibiotics resulted in even more spectacular reductions in death rates, still without fundamental change in economic or social conditions. Several of the smaller countries from Japan to Iraq have death rates comparable to those of the western world. Where the birth rate remains at "Asian" levels, population increases substantially above 2% per year are the result, as in Ceylon and southwest Asia. Japan is the only major country where a sharp reduction in the birth rate has led to a marked decline in the rate of population increase. However, in India and Formosa in the 1960s, and from time to time in China also, there was official advocacy of family limitation and support of educational and technical programs to facilitate birth control. These, obviously, represent a major departure from traditional attitudes.

For the future the most that can be said is that Asia retains the potential for tremendous population increase because of the size of the population and its favourable age distribution, as well as the underlying social and economic conditions and widespread cultural attitudes. Irene Taeuber sets the possible population of Asia (excluding the Soviet portion) at from 2,900,000,000 to 4,200,000,000 by the year 2000, but is careful to point out that a forecast is impossible in view of the many variables involved. Meanwhile the presumed 2% increase of China's population adds about 15,000,000 Chinese per year in contrast to the annual increase of about 3,000,000 persons in the entire Soviet Union.

Soviet Asia.—Population in the Russian portion stands in contrast to the rest of Asia in terms of numbers and density and in most other respects as well. In Soviet central Asia and the Caucasus live Asian peoples, long settled on densely populated, irrigated oases, or engaged in extensive animal raising on subhumid grasslands. More significant, however, has been the influx of population from western Russia with the attendant development of rail and other transport facilities and a western-type, commercial, mechanized agriculture. Major development of mineral and manufacturing industries with the accompanying growth of cities has been particularly significant in west and central Siberia, but by no means lacking in the eastern and southern sections. Soviet Asia remains a frontier area where the economy and population grow because of immigration. Elsewhere in Asia the closest parallel to this type of pioneering has been the movement of Chinese into Manchuria after about 1900 and the later development of northwestern China under the Communist regime.

See also references under "Asia" in the Index.

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ASIA, ROMAN PROVINCE OF, the first and westernmost Roman province in Asia Minor, stretching at its greatest extent from the Aegean coast in the west to a point beyond Philomelium (Aksehir in the modern Turkish *Il* of Konya) in the east and from the Sea of Marmara in the north to the strait between Rhodes and the mainland in the south; thus it comprised the Troad, the coastal cities, Mysia, Lydia, western Phrygia and, south of the Maeander (Buyukmenderes) river, Caria. The province was first constituted when Attalus III, king of Pergamum (*q.v.*), bequeathed his dominions to the Romans in 133 B.C. It then contained many different communities at different stages of development: the old Greek cities on the coast, newer hellenistic foundations, native towns already largely hellenized and indigenous peoples still living in tribes and villages about their tem-

ples. The province was rich in natural resources, and its dyestuffs and woolen textiles were famous. Under the Roman republic, however, its prosperity was ruined by commercial exploitation, taxation and war, so that the advance toward hellenization and urbanization begun under the Seleucid and the Pergamene kings was impeded, Mark Antony left an exhausted province for Augustus after the battle of Actium (31 B.C.).

Recovery under the empire was rapid and secure. A peaceful province, Asia remained senatorial in the division of provinces between Augustus and the senate and was governed from Ephesus by a proconsul of consular rank (under the republic the governor had usually been a former praetor) assisted by three legates and a quaestor. Besides these the procurators who administered the imperial properties and imperial taxes became increasingly important. For the administration of justice, the province was divided first into nine *conventus* (assize districts), later into more. The provincial assembly, called the *koinon* of Asia, to which the cities sent representatives, met annually in different cities, chose the officials known as Asiarchs and also high priests for the official worship of the emperor, passed resolutions, made appeals and sent deputations on provincial matters. The older cities retained their traditional councils, magistrates and assemblies in the Greek form, and new ones were steadily added as prosperity increased and hellenization advanced. The Roman businessmen and the Roman colonists were assimilated to their neighbours.

The great cities of Asia—Pergamum, Ephesus, Miletus, Sardis, Smyrna (*qq.v.*) and many more—were leading educational and cultural centres. Important Christian communities and bishoprics grew up within the province (for example, the Seven Churches of Asia), and important heresies, such as Montanism, also. The province shared in the sufferings and decline of the 3rd and the 4th centuries and lost much in economic importance as the development of the Balkan provinces, military needs and the founding of Constantinople turned the empire's main lines of communication away from the Aegean toward the northwest. Yet its reserves of products and manpower and its relative immunity from devastation made it an important factor in the survival of the Eastern Roman empire. Under Diocletian it was divided into seven provinces: Hellespontus (Troas and Mysia), Insulae (islands off the coast), Asia (the coast from Assus to the Maeander), Lydia, Caria, Phrygia Prima and Phrygia Secunda, most of them in the diocese of the East. There remained, however, a proconsul for Asia directly responsible to the emperor.

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ASIA MINOR, the broad peninsula (area *c.* 287,000 sq.mi.) which comprises the main (Asian) part of the modern republic of Turkey. To the east, its landward limit may be conveniently placed at the Anti-Taurus mountain ranges, since these not only form a watershed separating the drainage to the Black sea and Mediterranean from that which flows to the Caspian and the Persian gulf but they are also an important strategic and ethnic barrier. The Byzantine emperors for four centuries used the outer range of the Anti-Taurus as their military frontier against the Arabs; and nowadays the chief minorities of the Turkish state live east of this mountain divide.

The Black sea on the north is linked to the Aegean sea and Mediterranean (on the west and south) by the Sea of Marmara which, with its two famous straits of Bosporus and Dardanelles, separates European from Asiatic Turkey. Asia Minor contains the main land links between Europe and Asia and has often been the scene of struggles between occidental and oriental civilizations.

The term Asia Minor, the earliest use of which, in its modern sense, is in the *Historia adversus Paganos* of Orosius, who wrote in the 5th century A.D., was probably applied in the first instance to the Roman province of Asia to distinguish it from the continent. The name Anatolia—the Levant—may be taken as synonymous with Asia Minor. It was first used by Constantine Porphyrogenitus in the 10th century A.D. and was later taken over, in the form of Anadolu, by the Turks, who used it, like Rum (*q.v.*), to mean roughly the territory which was conquered from the Byzantines.

This article contains the following sections and subsections:

I. PHYSICAL GEOGRAPHY

Asia Minor is a predominantly mountainous peninsular projection of southwest Asia and a western prolongation of the high Armenian plateau.

1. Geological Structure.—The peninsula forms part of the belt of Tertiary fold mountains which crosses the old world latitudinally from Portugal to the Malay archipelago. These mountains are built from the detritus which accumulated in the depths of the Tethys sea, and as they were thrown up they were often moulded round the edge of ancient stable blocks which had formed islands in that sea. In Asia Minor the central plateau is such an ancient block, and round it were shaped the multiple ranges of Pontus in the north and Taurus (Toros Daglari) and Anti-Taurus in the south.

After the mountains were built, the structure of the country was further complicated by rifting and subsidence. The whole of the Aegean, for example, is a collapsed part of this system of fold mountains, like the fallen keystone of an arch. This rifting was frequently followed by the outpouring of volcanic rocks and, finally, the landscape was further modified by erosion. There are many signs that the processes of mountain building have only recently become quiescent in Asia Minor; for example, the earth tremors which frequently afflict the Troad, the hot springs and poisonous gases which issue from the ground in some places in Caria, the perpetual flame at Yanar Tas (the "Lighted Stone") in Lycia and the flows of unweathered basalt which in ancient times earned for part of Lydia the name of Catacecaumene, the "Burnt Land." Asia Minor has now no active volcanoes, though Strabo (xii, ii, 7) mentions fire pits which in his day were a danger to straying cattle on the plains below Mt. Argaeus (Erciyas Dagi).

2. Relief and Drainage.—The central plateau is an ancient block overlaid with late Tertiary fresh-water strata and in part also with deposits of soft volcanic tufa which weather into cones and pinnacles of fantastic shape. The general level of the plateau rises from about 2,500 ft. above sea level in the west to 4,500 ft. in the east. In the southwest the ranges of Sultan Daglari and Emir Daglari, outliers of the Taurus system, break the level surface of the plateau, while elsewhere ancient volcanoes frequently protrude. The chief of these lie near the front of the Anti-Taurus, namely Erciyas Dagi (12,848 ft.—the highest point in Asia Minor), Hasan Dagi, Karaca Dagi and Kara Dag. Sometimes these intrusive trachytic masses were used as citadels, like the heights of Old Ankara and the precipitous rock which commands the city of Afyonkarahisar (Afyon).

On the southern side of the central plateau, the ranges of the Taurus sweep in a wide curve from the lake region of Phrygia first to the southeast and then northeastward to the north of Cilicia. There they are joined by the ranges of Nur Daglari

(Amanus or Gavur Daglari), which are probably continuous structurally with the Karpas range of northern Cyprus. The combined Taurus and Amanus systems continue as the Anti-Taurus and merge into the Tunceli (Dersim) and Bingol massifs of the upper Euphrates basin. The coastal plain of Cilicia lies in the angle between the Taurus and Amanus folds, in the same way as the lowland of Pamphylia is contained between the western extremities of the Taurus and another system of fold mountains which run north and south through Lycia. All these mountains of the south and east of Asia Minor, which rise in places to 10,000 ft., are built mainly of Eocene and Cretaceous limestones. They consist of a series of ranges, disposed in echelon, and in the Anti-Taurus in particular they form a broad belt more than 50 mi. across, including high plateaus and basins. In Lycia and southern Phrygia, where two fold systems meet, these depressions among the mountains are especially common and often contain lakes.

On the northern side of the peninsula, the Pontic ranges make a gentle double bend which is reflected in the outline of the southern shore of the Black sea. These mountains, which reach a maximum height of about 6,000 ft., are wider and lower than those of the Taurus and Anti-Taurus and are also much more dissected by rivers, partly because the rainfall is heavier there and partly because porous limestones are not so common and more of the drainage keeps to the surface. The deep and often isolated river plains (*ovas*) among these mountains, such as those of Tokat and Amasya, are more fertile and populous than the high basins of the Taurus, which are in many cases drained by underground escape channels. The Pontic ranges are constructed of Mesozoic rocks, mainly Cretaceous but with Jurassic and Triassic outcrops toward the west where, in the coastal district of Eregli and Zonguldak, Carboniferous strata near the surface contain Turkey's only important deposits of coal.

In the west of Asia Minor, the fold ranges run latitudinally, and the two main valleys between them, those of the Buyukmenderes (Maeander) and Gediz (Hermus), have been widened by rifting to form easy corridors leading from the coast up to the plateau. To the south of these natural routes, the districts of Caria and southern Lydia are higher and more isolated, for there parts of an ancient stable block of serpentine and schistose rocks outcrop among the newer fold mountains.

Coasts.—While the north coast of Asia Minor and most of its south coast run parallel to the grain of the relief, the fold mountains meet the sea transversely in the west and produce an irregular shore line with deep indentations and offshore islands. In the southwest, the north- and south-trending ranges of Lycia again meet the coast squarely, and there are deep natural harbours, like Marmaris Limani, of great strategic though of little commercial importance.

In the Sea of Marmara, too, the Pontic ranges meet the coast at right angles, producing the deep inlet Izmit Korfezi, while the nearby Golden Horn (Halic), the port of Istanbul, is a tributary annex of a drowned river valley, the Bosporus (Istanbul Bogazi). The Dardanelles (Canakkale Bogazi, ancient Hellespont) marks the line of another valley flooded by an irruption of the sea and, like the Bosporus, gives the illusion, with its powerful southward-flowing current, of being a wide river. By contrast, the smooth north coast has no good natural harbours, the chief anchorages being in the wide bay of Samsun and behind the promontory of Sinop. The south coast from Pamphylia eastward suffers from the same deficiency, and the ports of Antalya (Adalia), Mersin and Iskenderun (Alexandretta) all have very indifferent natural shelter.

Many of the details of the coastal outline of Asia Minor have been markedly changed since classical times as a result of very rapid silting by the rivers. This process cannot be attributed to any natural cause, but appears rather to be a consequence of the decline in the standard of cultivation which began at about the start of the Christian era and which was followed by the abandonment of hillside terraces and by the extensive spoliation of forests.

Drainage.—The rivers of Asia Minor vary greatly in depth from summer to winter and, being also frequently of irregular gradient and encumbered in their lower courses with silt, they are of little use for navigation, though they often provide water for irrigation.

In the west and southwest, the Gediz, Buyukmenderes and Koca (Xanthus) run conformably to the grain of the relief. In the north, however, the three main rivers, the Sakarya (Sakaria, Sangarius), Kizil Irmak (Halys) and Yesil Irmak (Iris), and their tributaries cut across the trend of the mountains, partly by keeping to courses established before the mountains were built and partly as a result of "capture" by streams cutting back from the coast. The Kizil Irmak in particular has encroached on the drainage of a wide area of the northeastern plateau, through which the river sweeps in a broad arc.

The southward-flowing rivers of Asia Minor have not cut so far back into the plateau as have those which enter the Black sea. This is the result in part of the smaller rainfall of the southern mountains and to some extent also of their limestone rocks, which absorb much of the runoff into subterranean channels. The Seyhan (Seihun, Sarus) and Ceyhan (Pyramus) rise in the heart of the Anti-Taurus and flow partly within and partly across the ranges before entering the sea over the plains of Cilicia. Farther west, the Gokoluk (Yesiloluk), one of the headwaters of the Tarsus (Cydnus), has cut almost through the Taurus ranges to Pozanti to form the famous pass known as the Cilician Gates. Between this river and the Koca of Lycia, however, the Goksu (Calycadnus) is the only river of appreciable size which flows from the Taurus, and it has cut a deep gash southeastward through the ranges from the plateau to the sea at Silifke (Seleucia).

Although there is so little surface drainage in the Taurus mountains, large streams fed by rain in the autumn and by melting snows in the spring flow underground both to the north and to the south. On the north side of the Taurus, these hidden streams are largely responsible for replenishing the waters of a series of lakes, of which the principal, Egridir (Limnae) and Beysehir (Beishehr, Karalis), have no outlet to the sea. The overflow of Beysehir drains northward, where it irrigates the gardens around Konya before being lost in the loose sands and gravels of the central desert.

The heart of the plateau is itself a basin of inland drainage and, as its name implies, the Tuz Golu ("salt lake") is a shallow sea which recedes each summer to leave a desolate expanse of incrusted salt.

Natural Routes and Passes.—The only wide and easy approaches to the plateau of Asia Minor are from the west, up the valleys of the Sakarya, the Gediz and the Buyukmenderes. These three routes reach the plateau at the cities of Eskisehir (Eski-Shehr), Afyonkarahisar and Dinar (Dineir), while at their seaward ends they are commanded in the first case by Istanbul and in the other two instances by Izmir (Smyrna).

The plateau is crossed by two main routes, one keeping to the foot of the northern ranges, the other skirting those of the south. In each case the road follows a chain of mountain-foot oases that make use of the waters which drain inward from the border ranges to the central plateau. The northern route passes from Eskisehir through Ankara (Angora) to Kayseri (Caesarea Mazaca), the southern from Dinar past Afyonkarahisar, Aksehir and Konya (Konia) to Ulukisla. Kayseri and Ulukisla, which are joined by a route through the oases of Nigde and Bor, thus completing the circuit of the central plateau, are the bases for the main passes of the Taurus and Anti-Taurus. The three passes commanded by Kayseri are those through Sivas to Malatya, through Darende to Malatya, and through Goksun to Maras, while from Ulukisla a single narrow road, in part widened by cuttings in the solid rock, leads through the Cilician Gates (Kulek Bogazi) to the coastal plains, from where the road to Syria has to make a further crossing, by the Bahce or Belen passes, over the Amanus.

Apart from the Cilician Gates, the only important approaches from the plateau to the south coast are down the Goksu valley from Karaman and over the mountains from Burdur to Antalya, but in each case the way is long and difficult compared with that through the Cilician Gates. As a result the plain of Pamphylia and the coasts of Cilicia Trachea have always been much more isolated from the plateau than has the lowland, Cilicia Pedias,

ANCIENT PROVINCES AND TRADE ROUTES OF ASIA MINOR. MODERN NAMES APPEAR IN PARENTHESES

The tortuous and often constricted valleys of the Kizil Irmak and Yesil Irmak do not open routes of access to the interior from the Black sea. The chief passes on this side are those from Samsun to Amasya (Amasia), from Sinop to Ankara and from Trabzon (Trebizond) to Gumusane and beyond.

3. **Climate.**—Being cut off by peripheral mountains from the tempering influence of the sea, the central plateau experiences great extremes of heat and cold. Snow may lie there for three or four months of the winter, while in midsummer the heat and drought are extreme. High winds are common at all seasons, but they are usually dry and most of the rain is caused by local convection currents in the spring and early summer. In all these respects the Anatolian plateau resembles the steppes of central Asia and in both cases these special conditions of climate account for the generally treeless landscape.

The winds which blow outward from the cold air mass of the plateau in winter are heated by their descent to the coasts, so that in Cilicia in particular average winter temperatures are mild and snow is almost unknown. Nevertheless, winter conditions are precarious there and a sudden severe frost may ruin the whole orange crop. The eastern part of the north coast has milder winters than the western since it is sheltered in some degree by the Caucasus ranges from the winds from the Russian steppes. Consequently, the olive only thrives along this coast to the east of Sinop.

Eastward-moving cyclonic storms bring winter rains to all the coastlands and particularly to the west coast and valleys, but these storms are deflected from the central plateau by the mass of heavy cold air which settles over it in the winter. As a result, there is very little fall of rain or snow in the interior at this season and even the convectional rains of spring are slight and unreliable. All important settlements keep to the outer fringes of the plateau where springs fed by snow-melt waters from the mountain ranges produce local oasis conditions.

In midsummer, as usual in Mediterranean countries, drought settles over the whole land, including the coasts. The single exception is the north coast, especially in its eastern section, where the normally dry southward-blowing winds, having collected some moisture by evaporation during their crossing of the Black sea, meet the Pontic ranges obliquely and release a considerable rainfall. These ranges therefore, at least on their northward slopes, receive rain in both summer and winter, and this accounts for their luxuriant vegetation. (WM. C. B.)

4. **Vegetation.**—The flora of Asia Minor is rich in species and is still incompletely known, especially in the central and eastern parts. The great east-to-west extent of the Anatolian peninsula has to be borne in mind as it makes Asia Minor the most important existing route for the migration of plants, other than boreal ones, from Asia into Europe and from southern Europe into Asia.

The natural vegetation, the distribution of which is obviously mainly controlled by climatic conditions, is varied and ranges from evergreen forests and brushwoods, through deciduous woods of oaks, oriental beech and Spanish chestnut, to steppe and even almost desert communities. Both the flora and the vegetation become less Mediterranean and more Iranian the farther east and the farther inland one goes and, to a certain extent, the higher the altitude one reaches.

In conformity with the climate, the western and southern margins of Asia Minor have a Mediterranean flora and the climax vegetation is largely composed of evergreen woody communities of pines (*Pinus halepensis* subsp. *brutia* and *P. pinea*) and of maquis which by cutting, grazing and burning have often degenerated into low kermes oak scrub (phrygana). There are many bulbous plants and a wide range of shrubs, climbing plants (such as smilax and Etruscan honeysuckle) and annual and perennial herbs. Farther inland and at higher altitudes, woods of oak (various species of *Quercus*), Spanish chestnut and black pine occur. The higher peaks and chains rise above the forest limit and have a vegetation of dwarf shrubs (barberry, junipers, brooms, astragali, etc.), open scree communities and rock plants.

The northern part of the peninsula, bordering the Black sea, has what is basically a Mediterranean plant cover, but with increasing modification from west to east and at higher altitudes. In the west, maquis of evergreen shrubs, with the strawberry tree, laurel, myrtle and tree heath, are characteristic. The occurrence of *Rhododendron ponticum* and *Fagus orientalis*, even in Bithynia, strikes a distinct note. Eastward, more and more Colchic-Caucasian species are found and some Mediterranean plants (as the strawberry tree) die out.

The eastern high mountains are said to have a rather poor flora, but large areas are still not fully explored botanically. The severe winter climate, the rather low rainfall and often shallow soils result in the dominance of steppe communities. Characteristic genera include *Stipa* and *Aristida* (grasses), *Astragalus* (milk vetches in numerous species, many of which form spiny cushions), *Alhagi* (camel's-thorn), *Artemisia* (wormwoods), *Euphorbia* (spurges), *Berberis* (barberry), *Achillea* (milfoils), *Verbascum* (mulleins) and *Epilobium* (willow herbs).

The high plateau of central Asia Minor has a continental type of climate with hot dry summers and cold winters. The flora is probably richer than is at present known but the vegetation, over much of the area, consists of treeless steppes. Trees are found in some valleys and other favoured habitats and include junipers, almonds, oaks, nettle trees and wild pears. In the steppes there are many tufted grasses (*Stipa, Andropogon, Bromus*, etc.), plants with bulbs or corms (*Ornithogalum, Muscari, Gagea, Crocus*, etc.), spring flowering annuals and perennial herbs. Where the surface waters are saline, a salt-marsh flora appears, dominated by members of the goosefoot family. (W. B. T.)

5. **Animal Life.**—The animals of the western and southern parts of the Anatolian peninsula clearly belong to the Mediterranean fauna, while those of the eastern and central parts belong to

the Irano-Turanian (Asiatic steppe) fauna. In the Pontic mountains of the north, the Euro-Siberian element shows a strong penetration, and at the eastern edge certain peculiarities are found, such as melanism (especially in rodents), the presence of very peculiar mollusks and of the Caucasian salamander (*Martensiella*), and the survival of the Colchian pheasant. In the dry mountains of the south and southeast, southern elements like the Israeli gazelle (in the steppes), the striped hyena (in the mountains) and the monitor, a giant lizard, are seen. Typical of the high plateau of central Asia Minor and its eastern mountains are at least two mole rats (the European mole being restricted to European Turkey). Genera like the ground squirrel *Citellus*, the jerboa *Allactaga*, the steppe marten *Vormela*, as well as species of hare, fox and hedgehog are all Irano-Turanian steppe animals. The Moroccan locust is a permanent inhabitant of these steppes, but outbreaks only occur along the Mediterranean borders, where there are extreme fluctuations in rainfall. (*See* LOCUST.)

In the Mediterranean mountains, including those of the Pontic ranges and of the Taurus, live red and roe deer, the brown bear (with the Syrian bear in the southeastern mountains), mouflon, wild goat, and the ibex, lynx, wildcat and, rarely, leopard. Wolf, jackal, boar, badger, marten and otter occur everywhere.

Among domestic animals, the small stature of the cattle is noticeable. These beasts are almost entirely used for plowing and for transport, rarely for milk which is mainly obtained from sheep and goats. All Anatolian sheep, most of which belong to the Karaman race, are fat-tailed, with the tail ending in a thin appendix. The wool of the Angora goat of the high plateau is famous. Heavy buffaloes are kept mainly in the northwest.

The Anatolian horse is hardy and well adapted to the mountains. Hybrids of dromedaries and Bactrian camels are used for transport and in late winter, which is the rutting season, they are also used for camel fights. Pariah dogs still occur in the plains, while the dogs of mountains and high plateau are wolflike, yellowish, half-wild sheep dogs, much resembling the Molossian dogs of antiquity.

Cats are rare, but the true Angora cat excels by its long silky fur.

The birds of the Mediterranean areas show no peculiarities. In the high plateau and mountains, steppe and rock partridges abound, the francolin and two bustards are not uncommon. Colonies of the beautiful pink flamingo breed in a small lake near the salt lake Tuz Golu. Storks, both white and black, are common breeders. More common birds of prey are the bigger and lesser kestrels, griffon vulture, Egyptian vulture, golden eagle, honey buzzard, long-eared owl and eagle owl.

The only poisonous snake of general distribution in Asia Minor is the Aegean viper (*Vipera xanthina*). Other common snakes are a rat snake (*Coluber asianus*), the ring snake and five species of chicken snake (*Elaphe*). Among the abundance of fishes may be mentioned a rather common trout, barbels and *Varicorhinus; Nemachilus* and *Silurus glanis* are bottom fishes. The rich fauna of the upper Euphrates and of the Tigris is still little known.

The invertebrates are chiefly notable for the giant earthworm, found close to rivulets, and the abundance of big leeches which during the 18th and early 19th centuries were exported in quantity to Europe. Snails in the high plateau include the big *Helix lucorum, Helicella derbetina* and *Theba schuberti*. Conspicuous species of insects are the big bluish-black carabid beetles (*Calosoma*) and the big plump crickets (*Bradyporus*). The numerous butterflies in the mountains include *Parnassius apollo, P. mnemosyne* and *Doritis apollinus*. At Bursa (Brusa) silkworm breeding is still carried on by a special research institute and school. Everywhere bees are kept in primitive plaited or wooden hives. The variations of the honeybee (*Apis mellifica*) reflect the general zoogeographical character of the Anatolian fauna, for the Caucasian variety, *A. m. caucasica*, is found in the northeastern mountains, the Irano-Turanian variety, *A. m. remipes*, in the high plateau and the eastern Mediterranean variety, *A. m. syriaca*, in the Mediterranean areas which also show, near Istanbul, transitional variations between *A. m. syriaca* and the western Mediterranean *A. m. ligustica*. (F. S. BR.)

II. ETHNOLOGY

The Anatolian peninsula, being constricted between the Black sea and the Mediterranean, forms an obvious land link between southeast Europe and the countries of southern Asia, and was used as such by migratory plant and animal species as well as human races. At the same time the country has provided a retreat for specimens of these migrant populations, and the large total of its botanical and zoological species is matched by the wide variety of its racial strains.

The ethnic map of Asia Minor, therefore, is very complicated. Even as early as the 1st century A.D., Strabo (xii, viii, 1–4), in attempting to describe the peoples of Mysia and Phrygia, was perplexed by "the confusion which has existed among the nations in this district" with their many different fables of origin. Indeed, he quotes a proverb about the difficulty "of assigning the confines of the Mysians and Phrygians."

Since that time, the situation has been made still more involved by further waves of migration, notably those of the Turkish tribes in the 11th century. Moreover, the Ottoman administration aided the mixing of population. For every millet or community was traditionally expected to ply a particular craft or profession, as the Greeks their trading and the Armenians their architecture. They had cultural and religious freedom, but not territorial autonomy, and were deliberately encouraged to spread into every part of the empire.

1. Racial Prehistory.—After 1930, excavations on the plateau provided enough evidence to disprove the once popular hypothesis that the aboriginal population of Asia Minor was broad-headed, particularly of that specialized variety known as Armenoid, with a prominent nose and high back to the head. On the contrary of 32 individuals whose remains were found in Chalcolithic and Copper Age (that is, roughly, 3rd millennium B.C.) deposits in various parts of the plateau, no less than 27 were found to be long- or medium-headed. Of these, the majority were of small build with light brow ridges and thus belonged to the gracile variety of the Mediterranean race rather than to the more robust Eurafrican variety which predominated in early Mesopotamia.

In the early part of the 2nd millennium B.C., to judge from the human remains from Bronze Age strata at Alisar, Kusura, Arslan Tepe and Hisarlik, the proportion of broad-headed individuals in the population increased very quickly from about 16% in the earlier period to 42% in the later. This sudden change can only be the result of immigration and it coincides significantly with the emergence of Hittite power in Anatolia. The Hittite aristocracy probably entered Asia Minor from the east, like the Turks much later, possibly from eastern Persia or the region of the Pamirs where the population, particularly among the Tajiks, is still generally broad-headed.

These broad skulls of the early Bronze Age in Anatolia are of Alpine type, not Armenoid; that is, they are only moderately broad and show no flattening of the back of the head. This brings up the question of the origin of the Armenoid physical type, which F. von Luschan in 1911 argued to be indigenous to the plateau of Asia Minor. His thesis was based on two main observations: first that the scattered outcaste tribes, like the Tahtaci, Kizilbash, Yezidi and Druze, who live in mountainous refuges in Anatolia and Syria and whose culture proves them to be survivors of a very early population, show these Armenoid features in a very pure and extreme form; and second, that the profiles of the figures on Hittite sculptured reliefs—the only direct evidence available at the time of the physical type of the early population—are also manifestly Armenoid.

It is now clear, as has just been described, that not only was the aboriginal population of Anatolia not Armenoid, but not even the invading Hittites belonged to this race. However, the evidence adduced by Von Luschan can be reconciled with these new discoveries, thanks to what is now known about the evolution of the Armenoid physical type. This is, in fact, a hybrid, the outcome of the mixing of Alpine and Mediterranean stocks in a population, and it retains in an exaggerated form features derived from both of its progenitors. To the Mediterranean side of its ancestry may be traced the long face, close-positioned eyes and sel-

back ears, while on the other hand the sallow complexion, prominent nose and high short head clearly come from the Alpine stock. Obviously, this hybrid type may be evolved quite separately and independently in different regions where similar conditions of mixing occur. The so-called Dinaric race of the Balkans, for example, is very similar to the Armenoid, the main differences between them being the result of special features of the local variety of the Mediterranean stock to which they trace part of their ancestry.

The arrival of the Hittites of Alpine race among the aboriginal Mediterranean population of Anatolia would thus create just the right conditions for the breeding of a hybrid Armenoid race. The discrepancy between the evidence of the 2nd-millennium skulls, which are Alpine, and of the sculptured reliefs, which show Armenoid features, is explicable by their difference of date; the skulls so far investigated are nearly all early Hittite, of a time previous to extensive mixing of the populations, while the reliefs are almost without exception neo-Hittite, that is, about 1,000 years later, by which time the hybrid race had had time to develop.

Once established, the Armenoid race appears to be very persistent and, among heterodox sects of both Christianity and Islam who live and breed in conditions of extreme geographical and social isolation in remote highland regions, it has for long remained pure and resisted dilution with immigrant strains. Instances are the Kizilbash of Cappadocia, the Tahtaci of Lycia and the Armenians about Lake Van.

2. Racial Movements in Historic Times.—In the last millennium B.C., the country was invaded, and in some cases colonized, from various directions, as by the Phrygians from Thrace, the Cimmerians from across the Caucasus, the Gauls from the Balkans, and by the Jewish, Greek and other settlers brought into the cities newly founded by Alexander the Great and his successors. It would, however, be a difficult task to find any trace of the culture and still more of the physical type of these various incursors. Each in turn appears to have imposed its language and, to a less extent, its institutions, on at least a part of the country, but ultimately to have accepted the way of life native to the land and to have lost its physical identity through interbreeding.

The course of the last great migration into Asia Minor, that of the Turks in the 11th century A.D., may serve as an illustration of what, in outline at least, had happened many times before. After the initial conquest they insisted, in the regions where they settled, on the adoption of the Turkish language and on at least nominal capitulation to Islam. This much was conceded, but at the same time Turkish Islam adopted many local customs and took on a very "Anatolian" aspect, which it still retains. The Turks for the most part settled and intermarried with the indigenous population, learning from them the arts and crafts of village life and looking down on those tribes, whom they called "Turkmen," who refused to settle and kept their traditional nomadic habits in some mountain districts.

An important section of the population of the north and west coasts and of the southern portion of the plateau retained its Greek language and Christianity until the early years of the 20th century, when it was being rapidly reinforced by immigration from across the Aegean. In the early 1920s, however, most of these people were transferred to Greece under an agreement for the exchange of population by which about 1,500,000 Greeks and Armenians left Turkey and 400,000 Turks arrived there from Greece. Later, many more Turks returned to Anatolia from the Balkans, particularly from Bulgaria, which sent back 50,000 in 1950 alone.

At mid-20th century the largest minority in Turkey speaking a foreign language was that of the Kurds (*q.v.*). They are a tall, aquiline-featured people, with long and high heads, and include a large proportion of fair individuals. They are undoubtedly an intrusive Nordic stock, akin to one racial strain in the Iranian population, and speak an Indo-European language very like Persian. They live mostly east of the Euphrates, however, and are found only in eastern Asia Minor in the Anti-Taurus. They are often noticed among the mixed population of cosmopolitan Istanbul, where they come regularly to act as porters. *See* also TURKMEN; TURKIC PEOPLES; TURKEY: *The People and Population.*

III. ARCHAEOLOGY

Many different kinds of evidence must be taken into account in studying the archaeology of Asia Minor, including that of architectural remains, rock reliefs, inscriptions, burials and even of casual finds of pottery and stone implements. The most important sources of information are, however, stratified excavations, and this account will pay special regard to such work undertaken after 1930. An attempt will be made to show what are the main outstanding problems of Anatolian archaeology and what progress has been made toward their solution.

1. Stone Age.—Thanks largely to the intensive work of Sevket Aziz Kansu and his assistants at the University of Ankara, the range and variety of the Stone Age cultures of Turkey have now been thoroughly explored and a beginning has been made on the task of preparing their detailed stratigraphy.

Abbevillian (formerly called Chellean) hand axes were found on the surface of the ground near both Istanbul and Ankara, while a hand axe of Acheulean type was discovered at Tekkekoy near Samsun and some pieces belonging to the Micoquian (Upper Acheulean) industry were excavated in 1937 in the terraces of the Cubuk Suyu (stream) at Etiyokusu near Ankara, 3.1 m. (10.168 ft.) below ground level.

Specimens of the Levalloiso-Mousterian industry were excavated from the Pleistocene terraces of the Cubuk Suyu at Etiyokusu and at other places in the neighbourhood of Ankara. Further samples of the same industry were found at Golkoy near Kastamonu (Kastamuni), at Gemerek near Sivas, and near Nevsehir and Nigde in the southern part of the plateau. Tools of Mousterian type were discovered at Adiyaman near Malatya, in the valley of Tekkekoy near Samsun and in the Karain cave at the village of Yagcakoy near Antalya.

Of the classic Upper Paleolithic industries, the Solutrean and Magdalenian are unknown in Asia Minor. Tools of Aurignacian type were, however, discovered at Adiyaman in the Anti-Taurus, near some rock engravings of wild mountain goats, which probably belong to the same period. Artifacts belonging to the Aurignacian industry were taken from a stratified cave deposit near Bozanonu in the district of Isparta.

Flints characteristic of the Mesolithic period are recorded from excavations in caves and mounds near Samsun on the north coast and also from an occupation deposit at Baladiz near Isparta, while the lower strata of the mound of Pilir in the lake of Hafik, about 20 mi. N.E. of Sivas, have produced traces of wooden shafts and miniature flint blades of Campignian type. The transition from Mesolithic to Neolithic cultures may have been found by 1959 in the rock shelter of Beldibi near Antalya, which is remarkable also for its wall paintings of goats and ibexes.

2. Comparative Stratigraphy.—The main deep excavations on the plateau of Asia Minor are those of the Chicago expedition to Alisar, of the Turkish Historical society at Alaca Huyuk (hill) and of the British parties at Kusura and Beycesultan, while further information was obtained in 1950 from the deep sounding at Polatli, undertaken by a joint Anglo-Turkish party. The combined evidence from all these places made clear the sequence of cultures on the plateau which may be compared with those revealed at Hisarlik in the northwest and Mersin in the southeast. Hisarlik, the city mound of Troy (*q.v.*), is intermediate between the plateau of Asia Minor and the islands and shores of the Aegean, while Mersin, with the nearby site of Tarsus, provides a link with Syria and Iraq.

The first conclusion to be drawn from a study of the excavations on the plateau is that this region has generally remained culturally separate from the neighbouring areas to east and west.

Second, it is now clear that the civilization of the plateau has developed along a steady course and that despite the entry of alien painted ceramic styles in the early Bronze Age, Asia Minor remained generally faithful, from the earliest Neolithic times until the collapse of the Hittite empire, to a tradition of using monochrome pottery.

Third, by 1960 J. Mellaart had shown that an exception must be made of the southwestern corner of the plateau. There at Hacilar the painted-ware Chalcolithic culture of north Syria intruded.

3. Chalcolithic Period (Before c. 2600 B.C.).—At mid-20th century, the oldest pottery on the plateau (except in the southwest) could not be dated earlier than about 3000 B.C. As its name implies, it is already found in association with copper as well as stone tools. This Chalcolithic pottery usually has a black and burnished surface, generally plain but occasionally ornamented with rectangular incised patterns accentuated with a chalky filling, or still more rarely with similar designs in loose white paint. Simple dishes and open bowls were the most common vessels at this stage, but sometimes elegant pedestaled shapes were thrown, like the "fruit stands" of Level O at Alisar (*see* diagram). By the Aegean seaboard, in the lowest levels at Hisarlik and the neighbouring sites of Yortan and Thermi, the same white-filled incisions occur, but the vessels are of different shapes, handled jugs and basins with sagging bellies, modeled on leather prototypes, being very characteristic.

In view of its style and date, this Chalcolithic pottery of the plateau must be compared with the white-on-black ware of Level XII A at Mersin, which introduces half a millennium during which the Cilician plain was engulfed by the culture of the plateau. For at least 1,000 years before this, however, Cilicia had a civilization characterized by painted pottery of styles which can be matched in Syria, Iraq, Armenia, Iran and Turkistan, but not in Asia Minor, from where, except near Burdur and Konya, the painted-ware cultures were rigorously excluded by the barrier of the Taurus range.

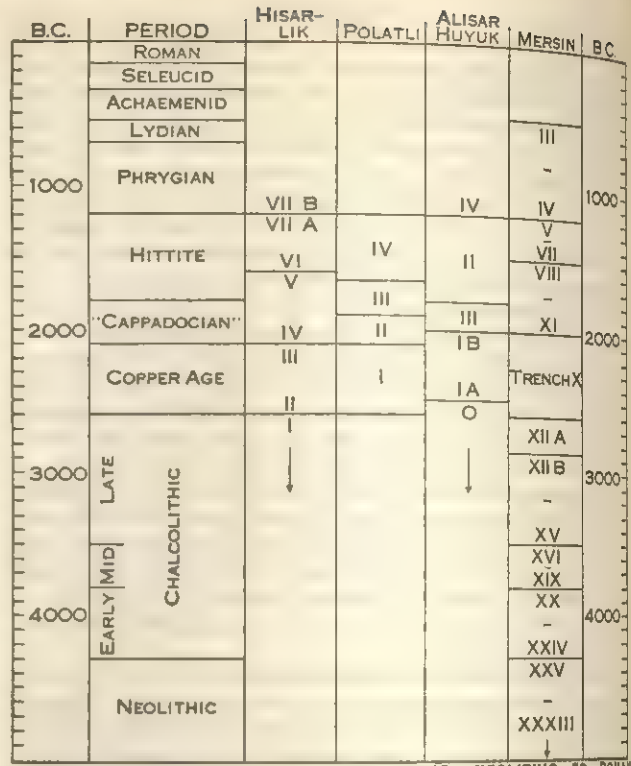
The problem therefore arises of what culture, if any, flourished on the northern and central parts of the plateau in the painted-pottery era of Cilicia and Syria. None of the relevant excavations go deep enough to answer this question with certainty. However, the pottery of the lowest Chalcolithic levels in this region is by no means primitive and there must lie behind it a long history of slow evolution, the early stages of which may be illustrated in the Neolithic levels of Cilician and northern Syrian sites. For at Mersin, Jubayl, Tell Halaf and Ras Shamra, as well as farther afield at Knossos (Cnossus) and Nineveh, the Chalcolithic painted-ware levels are underlain by Neolithic strata with a distinct style of monochrome pottery whose burnished finish and incised ornament foreshadow the traditional style of the plateau Chalcolithic wares. The shapes of the pots, however, are naturally less ambitious at this early stage.

At Mersin, the burnished and incised monochrome pottery of the Neolithic period was almost entirely replaced by the painted wares which first occur, in a crude style, at Level XXIV. Throughout the Chalcolithic millennium, however, specimens of the early monochrome pottery keep appearing and these are so different in shape and ornament from the contemporary painted wares that they are almost certainly imports from another region.

After Level XII B the painted pottery disappears as suddenly as it came in and is replaced in the succeeding Level XII A and Trench X by monochrome burnished wares of shape and decoration which can be paralleled in the earliest Chalcolithic strata known on the northern plateau. It must be assumed, therefore, that somewhere in Asia Minor the culture represented by the monochrome burnished and incised pottery, which was very widespread throughout the near east in Neolithic times, survived and developed during the 1,000 years when it was replaced in Syria and neighbouring countries by the painted-ware civilization. The place of this survival has yet to be discovered, but surface explorations point to the high basins of the Anti-Taurus, such as the plain of Elbistan, as a likely region.

4. Copper Age (c. 2500–2000 B.C.).—During the Copper Age the culture of the whole plateau of Asia Minor was probably more uniform than at any time before or since. Moreover, it was at this period that the civilization of the plateau spread for the first time far outside Asia Minor and influenced an area comparable in extent with that of the Hittite, or even of the Ottoman, empire.

The pottery styles of the Copper Age of Asia Minor develop naturally from those of the preceding Chalcolithic period. The same predilection for single-coloured burnished wares, with incised or occasionally molded ornament, continues, but some very characteristic shapes now occur which serve to identify this culture



COMPARATIVE STRATIGRAPHY OF ASIA MINOR, NEOLITHIC TO ROMAN PERIODS

with ease and certainty. Such are the broad-bellied jug, often with ornamental knobs, the shallow saucer with high vertical handle, and above all the elegant two-handled cup, probably modeled on a metal prototype and identified with the Homeric *depas amphikypellon* (*Odyssey*, iii, 40–63).

This plateau culture is clearly intrusive at Mersin in the disturbed strata of Trench X, corresponding with Period A at Tarsus, and also on the Amuq plain near Antioch in Judeideh XI and Tabara el Akrad IV. In these last two instances, the style of pottery whose arrival marks the change is the Khirbet Kerak ware, named after one of the sites in Palestine where it also appears suddenly about 2600 B.C. and remains in use for two centuries. This Khirbet Kerak ware is characteristically Anatolian, but is distinguished by its ornament of ribs and flutings and of raised geometrical patterns, especially spirals, as well as by its bold use of contrasting colours, the insides of many of the vessels being brilliant red, by contrast with their outsides which are black. This effect is produced by careful control of the conditions of firing and is an art which was used commonly in the Copper Age in Asia Minor, but with special skill in the upper Euphrates and in the Kura-Aras valleys of the Caucasus, from where the southward invasion of the makers of the Khirbet Kerak ware seems to have stemmed. Sir Charles Leonard Woolley (*A Forgotten Kingdom*, pp. 33–35, 1953) identifies these invaders as the early Palestinian Hittites, who are referred to in several contexts in the Old Testament, such as Numbers xiii, 29 and Genesis xxiii. He suggests further that Hittite power was established in Asia Minor by a branch of this invasion which moved westward and then northward from Syria and through Cilicia.

Approximately at the same time as this Khirbet Kerak invasion of Syria and Palestine from the north, typical Anatolian Copper Age pottery suddenly entered the southern Balkans, with the Early Helladic cultures. In Greece, as in Syria and Cilicia, the Anatolian type of pottery overlies earlier painted wares, of the Sesklo and Dimini styles, which are indeed so like those of the Syrian Chalcolithic that they must be presumed to be derived from that source. The link was probably by sea, though Chalcolithic painted shards found near Konya and Afyonkarahisar give a clue that the land route across the south of the plateau from Cilicia to the Aegean was already in use.

The most remarkable relics of the Anatolian Copper Age are the

royal tombs of Alaca Huyuk, which lay below the level of Hittite occupation and were sealed from it by a deep "destruction" layer of ashes. There were 13 rich tombs, dated by the Turkish excavators from their stratification and the style of the included pottery to the period of approximately 2500–2300 B.C.

5. Early Bronze Age or "Cappadocian" Painted-Ware Period (*c.* 2100–1850 B.C.).—The earliest written records found in Asia Minor are the clay tablets which were recorded from Cappadocia in 1882 but which were first carefully collected by the famous expedition of Ernest Chantre in 1893–94. Since 1948 the excavations of T. Özgüc at Kultepe illuminated the culture in which these records occur. The tablets themselves are mostly business letters, but also legal documents and accounts, belonging to a colony of Assyrian merchants.

It happens that the establishment of this commercial link with Assyria coincides closely with the appearance on the plateau of a quite new and distinctive type of polychrome painted pottery, the so-called "Cappadocian" ware. Some features of this new painted style, such as the "hawk eye" pattern on the spouts of painted jugs, can be matched in northern Syria, as would be expected in view of the southward trading contacts of Kultepe at the time; but in its general patterns, shapes and colours this pottery is quite distinctive and bears all the signs of having been introduced into Anatolia by new settlers. Moreover, from the distribution of their pottery, it seems that these immigrants must have come in from the east rather than the west, for Cappadocian ware is found only very sporadically west of the Kizil Irmak, but it has already been traced as far east as Lake Urmia in Azerbaijan, Iran, where it occurred in quantities in Period D at Geoy Tepe. (T. Burton-Brown, *Excavations in Azerbaijan, 1948,* 1951.)

From the evidence of language and physical anthropology, the Hittite peoples appear to have entered the plateau from the east at about the same time and it seems therefore reasonable to recognize in them the bearers of the Cappadocian painted-ware culture. Against this assumption must be reckoned the eclipse of the painted wares when the Hittite empire first took shape in the 18th century B.C. Nevertheless, it is quite conceivable that those who introduced this Cappadocian pottery were in fact proto-Hittite invaders and that, having arrived on the plateau, they quickly came to terms with the indigenous inhabitants whom they found there and took over and developed many features of the native civilization including its style of pottery. In later times the successive invasions of the Phrygians, Gauls and Turks, for example, followed a course very like this.

6. Imperial Hittite Period (*c.* 1850–1200 B.C.).—Asia Minor now enters the full historic era, and the evidence of archaeology becomes supplementary to that of documents. In both texture and ornament, the pottery of this period follows the monochrome tradition of the Copper Age, but the invention of the potter's wheel makes possible the manufacture of vessels of more elegant and ambitious shapes, like the long-spouted jars (Schnabelkannen), some of which were evolved from prototypes of the Cappadocian period.

The Hittite empire was centred on the plateau, but was not so preponderant on the coasts, which seem at this period to have been generally under Mycenaean influence, as shown for example by the pottery of Level VI at Hisarlik. The Mycenaean civilization, which probably corresponds to that of the Achaeans of Greek tradition, did not belong to a centralized empire like the Hittite but rather to a loose confederacy of sea-trading communities which controlled many of the shores of the eastern Mediterranean from the 15th to the 13th century B.C. (*See* AEGEAN CIVILIZATION.) The type and degree of contact between the Hittite and Mycenaean civilizations are not yet clear. In his *Ionia and the East* (1909), D. G. Hogarth argued that along the central Aegean frontage of Asia Minor, the region which later became Ionia, the Hittite power penetrated to the coast and excluded the Mycenaean. Certainly some of the rock reliefs of Hittite style near Smyrna would seem to point to this conclusion; yet excavations at Old Smyrna have not yet revealed a Hittite stratum. The Middle Bronze Age city uncovered by Seton Lloyd at Beycesultan on the upper Buyukmenderes was culturally distinct from its Mycenaean and Hittite neighbours, but shared some architectural features with Minoan Crete.

On the Cilician coast, however, at least one point was under Hittite control, as proved by the remains of the fortress in Levels VII–V at Mersin. There the few Mycenaean shards in Level V are a rare sign of contact between the two cultures, which seem also to have met on the plateau at the Hittite city at Fraktin, where Mycenaean pottery has been discovered. (*See* also HITTITES.)

7. Phrygian Period (*c.* 1200–700 B.C.).—About the year 1200 B.C. the Hittite empire came to a sudden end as a result of the attacks of the land and sea raiders who swept forward from beyond the Aegean, through Asia Minor and Syria, until they were held up in 1193 in Palestine by Rameses III of Egypt. The disaster is marked at Alishar Huyuk, Kultepe, Bogazkoy and Alaca Huyuk (*qq.v.*) by a great conflagration in the last Hittite level, and at Mersin and Atchana occupation ceases with equal abruptness. At Hisarlik the break comes between Cities VII A and VII B at a time which corresponds very closely with the traditional date for the fall of Troy.

The Mycenaean culture of the sea frontages suffered from the same upheaval. After a short confused period, it was replaced by new barbaric cultures, in which iron was more commonly used, button seals replaced cylinders and the naturalistic art of the Minoan-Mycenaean tradition gave place to the protogeometric pottery style, with mechanical zoned and paneled designs based on triangle, lozenge and concentric circle patterns.

Out of the chaos which followed the overthrow of the Hittite empire there emerged the Urartaean power in Armenia, the Phrygian kingdom of the western plateau and the neo-Hittite states of northern Syria and the Taurus and Anti-Taurus foothills.

These last neo-Hittite principalities used a hieroglyphic script which appears on many monumental inscriptions of southeastern Asia Minor. In 1946 at Karatepe (*q.v.*), an 8th-century B.C. fortress in a remote part of the valley of the upper Ceyhan, were found the most important of these inscriptions, for, being written alongside a Phoenician translation, they have considerably aided the decipherment of this enigmatic script. The Karatepe inscriptions record the founding of the city by a certain Azitawad, king of the Dananiyim, who lived in the plain of Adana.

The successors of the Hittites on the major part of the plateau were the Phrygians (*see* PHRYGIA) who according to Greek tradition were related to the Thracians and ultimately colonized Armenia. They spoke an Indo-European language, of the eastern branch, and doubtless included an immigrant element recently arrived from across the Bosporus; but it seems that their kingdom was peopled more by a coalition of former subjects of the Hittite empire than by its invaders. Certainly the art of the Phrygian rock monuments in the district about Gordium (*q.v.*), the capital of the kingdom, owes much to Hittite inspiration; for instance, the pairs of opposed lions rampant over the doorways of tombs.

Yet there are many features of Phrygian art and architecture which came new to Asia Minor such as the stone tumuli with corbeled burial chambers like the "Tomb of Tantalus" on the slopes of Yamanlar Dagi (Mt. Sipylus) above Izmir. Moreover, the gabled façades to the false rock-cut tombs near Gordium have no counterpart in Hittite sculpture, and the intricate geometrical patterns carved on these tomb fronts, possibly in mimicry of carpet designs, are also specifically Phrygian. This sculptured ornament recalls the friezes on the painted Phrygian pottery of a style which is quite novel in Anatolia. This pottery, with its geometrical patterns, repetitive panels, simple animal silhouettes and miniature circles multiplied to fill vacant spaces, has basically much in common with the contemporary geometric styles of the eastern Mediterranean while keeping certain features of its own.

8. Lydia, Caria, Lycia and Greek Colonies (*c.* 700–546 B.C.).—Despite the overthrow of the Phrygian empire by the invading Cimmerians in the early 7th century B.C., some offshoots of this civilization survived in the interior, as, for example, at the castle of Pazarli, dating from about 500 B.C., where Hamit Zübeyr Kosay uncovered in 1937–38, for the Turkish Historical society,

Phrygian reliefs and wall paintings of lions, bulls, deer, winged griffons, centaurs and soldiers parading with shields and spears.

Elsewhere the Phrygian power was succeeded by the various civilizations speaking Asianic languages like those of Lydia, Caria and Lycia (*qq.v.*). These peoples were of various origins, some being invaders who brought about the downfall of the Hittite realm, others relics of the old subject populations of the Hittite empire.

These indigenous civilizations of Asia Minor flourished at the same time as the Greek colonial foundations, Aeolic, Ionic and Doric, which began to be established on the Aegean shores in the 8th century B.C.; it is therefore important to know what sort and degree of contact there was between them, and in particular how much the young civilization of Ionia (*q.v.*) owed to its neighbours inland. Certainly Phrygia must have had some connection with the Greek world shortly before the collapse of the kingdom, for the alphabet of the inscriptions on the Midas tomb and other monuments is patently borrowed from the Greek. Moreover, the large cultural debt of the Ionian cities to their inland neighbour, Lydia, was proved by G. Radet (*La Lydie et le monde grec*, 1893), by Sir William M. Ramsay (*Asianic Elements in Greek Civilisation*, 1927) and by D. G. Hogarth (*Ionia and the East*, 1909). Hogarth, however, overestimated the continuity between the Hittite and early Greek civilizations, through Phrygian and Lydian intermediaries, and Ekrem Akurgal's work (*Spaethethitische Bildkunst*, 1949) has shown how long was the hiatus between the imperial Hittite and the fully developed Phrygian civilization, and how comparatively late the land routes from the Aegean to the east were reopened. It is probable that the early Greek colonists on the coasts of Cilicia and north Syria, who had close links with the neo-Hittite states of the southern Taurus and north Syria, were at least as influential as the overland traders of Ionia and Lydia in introducing the "orientalizing" features into the art of the Aegean world in the late 8th and in the 7th centuries B.C.

9. Achaemenid and Seleucid Asia Minor (546–133 B.C.).—With the conquest of Lydia by Cyrus (*q.v.*) in 546 B.C., the major part of Asia Minor again came under single control for the first time since the downfall of the Hittite empire. The old Hittite road round the north side of the central plateau, which had probably never been completely abandoned, was re-established as the royal road from Sardis in Lydia to Susa in Persia, while the great eastern trade route was opened along the southern edge of the plateau.

The Persian kings, however, did not change the civilization of Asia Minor as much as Alexander and his successors, whose policy was not to rule the country from outside but to colonize it. So, beginning in the late 4th century, a whole series of new cities was founded, usually at strategic points along the routes of trade and administration which had been re-established by the Persians. Sometimes old Anatolian religious centres, like Hierapolis, were refounded and renamed; elsewhere, completely new cities were set up, like Laodicea on the Lycus.

These foundations were profoundly different in both economy and administration from the old rural centres of Anatolia, and these differences were reflected in their architecture. The old Anatolian cities, like Pessinus, Olba and Comana of Cappadocia, had been, as Strabo's descriptions show, provincial centres with a large agricultural population subordinate to and serving the temple. They were distinguished not by their constitution but only by their size from the Anatolian villages, where the populace was divided into the same two strata of theocracy and serfs.

In the new Hellenistic cities, by contrast, a more elaborate and democratic administration was practised. The population was divided into age grades, residential tribes and trade guilds, and various paid and honorary officers supervised the work of the police, schools, markets and other municipal functions. Specialized industries were set up, trade became increasingly important and the cities ever more dependent on the highways between them.

10. Roman Rule (From 133 B.C.).—When Roman power was extended to Asia Minor, these municipalities and highways were used as bases for annexing and ruling the whole of the country. The cities became progressively larger, more luxurious and more detached from the surrounding countryside. Their great public buildings, agorae, stadia, amphitheatres, gymnasia and triumphal arches, whose ruins are today so common throughout Anatolia (*see*, for example, EPHESUS), were built on a pattern which was common throughout the Roman world. In imperial times, as these cities grew in size, increasingly elaborate aqueducts and drainage canals were needed to serve them. Justinian's trench at Edessa (*q.v.*) and the flood-diversion works of Vespasian and Titus at Seleucia Pieria are impressive monuments of the engineering skill of the age.

11. Christian Antiquities.—In many districts Christianity and paganism rose to strength alternately in accordance with the trend of official persecution or toleration. Elsewhere the two appear, from the evidence of ambiguous epitaphs, to have combined into an unstable mixture, and in these regions heresy was constantly liable to arise.

Some of the earliest Christian churches of the world lie just outside Asia Minor proper, in the districts of Urfa and Mardin, while in Anatolia most of the Christian basilicas date from the time of Justinian or later. The catacombs of the Cave of the Seven Sleepers at Ephesus and the chapels hewn from the soft volcanic rock at Bin Bir Kilise (the "Thousand and One Churches") on the slopes of Kara Dag are two remarkable Christian monuments.

12. Seljuk Conquest (A.D. 1071).—The immediate result of the Seljuk conquest of Asia Minor in the 11th century A.D. was that many of the great Hellenistic foundations became deserted. This was very rarely the result of destruction of the cities but rather of the almost accidental interruption of commerce, communications and, above all, water supply by the nomadic tribes who followed in the wake of the invading armies.

The massive walls of the *hans* or caravansaries, which are among the grandest monuments of Seljuk rule in Asia Minor, are proof of the state of insecurity which prevailed in the country in early Turkish times, the result of the depredations of the unruly nomadic tribes. Hence the Turkish towns served as local market centres rather than as emporia or administrative links on imperial highways and were obliged to be much more self-sufficient than in the former days of easy communications.

13. Asia Minor as a Link Between Europe and Asia.—The archaeology of Asia Minor illustrates the mobility of the ethnic and cultural frontier between east and west. At some periods like the Achaemenid, the boundary lay just inland from the Aegean; later, in Seleucid times, it moved temporarily eastward as far as the Punjab; while in imperial Roman times it remained static for several centuries along a defensive frontier running from the Caucasus, through Armenia, Syria and the province of Arabia to the Gulf of Aqaba. The fluctuations of this boundary help to explain the variety of the cultures which have influenced Anatolia both from the west and from the east.

At the same time, Asia Minor has kept, from the earliest period, strong individual traditions in its culture and economy and often the immigrants themselves gradually modified their habits and institutions to accord with those of the indigenous inhabitants who knew "the manner of the God of the land" (II Kings xvii, 26. Both the ethnology and archaeology of Asia Minor illustrate the vigour of the old rural civilization of Anatolia and of the native genius of the country, which has continued to assert itself despite every outward change of rule, race and religion. (WM. C. B.)

IV. HISTORY

The course of the prehistory and of the ancient history of Asia Minor is broadly outlined in the ethnological and archaeological sections of this article. An exhaustive account of the dominant power in Asia Minor in the greater part of the 2nd millennium B.C. is given in the article HITTITES. For the peoples whose invasions precipitated or exploited the decline of the Hittite kingdom, from *c.* 1200 B.C., *see* AEGEAN CIVILIZATION and PHRYGIA. The Phrygian kingdom succumbed to the invasion of the Cimmerians (*q.v.*) *c.* 700 B.C., on whose disappearance various "Asianic" civilizations rose to importance (*see* LYDIA; LYCIA; CARIA;

also MYSIA). Lydia, the most important of these, survived the invasion of Cyaxares the Mede but fell to Persia when Cyrus defeated Croesus in 546. For the Greek cities of the Aegean coast during the Persian period, *see* IONIA.

The invasion of Alexander the Great in 334 B.C. put an end to the Persian empire of the Achaemenids and brought most of Asia Minor into the Hellenistic world. The Wars of the Diadochi gave the greater part of Asia Minor to the Seleucid dynasty (*q.v.*), but the 3rd century B.C. saw also the rise of Bithynia and the incursion of the Gauls (*see* BITHYNIA; GALATIA), as well as the beginnings of the kingdom of Pergamum (*q.v.*).

The battle of Magnesia (*q.v.*) (190 B.C.) established Roman influence in the place of Seleucid; but the Roman province of Asia, of which Pergamum was the nucleus, was not formed till 133 B.C. The competition that Pontus (*q.v.*) offered to Rome in the 1st century B.C. was eliminated by the defeat of Mithradates VI.

For further details of the region's ancient history *see* CAPPADOCIA; LYCAONIA; PAMPHYLIA; PAPHLAGONIA; and PISIDIA.

The early history of the spread of Christianity in Asia Minor is familiar to readers of the Acts of the Apostles and of the Pauline epistles; a later development was Montanism. One of the pre-Christian cults is discussed under GREAT MOTHER OF THE GODS and ATTIS.

For Diana of the Ephesians *see* ARTEMIS.

When the Roman empire was divided in the 4th century A.D., Asia Minor was of course included in the Eastern or Byzantine part. The Persian armies of Khosrau II, which overran the country in the first quarter of the 7th century, were eventually expelled by Heraclius. Next, the Arab conquest of Syria exposed Byzantine Asia Minor to a new enemy whose incursions continued, with varying degrees of success, until the middle of the 10th century (*see* CALIPHATE). The 11th century, however, saw the arrival of the Seljuk Turks, the battle of Manzikert, the formation of the Lesser Armenian state of Cilicia and the beginning of the crusades. (*See* SELJUKS.) The Greek Christian empire of Trebizond (*see* TRABZON) was set up after the establishment of the Latin empire at Constantinople during the fourth crusade. After the Seljuk empire of Rum was subdued by the Mongols (1243), its vassal peoples began to assert their independence. The culmination of this process was the emergence to power of the Osmanli or Ottoman Turks. From this point the history of Asia Minor is that of Turkey (*q.v.*).

See also references under "Asia Minor" in the Index.

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ASIANIC LANGUAGES: *see* ANATOLIAN LANGUAGES.

ASIENTO, a Spanish word meaning contract, is used in particular to designate the *Asiento de Negros* or "Asiento treaty" concluded between Great Britain and Spain in 1713. The idea of a contract for the supply of Negro slaves to Spanish America originated in the middle of the 16th century, when the Spanish monarchy found itself unable to do more than keep its colonies supplied with manufactures. *Asientos* before 1713 had been held by individual Spaniards, by Portugal and, in 1701, by France. Though heavy taxation, government interference and disturbed conditions of trade had combined to make them unprofitable, the idea of an *asiento* yet remained popular with foreigners as affording a chance to share in the trade with Spanish America and to acquire some of the bullion that it produced. Consequently the treaty signed with Great Britain on March 26, 1713, raised high hopes and constituted the solid basis for the South Sea Bubble (*q.v.*).

Essentially the treaty gave the South Sea company the right to send 4,800 Negro slaves to the Spanish colonies yearly for 30 years and permitted the dispatch of an annual ship of 500 tons to engage in general trade. The South Sea company found its *asiento* no more profitable than had earlier contractors: first, trade was considerably disturbed by war (between 1717 and 1727, for instance, the ship sailed only four times); secondly, the company was obliged to pay an annual tax of £34,000 on the first 4,000 slaves, regardless of whether they were actually imported (which, in fact, they never were). Moreover, the concession of the right to send the annual ship gave rise to a vast contraband trade which continually exacerbated relations between Great Britain and Spain, leading, in 1739, to war. This upset the profitable trade with peninsular Spain. Therefore, although Spain renewed the *asiento* at the peace of 1748, Great Britain agreed, in a new commercial treaty of 1750, to relinquish its rights in return for a payment from Spain of £100,000.

See J. O. McLachlan, *Trade and Peace with Old Spain, 1667–1750* (1940). (B. J. R.)

"AS IF," PHILOSOPHY OF, the English version of the name given by the German philosopher Hans Vaihinger (1852–1933) to the system expounded in his book *Die Philosophie des Als Ob* (1911; English trans. by C. K. Ogden, *The Philosophy of As If*, 1924). The distinctive feature of this work is its account of "fictions." These fictions are held to be the constituent elements of all human knowledge, whereby the will, in its effort to come to terms with irrational and unknowable reality, constructs rational explanations of phenomena "as if" there really were knowable grounds for believing them to be true in the sense of conforming to reality. The value of these fictions (which are not to be confused with hypotheses, verification of which would be assumed to be possible) consists only in their satisfying the practical purpose of the will to fabricate a habitable universe. For this purpose, Vaihinger maintained, it did not matter if they were recognized as involving ultimate logical contradictions. Fictions must provide all man's science and the foundation of all ethical behaviour and of all religious belief. Man must make up his physics "as if" such concepts as force and matter corresponded to a physical reality, his morality "as if" ethical certainty were possible, his theology "as if" there were a God.

Vaihinger's philosophy, which he himself described as based on "idealist positivism" or "positivist idealism," owes much to the immediate influence of Arthur Schopenhauer and F. A. Lange. Ultimately it takes as its point of departure the Kantian distinction between the phenomenon, to which knowledge is confined, and the "thing in itself," or unknowable reality (*see* KANT, IMMANUEL). It is interesting as a development of Kantianism in the direction of pragmatism (*q.v.*)—a move made by Vaihinger quite independently of contemporary U.S. philosophers.

ASIR ('ASIR), the southwestern province of Saudi Arabia, consists of three parts: a coastal plain, a belt of high mountains with a highest peak of 9,400 ft., and the upper Bishah and Tathlith valleys, both of which rise in its highlands. Area 40,130 sq.mi., pop. about 1,000,000. The capitals of the three sections are Qizan (Jizan), the principal Red sea port, Abha (7,150 ft.) and Khamis Mushayt, respectively. The southern boundary, from a

point on the coast 40 mi. S. of Qizan to the edge of the Empty Quarter (Rub' al Khali) (and including the administratively separate province of Najran), was agreed between the Saudi and Yemen governments in the treaty of Taif (May 1934), being later (1935–36) demarcated and mapped in detail. The northern boundary runs roughly along 18° N. lat. from the small port of Al Qahmah to Abha and Khamis Mushayt, whence it goes northeast to Al Kahfah in the Tathlith valley. Some of the finest mountain scenery of the kingdom is in this province, as at Fayfa', a fine 7,000-ft. peak, terraced up to its summit with varied cultivation, including coffee, indigo, ginger and *Catha*. Geographically the province forms a northern extension of Yemen, whose mild climate and relatively generous rainfall it largely shares.

Under the aegis of the Abbasid caliphs of Baghdad, Asir long constituted the Mikhlaf Sulaimani of the Zaidi rulers of Yemen, who derived a large revenue from its agricultural prosperity, which the Saudi government has planned to revive. In the 13th century its capital, Quhaifa, on the banks of the Wadi Qizan, was reputed to have had 500 sesame oil presses. The principal mosque of Abu'Arish, built in the 17th century by an ancestor of the imams of Yemen, is in ruins; but the surviving 18th-century mosque of the Ashraf commemorates a revolt against Zaidi rule by a local *sharif*, who made the town his capital (of Asir Tihamah). His successors maintained their position until 1872 when, after the opening of the Suez canal (1869), the Turks occupied Asir and Yemen until World War I. Ahmad ibn Idris al-Idrisi, a sharif from Morocco, founded in the early 19th century at As Sabya, 22 mi. N. of Qizan, the Idrisiyya religious order, and the hamlet developed into a considerable township of his devotees. He died there in 1837. Neither he, however, nor his son and grandson who succeeded to his spiritual mantle showed any sign of coveting temporal power, living peaceably under the Ashraf and Turkish regimes until about 1909 when the Young Turks sought to replace the prevailing *Shari'a* law by their secular codes. This produced revolt, before which the Turks withdrew, leaving the field open to Ahmad's great-grandson, Mohammed al-Idrisi, who proclaimed himself ruler of Asir Tihamah. During World War I he sided with the British against Turkey, and was rewarded with the gift of the Yemen Tihamah down to Al Hudaydah inclusive in 1921, though the imam Yahya recovered this slice of territory in 1925. Mohammed died in 1923 and was succeeded by his inexperienced son 'Ali, who was deposed in favour of his uncle Hasan by Ibn Sa'ud in 1926 on his proclamation of a protectorate over Asir. Meanwhile, in 1920, Ibn Sa'ud had wrested the highland and eastern sections of Asir from the Ibn 'Aidh dynasty of Abha; and in 1930 the process of absorption of the province into his realm was completed by the abolition of the protectorate and the establishment of regular administration.

Apart from agriculture, the economy of Asir is supported by a mine of rock salt at Qizan, while the Farasan Islands, 10 mi. offshore, consist largely of salt domes. Several efforts to prospect for oil in the latter proved unsuccessful. Cattle, sheep, goats and camels are widely raised throughout the province.

See H. St. J. B. Philby, *Arabian Highlands* (1952).
(H. St. J. B. P.)

'ASKARI, JA'FAR AL- (1887–1936), Iraqi statesman, a devoted servant of the kingdom of Iraq from its creation in 1921, was born in Baghdad in 1887, educated locally and in Istanbul and commissioned in the Turkish army in 1909. A burly, attractive figure and an accomplished linguist, he gave proof of excellent abilities and of outstanding moral and social qualities. Sent in 1915 to join Turkish forces in Cyrenaica during World War I, he was wounded and taken to Cairo as a prisoner by the British and, after an attempted escape, joined the Arab rebel movement against the Turks (1916), together with Nuri as-Sa'id (*q.v.*), his brother-in-law and lifelong close associate. In the Hejaz and later Syrian campaign of 1916–18 he rendered valuable services as the amir Faisal's chief of staff and army commander, and during 1918–20 he served as Faisal's governor of Aleppo and in other posts. Moving to Iraq, he became, under the high commissioner Sir Percy Cox (*q.v.*), defense minister in the first Iraqi cabinet, a creator of the Iraqi army and, from Aug. 1921, a pillar of the new monarchy. Thereafter until his murder by insurgent troops at Baghdad on Oct. 30, 1936, he was repeatedly minister, prime minister and Iraqi ambassador in London, contributing greatly to Iraqi progress and stability.

See S. H. Longrigg, *Iraq, 1900 to 1950* (1953).
(S. H. Lo.)

ASKE, ROBERT (1501?–1537), English country gentleman and lawyer who in 1536 led the northern insurrection called the Pilgrimage of Grace, came from an old Yorkshire family. Discontented with the policies of Henry VIII, he occupied York on Oct. 16 and five days later captured Pontefract castle from Lord Darcy of Templehurst, who with the archbishop of York then joined the rebels. Aske arranged for the monks and nuns to be reinstated and prevented the king's herald from reading to the commons a royal proclamation which had recently quieted a similar rebellion in Lincolnshire. With the banner of St. Cuthbert and the badge of the "five sacred wounds" brought by the Durham contingent, he led some 30,000 men toward London to present their grievances to the sovereign and to obtain the expulsion of low-born councilors and restitution for the church. But at Doncaster he met the duke of Norfolk who, commanding royal forces vastly inferior in numbers, tricked him into disbanding his followers on the assurance of the king's pardon and the promise of a parliament at York.

Aske then went to London under safe conduct, was well received by Henry VIII and put into writing a full account of the rising and of his share in it. Persuaded of the king's good intentions, he returned home in Jan. 1537, bringing with him Henry's promise to hold a freely elected parliament at York. Throughout prolonged negotiations he alone was responsible for keeping the rebels quiet and content to rely on Henry's word; in Jan. 1537 he assisted in pacifying Sir Francis Bigod's rising. This new rebellion, however, gave the king an excuse for breaking his promise and he sent the duke of Norfolk to Yorkshire with another army. Aske, now at last disillusioned, appears to have involved himself in technically new treasons not covered by his pardon, and on false assurances of security he was persuaded to go to London, where he was arrested in April and on May 17 was sentenced to death. He was taken back to Yorkshire on June 28, paraded through the towns and countryside and on July 12 was hanged at York, expressing his repentance for having broken the law but maintaining that both the king and Thomas Cromwell had promised him pardon.

Though little enough is known of him, it is clear that Aske possessed remarkable qualities of leadership. He gave to an expression of largely selfish discontents the spirit of a religious crusade, and his hold especially over the common people rested on his manifest sincerity. A loyalist by nature, he made an ineffectual rebel, but his fate and person dignified the Yorkshire rising and the old religion.

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(G. R. E.)

ASMA'I, AL- (al-Asma'i 'Abd-al-Malik ibn Quraib) (c. 740–830), Arab scholar, the greatest philologist of his age, was born in Basra and became a leading figure in the philological school there. He later became for a time tutor to the son of Harun al-Rashid in Baghdad and then retired to Basra, where he died c. 830. He was famed especially for his knowledge of ancient Arabic poetry and most of the existing collections of the works of the old poets of Arabia were compiled by him, as well as an anthology called *al-Asma 'iyyat*. Of Asma'i's many works mentioned in the *Fihrist* ("Catalogue") of the 10th-century Arabic bibliographer al-Nadim about 15 or 20 are extant, mostly in recensions made by his students. They are mainly philological monographs on the various animals, plants, customs, grammatical forms, etc., which occur in pre-Islamic Arabic poetry.

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ASMARA, the capital of the state of Eritrea, northeast Africa,

formerly an Italian colony but now federated with Ethiopia, stands on the eastern edge of the Hamasen plateau at an altitude of 7,600 ft. from where a spectacular road and a mountain railway descend to the port of Massawa on the Red sea coast 40 mi. away. It has a pleasant climate, with a rainy season from June to September. The surrounding country is hilly and somewhat bare. Pop. (1956 est.) 123,083, roughly half Christian and half Muslim, with 10,000 foreign inhabitants, mainly Italians.

The town, formerly divided into European and native zones, contains well-planned streets, avenues and modern buildings, including the palace in its park, now the residence of the imperial representative, the legislative assembly building reconstructed since federation and the new municipal building. The Roman Catholic cathedral, the striking Coptic church, one of the largest of its kind, and a fine mosque were built by the Italians. There are large markets and many good shops. From the airport, 2½ mi. away, there are services to Addis Ababa and other African towns linked up with world airlines.

Until 1897 Asmara was a hamlet with no distinction save that of having been for a while in the 1880s the headquarters of Ras Alula, the viceroy of King John IV (Johannes). It became the capital of the new Italian colony of Eritrea (1900), but until 1934 was a small colonial town. It then expanded rapidly, first as the main base for the attack on Ethiopia and then as leading city in the new Italian empire. It was captured by commonwealth forces in 1941 and with the rest of the territory remained under British military administration until Nov. 1952, when, in accordance with a resolution of the United Nations, Eritrea became federated with Ethiopia. (F. E. Sd.)

ASNIÈRES, a town in north central France in the former *département* of Seine on the left bank of the Seine, 1.5 mi. N.N.W. of the fortifications of Paris of which it has become an industrial suburb. Pop. (1962) 81,747. There are the 17th-century church of St. Geneviève, an 18th-century chateau and a dogs' cemetery on an island in the Seine. The town is a boating centre for Parisians. Automobiles, medicines, margarine and perfumes are manufactured.

ASOKA, emperor of India from *c.* 274 to 232 B.C. His precise dates have been much disputed. The evidence for his reign comes both from inscriptions engraved on rocks and pillars throughout his dominions and from traditions preserved in Sanskrit literature and in the Pali chronicles of Ceylon. According to the latter he secured his throne by a wholesale massacre of his brothers, but this may be merely legendary. To the empire inherited from his father Bindusara and his grandfather Chandragupta (*q.v.*), he added the coastal province of Kalinga between the Mahanadi and the Godavari rivers. On the northwest his empire embraced the satrapies of Paropanisadae (Kabul), Aria (Herat), Arachosia (Kandahar) and parts of Gedrosia (Baluchistan), ceded to Chandragupta by Seleucus I Nicator; on the northeast his empire reached Kamarupa (Assam), and included Kashmir and Nepal and the whole of the Indian peninsula as far south as the Penner river.

Two versions of the inscriptions in the northwest (at Shahbazgarhi and Mansehra) are in the Kharosthi script, while those from the remainder of the subcontinent are in Brahmi. They are thus of great importance not only as historical documents but also as evidence for the early development of the Indo-Aryan languages and for the study of the history of writing in India. Composed in Prakrit, these inscriptions were first deciphered in modern times by James Prinsep in 1837. In addition to the inscriptions entirely Indian in language, a fragmentary inscription in Aramaic is known from near Laghman (Sanskrit, Lampaka) on the Kabul river; and in 1958 a bilingual inscription in Greek and Aramaic was discovered near Kandahar.

In the inscriptions the king is regularly named only by the royal title Piyadassi ("of benevolent aspect," Sanskrit *Priyadarsin*; the Kandahar Greek reads *Piodasses*), but his identification with the Asoka of the literary sources was confirmed by the discovery at Maski in 1915 of a version of one of the minor edicts where the name Asoka does occur. In accordance with the doctrine of *ahimsa* ("nonviolence") he suppressed the royal hunt and stressed the sanctity of animal life. One of the edicts records that Asoka became a lay Buddhist (*upasaka*), but there is no direct evidence that he entered the Buddhist order as a monk. He did, however, send out envoys and missionaries to foreign countries, and the conversion of Ceylon to Buddhism is attributed by the Pali chronicles to Asoka's son Mahinda.

In the 13th year after his coronation he instituted quinquennial circuits of officials for the purpose of proclaiming the moral law, and in the following year he appointed *dharma-mahamatras*, or censors of religion and morals. He was eulogized for his policy of religious toleration, and there is no need to doubt his sincerity; but it is also clear that his preaching was a deliberate instrument of policy.

See also Index references under "Asoka" in the Index volume.

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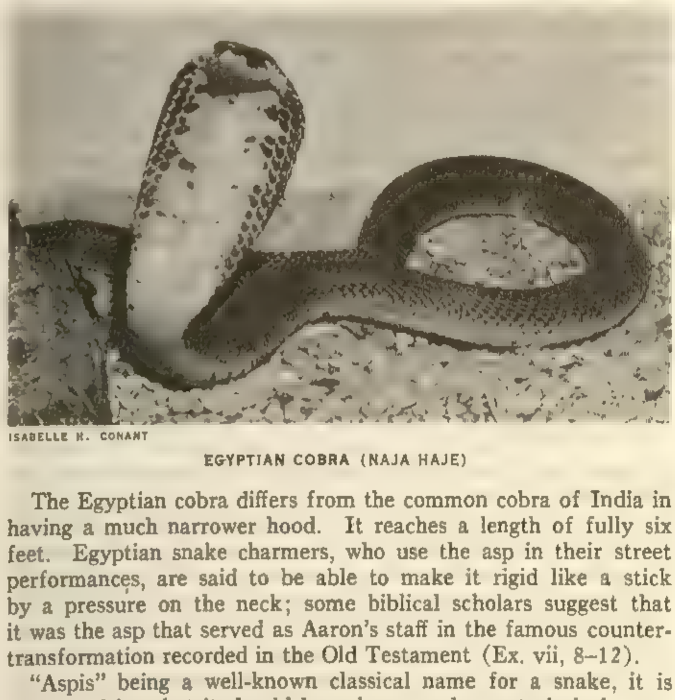
(C. C. D.; J. Br.)

ASP, the very venomous Egyptian cobra (*Naja haje*), a snake sacred to the Egyptians and adopted as a symbol by their royalty. The asp, as the *aspis* of the Greeks and Romans, is familiar in literature; and since Galen reports the use of this species to give a merciful death, by a bite in the breast, to condemned prisoners, there seems to be no reason to search further for the identity of Cleopatra's asp.



ISABELLE H. CONANT

EGYPTIAN COBRA (NAJA HAJE)

The Egyptian cobra differs from the common cobra of India in having a much narrower hood. It reaches a length of fully six feet. Egyptian snake charmers, who use the asp in their street performances, are said to be able to make it rigid like a stick by a pressure on the neck; some biblical scholars suggest that it was the asp that served as Aaron's staff in the famous countertransformation recorded in the Old Testament (Ex. vii, 8–12).

"Aspis" being a well-known classical name for a snake, it is not surprising that it should have been used as a technical name for various venomous snakes (the south European *Vipera aspis*, for example).

See also Cobra. (K. P. S.)

ASPAR (Flavius Ardaburius Aspar) (d. A.D. 471), Roman general of Alan descent, influential in the Eastern Roman empire under Marcian and Leo I. He led an East Roman fleet in 431 to expel the Vandals from Africa, but was defeated and withdrew in 434, in which year he was consul. He fought the Persians successfully in 441, but in 443 was defeated outside Constantinople by Attila. His influence increased when Marcian, who had formerly been in his service, became emperor in 450. He then became a patrician, and his son was appointed *magister militum* (master of the soldiers) in the east and soon afterward was also made a patrician. When Marcian died Aspar had his protégé raised to the throne as Leo I (Feb. 7, 457). Aspar was then at the height of

his power, with a Gothic army devoted to him. Leo, however, was not content to be a puppet and began more and more to rely on Isaurian supporters. For about four years there was a struggle for ascendancy in the East Roman empire between the two factions, Aspar's Germans and the Isaurians led by Zeno. Aspar managed to have the rank of Caesar conferred *c.* 470 on his son Patricius, although the latter was, like his father, an Arian, which caused much resentment in Constantinople; and Patricius was soon after betrothed to the emperor's daughter Leontia. But a conspiracy organized in 471 by the Isaurians and Leo led to the murder of Aspar and thus put an end to German domination over East Roman policy, which had lasted for several decades. (E. A. T.)

ASPARAGUS, a large genus of the lily family (Liliaceae) with about 150 species native from Siberia to southern Africa. Perhaps the best-known asparagus is the garden asparagus (*A. officinalis,* especially variety *atlilis*) cultivated as a green vegetable for its succulent spring stalks. Several African species, however, are grown as ornamentals (*see* below).

The plants are erect or climbing, sometimes more or less woody. The rhizomelike—or sometimes tuberous—roots give rise to conspicuous leaflike branchlets (cladodes); true leaves are reduced to small scales. Small greenish-yellow flowers in the spring are followed by red berries in the fall.

Garden Asparagus.—Economically this is the most important species of the genus. It is native from England to central Asia and is now cultivated and naturalized in most temperate and subtropical parts of the world. As a vegetable it has been prized by epicures since Roman times.

In the United States over 150,000 ac. are planted to asparagus annually for the commercial market. The production totals about 175,000 tons, of which almost 60,000 tons are sold for the fresh market and more than 115,000 tons are sold for processing. Increases in production for processing have resulted from advances in the methods of freezing and handling asparagus. Nearly half of the asparagus acreage in the United States is in California. The remainder is produced chiefly in New Jersey, Washington, Illinois and Michigan; several other states are lesser producers.

Commercial plantations are not undertaken in regions where the plant continues to grow throughout the year, for the shoots become more spindling and less vigorous each year; a rest period is required. In some warm, dry regions the rest period may be provided by withholding irrigation. Where the climate is favourable a plantation may be productive for 10 to 15 years. Asparagus can be grown in many kinds of soil with good drainage, but the best types for permanent plantations are deep, loose and light clays with much organic matter and light sandy loams. Asparagus will thrive in soils too salty for most other crops, but acid soils are to be avoided. In starting a crop, seeds are sown as early as possible, dropped 10 or 12 to a foot of row; the rows are usually 24–30 in. apart. The plants are grown for one year in nursery rows, then the year-old crowns (roots with stem attachment near the ground surface) are transplanted into the permanent fields as early in the year as the soil can be worked—in parts of the south and in California where climatic conditions are favourable even in fall or winter. Only the best and most vigorous crowns are used in transplanting; they are set 6 to 8 in. deep in loose soil and only 3 to 4 in. in heavier soil, placed 12 to 24 in. apart in rows 4 to 8 ft. apart, depending on soil and climate and on the end use of the asparagus.

Three classes of asparagus based on colour are marketed. Green spears and green with white butts are the kinds produced for the fresh market. Most canning asparagus is blanched white. The cutting season varies from 2 to 12 weeks, depending on age of plantation and on climate.

Ornamentals.—The several species prized for their delicate and graceful foliage are: *A. plumosus,* the asparagus fern or florist's fern (not a fern at all, however), which has feathery sprays of branchlets often used in corsages and in other plant arrangements; and *A. sprengeri* and *A. asparagoides* (the latter being the smilax of florists) likewise grown for their attractive lacy foliage, sometimes as house plants.

See Ross C. Thompson *et al.,* "Asparagus Culture," U.S. Department of Agriculture *Farmers' Bulletin No. 1646* (1958). (L. O. W.)

ASPARAGUS PEA (GOA BEAN), the name of a group of cultivated leguminous plants mostly derived from *Psophocarpus tetragonolobus,* native to India. All varieties are rapidly growing vines, 10 ft. to 50 ft. long, producing quadrangular, green-winged pods, 3 in. to 9 in. long. The tender young pods are eaten like string beans and have a distinct flavour resembling that of asparagus.

The seeds, which are about the size of peas, have a high protein content. Because of their extreme hardness when ripe, they are difficult to cook, hence usually only the immature seeds are eaten.

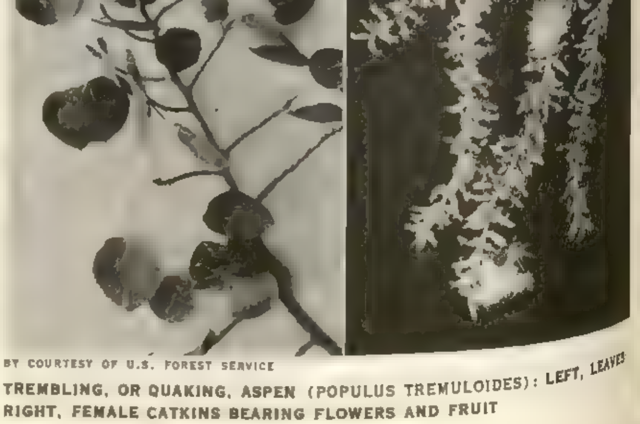
The plant is a quasi-perennial, bearing almost continuously for one or two years, and its cultivation is increasing in tropical countries; it is also grown as a cover crop.

ASPASIA (5th century B.C.), mistress of the Athenian statesman Pericles, was born in Miletus. Coming to Athens, she lived with Pericles from *c.* 450 B.C. to his death in 429. Pericles already had two young sons by an Athenian wife whom he had divorced and had himself carried a law in 451 requiring Athenian birth on both sides for citizenship. His son by Aspasia, who took his own name, was therefore illegitimate.

Aspasia was a vivid figure in Athenian society. She was continually attacked in comedy for her private life and public influence. She was irresponsibly accused of urging Pericles to crush Samos (Miletus' old rival) and to provoke the Peloponnesian War. But she was respected and remembered by philosophers. The associates of the young Socrates knew her well; she is a character in the *Menexenus* (falsely attributed to Plato); and she gave her name to a philosophic dialogue by the Socratic Aeschines. Shortly before the Peloponnesian War she was prosecuted for impiety but acquitted, and, when Pericles' two legitimate sons had died in the plague, his son by Aspasia was made an Athenian by special enactment and later became a general. After Pericles' death she is said to have lived with Lysicles (probably the man elected *strategos* for 428, regarded by Aristophanes unfairly as a vulgar demagogue). (R. ME.)

ASPECT RATIO. The aspect ratio of an airplane wing is the ratio of the span to the chord, the latter being the length of the straight line drawn from the leading to the trailing edge, at right angles to the length of the wing (*see* AIRPLANE). For a screen on which an image is projected, such as a motion-picture or television screen, the aspect ratio is the ratio of image width to image height (*see* MOTION PICTURES: *History: Wide Screens*).

ASPEN, a common name for several trees of the poplar genus (*Populus*), of which the common aspen of Europe, *P. tremula,* may be taken as the type. This is a tall, fast-growing tree with a



BY COURTESY OF U.S. FOREST SERVICE

TREMBLING, OR QUAKING, ASPEN (POPULUS TREMULOIDES): LEFT, LEAVES; RIGHT, FEMALE CATKINS BEARING FLOWERS AND FRUIT

slender trunk and gray bark that becomes rugged when old. The roundish leaves, toothed on the margin, are slightly downy when young but afterward smooth, dark green above and grayish green below; the long slender petioles, flattened toward the outer end, allow of free lateral motion by the slightest breeze, giving the foliage its well-known tremulous character. By their friction on each other the leaves give rise to a rustling sound. The flowers, which appear in March and April, are borne on pendulous hairy catkins, two or three inches long; male and female catkins are, as in the other species of the genus, borne on separate trees (dioecious).

The American aspen (*P. tremuloides*), called trembling aspen, closely allied to the European species, attains a maximum height of 100 ft. and a trunk diameter of 3 ft., but is usually much smaller. The bigtooth aspen (*P. grandidentata*) of North America has ovate or roundish leaves deeply and irregularly serrated on the margin.

P. tremuloides is the most widely distributed tree in North America, ranging from Labrador to the mouth of the Mackenzie river and the valley of the Yukon and southward to Pennsylvania, Missouri and Nebraska, and in the Rocky mountains and the Sierra Nevada to Chihuahua and Lower California, often ascending to an altitude of 10,000 ft. The aspen is an abundant tree in northern Great Britain, and is found occasionally in the coppices of the southern counties; it abounds in the forests of northern Europe, while in Siberia its range extends to the Arctic circle.

Aspen wood is light and soft, though tough; it is employed for various articles for which its lightness recommends it; in medieval days it was valued for arrows; the bark is used for tanning; cattle and deer browse on the young shoots and suckers. Charcoal prepared from it is light and friable, and has been employed in gunpowder manufacture. The powdered bark is given to horses as a worm medicine. The wood of both American species is manufactured into furniture, matches and wood pulp.

(E. S. Hr.; X.)

ASPENDUS (Gr. Aspendos; modern Bal-kiz kale in the Turkish *il* of Antalya), an ancient city of Pamphylia, strongly situated on an isolated hill on the right bank of the Eurymedon (Köprusu) river at the point where it issues from the Taurus mountains. The sea is about 7 mi. distant, and the river is navigable only for about 2 mi. from the mouth, but in the time of Thucydides ships could anchor off Aspendus. Really of pre-Hellenic date, the place claimed to be an Argive colony. It derived wealth from great salt pans by Lake Capria (possibly marked now by the winter marshes to the west of the site) and from a trade in oil and wool, to which the wide range of its admirable coinage bears witness from the 5th century B.C. onward. The city bought off Alexander the Great in 333 B.C., but, not keeping faith, was forcibly occupied by him. In due course it passed from Pergamene to Roman dominion and, according to Cicero, was plundered of many artistic treasures by Verres. It was ranked by Philostratus the third city of Pamphylia. In Byzantine times it seems to have been known as Primopolis, under which name its bishop signed at Ephesus in A.D. 431. In the middle ages it was evidently still a strong place but is now a small hamlet.

With the Roman theatre, the most perfect in Asia Minor and possibly the finest in the world, the ruins have earned for the place a mythical connection with Solomon's Sheban queen. On the flat summit of the hillock, divided in two by a small ravine and surrounded by a wall with three gates, lie the remains of the city. These include an agora, a basilica, a *nymphaeum*, a small theatre, an arcade and traces of rock-cut chambers of Phrygian style. In the plain below are large thermae and ruins of a splendid aqueduct. The huge theatre, half hollowed out of the northeast flank of the hill, had an auditorium of a circuit of 313 ft. with 40 tiers of seating and would accommodate 7,500 spectators. It was erected to the honour of the emperor Marcus Aurelius and his colleague Lucius Verus by the architect Zeno for the heirs of a local citizen. A relief of Bacchus over the centre of the theatre's colonnade is the "Bal-kiz" or "honey girl" from whom the present village takes its name.

(Wm. C. B.)

ASPERGES, the ceremony of sprinkling the altar and the people with holy water (*q.v.*) before High Mass in the Roman Catholic Church, so called from the opening words, *Asperges me, Domine, hyssopo* (Ps. li., 7), of the chant that accompanies the ceremony. The sprinkler is called aspergillum, and a vessel for holy water is called aspersorium.

See C. Goeb, "The Asperges," *Orate Fratres,* 2:338–342 (1927–28).

ASPERN-ESSLING, BATTLE OF, Napoleon's first serious reverse, was fought on May 21 and 22, 1809, between his French and allied forces and the Austrians commanded by the archduke Charles (*see* Napoleonic Wars). After the repulse of his initial invasion of Bavaria in April, Charles's army had retired eastward in two groups. The French entered Vienna on May 12 to find the bridges across the Danube cut and the enemy reassembled on the north bank. Napoleon accordingly determined to force a crossing six miles below Vienna via Lobau, the largest of the islands which split the swollen river into smaller channels about that point. On May 21, by midday, 25,000 French troops had reached the farther bank, where the villages of Aspern and Essling secured their left and right flanks. Although the state of the bridges delayed the arrival of reinforcements, they maintained their bridgehead until nightfall against the heavy but badly coordinated attacks of Charles's 95,000 men. Reinforced substantially during the night, the French resumed battle at first light on May 22. Masséna cleared Aspern of the enemy who had penetrated it, and Lannes retook Essling, which had fallen early in the day. A general French offensive in the centre was halted, however, and Aspern was again lost. Furthermore, the bridges to the right bank were severed, and at 11 A.M. Napoleon called off his attack. Furious fighting accompanied the costly French retreat to the Danube during the afternoon. Determined French resistance, their own exhaustion and Charles's indecision prevented the Austrians from routing the French before they could withdraw to Lobau under darkness. The French suffered 20,000 casualties (Lannes being killed), and the Austrians 23,000. Early in July the French were able to cross the Danube again to defeat Charles at the battle of Wagram.

(J. H. N.)

ASPHALT, an organic material that is sticky, black or brown in colour and of a consistency varying from heavy liquid to solid. Asphalt, whose chemical composition is too complex and variable to be determined precisely, is obtained either from the distillation of petroleum or from natural deposits. Asphalts from the two sources resemble each other in all respects except that natural asphalt, believed to be an early stage in the breakdown of organic marine deposits into petroleum, often contains minerals while petroleum asphalt does not. Asphalt is of great commercial value, with its most important uses in road building, waterproofing, roofing, floor tiling and automobile manufacturing.

Sources.—The earliest known asphalts occurred in springs in the east and to some extent in Europe. Later, deposits of solid, semisolid and liquid asphalts, usually mixed with minerals ranging from dust to sand, were found and mined. Lake asphalt from Trinidad was the first large commercial source but natural asphalt has declined in relative importance as petroleum became the major source. Gilsonite, wurzilite and similar vein asphalts that are very hard and are mined like coal have special uses in heat-resistant enamels. Petroleum asphalt is produced in all consistencies from light road oils to heavy (high viscosity) industrial types.

History.—The use of asphalt is very old. Probably its earliest use was as a water stop between brick walls of a reservoir at Mohenjo-Daro (beginning in the 3rd millennium B.C.) in India. Early Buddhist traditions mention "earth-butter." In the middle east it was extensively used for roads and water works, such as flood control; a king left an inscription to the effect that he had found his realm in mud and had left it "laced with roads glistening with asphalt."

Composition.—Asphalts are often referred to as hydrocarbons (hydrogen and carbon compounds) but this is seldom technically correct. For the most part they consist of hydrocarbons that have combined with nitrogen, sulfur and oxygen. No method for accurately analyzing asphalt has yet been discovered. Its constituents appear to be enormously variable, complex and subject to rapid change under different methods of treatment, although

possessing rather stable physical properties except when heated. Methods of analysis have usually consisted of determining relative molecular weights, general nature of compounds and elemental composition rather than specific chemical structure.

Uses.—*Asphalts for Roads.*—A great variety of road uses exists, from light oil dust layer treatments, which by repetition may gradually build up a permanent surface, to precisely designed road surfaces of graded mineral-asphalt composition up to eight inches thick. The lowest-cost method, aside from the dust layer method, is the spraying of road oil on the prepared surface, followed by the application of granular aggregate, forming what is termed a "seal coat." The seal may consist of single, double or multiple coats. The next method in increasing order of cost is the mixing of local materials in place with road oils, by traveling machinery, to form a low-cost but also usually a low-quality pavement. A considerable use of asphaltic oils has been made for mixing directly with soils to form waterproof bases or subbases for pavements. This is termed "soil stabilization" and for success requires special oils.

Asphalts for Hydraulic Uses.—These uses include applications to canal linings, dam facings, river and sea revetments, beach erosion barriers and reservoir linings, and injection into sands and fissured rock formations to stop the flow of underground water. Linings vary from thin, sprayed membranes covered with earth for protection against weathering and mechanical damage to thick surfacings similar to road pavings, and to stone riprap bound with asphalt. In general, mixtures used for hydraulic purposes employ more asphalt by percentage than do road work mixtures and are less mechanically resistant.

Asphalts for Industrial Use.—These normally consist of road type or steam-refined asphalts that have been intensively oxidized. The principal industrial uses are for roofs, coatings, floor tiling, automobile manufacture, battery manufacture, soundproofing, waterproofing and other specialities in great number. A considerable amount of industrial-type asphalt also is used in hydraulic works.

Asphaltic Emulsions.—Asphaltic emulsions consist of fine globules of asphalt suspended in water and prevented from coagulating by protective surfaces furnished by chemicals mixed into the asphalt prior to emulsifying. The emulsification is carried out with a colloid mill. The uses in general parallel those of regular asphalts except that emulsions are not used in heavy paving mixtures. An advantage of emulsified asphalt is that it does not have to be heated before being applied.

Mechanical Properties.—Asphalt is thermoplastic and subject to variable mechanical reactions; these properties are affected by the conditions of loading and by the presence of solvents remaining from distillation or added. Mechanical resistance to deformation can be measured in terms of poise, which is an absolute unit of viscosity; resistance can be measured in all ranges of consistency and at all ordinary temperatures. Formulas also exist for transforming some older units of resistance to absolute units.

In asphalts deviation from pure liquid, or Newtonian, flow is common, with various forms of plastic behaviour being found. The deviation also can be measured and expressed in terms of poises. The sliding plate viscometer was the most suitable instrument for measuring viscosity early in the sixth decade of the 20th century.

Elasticity appears in asphalts under certain conditions. In the Newtonian or pseudo-Newtonian types it appears as a roentgen effect, or reaction to impact; in oxidized industrial asphalts it is a weak solid-type, partly static reaction. These effects have various applications in practical use. The roentgen effect is of special importance in road use, where dynamic impact is high.

Mechanics of Asphalt-Mineral Mixtures.—The mechanical properties of asphalt are of little significance except when it is used as a binder or adhesive. The reactions that occur in binding and adhesion are exceedingly complex, involving viscosity, plasticity and granular solid structure. For static loadings or loadings at low velocities, the triaxial form of test, which applies loads to a completely confined test specimen, is the most scientific and informative. For impacts, there are various vibratory methods, some for field and some for laboratory use.

The history of asphalt-testing methods has been influenced by the somewhat paradoxical fact that although the subject is very complex scientifically, good results in road work can be obtained by trial and error, and this is the manner in which such work proceeded in former times. Research on testing has actually largely taken the form of rationalizing and improving work done originally by trial and error at great public cost. *See* GEOCHEMISTRY: *Bioliths;* TRINIDAD AND TOBAGO; GILSONITE; OZOCERITE; ROADS AND HIGHWAYS: *Construction;* HOUSE DESIGN: *Materials;* BLACK VARNISH.

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ASPHALT TILE: *see* FLOOR COVERINGS.

ASPHODEL, a much misunderstood common name for several flowering plants belonging to the lily family (Liliaceae). The asphodel of the poets is often a narcissus; of the ancients it is either of two genera, *Asphodeline* or *Asphodelus*, containing numerous species in the Mediterranean region.

They are hardy herbaceous perennials with narrow tufted radical leaves and an elongated stem bearing a handsome spike of white or yellow flowers.

Asphodelus albus and *A. fistulosus* have white flowers and grow from 1½ to 2 ft. high; *A. ramosus* is a larger plant, the large white flowers of which have a reddish-brown line in the middle of each segment.

Bog asphodel (*Narthecium ossifragum*), of the same family, is a small herb growing in boggy places in Great Britain, with rigid, narrow, radical leaves and a stem bearing a raceme of small golden-yellow flowers. In the United States the American bog asphodel (*N. americanum*), of the pine barrens of New Jersey and Delaware, and the western bog asphodel (*N. californicum*), of the coast ranges of California and Oregon, are both rare plants.

In Greek legend the asphodel is the most famous of the plants connected with the dead and the underworld. Homer describes it as covering the great meadow, the haunt of the dead. It was planted on graves and is often connected with Persephone. Its general connection with death is due no doubt to the grayish colour of its leaves and its yellowish flowers, which suggest the gloom of the underworld and the pallor of death. The roots were eaten by the poorer Greeks; hence such food was thought good enough for the shades.

The asphodel was also supposed to be a remedy for poisonous snake bites and a specific against sorcery; it was fatal to mice, but preserved pigs from disease. According to Herodotus, the Libyan nomads made their huts of asphodel stalks.

ASPHYXIA, a term in medicine signifying suffocation or any interference with oxygenation of the blood. It is the result of many causes and may be seen at any stage of life. *See* RESPIRATORY SYSTEM, DISEASES OF. (F. L. A.)

ASPIDISTRA (CAST-IRON PLANT), a small genus of the lily family (Liliaceae) native to China and Japan. The plant will withstand adverse conditions and thus is considered among the most useful foliage plants for growing indoors. *Aspidistra elatior* bears green or white striped leaves, about 18 to 20 in. long, and when pot-bound produces small, purple, cup-shaped flowers close to the soil. (R. T. V. T.)

ASPIRIN is a trade name for acetylsalicylic acid, introduced into medicine by Hermann Dreser in 1893. It is widely used as an antipyretic and analgesic.

Like other salicylates, aspirin will relieve the joint pains in acute rheumatic fever without, however, influencing the course and complications of the disease. The symptoms of overdosage ("salicylism") include ringing of the ears, headache, dizziness, dimness of vision, mental confusion, nausea, vomiting and diar-

rhea.

Some individuals are hypersensitive to aspirin as manifested by skin rashes and anaphylactic phenomena. Aspirin may also cause gastric irritation.

See also SALICYLIC ACID.

ASQUITH, HERBERT HENRY: *see* OXFORD AND ASQUITH, HERBERT HENRY ASQUITH, 1ST EARL OF.

ASS, a member of the horse family, typified by the domestic donkey. The ears are long, the long hairs on the sides and end of the tail form a tuft, the mane is hogged or erect and there are no horny bare patches on the hind leg just below the hock or heel joint. A dark stripe runs along the back and another crosses it over the shoulder; the legs are often banded with dark stripes. The voice is a roaring "hee-haw" bray. Gestation lasts 12 months, a month longer than in the horse.

When an ass or donkey is mated with a horse, the offspring is a mule (*q.v.*).

The common donkey is a domesticated race of the African wild ass, *Equus asinus*, of Ethiopia and other parts of northeast Africa, which with some exceptions is larger than most domestic varieties. In Somaliland the wild asses lack the shoulder stripe and have conspicuous bands on the legs so that they are regarded as a distinct subspecies.

The wild ass of Asia, *E. hemionus*, is generally similar but with less gray and more rufous or fawn in the coat colour; the stripes along the back and across the shoulder and the bands on the legs are also generally present. Five subspecies are recognized: the Syrian wild ass, *E.h. hemippus*, from the Syrian desert but now nearly extinct; the onager, *E.h. onager*, of northwest Iran to Soviet Turkestan; the Indian wild ass, *E.h. khur*, from western India and Baluchistan, in which the shoulder stripe and leg bands are often pale or wanting; the kiang, *E.h. kiang*, of the high plains of Tibet at a height of 15,000 ft. and more, a large ass with pale back stripe, no band on the legs and little indication of the shoulder stripe; and the kulan, *E.h. hemionus*, from central Mongolia.

Wild asses inhabit arid, semidesert plains where the vegetation is sparse and coarse; the domestic donkey does well on very coarse food and is extremely hardy under rough conditions, hence its great usefulness to man as a beast of burden in places where horses cannot flourish.

The donkey's occasional obstinacy in refusing work too heavy for it has become proverbial, but its equally proverbial stupidity has probably become legendary through its reaction to brutal treatment and neglect. It is naturally patient and persevering, responding to gentle treatment with affection and attachment to its master. (L. H. M.)

ASSAB, a port of Eritrea, Ethiopia, on the Eritrean coast, 60 mi. N. of the strait of Bab el Mandeb, lies at the entrance to Assab bay in a rainless region of very high temperatures. Pop. (1956 est.) 4,248. The federation between Ethiopia and Eritrea in 1952 made possible the development of the port as a natural outlet for the southern half of the country.

The port, which is connected by a good truck road with the main Addis Ababa-Asmara highway, was being enlarged and modernized in the early 1960s. About one-third of Ethiopia's external trade passes through Assab. The salt-evaporation pans produce about 125,000 tons annually.

Assab was for many centuries a terminus of caravan routes across the Danakil desert from the highlands, and there are Sabaean ruins 10 mi. S. of the town. It acquired a greater significance after the opening of the Suez canal, and the area was purchased in 1869 by Giuseppe Sapeto from the sultan of Raheita (30 mi. S.). It was later taken over by the Società di Navigazione Rubattino which was acquired by the Italian government in 1882, Assab thus becoming the first Italian colonial possession in Africa. (G. C. L.)

ASSAM, the northeastern state of the Republic of India, is almost cut off from the rest of the country on the west by East Pakistan, and borders Bhutan (N.W.), Tibet (N.) and Burma (E.) Area 47,098 sq.mi. excluding the North East Frontier Agency (*q.v.*; area 31,438 sq.mi.). In British times the province of Assam included also the district of Sylhet (*q.v.*) in the south,

PAUL POPPER LTD.

SAMPAN SKIFFS ON THE BRAHMAPUTRA RIVER, ASSAM, INDIA

most of which is now part of East Pakistan, and the governor of Assam had supervision over Manipur which, on partition in 1947, became a union territory. Pop. (1951) 9,043,707; (1961) 11,872,772.

Physical Geography.—Assam proper comprises the valley of the Brahmaputra as far as the foothills of the Himalayas on the north where lies the frontier with Bhutan occupying the Himalayas to the west. The North East Frontier Agency covers the Himalayas in the northern and northwestern part of the state. The valley is roughly 500 mi. from east to west and 50 to 100 mi. wide and is bounded on the south by a succession of hill masses—the Garo, Khasi and Jaintia hills beyond which lies Pakistan, the Barail range on the Manipur border and the Patkai hills on the Burmese border. The agency has a long frontier with Tibet and China. Near the head of the valley a number of rivers unite to form the Brahmaputra (*q.v.*) proper; by far the most important is the Tsangpo (often called Brahmaputra on western maps), which after flowing eastward through Tibet for hundreds of miles turns south through the main Himalayan ranges in great gorges to fall in a series of rapids to the Assam valley where, 1,000 mi. from the sea, it is only 400 ft. above sea level. From there it follows a sluggish course meandering, dividing and reuniting, frequently many miles wide so that periodic flooding renders much of the Assam valley of little use. The various hill areas round the valley are named after the hill tribes inhabiting them; at the far eastern end the great mountain barrier became known during the early part of World War II as "The Hump" over which supplies were flown to western China then resisting the Japanese invasion.

Geologically the hill mass of southern Assam is a detached portion of the Indian plateau consisting of Pre-Cambrian schists and gneisses overlain in places by little folded Cretaceous and Tertiary rocks, sometimes with seams of coal and also with nummulitic limestone beds. The Himalayan and Burmese ranges are intensively folded, apparently against and around the stable block of the Assam hills, and include rocks up to Late Tertiary. Oil occurs associated with Mid-Tertiary rocks in tight anticlinal folds, notably at Digboi. Folding has not ceased; earthquakes are frequent in the mountains of the northeast and especially severe were those of 1897, affecting the Garo-Khasi hills, destroying Shillong and killing 1,542 people, and of 1950.

Climatically the cool season (Jan. average 61° F. in the valley) is marked by the northeast monsoon blowing down the valley and fogs are common and a little rain. Assam escapes the normal Indian hot dry season; some rain occurs from March onward but the real force of the monsoon winds is felt from June onward. They blow at right angles to the Assam hills, and Cherrapunji (*q.v.*) overlooking the valley of the Surma (in Pakistan) is reputed to be the wettest place in the world, with an annual average of more than 400 in. By the time the winds have crossed the hills they bring little rain to the valley where Gauhati averages only 67 in. Average temperature is kept moderate (84° F. in the hottest month). At high levels snow falls.

The range in climate is reflected in natural vegetation—from evergreen rain forests resembling but floristically different from equatorial forests, through evergreen oak and pine, to rhododendron thickets and the snow line. Timber is valuable. Elephants are numerous in the foothills; the Kaziranga game reserve is the last great Indian stronghold of the one-horned rhinoceros and has herds of buffalo and swamp deer. Other animals besides the ordinary Indian fauna include the clouded leopard, Temminck's cat, Malayan bear, Malayan sambar, musk and mouse deer, red serow, pigmy hog and white-browed gibbon. (L. D. S.)

History.—Sources for the history of Assam are limited to Ahom (*see* below) chronicles of doubtful accuracy, references in Burmese chronicles, a few inscriptions and copper plates, coins for the later periods and Muslim accounts of the wars of the 16th and 17th centuries. From remote antiquity the valley was occupied by a Tibeto-Burman-speaking people. This stock still forms the bulk of the indigenous population.

Indo-Aryan settlement in the valley must have begun before the opening of the Christian era. Three lines of kings are known to have ruled from the 6th to the 12th century. In the 13th century the first Muslim invasions broke up the old kingdom; about 1515 a Koch dynasty carved out lands that now comprise the district of Cooch-Behar (*q.v.*) and lower Assam, and which soon split into an eastern and a western kingdom.

Meanwhile the Burmese Shans, known as Ahoms, who were to give their name to the country and rule it for centuries, had crossed the low ranges at the head of the valley and were consolidating their power in upper Assam. The traditional date of the Ahom invasion according to their chronicles is A.D. 1228, but students of Burmese history consider a date in the late 15th or early 16th century more probable (*see* AHOM). They at once came into conflict with the Kacharis, whose leaders retreated down the south bank of the Brahmaputra.

In 1527 Muslim marauders from Gaur (*q.v.*) invaded the Ahom kingdom for the first time and were defeated. The Ahoms, pressing west against the Kacharis, sacked Dimapur, their capital, and forced them into the north Cachar Hills, where they built a new capital at Maibang. Surviving ruins show that the Kacharis at this period had attained a considerably higher state of civilization than their conquerors. Wars with the Muslims occupied much of the 17th century, and in 1662 lower Assam was ceded to the Mughal emperor Aurangzeb. In 1706 the Kacharis were driven out of Maibang and established their last capital at Khaspur in the plains of Cachar. About this time the Ahom king Rudra Singh became an orthodox Hindu, and in the reign of his successor Sib Singh (1714–44) Hinduism became the predominant religion.

The country had frequently been distracted by rebellions in which both sides showed appalling brutality, and by 1792 such was the state of affairs that the king, Gaurinath, sought and received aid from the British in Bengal. This aid was soon withdrawn, however, and in 1816 a claimant to the throne called in the Burmese, who plundered the country and returned the following year. After further disorder and a period of direct British rule (1826–32), Assam was in 1838 incorporated in Bengal (*q.v.*) and remained a part of that province until a separate chief commissionership was set up in 1874. This arrangement continued, with one interval, until 1919, when Assam became a governor's province.

During World War II the Naga Hills, especially the area around Kohima, were the scene of bitter fighting between the British 14th army and the Japanese forces which had occupied Burma in 1942. Assam became one of the main supply routes for all the Allied forces operating in this area.

On Jan. 26, 1950, when the constitution of India came into force, Assam became a state of the republic.

A movement for independence, which started in 1955 among the Naga tribes in the Tuensang frontier division of the North East Frontier Agency and in the Naga Hills district of Assam, developed into a rebellion in 1956–57, necessitating operations by the Indian army. As of Dec. 1, 1957, the whole area affected was placed under the direct administration of the central government of India.

The rebellion continued, however, and although Nagaland became a separate (the 16th) state within the Indian Union in 1962 (inaugurated Dec. 1, 1963) a cease-fire was not agreed upon until 1964. Despite breaches the cease-fire continued in force during talks (1964–66) between the Indian government and the Naga rebels who demanded independence.

During the same period the Chinese, disputing the McMahon Line as boundary between India and Tibet, crossed it into the North East Frontier Agency area of Assam to occupy an Indian outpost at Longju. In much greater strength (September 1962 they deeply penetrated Agency territory. In December, however they voluntarily withdrew behind the McMahon Line.

On Feb. 28, 1966, Mongoloid rebel groups, who demanded a separate Mizo (*q.v.*) state, began to fight as guerrillas against the Indian Army. (*See* also INDIA: *History;* NAGALAND.)

(J. P. M.; F. R. A.; X.)

Population and Administration.—According to the 1961 census the population of Assam was 11,872,772. The population is heterogeneous and includes many people of distinctly Mongoloid physical type, among them such tribal groups as the Khasis and the Nagas. About 40% are recorded as speaking Assamese and about 24% Bengali. About 65% are Hindus, 22% Muslims, and most of the remainder professing Christianity or tribal beliefs. Labour for the tea gardens has brought in many workers from Bihar, while after 1911 many land-starved peasants from Mymensingh in Bengal settled in the valley. Hindi, Oriya, Mundari, Nepali and a variety of languages and dialects classified under the general category of Tibeto-Burman languages (*q.v.*) are also spoken. There has never been a regular or adequate census of the tribal population in the state for the administration in the North East Frontier Agency and other tribal areas rests lightly.

The state government has a unicameral legislature under a governor and cabinet. The N.E.F.A. is completely separate from Assam administratively. The governor rules the agency with the help of an adviser in Shillong and the ultimate responsibility for the area rests with the external affairs ministry of the government of India. Assam comprises the 11 administrative districts of Goalpara, Kamrup, Darrang, Nowgong, Sibsagar, Lakhimpur, Cachar, Garo Hills, Khasi-Jaintia Hills, Mizo Hills and Mikar and North Kachar Hills. (S. CH.)

Social Conditions.—In 1956–57 an estimated 1,155,000 children were receiving education, of whom more than two-thirds were boys, and 90% came from rural areas. Primary education was being given to 61.7% and secondary education to 16.3% of the children in the respective age groups. Compulsory primary education was in force for children of 6–12 in 13 towns and 4,405 villages. The 1961 census recorded that literacy among males was 35.5% and among females only 14.6%. Gauhati (*q.v.*) is the seat of Assam's only university. In 1955 birth and death rates were respectively 33.9 and 15.6 per 1,000 persons. Seventeen welfare extension projects, operating through 83 centres and covering 300,000 people, were providing recreational and cultural facilities for women and children. (S. B. L. N.)

The Economy.—In comparison with most of the states of India Assam is still relatively underpopulated and has land awaiting settlement and development. Government reserve forests cover 6,350 sq.mi. (1951–52). Among the many valuable hardwoods are sal (*Shorea robusta*), bonsum (*Phoebe hainesiana*) and hollock (*Terminalia myriocarpa*) but much forest land is too inaccessible to be of economic importance. Bamboo cane is also exported. In the Assam valley rice is the principal crop, averaging in the state more than 4,000,000 ac. and a production of nearly 2,000,000 tons. Large areas of land liable to flooding and changes of river course are at present classed as "cultivable waste." The western end of the valley comes within the jute-growing belt of India. Tea is the most important article of commerce and its cultivation is a basic factor in the development and economy of Assam. More than 1,000 tea gardens covering nearly 400,000 ac. and employing over 500,000 people are found especially on the sloping land of the valley sides but also, provided soil drainage is good, on the plains. The Assamese are too concerned with their own holdings and

too prosperous to seek work on tea plantations; the necessary labour is brought in from Bihar and central parts of India. Legislation ensures the labourers' protection and repatriation but many settle permanently at the end of their engagement, indeed less than a quarter of the state's population are native-born Assamese. Other crops include sugar cane, oilseeds and mustard, with short-stapled cotton, millet and maize in the hills. Potatoes and oranges are exported in large quantities from the Khasi hills. The hill tribes practise shifting cultivation, which creates an erosion problem, but permanent irrigated terraces are found in some areas.

Cottage industries, mainly sericulture and hand weaving, employed about 2,000,000 persons in the early 1960s. Modern industry has scarcely reached Assam but the refinery at Digboi processes about 250,000 cans of petroleum annually from the nearby oil fields. A little coal is quarried, and many deposits are not yet touched. Limestone is quarried on the southern fringe of the Khasi hills, and sillimanite from the plateau above is used in glass furnaces in India and Europe.

Shillong (*q.v.*), the state capital pleasantly situated on the cool height of the plateau, has no railway but is reached by motor road from Gauhati where the two main sections of the Assam railway are separated by the Brahmaputra. The direct line from there to Calcutta lies through East Pakistan and there has been no through running since partition in 1947. By the construction of a short link line, Calcutta can now be reached by a tortuous route round the north of East Pakistan but one lying entirely in Indian territory. The only direct access to Assam from the main part of India is by air.

See also references under "Assam" in the Index.

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ASSAMESE LANGUAGE, the Indo-Aryan tongue spoken in the Assam valley. In its grammar it closely resembles Bengali (*q.v.*), since both are derived from a common source. Its vocabulary is mainly tadbhava. Tadbhava means "of the same character as" Sanskrit, contrasted with tatsama, "identical with" the Sanskrit word. The French word ange is tadbhava, while angelus is tatsama, identical with the Latin.

The Assamese language has been affected by its proximity to Tibeto-Burman dialects both in vocabulary and in structure, as in the use of pronominal suffixes, and in phonetics, though following Bengali generally in its accentuation.

The chief glory of Assamese literature is in history. The *buranjis* or historical works are voluminous and have been carefully preserved.

ASSASSIN, a general term for one who murders by treacherous violence (properly *hashishin*, a taker of hashish), originally a name applied to the branch of the Isma'ili sect of Shi'ite Muslims founded by Hasan ibn al-Sabbah at the end of the 11th century.

Hasan, a native of Khurasan and a supporter of the official Isma'ili doctrine of the Fatimid caliphate in Cairo, became the leader of the great Isma'ili revival in Persia directed chiefly against the new Seljuk regime (*see* SELJUKS). After the death of the Fatimid caliph Mustansir in 1094, Hasan and the Persian Isma'ilis refused to recognize the new caliph in Cairo and transferred their allegiance to his deposed elder brother Nizar. Nizar and his son were murdered in prison in Egypt, but, according to Assassin tradition, an infant grandson was smuggled out to Persia and there brought up by Hasan ibn al-Sabbah to found a new line of Nizari imams. Hasan and his two successors in the grand mastership of the Persian Isma'ilis, Kiya Buzurgumid (1124–38) and Mohammed (1138–62), claimed only to be representatives of the imams; but the fourth grand master, Hasan ibn Mohammed (1162–66), proclaimed himself the son of the infant brought from Egypt and the first of a new line of open imams (now represented by the Aga Khan; *q.v.*). The Assassins made a number of changes in Isma'ili doctrine and practice, the most significant, from the point of view of the outside world, being the adoption of "assassination" (*i.e.*, the murder of the sect's enemies) as a sacred religious duty.

The open history of the sect begins in 1090, when Hasan ibn al-Sabbah, the first "Old Man of the Mountain," seized the castle of Alamut in an impregnable valley near Kazvin. By the end of the 11th century he commanded a network of strongholds all over Persia and Iraq, a corps of devoted terrorists and an unknown number of agents in the camps and cities of the enemy. In Alamut, which remained the headquarters until its destruction by the Mongols, the grand master presided over a hierarchy of propagandists (*da'i*), terrorists and lay brothers and directed the policies and activities of the sect. Seljuk attempts to capture it were unavailing, and soon the Assassins were claiming many victims among the generals and statesmen of the caliphate, including even some of the caliphs themselves. The Fatimid government in Cairo, with which the Assassins were now on terms of open hostility, also suffered from their attentions, though to a lesser extent.

At the beginning of the 12th century the Persian Assassins extended their activities to Syria, where the expansion of Seljuk rule, followed by the arrival of the crusaders, had created a favourable terrain. The Syrian population had long included important extremist Shi'ite minorities who might be expected to welcome the Assassin emissaries. After a period of preparation the Assassins seized a group of castles in the Jebel Ansariya, the chief of which was Masyaf, and from there waged a war of terror against Turks and crusaders alike. They seem to have remained under the orders of Alamut, though there is evidence that Rashid al-Din Sinan (d. 1192), the greatest of the Syrian grand masters, acted independently. After two attempts on the life of Saladin, he appears to have reached some understanding with him against the common enemy. After the death of Sinan the authority of Alamut was restored over the Syrian castles.

The end of the power of the Assassins came under the double assault of the Mongols and of their deadliest enemy, the Mameluke sultan Baybars. In Persia the Mongol general Hulagu captured the Assassin castles one by one with surprising ease; in 1256 Alamut itself fell, and the last grand master, Rukn al-Din Khurshah, was compelled to surrender. He was hanged shortly after. In Syria the Assassins tried to ingratiate themselves with Baybars, but without success. One by one the Syrian castles were subjugated and placed under Mameluke governors, the last, Kahf, falling in 1273. Henceforth the sect stagnated as a minor heresy, with little or no political importance. Its followers are still to be found in Syria, Persia and central Asia, with the largest group in India and Pakistan, where they are known as Khojas and owe allegiance to the Aga Khan.

The term assassin was brought to Europe by the crusaders from Syria and derives from the terrorists' alleged practice of taking hashish to induce ecstatic visions of paradise before setting out to face martyrdom. The stories told by Marco Polo and others of the gardens of paradise into which the drugged devotees were introduced to receive a foretaste of eternal bliss are not confirmed by any known Isma'ili source. The fame of the sectaries soon spread in the west, and before long perfervid imaginations detected the hand of the "Old Man of the Mountain" in political murders and attempts even in Europe.

See also ISMA'ILISM.

See P. R. E. Willey, *The Castles of the Assassins* (1963). (B. LE.)

ASSAULT AND BATTERY. Under common law in the United States and England, and by statute in many states of the United States, an assault is generally defined as an attempt to commit a battery, or the commission of an unlawful act which causes another reasonably to fear an imminent battery. A battery is an unlawful application of physical force to another. The legal concepts of assault and battery are designed to protect the individual from rude and undesired physical contact or force and from the fear or threat thereof.

The protection afforded by the law against assault does not

extend to the mere possibility of harm or to the threat of a battery in the distant future. Rather, an apparent, imminent danger is required, and some overt act which appears to threaten a battery is prerequisite to an assault. Thus, words alone do not constitute an assault.

With respect to the actual commission of a battery, the degree of force is unimportant; a battery may be accomplished by a mere touching. Moreover, the force used need not be direct. For example, one may commit a battery not only by coming into physical contact with another but also by striking his cane or horse, administering poison or drugs, or even communicating a disease.

There are some instances in which force may be lawfully employed without the consent of the victim. For example, due execution of the law, defense of one's person or property, or reasonable correction of a child may warrant the use of force. Generally speaking, however, lack of consent by the person to whom force is applied results in a battery. Nonetheless, even where consent has been given, the law will not recognize it when obtained by fraud or duress, when given by one too young or too feeble-minded to be capable of consent, or when given in connection with a battery so serious that the law could not permit consent, as in the case of a serious beating or a breach of the peace. One is presumed, however, to consent to certain physical contacts normal to everyday life, such as a tap on the shoulder or jostling on a crowded bus.

There are two forms of legal redress for assault and battery: a civil or private action by the victim for damages, and a criminal prosecution in the name of the state. Certain differences exist between the civil and criminal law with respect to assault and battery.

In a civil case, the victim of an assault must show that he has been harmed in some manner. Consequently, if he was unaware of any danger at the time of the assault, he cannot recover in a civil suit. The purpose of a criminal prosecution, however, is the punishment of conduct prohibited by society through its laws. Therefore, in the United States, one who has committed an assault is criminally responsible for his conduct irrespective of whether his intended victim knew of the attempt. In England, however, the rule is different. There, neither a criminal nor a civil assault has occurred unless the victim knew of the threat.

In both civil and criminal law, a battery may take place even though the victim is unaware of the use of force against him at the time of its application.

Assault and battery generally require an intent to harm. However, where one has intentionally placed another in fear of a battery, although without any intention of actually committing one, English courts and most courts in the United States hold that the party is guilty of a criminal as well as a civil assault. A few courts in the United States, however, refuse to hold such a party guilty of criminal assault, reasoning that neither criminal intent nor ability to harm exists in such a case. A typical situation is that in which one points an unloaded revolver at another, threatening to shoot.

A purely accidental injury is not punishable as a battery. However, where one accidentally causes injury to another during the commission of an unlawful act, he is guilty of a battery. Moreover, careless conduct may result in an action for damages or a criminal prosecution. Thus, a civil action may be brought for an injury caused by the ordinary negligence of another. A criminal prosecution, however, cannot be maintained for an injury caused by ordinary negligence; gross, or criminal, negligence, involving a high degree of carelessness, is required in such an action.

England and some jurisdictions in the United States define certain types of assault (such as assault with a deadly weapon, with intent to kill, etc.) as "aggravated" assault, with convictions carrying higher penalties than ordinary assault.

Under military law, assault is defined as an attempt or offer with unlawful force or violence to do bodily harm to another. An assault against a superior officer is generally punishable by death in time of war. (C. R. Se.)

ASSAYING, the process of determining the proportion of metals in ores and metallurgical products. There has been a tendency to restrict the term to methods for the determination of the precious metals and to fire methods (reducing the metallic content of an ore sample to metal in a small analytical crucible for the determination of base metals such as lead and tin. Wet chemical analytical procedures and spectrographic methods of analysis are usually termed analyses instead of assaying.

The methods of assaying had their beginnings in antiquity, before the dawn of chemical knowledge. They evolved from the fumbling experiments of ancient alchemists and goldsmiths who were striving to find and produce the precious metals. Successful recovery processes were devised and quantitative procedures developed at an early date. Trial by touchstone and by fire is mentioned by Theophrastus (*c.* 371–*c.* 288 B.C.). Germination of the seeds of modern chemistry and metallurgy can be seen in the *Probierbüchlein*, "The Little Book on Assaying," and in Lazarus Ercker's *Treatise on Ores and Assaying*, both published in the 16th century.

Many of the operations of fire assaying are carried out today much as they were then. These ancient methods are still taught in university courses for metallurgists because they offer a convenient way of studying the reactions of igneous chemistry. They are still used in industry because modern science has been unable to develop better methods of determining the precious-metal content of ores. This is largely due to the sampling problem. The precious metals tend to occur in ores as ductile particles and each particle has a high value. Hence the sample of ore must be relatively large so that the chance variation in the number of precious-metal particles will not change the value of the sample beyond the allowable error. Large samples can be economically and accurately assayed by the fire methods but spectrographic methods of analysis are not adapted to operating on large sample portions and wet chemical methods, involving the complete decomposition of large samples, would be very expensive. Leaching with cyanide solution has been used as an analytical process but usually an important part of the values remains in the undecomposed ore particles and is not recovered.

UNITS USED IN ASSAYING

In the United States, Canada and South Africa the proportion of precious metals is expressed as troy ounces per short ton (2,000 avoirdupois pounds) of ore. A system of assay-ton weights is used in weighing the assay portion of ore which is taken for the assay process. The assay ton contains the same number of milligrams (29,166⅔) as there are troy ounces in a short ton. Hence the number of milligrams of precious metals found in an assay ton of ore indicates the assay in troy ounces per short ton.

In England and Australia the long or gross ton of 2,240 lb is used. It has an equivalent assay long ton of 32.667 g. The gold assay in British countries is commonly reported in pennyweight (dwt.), a troy weight containing $\frac{1}{20}$ troy ounce.

In Mexico, South America and other countries using the metric system the proportion of the precious metals is reported in kilograms and grams per metric ton of ore. The metric ton contains 1,000.000 g.; consequently, 1 mg. of gold from a 10-g. assay portion of ore indicates 100 g. of gold per metric ton of ore.

Assays of lead and copper bullion are reported in the same units as those used for ores. Gold and silver bullion assays are universally reported in fineness, or parts per 1,000. The gold content of jewelry is reported in carats, or $\frac{1}{24}$ parts. Twenty-four-carat gold is pure gold and 18-carat gold is $\frac{18}{24}$ or 75% gold. Eighteen-carat gold is 750 fine.

ASSAYING FOR GOLD AND SILVER

Ores are assayed for gold and silver by the following steps:

1. Sampling: taking a representative portion of ore for assay.
2. Fusion: decomposing the assay portion by melting with fluxes and reagents to produce a lead button containing the precious metals and a slag which is discarded.
3. Cupellation: melting the lead button in an oxidizing atmosphere to oxidize the lead and leave a *doré* (gold and silver alloy) bead.

4. Weighing: the weight of the *doré* bead is reported as gold plus silver.

5. Parting: treating the *doré* bead with hot dilute nitric acid to dissolve the silver.

6. Weighing: the residual gold is weighed on a delicate balance and reported as gold. The weight of silver is obtained by calculating the difference between this weight and the weight of the *doré* bead.

Sampling.—Samples are customarily dried and pulverized to a size that will pass through a 100-mesh sieve before the assay portion is taken. At this particle size an assay portion of one-tenth to two assay tons may compose a sufficiently reliable sample. For the same reliability, the assay portion of the pulverized ores must vary with the degree of uniformity of the ore particles. When the values are finely divided and uniformly distributed, small assay portions can be used with a saving of reagents. Pulverized ores containing relatively large, rich particles require larger assay portions. Some ores contain rich malleable particles which are larger than 100-mesh. Such ores require an assay portion of a kilogram or more which is handled by a "metallics assay." In the metallics assay the large assay portion is weighed and then carefully crushed in stages with repeated screening to separate the malleable particles. Finally a "metallics portion" is obtained which contains the malleable particles, and the bulk of the sample has been pulverized to pass a 100-mesh sieve. All of the metallics portion is put through an assay process to recover its gold and silver, and the minus 100-mesh material is sampled and assayed in the usual way. The gold and silver content of the ore is calculated from the results of the two assays.

Fusion.—In assay fusion the assay portion of ore is heated with reagents in such a manner that the ore is decomposed and formed into a fusible slag while the precious metals are released and dissolved in molten lead. Lead is supplied in the form of lead oxide (litharge) in the crucible process and as granulated lead in the scorification (reduction to slag) process.

The crucible process takes place in a clay crucible. It is a reducing fusion in which a part of the litharge in the charge is reduced to metallic lead. Reduction is brought about by reducing agents such as flour or charcoal added to the charge or by sulfide minerals in the ore. Some ores possess too much reducing power and require the addition of an oxidizing reagent such as nitre. The objective is to produce about 25 g. of lead and to leave as a flux an amount of litharge at least equal to the weight of the assay portion of ore. Other fluxes such as soda ash and borax glass are commonly used to help decompose the ore and to increase the fluidity of the slag. Crucible fusions are effected at a temperature slightly over 1,000° C. in muffle furnaces, in which the charge is separated from the combustion chamber by a closed vessel, or oven. After the reactions have been completed the fluid contents of the crucibles are poured into conical iron molds and allowed to solidify. The slag is then broken and the lead buttons are hammered to free them from the slag and to produce a cubical shape for easy handling.

The scorification process is not often used because it cannot conveniently handle as large an assay portion of ore as is generally necessary. The maximum weight of ore ordinarily handled by scorification is 0.2 assay ton. The assay portion is charged into a shallow fire-clay dish with granulated lead and a little borax glass. The scorifying dish and its charge are then placed in a muffle furnace at about 600° C. After the lead has melted the muffle door is opened to provide air for oxidation and the temperature is gradually raised to approximately 1,000° C. The molten lead oxidizes and the lead oxide fluxes the ore. Finally the ore is decomposed and a fluid slag is formed which covers the remaining lead. At this stage action has stopped and about 25 g. of lead should be left unoxidized. The scorifying dish is withdrawn from the furnace and the contents poured into an iron mold as in the crucible process.

Cupellation.—Lead buttons containing the gold and silver from assay fusions are treated by cupellation to recover the precious metals. Cupellation is an oxidizing fusion in a small porous vessel known as a cupel. During cupellation the lead is oxidized to litharge which is mostly absorbed by the cupel. The temperature must be low to avoid excessive loss of silver but it must also be above the melting point of litharge. At the end of the process a *doré* bead containing the gold, silver and most of the platinum that may have been present in the ore is left in the bowl of the cupel.

Weighing and Parting.—The *doré* bead is squeezed with pliers and brushed to remove adhering material from the cupel. It is then weighed. This weight represents the weight of the combined precious metals. Silver is then removed by parting (dissolving) in hot dilute nitric acid. The residual gold is washed, dried, annealed and weighed. *Doré* beads containing less than two times as much silver as gold will not part. Such beads are melted with additional silver, a process called inquartation, before parting.

ASSAYING ORES FOR PLATINUM METALS

The platinum metals present in an ore are collected in the lead button of an ordinary fire-assay crucible fusion or scorification. Platinum, palladium and rhodium dissolve in the molten lead and are collected in the same manner as gold and silver. Osmium, iridium and ruthenium do not alloy with the lead but are "wetted" by it in the assay fusion: they sink into the lead and are mechanically held at the bottom of the lead button.

Cupellation of lead buttons containing more than 15 times as much gold and silver as platinum metals proceeds normally. Platinum, palladium and rhodium alloy with the gold and silver and are satisfactorily recovered in the final bead. Platinum causes a roughening of the surface of silver beads, giving them a characteristic frosted appearance. Iridium does not alloy with the gold and silver; when present during cupellation it forms a black deposit that clings to the bottom of the bead. Osmium and ruthenium form volatile oxides when heated in air and consequently they suffer a large loss during cupellation. When these metals are present cupellation should be avoided and the lead button should be analyzed by wet chemical methods.

The nitric acid parting treatment given *doré* silver beads during the assay for gold and silver will dissolve palladium and part of the platinum. To avoid reporting these metals as silver, the spent acid should be watched for indications of platinum and palladium. Palladium produces a yellow colour in the acid. Platinum dissolves only when the bead contains more than ten times as much silver as platinum. A considerable amount of platinum gives the spent acid a dark brown colour like a colloidal solution of carbon. Rhodium, iridium, osmiridium and some platinum remain with the gold during parting and give it a "not completely parted" appearance. When platinum metals are present, either the lead button or the *doré* bead should be treated by wet chemical methods for the determination of the separate platinum metals.

FIRE ASSAYING FOR BASE METALS

Fire-assaying methods have been used for the determination of the easily reducible base metals such as lead, bismuth, tin, antimony and copper. In order to determine one of these metals by fire methods a five- or ten-gram assay portion of the ore is mixed with fluxes and an excess of reducing agent in a crucible. The crucible is heated in a furnace to produce a button of the reduced metal and a fusible slag. The button is weighed to determine the amount of metal. Results tend to be low because of loss of metal and tend to be high due to reduction of impurities. Wet chemical analytical procedures give greater precision and have almost completely supplanted fire-assaying methods for the determination of the base metals.

For information on chemical analytical procedures *see* CHEMISTRY: *Analytical Chemistry*.

See also articles on the various metallic elements, as GOLD; IRON; ZINC; etc.

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(O. C. S.)

ASSAY OFFICE, a place where samples of metals and ores are tested to determine what quantity of the various metals are

present in them. The term assay office was first generally applied to offices established by the United States in various locations as part of the government mint service to purchase newly mined gold and silver and to assay samples of bullion and ores. There are two U.S. assay offices, one in New York city and the other in San Francisco, Calif. The latter, known as the San Francisco mint, discontinued coinage operations in 1955.

The assay offices receive deposits, assay, process, and store gold and silver bullion. The New York office maintains an electrolytic refinery for refining gold and silver. It has special facilities for assaying metals in the platinum group and also receives and issues gold bars for the settlement of international balances. Both the New York and San Francisco offices sell gold and silver bars for industrial, professional and artistic use. Two other U.S. mints, in Philadelphia, Pa., and Denver, Colo., also handle gold and silver.

A special Assay commission meets at the Philadelphia mint once a year to examine and test U.S. silver coins.

The assay offices, bullion depositories and mints comprise the bureau of the mint, which is a part of the treasury department. *See* also ASSAYING; MINT. (L. HD.)

ASSEMANI, the name of a Syrian Maronite family of orientalists.

JOSEPH SIMONIUS (1687–1768), from Mt. Lebanon, studied at the Maronite college in Rome and then entered the Vatican library. Having been sent to Egypt and Syria in 1715 in search of manuscripts he secured about 150 select specimens. This success induced the pope to send him again in 1735 and a still more valuable collection was acquired. On his return he was created titular archbishop of Tyre and librarian of the Vatican library. His chief work is his *Bibliotheca Orientalis,* a treasure store for later scholars. This was intended to cover in four parts manuscripts in Greek and a number of oriental languages, but only the Syriac in three volumes appeared: *De Scriptoribus Syris Orthodoxis* (1719); *De Scr. Syr. Monophysitis* (1721); and *De Scr. Syr. Nestorianis* (1725–28). With his nephew, Stephen Evodius (*see* below), Simonius published *Bibliothecae Apostolicae Vaticanae Codicum Manuscriptorum Catalogus* (1756–59). This was reproduced photographically in Paris in 1927–30. He also produced the first three volumes, the Greek texts, of *Ephraemi Syri Opera Omnia . . . in sex tomos distributa* (1732–46).

His nephew, JOSEPH ALOYSIUS (*c.* 1710–82), was professor of oriental languages at Rome. STEPHEN EVODIUS (1707–82), titular archbishop of Apamea in Syria and holder of several ecclesiastical preferments in Italy, assisted his uncle, Joseph Simonius, in the Vatican library and collaborated in producing its catalogue. His chief works are *Bibl. Mediceae Laurentianae et Palatinae Codd. Mss. Oriental Catalogus* (1742) and *Acta SS. Martyrum* (1748). SIMON (1752–1821), grandnephew of Joseph Simonius, was professor of oriental languages at Padua. (W. D. McH.)

ASSEMBLIES OF GOD, a religious sect in the United States belonging to the so-called Pentecostal group, was formed by a union of several small bodies at Hot Springs, Ark., in 1914. In 1916 its headquarters were established at Springfield, Mo., and it was incorporated under the name of the General Council of the Assemblies of God.

It is the largest of all the numerous Pentecostal bodies in the country, having more than 8,000 local churches and pastors and more than 500,000 members, with a dozen administrative boards and several publications issued by its central publishing house.

In doctrine the Assemblies of God is conservative, embracing the so-called Fundamentalist theology. It teaches entire sanctification but differs from similar churches in that it does not insist that this is a second work of grace subsequent to justification or conversion but recognizes the progressive character of the experience.

The distinctive feature of the doctrines and practices of the Assemblies of God is that of the glossolalia, or "speaking in other tongues as the Spirit gives utterance." (*See* TONGUES, GIFT OF.) This is regarded as the climactic experience of the religious life and is bestowed upon believers instantaneously following the attainment of holiness or perfection. It derives from the phenomenon on the Day of Pentecost as recorded in Acts ii, 1–13.

See Elmer T. Clark, *The Small Sects in America* (1949); Charles W. Conn, *Like a Mighty Army* (1955); *The Church of God* (periodical published at Queens Village, N.Y.). (E. T. CL.)

ASSEMBLY, RIGHT OF, the privilege of individuals to meet together for such purposes as deliberation, worship or the expression of grievances.

Assembly to discuss grievances poses a dilemma for every government which aspires both to freedom of the citizen and to order in society. Angry crowds can seriously trouble many, partisans and nonparticipants alike; but liberty to meet and debate grievances is basic in a reasonably free society. Essential to reconciliation of these conflicting tensions are not only wise constitutional and statutory guarantees, enforced by independent and courageous judges; even more essential is an enlightened policing system.

England approached this problem by forbidding disorderly gatherings rather than by guaranteeing free assembly. A statute of 1661 forbade presentation of petitions to king or parliament by more than ten persons at a time (13 Car. 2, c. 5). The English Bill of Rights of 1689 omitted assembly but guaranteed the right to petition the king (1 Will.-Mary, sess. 2, c. 2). Across the Atlantic, however, the First Continental Congress on Oct. 14, 1774, proclaimed the colonists' right to assemble and petition the king. Seventeen years later the first amendment to the then three-year-old constitution forbade the congress to abridge ". . . the right of the people peaceably to assemble, and to petition the Government for a redress of grievances."

Almost all state constitutions in the United States contain similar guarantees; and the U.S. supreme court has held that even when a state constitution fails to assure a reasonable right of assembly the 14th amendment of the federal constitution guarantees against unreasonable state restriction (*De Jonge* v. *Oregon,* 299 U.S. 353 [1937]). There are difficult problems in applying this guarantee, however. Often assemblies arouse their adversaries to violent objection; police sometimes find it easier to stop the meeting than to suppress the disorderly opponents. The supreme court has indicated that police cannot thus be used as an instrument to suppress unpopular views, but when a public speaker attracts a crowd which blocks traffic, or when he passes the bounds of argument or persuasion and incites to riot, the police may constitutionally arrest him (*Feiner* v. *New York,* 340 U.S. 315 [1951]). Where the meeting is held indoors, violent opposition from outside furnishes less justification for police interference with the meeting (*Terminiello* v. *Chicago,* 337 U.S. 1 [1949]).

Another administrative problem arises from competition for public space. A state or city, as proprietor of its parks, was once held constitutionally empowered to forbid all meetings there (*Davis* v. *Massachusetts,* 167 U.S. 43 [1897]). This is probably not law today, but a state may enforce reasonable requirements for permits in order to prevent unseemly clashes between groups which attempt to meet at the same time (*Poulos* v. *New Hampshire,* 345 U.S. 395 [1953]). An official may not constitutionally be entrusted with discretion to grant or deny a permit as he sees fit, with no standards to guide his judgment (*Kunz* v. *New York,* 340 U.S. 290 [1951]). And functionaries empowered to grant permits for park meetings may not constitutionally play favourites between groups (*Fowler* v. *Rhode Island,* 345 U.S. 67 [1953]). An assembly to plan or carry out a crime is not privileged.

Judicial protection of the right of assembly is inevitably slow. The Committee for Industrial Organization, forbidden by Mayor Frank Hague in Nov. 1937 to hold a public meeting in Jersey City, N.J., sued the mayor and other officials. The supreme court of the United States finally decided in favour of the committee's right to hold the meeting, but not until June 1939 (*Hague* v. *Committee for Industrial Organization,* 307 U.S. 496 [1939]). In many cases far less delay would frustrate the purpose of the meeting. An effective right of assembly really depends on wise and tolerant police, willing to allow meetings unless impending violence is clearly apparent. The English have provided a proverbial example of such tolerance in Hyde Park, London. (*See* also BILL OF RIGHTS, UNITED STATES.) (A. E. SU.)

English Law.—As suggested above, in English law the best ap-

proach to the question of the right of assembly is to find out what types of assembly are unlawful and in what circumstances. J. F. Archbold's *Criminal Pleading, Evidence and Practice*, 34th ed. (1959), p. 1335, defines an unlawful assembly at common law as "an assembly of three or more persons (*a*) for purposes forbidden by law, such as that of committing a crime by open force; or (*b*) with intent to carry out any common purpose, lawful or unlawful, in such a manner as to endanger the public peace, or to give . . . reasonable grounds to apprehend a breach of the peace in consequence of it." Riots are punishable both by common law and under the Riot act, 1714, while a rout (an assembly which gathers for the purpose of rioting and which makes a move towards the commission of its purpose) is another example of an unlawful meeting. In some parts of the Commonwealth and colonies particular emergencies have from time to time led to a suspension of the right of assembly.

See also RIOT. (W. T. Ws.)

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ASSEMBLY LINE: *see* MASS PRODUCTION.

ASSEN, a town in the northern Netherlands, capital of the province of Drenthe, lies 16 mi. S. of Groningen. Pop. (1957 est.) 27,041. Situated amid wooded surroundings, Assen has three parks, including one where children learn traffic regulations, and a museum of antiquities. The main electric railway from Amsterdam to Scandinavia, and the main road linking with Stockholm pass through the town. Eelde airport is 10 mi. north. Assen was founded in 1257 around the site of a small convent. It has some light industry and is scheduled by the government as an area for industrial development.

ASSENS, a county council district (*amtsrådskreds*) of southern Denmark, covers the northwest of Fyn (Fünen) Island. Pop. (1955) 58,005. Area 257 sq.mi. Its fertile loams grow good crops of barley, oats, wheat, rye and roots. Dairying and pig-rearing are traditional. The district is centred on the port of Assens (pop., 5,012) which has sugar and bacon factories. At Middelfart (pop., 8,883), a port connected to Jutland by the Little Belt bridge, there are porcelain and metal industries and market gardening flourishes in the surrounding district. (HA. T.)

ASSER (d. *c.* 909), Welsh monk, chiefly remembered as the friend, teacher, counselor and biographer of Alfred the Great (*q.v.*), was born in Wales and became a monk at St. David's abbey, Pembrokeshire. In 886, eager to learn Latin, Alfred summoned Asser, who had acquired some reputation for learning, to his court in Wessex, and on St. Martin's Day (Nov. 11), 887, as Asser himself tells us, the Latin lessons began. Thereafter Asser divided his time between the court and his own community, and became Alfred's friend as well as his teacher. The king made him abbot of the monasteries of Congresbury and Banwell, Somerset, and later appointed him bishop of the diocese of Devon and Cornwall. At the time of his death (recorded as being in 909) he was bishop of Sherborne, Dorset.

Asser's *Life of King Alfred* follows Alfred's career from his birth to his accession in 871, and describes in detail his reign and his wars, stopping abruptly in 887, 12 years before Alfred's death. As an account of historical events, it draws largely on the *Anglo-Saxon Chronicle*, but it adds much information on Alfred's care for his army, his fleet, his cities and their houses, his lawcourts, his enthusiasm for learning and for the spread of education, and his piety. It is naïve, and overfull of enthusiasm, carelessly constructed and sometimes hard to follow, but it is an indispensable source. Scholars have suggested that, in whole or in part, it is not the work of Asser, but this view has not been widely accepted.

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(E. S. DT.)

ASSER, TOBIAS MICHAEL CAREL (1838–1913), Dutch jurist, who shared the Nobel peace prize in 1911 with Alfred H. Fried, was born at Amsterdam, Neth., on April 28, 1838. In 1862 he became professor of commercial and private international law in the University of Amsterdam, being at the same time a successful barrister. In 1868, with John Westlake and Rolin Jacquemijns, he started the *Revue de droit international et de législation comparée*. He was also one of the founders of the Institut de Droit International in 1873.

In 1891 Asser prevailed upon the Dutch government to convoke the Hague Conference for the Unification of International Private Law, which first met in 1892 and later became a permanent institution, responsible, among other things, for the Hague treaties of 1902–05 concerning family law. In 1911–12 he presided over conferences for the unification of the law relating to bills of exchange. In 1893 he resigned his professorship and retired from his law practice, becoming a member of the *raad van state* (privy council). Asser was a Netherlands delegate to the Hague peace conferences of 1899 and 1907. His greatest success at the first conference was the organization of the Permanent Court of Arbitration. He died on July 29, 1913. (GD. E. L.)

ASSESSED VALUATION: *see* VALUATION.

ASSESSMENT, a demand or call made by a corporation upon stockholders for a specified sum of money per share of stock in addition to that already paid in. Such assessments are generally made when the company is financially embarrassed and it is a question of the stockholders meeting the assessment or the company becoming insolvent. Reorganizations of corporations frequently involve the placing of an assessment on the stockholders and sometimes even upon bondholders. *See* JUDICIARY AND COURT OFFICERS; VALUATION.

ASSESSOR, in the United States, an official who evaluates property for purposes of taxation. An assessor exists as a county officer in virtually all the states, and is elected by the voters for a term of two, three or four years. Originally, in the early colonial days, the work of the assessor was done by justices of the peace and was transferred in later colonial days to county boards of commissioners or supervisors. The duties of the assessor are generally to list all property and persons subject to taxation and to determine the value of property to be taxed. Appeals are provided by statutes to county boards of commissioners or supervisors or courts where the person taxed may protest against the amount assessed as being unfair. Some states have provided for township assessors, elected by the voters of the township, to work under the supervision of the assessor, and in others the assessor is permitted a sufficient number of deputies to aid him in the completion of his work, the assessments generally being made annually. Most of the states have state boards of taxation which supervise, to some extent, the work of the assessors. In most of the states this board is named by the governor, but in a few, such as Illinois, where it is called the board of equalization, it is elected.

In Roman law, used throughout Europe, wherever the civil law system is prevalent, an assessor is one who is called by the courts to give legal advice and assistance. In the United States federal district courts experienced shipmasters serve as assessors in this sense of the word in admiralty matters.

See also JUDICIARY AND COURT OFFICERS; VALUATION: *Taxation*. (S. LE.)

ASSIGNATS, the paper currency notes issued during the French Revolution period on the security of property belonging to the French nation.

The financial crisis that had brought about the summoning of the estates-general in 1789 (*see* FRANCE: *History*; FRENCH REVOLUTION) obliged the constituent assembly first to put ecclesiastical property "at the disposition of the nation" (Nov. 2, 1789) and

then to establish an "extraordinary fund" for the purpose of raising 400,000,000 livres (francs) by means of assignats on this property and on crown lands (Dec. 19). The assignat was thus a certificate of debt, a sort of treasury bond bearing interest at 5%, entitling the holder to repayment in property to the value of the assignat. The intention was that, as the transfer of the property was effected, the assignats would be returned and canceled and the national debt thus paid off. The operation, however, did not succeed, as the assignats were not taken up very readily (the clergy was still in occupation of its property, and the ecclesiastical reform had not yet taken place). The state's need for ready money remained constant, however, so that on Aug. 27, 1790, a crucial change was made: it was decided that the assignats should no longer bear interest. This turned the assignats from bonds into a paper currency, equivalent to banknotes. At the same time the issue was increased to 1,200,000,000 livres, despite grave warnings of the risk of inflation.

The change had political and social as well as financial consequences. Whereas the original assignats transferred property only to creditors of the state (financiers, contractors, persons entitled to compensation for loss of office as a result of administrative reforms), the assignats as currency might come into anyone's hands. Then, as more and more were issued, the assignats depreciated rapidly, particularly as the partisans of the former regime declared that if they were restored to power they would not recognize the currency of the Revolution. When the assembly itself authorized dealing in coin, there was little to check this depreciation; coin was hoarded and silver money went out of circulation. Finally, after long hesitation, the assembly even issued assignats of small denominations (assignat of five livres, 1791). Thereupon the price of commodities and the cost of living rose (higher prices were charged when payment was in assignats than when it was in coin), and unrest ensued. Even so, the consequences of the currency assignat were not altogether disastrous. In its beginnings, it revived the economy, ended unemployment and served to reduce the rate of foreign exchange (exporters, paid abroad in coin and paying to their workers at home wages which were only slowly rising, were especially benefited by it).

The outbreak of war in April 1792 was necessarily followed by more issues of notes, and inflation brought with it the eventual failure of the assignat. In Jan. 1793, it still stood at 60%–65% of its nominal value; the next month, it went down to 50%; and in July it stood at less than 30%. Capital went abroad, speculation increased, merchandise was hoarded and prices continued to rise. Pierre Joseph Cambon (*q.v.*), the financial expert of the Convention, now devoted himself to checking inflation and, on July 31, 1793, demonetized all royal, *i.e.*, pre-republican, assignats of more than 100 livres in nominal value. Price control, instituted by the *loi du maximum général* (Sept. 29, 1793), was more effective, and in December the assignat rose again to 50% of its nominal value. On Dec. 26, Cambon requisitioned all foreign bills and paid for them, at par, in assignats.

In the summer of 1794 inflation, which had been halted for a time, began again, and in the Seine *département* the assignat went down to 34% of its nominal value. The situation deteriorated further after the Thermidorian reaction, when the abandonment of the guided economy of the previous 12 months brought catastrophe. Prices soared, foreign exchange collapsed, and the state had to resign itself to large-scale inflation. In July 1795 the assignat was worth barely 3% of its face value. Tradespeople and peasants refused it and would no longer accept anything but coin. On June 21, 1795, the Convention reduced the nominal value of the assignat according to a proportional scale related to the successive issues. On July 20, moreover, it ordered that half the amounts due under the land tax and for farm rents should be paid in kind. It also granted to officials—the principal victims of the depreciation of the paper currency—a sliding salary scale calculated on the price of bread. Then, as salaries could no longer follow the steep rise in prices, purchasing power was correspondingly reduced and numerous businesses were forced to close. Famine aggravated the situation, and the Parisian sans-culottes rose twice in revolt (April and May, 1795). When price control (as under the *loi du maximum général*) was abolished (Dec. 24, 1794), the paper money in circulation was estimated at 8,000,000,000 livres; and on Oct. 23, 1795, three days before the dissolution of the Convention, it was assessed at 20,000,000,000.

When the Directory was established, inflation reached its highest point: the assignat of 100 francs was worth only 15 sous. The sale of national property was suspended, and in order to save creditors from ruin, a moratorium was declared. Within four months, issues had risen, reaching the nominal value of 39,000,000,000 francs: in the course of a night money was being printed for the morrow's expenditure. On Feb. 19, 1796, pretenses could no longer be kept up, and the assignat was abandoned.

There could be no question, however, of returning to a metal currency. The circulation of coin was then estimated at about 300,000,000—as against at least 2,000,000,000 livres in 1789. Accordingly, on March 18, 1796, a new paper currency was issued in the form of *mandats territoriaux* ("land warrants"), valid for the acquisition of national property, of which 2,400,000,000 francs' worth were issued. Of these 600,000,000 were to serve for repayment of the assignats at the rate of 30 assignats for 1 *mandat*; the rest would go to the treasury. The public, however, had no confidence in the *mandats*, which by July 1796 were no longer being taken up. The Directory then decided to return to a metallic currency. The law of 16 Pluviôse year V (Feb. 4, 1797), withdrew the *mandats* from circulation. Thus ended the history of the paper currency of the Revolution.

The social consequences of the issue of assignats were far-reaching. Inflation dealt a heavy blow to acquired wealth. During 1794–95 debtors hastened to redeem their debts cheaply and on July 11, 1795, the Convention was obliged to forbid the repayment of loans made before July 1, 1792, and the discharge of subsequent ones before they fell due. The old bourgeoisie of *rentiers* and office-holders, in so far as it was the state's principal creditor was ruined by the inflation, with the result that many of its members transferred their sympathies to the enemies of the Revolution. On the other hand the fluctuation of the currency brought into being a new bourgeoisie of successful speculators, who took advantage of it to enrich themselves to the detriment of the national assets and without benefit to the community.

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ASSIGNMENT, in law, denotes a transfer of rights, particularly with reference to intangible property, whether or not evidenced by a specialty, such as an insurance policy or a certificate of corporate shares. For the assignment of the property of a debtor for the benefit of creditors, *see* Bankruptcy; Debtor and Creditor Law. (J. A. MacL.)

ASSINIBOIA, a name formerly applied to three districts in western Canada. (1) The grant made by the Hudson's Bay company to Lord Selkirk in 1811 for his Red River settlement (*q.v.*) which included all southern Manitoba and also the Red river valley in North Dakota and Minnesota. (2) When the Selkirk grant was resumed by the Hudson's Bay company, the "District of Assiniboia" was organized in 1835. Comprising the area within a radius of 50 mi. from Fort Garry, it was administered by a local governor and council appointed by the company until it was ended by the formation of Manitoba in 1870 (*see* Manitoba: *History*). (3) In 1882 the federal district of Assiniboia was created as a part of the old Northwest Territories to extend from the boundary of Manitoba westward to the district of Alberta along the international boundary and south of the district of Saskatchewan. In 1905 about one-fifth of Assiniboia was absorbed by Alberta and the rest became part of Saskatchewan.

The original district had as its centre the valley of the Assiniboine river, a tributary of the Red, and the name was formed from that of the river and the Assiniboin Indians. (W. L. Mo.)

ASSINIBOIN, an American Indian Plains tribe who split from the Yanktonai Sioux before the 17th century and were known to the early French and English traders after 1640 as allies of the Algonkian Cree with whom they lived in the area west of Lake

Winnipeg. Over a period of 150 years, the Assiniboin gradually moved westward and southward. A few bands remained in Canada where they still continued to be known as Stonies, while the remainder settled near the junction of the Missouri and Yellowstone rivers. Although restricted in their movements after 1851, they were not placed on reservations until 1884. They are still dependent upon government for a good part of their subsistence and are more disorganized, poorer and less educated than their non-Indian neighbours. In the 1960s the Assiniboin numbered more than 1,000 in Canada (concentrated in Alberta), and were reported to exceed 4,000 in the U.S. (most of them sharing lands on the Fort Belknap and Fort Peck reservations in Montana with other tribes). Less than one-fourth of the Montana Assiniboin can be considered full-bloods; the others are mixed with white, Yanktonai Sioux, Cree and Gros Ventre.

See also PLAINS INDIANS; SIOUAN INDIANS.

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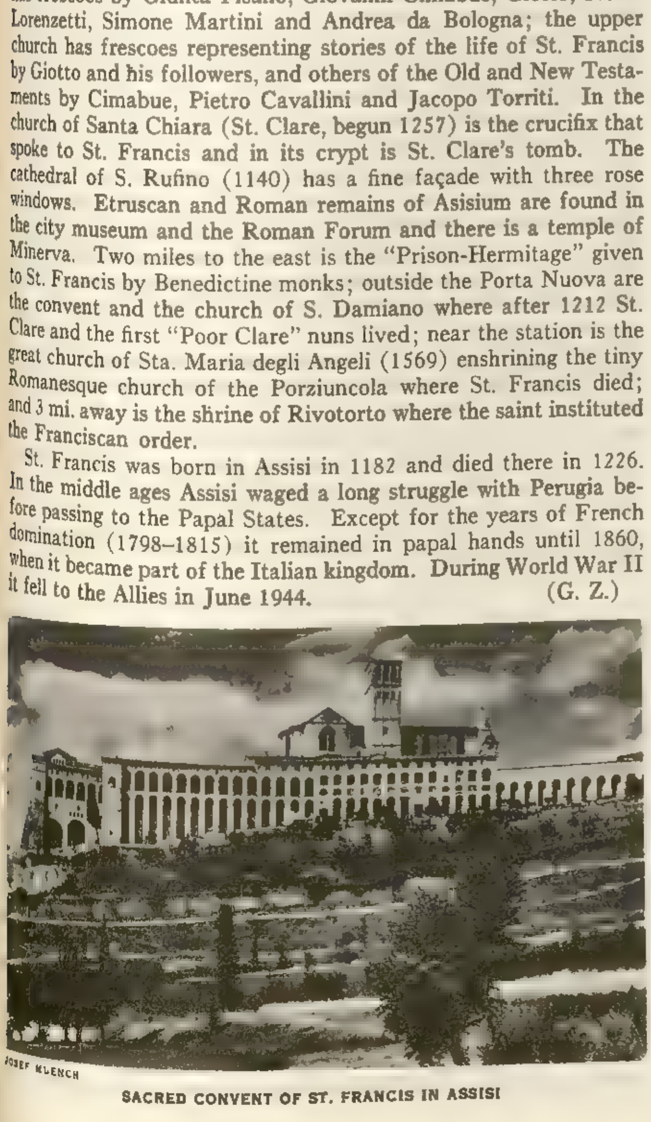
ASSISI, birthplace of St. Francis, is a city of the region of Umbria and province of Perugia in central Italy standing on a hill, 1,300 ft. high, above the valleys of the Topino and Chiascio 16 mi. by road east-southeast of Perugia. Pop. (1961) 25,373 (commune). The town, with its narrow winding streets, is surrounded by walls. The chief feature is the Romano-Gothic Sacred Convent of St. Francis with its upper and lower churches, begun immediately after the canonization of St. Francis in 1228 and completed in 1253. The crypt was added in 1818, when the tomb of St. Francis was opened. The saint is buried in the lower church which has frescoes by Giunta Pisano, Giovanni Cimabue, Giotto, Pietro Lorenzetti, Simone Martini and Andrea da Bologna; the upper church has frescoes representing stories of the life of St. Francis by Giotto and his followers, and others of the Old and New Testaments by Cimabue, Pietro Cavallini and Jacopo Torriti. In the church of Santa Chiara (St. Clare, begun 1257) is the crucifix that spoke to St. Francis and in its crypt is St. Clare's tomb. The cathedral of S. Rufino (1140) has a fine façade with three rose windows. Etruscan and Roman remains of Asisium are found in the city museum and the Roman Forum and there is a temple of Minerva. Two miles to the east is the "Prison-Hermitage" given to St. Francis by Benedictine monks; outside the Porta Nuova are the convent and the church of S. Damiano where after 1212 St. Clare and the first "Poor Clare" nuns lived; near the station is the great church of Sta. Maria degli Angeli (1569) enshrining the tiny Romanesque church of the Porziuncola where St. Francis died; and 3 mi. away is the shrine of Rivotorto where the saint instituted the Franciscan order.

St. Francis was born in Assisi in 1182 and died there in 1226. In the middle ages Assisi waged a long struggle with Perugia before passing to the Papal States. Except for the years of French domination (1798–1815) it remained in papal hands until 1860, when it became part of the Italian kingdom. During World War II it fell to the Allies in June 1944. (G. Z.)


JOSEF KLENCH

SACRED CONVENT OF ST. FRANCIS IN ASSISI

ASSIZE (ASSISE), a legal term meaning literally a "session," but in fact sometimes a jury, the sittings of a court, or the ordinances of a court or assembly.

It originally signified the form of trial by a jury of 16 persons, which eventually superseded the barbarous judicial combat; this jury was named the grand assize and was sworn to determine the right of seisin of land (*see* EVIDENCE). The grand assize was abolished in 1833; but the term assize is still applicable to the jury in criminal causes in Scotland.

In the only sense in which the word is not now almost obsolete, assize means the periodical session of the judges of the high court of justice held in the various counties of England, chiefly for the purposes of trying jailed prisoners and causes at nisi prius. Previous to Magna Carta (1215) all writs of assize had to be tried at Westminster, or to await trial in the locality in which they had originated at the septennial circuit of the justices in eyre; but, by way of remedy for the great consequent delay and inconvenience, it was provided by this celebrated act that the assizes of *mort d'ancestor* and novel disseizin should be tried annually by the judges in every county. By successive enactments, the civil jurisdiction of the justices of assize was extended, and the number of their sittings increased, until at last the necessity of repairing to Westminster for judgment in civil actions was almost obviated to country litigants by an act, passed in the reign of Edward I, which provided that the writ summoning the jury to Westminster should also appoint a time and place for hearing such causes within the county of their origin. The date of the alternative summons to Westminster was always subsequent to the former date, and so timed as to fall in the vacation preceding the Westminster term, and thus *"Unless before,"* or nisi prius, issues came to be dealt with by the judges of assize before the summons to Westminster could take effect. The nisi prius clause, however, was not then introduced for the first time. It occurs occasionally in writs of the reign of Henry III. The royal commissions to hold the assizes are (1) general, (2) special. The general commission is issued twice a year to the judges of the high court of justice, and two judges are generally sent on each circuit. It covers commissions (1) of oyer and terminer (*q.v.*), by which they are empowered to deal with treasons, murders, felonies, etc.; this is their largest commission; (2) of nisi prius; (3) of jail delivery, which requires them to try every prisoner in jail, for whatever offense committed; (4) of the peace, by which all justices must be present at their county assizes or else suffer a fine. Special commissions are granted for inquest in certain causes and crimes (*see* COURT; PRACTICE AND PROCEDURE).

Assizes, in the sense of ordinances or enactments of a court or council of state, as the "assize of bread and ale," the "assize of Clarendon," the "assize of arms," are important in early economic history. As early as the reign of John the observance of the *Assisae venalium* was enforced, and for a period of 500 years thereafter it was considered no unimportant part of the duties of the legislature to regulate by fixed prices the sale of bread, ale, fuel, etc. The word assize is used in a wider legislative connection by early chroniclers and historians—the "assisae of the realme," *e.g.*, occasionally meaning the organic laws of the country. For the "assizes of Jerusalem" *see* CRUSADES: *Organization of the Latin States.*

The term assize, originally applying to an assembly or court, became transferred to actions before the court of the writs by which they were instituted. The following are the more important.

Assize of darrein presentment, or last presentation, was a writ directed to the sheriff to summon an assize or jury to inquire who was the last patron that presented to a church then vacant, of which the plaintiff complained that he was deforced or unlawfully deprived by the defendant. It was abolished in 1833 and the action of *quare impedit* substituted. But by the Common Law Procedure act, 1860, no *quare impedit* can be brought, so that an action in the king's bench of the high court was substituted for it.

Assize of *mort d'ancestor* was a writ which lay where a plaintiff complained of an "abatement" or entry upon his freehold, effected by a stranger on the death of the plaintiff's father, mother,

brother, sister, uncle, aunt, etc. It was abolished in 1833.

Assize of novel disseizin was an action to recover lands of which the plaintiff had been "disseised" or dispossessed. It was also abolished in 1833.

Assize, clerk of, an officer "who writes all things judicially done by the justices of assizes in their circuits." He has charge of the commission and takes recognizances, records, judgments and sentences, grants certificates of conviction, draws up orders, etc. By the Clerks of Assize act, 1869, he must either have been for three years a barrister or solicitor in actual practice, or have acted for three years in the capacity of subordinate officer of a clerk of assize on circuit.

See Sir F. Pollock and F. W. Maitland, *History of English Law*, 2nd ed. (1898).

ASSOCIATED BANKS, banks that make daily clearings through the same clearinghouse. *See* CLEARINGHOUSE.

ASSOCIATED PRESS: *see* NEWS AGENCY.

ASSOCIATION, CHEMICAL. Association is a term used in a specialized sense in chemistry to denote the aggregation of atoms or molecules into larger units, the forces holding these units together being weaker than those involved in the formation of ordinary chemical bonds. The term is usually restricted to the formation of aggregates of like atoms or molecules. Polymerization (*q.v.*) also refers to the formation of large units by the union of like small units. A molecular aggregate formed by association is a polymer in which the forces holding the smaller units together are relatively weak. Association is thus a special case of polymerization. It is difficult or impossible to draw a sharp dividing line between association and other types of polymerization. In general, however, a polymerization which is not an association involves the formation of ordinary chemical bonds between the smaller units (monomers), whereas in mere association of molecules they are held together by weaker forces. Because of the qualitative difference between the strengths of the forces holding the small units together an equilibrium is often observed between an association complex and the corresponding simple molecules, whereas such an equilibrium is rarely found, except at quite high temperatures, between a polymer of the chemical bond type and its monomer. An equilibrium mixture of an association complex and the corresponding small molecules behaves chemically in much the same manner as would the small molecules by themselves, since the removal of some of the small molecules by chemical reaction shifts the equilibrium in such a way as to dissociate more of the aggregate, in accordance with the law of mass action (*see* REACTION KINETICS; PHASE EQUILIBRIA). Many physical properties (for instance, the density of a gas at a given temperature and pressure) depend on the number and average size of the independently moving units and thus on the number of molecules in each aggregate and the relative numbers of simple molecules and aggregates under the conditions of the experiment (*see* STOICHIOMETRY). For these reasons, much of the information regarding the existence of aggregates has come from studies of these physical properties, rather than from chemical studies. In some cases, X-ray diffraction (*see* CRYSTALLOGRAPHY: *Crystal-Structure Analysis*) and electron diffraction studies confirmed the conclusions arrived at in this way and, in addition, supplied detailed knowledge of the relative positions of the atoms in the aggregates.

Forces Producing Association.—The types of forces tending to make like molecules associate may be briefly considered. Most important are the forces of "hydrogen bond" (or "hydrogen bridge") formation, in which a hydrogen atom, bonded to an electronegative atom (*e.g.*, oxygen), forms a bridge to another electronegative atom. If these two electronegative atoms are in different molecules, the formation of the bridge unites the two. The energy required to break a hydrogen bond is of the order of 5 to 10 kg.cal. per mole; *i.e.*, about one-tenth that needed to break an average chemical bond in an organic compound. This is still much greater than the average energy per molecule at ordinary temperatures; hence, association complexes in which the component molecules are held together by hydrogen bonds are not readily broken up by molecular collision except at higher temperatures.

Molecules may also be held together, if the temperature is not too high, by dipolar attraction, resulting from the separation of positive and negative charges in each molecule. The molecule as a whole may be polar, one end having an excess positive charge and the other an excess negative charge, or it may contain polar groups. In either case it tends to orient and attract another similar molecule in the vicinity. If the attraction energy is large enough, relative to the average kinetic energy (see *Association in Gases,* below), association occurs.

Still weaker, in general, are the so-called London dispersion forces which act between any two atoms which are close together. These may be explained in the following way: an atom consists of a heavy, positively charged nucleus, surrounded by a cloud of (rotating) negatively charged electrons. The negative electron cloud may oscillate with respect to the positive nucleus. The atom can then be described as an oscillating dipole, changing polarity with each oscillation. Two neighbouring atoms tend to oscillate in synchronism with each other, in such a way that most of the time the two dipoles are so oriented as to produce a mutual attraction. This attraction is relatively weak; yet it is strong enough to produce some molecular association at low temperatures.

Association in Gases.—Molecules in the gaseous state are in practically constant motion, frequently colliding with each other. (*See* KINETIC THEORY OF MATTER.) As a rule, when two molecules collide they immediately rebound, remaining close together for only a short time. If, however, the attractive forces between them are strong enough, they stick together for awhile, until the association complex so formed is broken up by a sufficiently energetic collision with another molecule. If the energy of association is considerably greater than the average molecular kinetic energy, most of the molecules are associated at any given instant. Since raising the temperature increases the average kinetic energy of the molecules, it tends to decrease the degree of association, *i.e.*, the average fraction of the molecules which are associated.

As already implied, the degree of association of the molecules in a gas can be computed from measurements of its density at a given pressure and temperature. From a series of such measurements at various pressures, the equilibrium constant at that temperature for the association-dissociation equilibrium can be calculated. From measurements at two or more temperatures the energy of association can be obtained. With this information the degree of association at other temperatures and pressures can be computed.

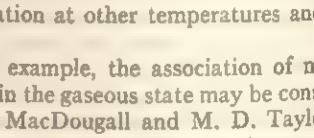
For a specific example, the association of molecules of acetic acid, CH_3CO_2H, in the gaseous state may be considered. Measurements by F. H. MacDougall and M. D. Taylor of the pressure exerted at constant temperature by a given mass of acetic acid vapour in different volumes show that, contrary to the behaviour of a nonassociating gas, the product of the pressure times the volume is not even approximately constant. The data can be quantitatively accounted for by assuming an equilibrium between single and double molecules:

$$2CH_3CO_2H \rightleftarrows (CH_3CO_2H)_2$$

The heat of dissociation is about 15.3 kg.cal. per mole.

The pressure of acetic acid vapour in equilibrium with the liquid at 25° C. is about 15.5 mm. of mercury. Under these conditions 91% of the acetic acid in the vapour is associated. At lower pressures or higher temperatures the association is less.

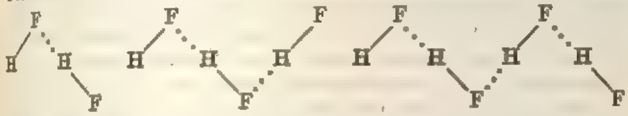
In an electron diffraction study of acetic acid vapour at room temperature and at 143° C. (when the association is about 9%) J. Karle and L. O. Brockway confirmed these conclusions and determined the relative positions of all the atoms except hydrogen in both the simple molecule and the dimer. The structure of the latter can be diagrammatically represented by the following formula:



The complex is held together by means of two hydrogen bridges.

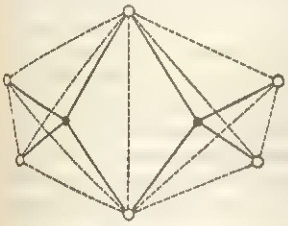
Further confirmation of this structure came from studies of the infrared absorption spectrum by R. C. Herman and R. Hofstadter and others.

Another substance exhibiting association in the gaseous state is hydrogen fluoride, HF. From vapour density measurements by J. W. Mallet, K. Fredenhagen and others, it can be concluded that there is a considerable degree of association even at rather high temperatures. As G. Briegleb showed, the data are best interpreted by assuming an equilibrium between molecules (or aggregates) of various sizes: HF, $(HF)_2$, $(HF)_3$, $(HF)_4$, etc. An electron diffraction study by S. H. Bauer, J. Y. Beach and J. H. Simons confirmed this and showed that the larger molecules have a zigzag structure, with adjacent fluorine atoms held together by hydrogen bonds:



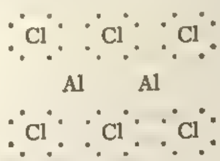
etc.

An example of association which does not involve hydrogen bonds is furnished by aluminum chloride, $AlCl_3$. Vapour density measurements by many workers show that in the gaseous state, below 400° C. (at atmospheric pressure), this substance is almost entirely associated to dimers $(AlCl_3)_2$ or Al_2Cl_6. K. J. Palmer and N. Elliott concluded, from the results of an electron diffraction study, that atoms in the dimer are arranged as indicated in the accompanying figure. The chlorine atoms are tetrahedrally arranged around the aluminum atoms, two chlorines being shared by both aluminums.



ARRANGEMENT OF ALUMINUM ATOMS (DOTS) AND CHLORINE ATOMS (OPEN CIRCLES) IN Al_2Cl_6. THE DIMER OF ALUMINUM CHLORIDE

This association can be explained as a result of the tendency of each aluminum atom, having an excess positive charge, to surround itself by as many negative chlorine atoms as possible, consistent with the requirement that, with each Al–Cl distance near its equilibrium value, the distance between the centres of adjacent chlorine atoms must not be so small as to produce large repulsions between them. Another equally valid point of view is to consider the association as resulting from the tendency of the aluminum atoms to complete tetrahedral four-electron-pair valence shells (octets; *see* VALENCE), as indicated by the following "dot formula":

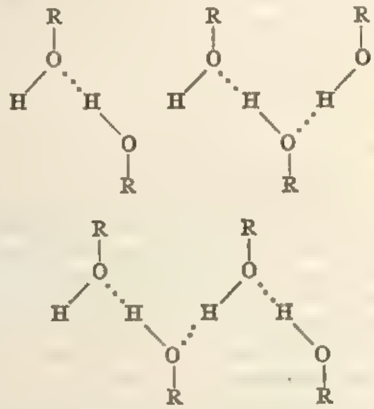


Although one can thus consider the dimer to be held together by chemical bonds, these are relatively weak and the energy required to dissociate the dimer into neutral monomeric molecules is considerably less than that usually associated with a chemical bond; hence, we are justified in considering this an example of association, rather than one of another type of polymerization.

Association in Solution.—Association often occurs between solute molecules dissolved in nonpolar solvents (those consisting of molecules which have no appreciable over-all polarity and which do not contain polar groups), if the mutual attractions between the solute molecules are large relative to the attractions between solute and solvent molecules and relative to the average molecular kinetic energy. Thus, acetic acid molecules, in a solvent such as benzene, are largely associated to dimers, similar in structure to those in the gaseous state. The existence of association is shown, for example, by determinations of the average molecular weight from measurements of the lowering of the freezing point below that for the pure solvent (*see* MOLECULE).

On dilution of a solution in which the solute molecules are largely associated, the degree of association becomes progressively smaller and smaller.

Alcohols (*e.g.*, methanol, CH_3OH) are also associated in dilute solution in nonpolar solvents, but freezing point data indicate the presence of a series of aggregates—ROH, $(ROH)_2$, $(ROH)_3$, . . . —in equilibrium with one another. The situation is closely parallel to that in hydrogen fluoride gas and here also one may confidently assume the aggregates to be held together by hydrogen bonds:



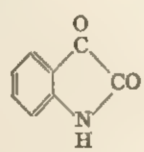
etc.

Association in the Solid State.—Crystal structure analysis by means of X-ray diffraction has led to a knowledge of the distribution in space of the atoms in many solid (crystalline) substances. (*See* CRYSTALLOGRAPHY: *Crystal-Structure Analysis.*)

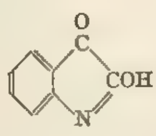
Contrary to previous belief, many of these substances are not composed of molecules. In a diamond crystal, for example, all the atoms (of carbon) are connected, directly or indirectly, by chemical bonds to all the others. If it is proper to speak of molecules at all, each crystal must be considered as comprising a single molecule. This is also true of ordinary salt, sodium chloride, which is composed of positively charged sodium ions and negatively charged chloride ions, in a regular pattern such that each ion is surrounded at the same distance by six of the other kind. There are no diatomic NaCl molecules in the structure.

On the other hand, many solids, especially of organic compounds, can properly be said to be composed of many small molecules. The atoms within each molecule are linked together by ordinary primary valence bonds, the forces between each molecule and its neighbours being much weaker. In some instances X-ray studies have shown the molecules in such solids to be connected by hydrogen bonds in pairs or larger aggregates. It seems justifiable to consider these as examples of molecular association within the solid state.

An interesting example is afforded by isatin (*q.v.*), a coloured organic compound which behaves in some respects as if it had the formula

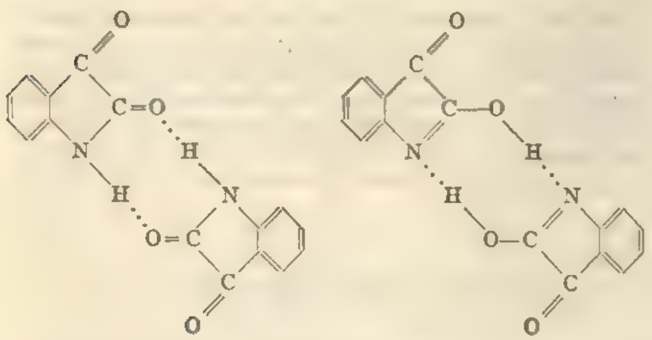


and in other respects as if its formula were



E. G. Cox, T. H. Goodwin and A. J. Wagstaff showed that in the crystal the molecular units are paired in such a way as to indicate

association by means of hydrogen bonds, in accordance with one or the other of the following formulas, or with both of them, in tautomeric equilibrium with each other (*see* TAUTOMERISM):

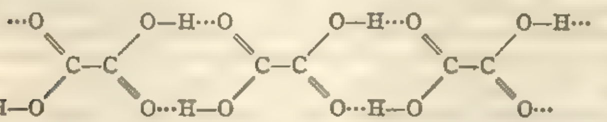


A more precise analysis by G. H. Goldschmidt and F. J. Llewellyn showed that the first of these two structures predominates.

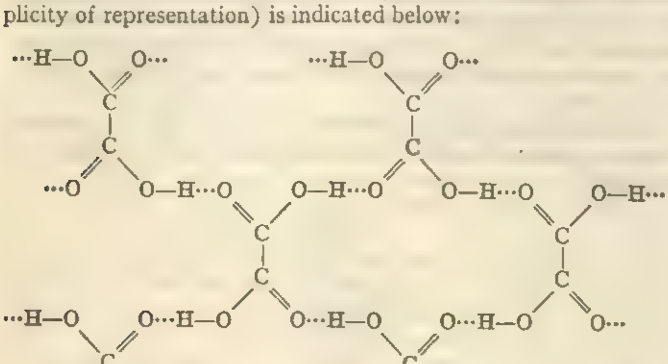
An ice crystal is an aggregate of associated water (H_2O) molecules. W. H. Bragg, interpreting X-ray data obtained by D. M. Dennison, showed that each oxygen atom in the ice structure is surrounded tetrahedrally by four others, equidistant from it within experimental error. The hydrogen atoms are undoubtedly on the oxygen-oxygen centre lines. As indicated by several lines of reasoning, including a thermodynamic argument presented by L. Pauling, each hydrogen is closer to one of its oxygen neighbours than to the other, in such a way that each oxygen has two close hydrogen neighbours and two others slightly more distant. The whole crystal is a giant network of H_2O molecules held together by hydrogen bonds.

Another interesting case is that of oxalic acid, $\begin{matrix} CO_2H \\ | \\ CO_2H \end{matrix}$

Two crystal forms are known. S. B. Hendricks showed, from X-ray diffraction data, that in one form the molecules are associated by means of hydrogen bonds into long chains, extending completely through the crystal:



In the other form the molecules are associated into sheets, each sheet extending completely across the crystal. The approximate distribution of bonds in each sheet (somewhat idealized for simplicity of representation) is indicated below:



Association in Liquids.—In a liquid, association between molecules, by hydrogen bond formation or otherwise, may result in a group of two or more of them remaining attached to each other for a relatively long time. A satisfactory quantitative definition of association in liquids is difficult to make, since it involves decisions as to how close two molecules must be to be considered attached to each other and how long they must be attached to be considered associated.

Even more difficult is the problem of measuring the degree of association in a liquid. Various methods have been proposed, mostly involving departure from the "normal" value of some experimental "constant." One constant is the Eötvös constant appearing in an equation, proposed by Sir W. Ramsay and J. Shields, which relates the surface tension of a liquid to its molecular weight, its density and the difference between the temperature of measurement and the critical temperature of the liquid. As shown by J. H. Hildebrand, greater constancy is exhibited by the entropy of vaporization (the heat of vaporization divided by the absolute temperature) at the temperature at which the vapour has a given volume. In general, the substances for which these constants have values markedly different from those for nonpolar liquids are those which one would expect to be highly associated. Quantitative correlation is difficult, however, and should hardly be expected, since factors other than association are certainly involved.

Many lines of evidence point to the fact that water is one of the most highly associated liquids. Previous to the development and verification of the hydrogen bond theory, liquid water was generally considered to be composed of an equilibrium mixture of various polymers, $(H_2O)_n$, of unknown structure. The modern point of view is that the H_2O molecules throughout the liquid are connected by hydrogen bonds, in much the same manner as in ice (*see* above) but less regularly and with the distribution constantly changing. The higher the temperature, the less perfect is the short-range order, the greater is the average amount of bending of the hydrogen bridges and the more frequently are they broken and reformed.

Alcohol molecules, in the pure liquid state as in solution, would be expected to associate by hydrogen bond formation in a chain-like fashion. This expectation was confirmed by W. H. Zachariasen, interpreting X-ray data from methyl and *n*-nonyl alcohols (methanol and 1-nonanol) obtained by G. W. Stewart and R. M. Morrow. Liquid carboxylic acids would also be expected to associate by hydrogen bond formation, forming both dimers, like those found in the gaseous state, and larger units in which the carboxyl groups are held together in chains.

Many other substances associate to a greater or lesser degree in the liquid state, but, as has been indicated, definite evidence is difficult to obtain In most cases the best that can be done is to reason by analogy with the behaviour of the same or similar substances in the gaseous or crystalline state or in solution. *See also* DISSOCIATION.

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ASSOCIATION, MENTAL. Originally the general principle of association was closely linked with problems of recollection. The principle stated that when any past event or experience is recalled, the act of recollection tends to bring again into use other events and experiences that have become related to this event in one or more of certain specified ways. As time went on the application of this general principle was expanded. It was invoked to cover almost everything that can happen in mental life, except original sensations, and "associationism" became a name for theoretical views embracing the whole of psychology.

In this sense, and also as the basis of a complete theory of knowledge, "associationism" is looked upon as a distinctively British doctrine, having a thoroughly empirical outlook and a "common-sense" sanction. It was Aristotle, indeed, who had proposed the three forms of association, by "similarity," by "contrast" and by "contiguity," and in doing so paved the way to much elabo-

rate annotation and controversy. The phrase "association of ideas" was first used by John Locke in *An Essay concerning Human Understanding* (1690). David Hume, nearly 50 years later, maintained in *A Treatise of Human Nature* (1739) that the essential forms of association were by resemblance, by contiguity in time or place and by cause and effect.

Following Hume the chief exponents of associationism were: David Hartley (*Observations on Man*, 1749), James and John Stuart Mill (*e.g.*, *Analysis of the Phenomena of the Human Mind*, 1829), Alexander Bain (*The Senses and the Intellect*, 1855) and Herbert Spencer (*The Principles of Psychology*, 1855). There was much criticism and disagreement about both the number and the proper naming of the forms of association, but in general all the associationists are usually said to hold views which are sensationalist, mechanical and atomistic. Knowledge is held to be acquired originally through one or more of the special senses. By repetitions occurring in the natural course of mental life the original sensory data are interconnected, and can be revived or reinstated as representative images or ideas. All human knowledge is built up from separate, simple and particular experiences, and is analyzable without remainder into these.

During the 1880s there was a strong reaction in England against associationism initiated, from a philosophical and metaphysical standpoint, by F. H. Bradley (*Mind*, 12, pp. 354–381; 1887) and by the analytical psychologists James Ward (in his famous article on "Psychology" for the *Encyclopædia Britannica*, 9th ed., 1875–89) and G. F. Stout (*Analytic Psychology*, 1896). All three basic contentions of the associationists were rejected. Knowledge, it was urged, cannot be founded solely on sensations, for it is impossible that they should be repeated: they happen and perish. It cannot be a product of chance repetition in experience, for there is an inherent element of purpose in all manifestations of mental activity. It cannot be reduced without remainder to simple original elements. None of these critics denied that association was a real mental process, or that it was of great importance within limits, but only that it could be made a basis for everything in psychology, or a firm foundation for the whole structure of knowledge.

The earliest experimental psychologists—W. Wundt and his immediate successors—all assumed that, for experimental purposes at least, sensations must be regarded as ultimate and simple elements, by various combinations of which everything else is built. But at the same time Wundt made it clear that in his view there was no possibility of experimenting, in the proper sense of the word, on the higher mental processes. Hermann Ebbinghaus and others, who developed the nonsense syllable style of experiment upon memory, tacitly accepted a thoroughly associationist standpoint. Their items were regarded as simple, each having, to begin with, no inherent connection with any others, and they acquired their connection by repetition in experience, although in this case the repetitions were controlled and not left to chance.

In *Principles of Psychology* (1890) William James wrote "When two elementary brain processes have been active together or in immediate succession, one of them, on reoccurring, tends to propagate its excitement into the other." This statement, it will be seen, replaced "association of ideas" by an association of central nervous processes set up by overlapping, or immediately successive, stimuli. In 1903 I. P. Pavlov used purely objective methods to study what had been called "association," and he arrived eventually at a complete and elaborate derivation of all behaviour from original and conditioned reflexes. The conditioned reflex theories, and even more literally many of the behaviourist theories which grew up about the same time, were an association psychology of conduct, making essentially the same claims as those of the "association of ideas" doctrines, and open to the same criticism. This is true also of much, perhaps most, of the stimulus-response psychology that became dominant in the United States and that persists in various forms. But as experimenters, who believed firmly in association as an explanatory principle and wanted to make the greatest possible use of it, designed and did more and more experiments, difficulties accumulated. E. L. Thorndike, for example, showed that mere repetition can do little or nothing to establish connections between stimulus and response. He himself considered most important the effect that followed action, and he thought of this effect chiefly in terms of pleasure or unpleasure (*The Fundamentals of Learning*, 1932). Others stressed an alleged direct effect of "knowledge of results" and others, like Clark Hull (*Principles of Behavior*, 1943), produced a complete account of learning mainly in terms of "need reduction," or the strength of the drive linking stimulus and response under various empirical conditions.

All of these—and there were many other varieties of view—demanded not the rejection, but some more or less radical reformulation of associationist principles. During the first ten years of the 20th century, however, came the experiments of the Würzburg school on thinking processes. This school started from a conventional associationist standpoint, but soon claimed to find processes, which were first called *Bewusstseinslagen* (usually translated as "conscious attitudes"), that could neither be derived by association nor accurately described in its terms. There were, it was maintained, vital processes in thinking that did not come from sensations, and could not be expressed in images. Just precisely how these processes were constituted and worked remained far from clear, but the Würzburg group were not calling for a reformulation of associationism, but for its total rejection so far as the higher mental processes were concerned.

About ten years later came the Gestalt psychologists. They would have nothing to do with simple and isolated sensations, and with these discarded all types of associationism. Forms, as well as items, were directly perceived and remained the same forms though the settings changed. The items gained their phenomenal character from the *Gestalten*, or configurations, in which they appeared. The Gestalt psychologists pointed out that if, for example, two stationary spots of light of suitable intensity and duration were exposed at experimentally determinable intervals of time and distance, an observer would see one single moving spot that, it was asserted, could not be analyzed into two discrete experiences corresponding to the two physical lights. The responses made to each stationary spot were changed, and an entirely new kind of experience created. When the details given for observation or treatment constituted a problem, the solution, equally new, often appeared suddenly and by "insight."

For a time Gestalt psychology had a considerable vogue. If its popularity declined, that is perhaps partly because some of its contentions were already familiar, from the discussions of such analytic psychologists as Ward and Stout; partly because as an elaborated psychological system it tended to become enmeshed in a highly speculative kind of physiology; partly because K. Lewin (*Dynamic Theory of Personality*, 1935) prematurely claimed that it justified a psychological dynamics that could be properly expressed in a mathematical form; and partly because psychologists seem to like a fairly frequent change of terminology, even when they do not greatly change their working notions.

The whole associationist treatment of causation, particularly in the form given to it by David Hume, was vigorously attacked by A. Michotte, of the University of Louvain, who based his contentions upon a series of most elegant experiments. Causation, he maintained, is not a generalization arrived at by induction from a large number of instances of regular succession. It is an immediate, compelling and necessary perception given certain simple conditions, as when a form A is seen to move toward another form B and, when they are very close or in actual contact, both move off in the same direction. Then, Michotte asserted, with abundant and varied illustration, B is actually "seen" to be launched into motion by A, and the motion of A is seen to have "caused" that of B.

The completeness or finality of criticisms of association as an all-embracing explanatory principle in psychology is uncertain. Attacks have been made upon associationist theories ever since their elaboration in the late 18th and early 19th centuries. Very few, if any, psychologists or students of the behaviour of animals other than man accord these theories the range and power once claimed for them. This however is mainly because more detailed, and especially experimental, studies have shown that mental associations cannot be formed in the purely mechanical

manner originally demanded, and that the "elements" associated cannot adequately be treated in the atomistic way originally required. Although the conditions of association are not those which the philosophers and psychologists of the pre-experimental period thought sufficient, most psychologists probably agree that association remains a genuinely important and effective principle, active in all instances of "learning through accumulated experience." *See* also CONDITIONING; LEARNING; MEMORY; PSYCHOLOGY.

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ASSOCIATION FOOTBALL: *see* FOOTBALL.

ASSOCIATION TESTS are used in psychology to study the organization of mental life, with special reference to the cognitive connections that underlie perception and meaning, memory, language, reasoning and motivation. In the usual "free association" test, the subject is told to give the first word that comes into his mind in response to a word, concept or other stimulus. In "controlled association" a relation may be prescribed between the stimulus and the response (*e.g.*, the subject is asked to give opposites, etc.). Though more complex analyses may be employed for special purposes, the reaction time for each response and the words the subject gives are the basic data provided by the test.

Association tests also are used to investigate personality and its pathology (*e.g.*, the Kent-Rosanoff test). In these the subject's reaction to emotionally charged memories and ideas provoked by certain of the test stimuli may produce atypical or revealing associations or, more often, unusually long or short reaction times. *See* also PSYCHOLOGICAL TESTS AND MEASUREMENTS; PERSONALITY. (H. F. HT.)

ASSOCIATIVE LAWS, in mathematics, are two laws relating to numbers, one with respect to addition and the other with respect to multiplication.

These laws may, respectively, be defined symbolically as follows: $a + (b + c) = (a + b) + c$, and $a(bc) = (ab)c$; that is, the terms or the factors may be associated in any way desired. (*See* also COMMUTATIVE LAWS.) The numbers may be either positive or negative, integral or fractional, rational or irrational and real or imaginary. The laws do not hold throughout the entire range of mathematics, however. For example, the associative law of addition does not hold for certain divergent series.

See also ALGEBRA; ALGEBRAIC GEOMETRY; ARITHMETIC; NUMBER: *Addition and Multiplication;* SERIES.

ASSONANCE, a term defined, in its prosodical sense, as "the correspondence or riming of one word with another in the accented vowel and those which follow, but not in the consonants" (*Oxford English Dictionary*). Much rustic or popular English verse is satisfied with assonance, as in such cases as

> And pray who gave thee that jolly red *nose?*
> Cinnamon, Ginger, Nutmeg and *Cloves,*

where the agreement between the two *o*'s permits the ear to neglect the discord between *s* and *v*. Assonance appears to have preceded rhyme in several of the European languages, and to have led the way toward it. It is particularly observable in the French poetry which was composed before the 12th century, and it reached its highest point in the *Chanson de Roland* (*q.v.*), where the sections are distinguished by the fact that all the lines in a *laisse* or stanza close with the same vowel sound.

When pure rhyme was introduced, about the year 1120, assonance almost immediately retired before it and was employed no more until modern times, when several French poets reintroduced assonance in order to widen the scope of their effects of sound. It held its place longer in Provençal and some other Romance literatures, while in Spanish it continued to retain its absolute authority over rhyme.

It has been observed that in the Romance languages the ear prefers the correspondence of vowels, while in the Teutonic languages the preference is given to consonants. Various German poets of considerable merit, and in particular Johann Tieck and Heinrich Heine, endeavoured, as English rhymers have done, to mix pure rhyme with assonance, but the result of this in almost all cases is that the assonances are drowned in the stress of pure rhymes. Assonance as a conscious art, in fact, is scarcely recognized as legitimate in English literature.

In Celtic poetry, on the other hand, assonance triumphed over pure rhyme, and the Irish poets writing in English who rhymed "Blarney" with "charming" were merely following a national tradition.

See ALLITERATIVE VERSE. (E. G.; X.)

ASSUMPTION, FEAST OF THE, celebrated on Aug. 15 by both eastern and western churches as the principal feast of the Blessed Virgin Mary. It commemorates her death (whence the name Dormition, Falling-Asleep), and especially her taking-up (Assumption) into heaven, body and soul.

This feast originated in the east and came to Rome through Byzantine influence about the middle of the 7th century, under the name of the Falling-Asleep of the Mother of God. Celebrated throughout the Byzantine empire on Aug. 15, but in Egypt on Jan. 18, it had grown out of an earlier "commemoration of the Mother of God" that had been observed during the 6th century and probably even earlier.

This general "commemoration of the Mother of God" had been transformed into a specific "Commemoration of the Falling-Asleep" during the last part of the 6th century under the influence of the *Transitus Mariae*, a 5th-century apocryphal work that nevertheless very likely preserves some half-forgotten traditions.

At Rome the name "Dormition" or "Falling-Asleep" gave way before long to the new title that was to prevail in the west: "the Assumption," which at first meant hardly more than death or passing, but which in time came to imply a real resurrection. When the Roman rite spread through the west during the 9th century the new feast went with it, although there was some opposition to the full implications of the name by which it had become known. By the end of the middle ages the feast was everywhere celebrated as one of the greatest in the year and the doctrine was universally accepted.

In 1950 Pius XII, in *Munificentissimus Deus,* declared that the doctrine was revealed—thereby defining officially what all Roman Catholics had believed for centuries. The Catholic position in the matter is that the Assumption of Mary is implicitly revealed, which means that it is a consequence of her divine Motherhood and perpetual Virginity. (*See* MARY: *Assumed into Heaven.*)

In the Roman rite the feast was given a new mass and office that more clearly state the doctrine and its implications.

See *La Mort et l'assomption de la Sainte Vierge* (1944). (W. J. O.)

ASSUMPTIONIST FATHERS (AUGUSTINIANS OF THE ASSUMPTION), a religious congregation founded in 1845 in Nîmes, France, by Emmanuel d'Alzon and approved by Pius IX in 1864. The Assumptionists' work is chiefly educational, missionary and social. They are organized into seven provinces, in 27 countries, the motherhouse being at Rome. *See* ALZON, EMMANUEL MARIE JOSEPH MAURICE DAUDE D'; ORDERS AND CONGREGATIONS, RELIGIOUS.

ASSUR: *see* ASHUR.

ASSUS (Gr. Assos; in Byzantine times MACHRAMION), an ancient Greek city of the Troad, the site of which is now partly occupied by the port of Behramköy in the Turkish *il* of Canakkale. Lying opposite the north coast of the island of Lesbos and possessing the only good harbour on the north shore of the Adramyttian gulf (Gulf of Edremit), Assus was constructed on the terraces, partly natural and partly artificial, of an isolated cone of trachyte, which rises steeply to a height of more than 700 ft. above the sea.

The city was reputedly founded by Aeolic colonists from Methymna in Lesbos early in the 1st millennium B.C. It retained a degree of independence while the Persians ruled the surrounding district, and one of its tyrants, Hermeas, brought Aristotle to the

city for the three years 347–344 B.C. Taken by Alexander the Great, Assus subsequently passed to Lysimachus, to the kings of Pergamum and then to the Romans. St. Paul visited it on his way to Mitylene.

In modern times the site was quarried, after the Crimean War, for stone for the docks of Istanbul, but much of the old city remains, including the submerged mole of the ancient harbour, parts of the defensive walls, and the ruins of a fine Doric temple of Athena. (WM. C. B.)

ASSYRIA (now part of northern Iraq) is the Greek form of a geographical name "land of (the god) Ashur," used in the cuneiform texts to denote the homeland of the Assyrian people, whose political importance in ancient western Asia lasted, with many vicissitudes, from about 2000 to 612 B.C. Ashur was thus the name of a god, a city and a country. The city of Ashur (*q.v.*) itself lay on the Tigris river about 40 mi. S. of its confluence with the Great Zab river, but the heart of Assyria was in the angle formed by these two streams, where lay the cities of Kalakh (Calah, modern Nimrud), Dur Sharrukin (modern Khorsabad) and Ninua (Nineveh, opposite Mosul), the capital of Assyria in the last years of its empire (8th–7th centuries B.C.). The political boundaries of Assyria to the north and east were naturally defined by mountains rising from the steppe, and to the west they varied greatly through the centuries according to the strength or weakness of the government, but to the south over against the still longer-enduring kingdom of Babylonia, a sister-state but often a bitter enemy, the boundary was usually about latitude 34° N. where the tributary Nahr al Uzaym joins the Tigris river. For a general account *see* BABYLONIA AND ASSYRIA. (C. J. G.)

ASSYRIAN LANGUAGE: *see* AKKADIAN LANGUAGE.

ASTARTE, the great goddess of the Semitic pantheon, and the chief deity of Sidon. The inscription of the Phoenician king of Sidon, Eshmunazar, records the building or restoration of a temple to Eshmun, the Baal of Sidon, and to "Astarte of the name of Baal." Tabnit, son and successor of Eshmunazar, was priest of Astarte. In Jerusalem, Solomon built for her a high place which king Josiah "defiled" (I Kings xi, 5; II Kings xxiii, 13). Figurines, plaques and reliefs found at many places in Palestine show that her cult as goddess of fertility and reproduction was widespread. Some of her images show foreign influence; those with a lotus flower in the hands and two long ringlets adorning the head point toward Egypt.

Astarte was worshiped in Cyprus, in Sicily, in Sardinia and at Carthage. She became identified with the Egyptian deities Isis and Hathor. By the Greco-Roman world she was assimilated to Aphrodite and Artemis, Diana and Juno. Her identification with Aphrodite/Venus suggests that she was equated with the planet Venus by the Syrians just as Ishtar (*q.v.*) was by the Babylonians. Under Egyptian influence she became the moon. This she cannot have been originally because to the Semites the moon was a male deity; the Phoenicians spread the cult of the moon as a goddess.

Because the Akkadian form of her name, Ishtar, and the Sabaean form, Athtar, both lack the Semitic feminine termination, it is possible that, like Athtar, Ishtar was originally male. Elsewhere the form of Astarte's name and the contexts in which it occurs define her as female. It is rendered Astarte in the Septuagint (Greek) version of the Bible and Ashtoreth (plural Ashtaroth) in the Hebrew, being there vocalized as *bosheth,* "shame," to indicate Hebrew contempt for her cult. The Moabites, neighbours of the Israelites, worshiped Ashtar-Chemosh. This compound name may indicate that Astarte was the spouse of the Moabite Baal; the Bible makes her the spouse of the Baal of Carmel—if, as is likely, the English rendering "prophets of the groves (Asherah)" stands for an original "prophets of Ashtoreth" (I Kings xviii, 19). Another compound of mixed sex is the divine Atargatis (*q.v.*), from Attar (Ashtart) and Atte (Anat). Atargatis is goddess of Ascalon in Palestine and identical in mythology with the maiden Derketo who, according to the Greek historian Diodorus Siculus, threw herself into a lake full of sacred fish near Ascalon, is associated with pools and fish and is represented with a body tailing off in the form of a fish (unlike the Astarte of Hierapolis near Aleppo, to whom also fish were sacred). At Ascalon the Philistines deposited the armour of Saul in the temple of Ashtoreth Astarte (I Sam. xxxi, 10).

See E. (Paul) Dhorme, *Les Religions de Babylonie et d'Assyrie* (1949). (T. FH.)

ASTATINE (chemical symbol At, atomic number 85), a synthetically produced chemical element, is the only member of the halogen family having no stable isotopes. Its name is from the Greek *astatos,* meaning unstable.

It is to be expected that all isotopes of astatine are radioactive. Therefore the only possibility of finding them in nature would be by virtue of their having very long half-lives, of the order of 10^9 years, or by their being in radioactive equilibrium with long-lived substances. No isotope of astatine has such a long life, but At^{218} and At^{219} have been found as rare branch products in the natural radioactive families.

Astatine was first prepared in 1940 at the University of California by Dale R. Corson, K. R. Mackenzie, and Emilio Segrè. They bombarded bismuth with alpha particles, obtaining a nuclear reaction that can be written $Bi^{209} + He^4 = At^{211} + 2n$. The isotope thus produced has a half-life of 7.5 hr. and shows a dual decay such that about 60% of the atoms emit alpha particles of 5.94 Mev (million electron volts) energy and transform into Bi^{207}, and the remaining 40% transform by orbital electron capture into Po^{211} (AcC′), which in turn emits alpha particles of 7.43 Mev energy to become Pb^{207} (AcPb). (For explanations of these radiochemical findings *see* RADIOACTIVITY.)

The longest-lived isotope of astatine has mass 210 and a half-life of 8.3 hr. It is best obtained by an (α, 3n) reaction on bismuth and it decays by orbital electron capture. By the 1960s about 19 isotopes ranging from mass number 201 to 219 had been identified. All have lives shorter than At^{210}.

From its position in the periodic table (following polonium and preceding radon) astatine would be expected to behave as a halogen, although the metallic properties already detectable in iodine should be more marked. Its electronic structure is a gold core plus $6s^2$, $6p^5$. Another 6p electron is needed to complete the radon core. This configuration has been verified by molecular beam experiments.

Using At^{210} and At^{211}, and employing the ordinary methods of radiochemistry, it has been possible to establish some of the chemical properties of the element. In general it resembles iodine (and, like iodine, it concentrates in the thyroid gland); however, in the normal course of qualitative analysis it appears in the group of metals having sulfides insoluble in acid solution. Its reaction to silver ion is markedly different from those of the other halogens. Under suitable conditions it is soluble in organic solvents. The ionic species At^-, At^0, and AtO_3^- and such organic compounds as $AtCH_3$ have been recognized either chemically or with the help of the mass spectrograph, or both.

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ASTER, a large genus of plants of the family Compositae (*q.v.*), so named from the radiate or starlike appearance of the flowers, and known as asters or starworts (Gr. *aster,* "a star"). Numerous species are described (estimates vary from 250 to 600), found chiefly in North America but scattered sparsely in Asia, Europe and South America. They are usually perennial, leafy-stemmed herbs, sometimes somewhat woody at the base, and bearing in late summer and autumn a profusion of flowering heads, mostly in clusters, but sometimes solitary. In each head numerous showy blue, red, purple or white rays surround a central disk of minute yellow tubular flowers. Many are strikingly handsome and cultivated as ornamental fall-flowering plants. The Michaelmas daisy is the finest of the cultivated sorts, its scores of varieties having been developed by hybridizing. Only one species, *A. tripolium,* is native to Great Britain.

In North America there are more than 175 species, most numerous in the northeastern United States and adjacent Canada. They are generously represented in the Rocky mountain region, about 40 species being found in Utah and Nevada and about 20

ALBERT W. KERR

MICHAELMAS DAISIES (ASTER AMELLUS), KING GEORGE V VARIETY

occurring in California. In the region east of Manitoba and Kansas and north of Tennessee, the asters, together with the goldenrods, dominate the floral landscape in autumn, filling fields, woodlands and roadsides with masses of brilliant colour. Among the many conspicuous kinds the New England aster (*A. novae-angliae*), found abundantly from Massachusetts to Alberta and south to Alabama and New Mexico, is the best known. It grows three feet to five feet high with handsome purple heads one and one-half inches to two inches across. Other noteworthy species are the New York aster (*A. novi-belgii*) and the smooth blue aster (*A. laevis*), both of which, like the foregoing, are widely cultivated. In California the common aster is *A. chilensis;* other noteworthy species are the somewhat woody desert aster (*A. tortifolius*) and the reedlike spiny aster (*A. spinosus*), which grows nine feet high in the southwestern deserts and is popularly called Mexican devilweed. The China aster (*Callistephus chinensis*) is also a member of the family Compositae. It is a hardy annual, a native of eastern Asia, and has yielded a great variety of forms. They are commonly known as garden asters in spite of not belonging to the genus *Aster.*

All the perennial species, especially the best of them, the Michaelmas daisy, need a reasonably rich soil, full sunlight and not too much summer heat. It is the latter that has made their culture difficult in many parts of the U.S., but most successful in England where dozens of varieties are commonly grown.

The native American woodland species are easily transplanted from the wild, but are apt to be rather weedy garden plants. All can easily be divided in spring or autumn and most Michaelmas daisies need such division and replanting every second or third year.

(N. Tr.)

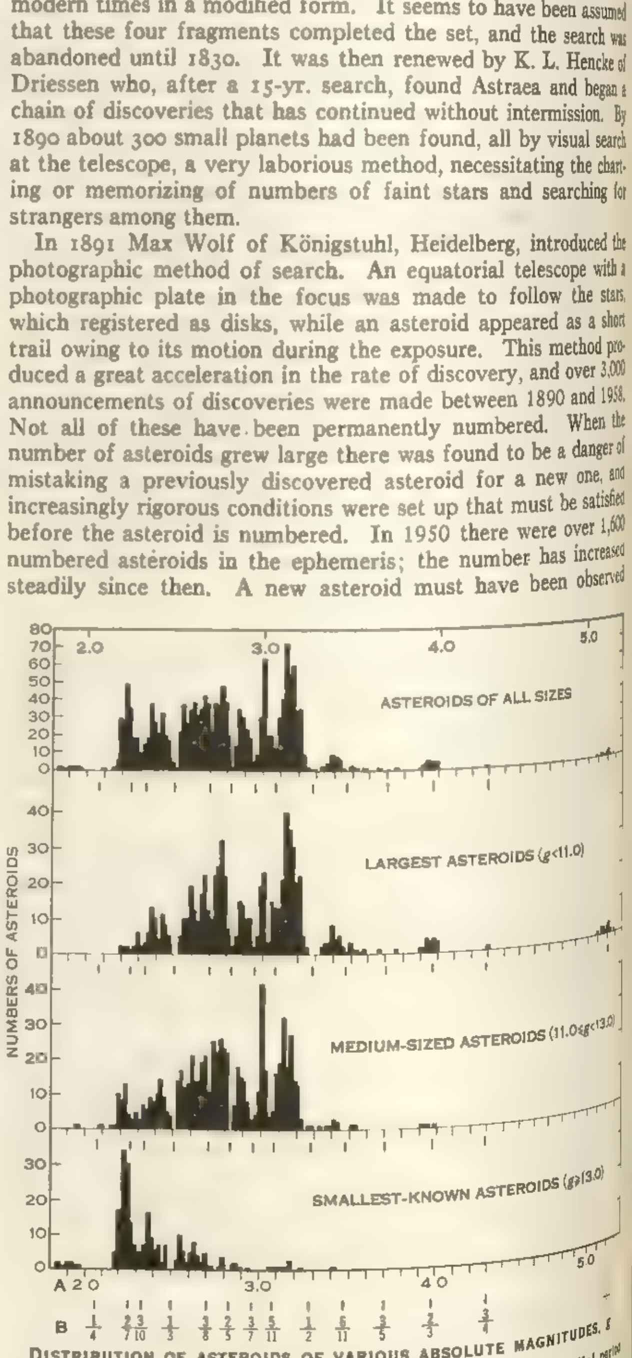
ASTEROIDS. The asteroids, or minor planets, are a vast host of very small planets that revolve around the sun in orbits that nearly all lie between those of Mars and Jupiter, though a few of them transgress these limits. The existence of a planet between Mars and Jupiter was suspected before any were found on the basis of an empirical law of planetary distances first put forward by J. D. Titius in 1766 though it attracted more notice when Johann E. Bode restated it in 1772. The law assigned the following numbers as representing the distances very closely: Mercury 4; Venus 7; Earth 10; Mars 16; (blank) 28; Jupiter 52; Saturn 100; (next planet) 196. It will be seen that, except in the first case, each interval is double the preceding one.

When in 1781 Sir W. Herschel discovered Uranus, which fitted exactly with the next term in the series after Saturn, conviction was strengthened of the existence of a planet in the gap, and a society of 24 astronomers, with Baron von Zach at its head, was formed to devote itself to the search. Giuseppe Piazzi, director of the Palermo observatory, was not a member of this society, but on Jan. 1, 1801, while examining a region in Taurus, he observed a small star which he had not seen there before; he soon found that it was moving, and followed it until Feb. 11. In the interval it ceased retrograde motion, and began to advance. In the following autumn difficulty was experienced in finding the body again; this served as an incentive to the mathematician Carl Friedrich Gauss to improve the existing methods of computing orbits from a few observed positions. As a result of Gauss's calculations Heinrich W. M. Olbers of Bremen recovered Piazzi's planet just a year after its discovery. (The three astronomers associated with the finding of the first asteroid have been commemorated by naming the planets numbered 1,000, 1,001 and 1,002 Piazzia, Gaussia and Olbersia.)

The new planet was named Ceres; its distance agreed exactly with the value predicted by the Titius-Bode law, but it was very small (modern measurements give a diameter of 470 mi., about one-fifth of the moon's) and its orbit was inclined to the ecliptic at the large angle of 10° 37′. Perhaps these circumstances led Olbers to suspect that it was one of a group of small planets for he continued to sweep the sky after he had recovered it, and three months later he found Pallas, whose distance from the sun proved to be almost the same as that of Ceres. Its orbit was inclined at the very large angle of 34° 43′, and the eccentricity was also large. The third and fourth members, Juno and Vesta, were added to the family within six years by C. L. Harding and Olbers respectively. Vesta is the brightest of the whole family, sometimes attaining visibility to the naked eye, but its diameter is only half that of Ceres.

It was natural that the discovery of these four little planets, revolving in closely adjacent orbits, should suggest the idea that a larger orb had been rent asunder by an explosion. This idea held the field for many years, and indeed was revived in modern times in a modified form. It seems to have been assumed that these four fragments completed the set, and the search was abandoned until 1830. It was then renewed by K. L. Hencke of Driessen who, after a 15-yr. search, found Astraea and began a chain of discoveries that has continued without intermission. By 1890 about 300 small planets had been found, all by visual search at the telescope, a very laborious method, necessitating the charting or memorizing of numbers of faint stars and searching for strangers among them.

In 1891 Max Wolf of Königstuhl, Heidelberg, introduced the photographic method of search. An equatorial telescope with a photographic plate in the focus was made to follow the stars, which registered as disks, while an asteroid appeared as a short trail owing to its motion during the exposure. This method produced a great acceleration in the rate of discovery, and over 3,000 announcements of discoveries were made between 1890 and 1958. Not all of these have been permanently numbered. When the number of asteroids grew large there was found to be a danger of mistaking a previously discovered asteroid for a new one, and increasingly rigorous conditions were set up that must be satisfied before the asteroid is numbered. In 1950 there were over 1,600 numbered asteroids in the ephemeris; the number has increased steadily since then. A new asteroid must have been observed



DISTRIBUTION OF ASTEROIDS OF VARIOUS ABSOLUTE MAGNITUDES, g

(A) Semimajor axis, a, in astronomical units; (B) fractions of the orbital period of Jupiter

during three oppositions to qualify for numbering. Even so, misidentifications in the published records have occurred and a systematic campaign during the decade 1948–58 was necessary to clear up most of the ambiguities. (A. C. DE C.; F. L. WE.; G. P. K.)

STATISTICS OF THE ASTEROID RING

The elliptical orbit of an asteroid is characterized by the semimajor axis a; the eccentricity e; the inclination on the ecliptic i; and quantities of lesser interest (*see* also PLANETS: *Orbits and Phases of Planets*). The asteroid itself has at opposition an apparent magnitude from which may be computed the absolute magnitude g (reduced to unit distance from the earth and from the sun); a true diameter d; an albedo, or reflectivity; a colour; and certain photometric and polarimetric properties found when observations are made away from opposition at different phase angles. Ceres has the largest diameter, just under 500 mi. The smallest objects observed are less than one mile in diameter. The albedos may be derived for only the 12 or so asteroids showing measurable disks. The value is roughly seven per cent, about the same as for the Moon and Mercury; Vesta is an exception, being nearly twice as bright. The colours of the asteroids vary somewhat, the average being a slightly yellowish gray, similar to the Moon and Mercury. None has been found to be as ochre as Mars. The colour does not appear to depend on the size of the asteroid. The photometric and polarimetric properties also resemble those of the Moon but some interesting differences have been found.

The distribution of asteroids with respect to a is shown in the chart, for three groups: largest asteroids ($g < 11.0$ or $d > 20$ mi.), a middle group ($11.0 < g < 13.0$ or $8 < d < 20$ mi.) and the smallest known objects ($g > 13.0$ or $d < 8$ mi.). Data on the smallest objects are very incomplete at the greater distances owing to their faintness. Only the bright objects may be regarded as complete over the entire range of a. It is noted that all three distributions show gaps. They are the Kirkwood gaps, named after their discoverer, D. Kirkwood. At their positions the periods of revolution are simple fractions of the orbital period of Jupiter. Particularly prominent are the gaps at the periods $\frac{1}{4}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{7}$, $\frac{1}{2}$ and $\frac{3}{5}$ of Jupiter. Where the fraction is $\frac{2}{3}$ and $\frac{1}{1}$ there are, by contrast, accumulations. The $\frac{1}{1}$ accumulation is the so-called Trojan group (*see* TROJAN PLANETS), of which 15 members are definitely known and several others are suspected. They occur near the points that define equilateral triangles with the Sun and Jupiter, situated in the plane of the Jupiter orbit. Motion around these points is stable if the amplitude of the oscillation does not exceed a certain value.

The width of the Kirkwood gaps is related to the mass of Jupiter. E. K. Rabe in this manner derived the mass responsible for the gaps and found it to be about 20 times the mass of the present planet. This value for the mass of proto-Jupiter confirmed earlier estimates by G. P. Kuiper based on his theory of the origin of the solar system. The orbits of the Trojans also contain important information on this subject. Kuiper assumed the Trojans to be former satellites of Jupiter, released because of the planet's mass decrease and forced into orbits around the triangular points. Rabe's analysis of this hypothesis also led to a mass of proto-Jupiter of about 20 times the present planet.

Additional information is obtained by a consideration of the orbital eccentricities and inclinations. These elements undergo fluctuations due to perturbations of the major planets, especially Jupiter. Average, or proper, values of e and i that are free of these fluctuations may be computed. The three-dimensional distribution of proper elements, a, e and i, then shows clusterings of asteroids on a general background which are called Hirayama families. K. Hirayama found ten such groups, comprising about $\frac{1}{6}$ of all known asteroids; D. Brouwer extended the number to 29 groups comprising 29% of the known asteroids. Some families, like the Coronis family, are tightly packed in the plot while others are loose and some may not be genuine groups. The origin and nature of these families has been debated. Brouwer regards them as compatible with an origin by collisional break-up, the fragments of one break-up resulting in one family. Rabe favours an earlier explanation by E. W. Brown who regarded them as "groups of comparatively stable orbits developed by the attractive forces, and might have arisen from a great variety of configurations." (Eugene Rabe, *Zeitschrift für Astrophysik*, vol. 40, p. 107, Springer-Verlag, 1956.) The uncertainty arises from the fact that the gravitational theories are not accurate beyond intervals of some tens of millions of years or about one per cent of the age of the solar system.

The distribution by absolute magnitudes g (or by diameters) shows interesting features. The different distance zones of the asteroid ring have notable population differences, with the zone from 3.0 to 3.5 astronomical units showing the most rapid increase toward the smaller bodies. The apparent discrepancy between this statement and the diagram is caused by the fact that the chart represents all that is *known* and not all that is present. This increase is so rapid, in fact, that the total mass per magnitude interval for the fainter asteroids continues to increase so that the total mass of the asteroid ring cannot be computed. It further means that the fragmentation by collisional break-up will be most rapid in the 3.0–3.5 unit zone. This zone must therefore be the region where the meteorites are formed. The brightness distributions of the three main parts of the asteroid ring all show two groups to be present: those larger than about 20 mi. in diameter; those smaller, with a discontinuity in the distribution near 20 mi. This feature may be due to two modes of asteroid formation: the larger having formed by condensation and accretion; the smaller largely by fragmentation in collisions.

The brightness of nearly all asteroids is found by continuous observation to vary by small amounts. The variations are periodic, with each cycle showing two light maxima and two minima. This state of affairs can be explained if the asteroids are nonspherical bodies in rotation; then during one period they will show twice a maximum projected area and twice a minimum area, as is verified by rotating an object of arbitrary shape. Only when the object is seen pole-on will there be no light variation. Since an asteroid may be observed in many different parts of the sky, owing to the orbital motions of both Earth and asteroid, many aspects can be studied and combined to give data on both the shape of the body and the position of the pole of rotation. The results are that the periods may be anywhere from 3 to over 20 hours, with 6–8 hours being rather typical; and that the poles of rotation approximate a random distribution in space. These results are not surprising in view of the many collisions that asteroids must have experienced; but one aspect was at first unexpected: that the collisions did not cause the axes of rotation to differ from the figure axes, which would have caused the asteroids to wobble in their rotational motions. Such a wobbling motion (latitude variation) has not been found; such motion would have led to nonperiodic light variations, contrary to observation. This result has been explained as due to damping of the latitude variation; K. Prendergast has shown that this damping occurs well within 1,000,000 years, so that only asteroids having suffered extremely recent collisions would still be expected to show the effects.

The composition and age of the asteroids may be ascertained through the study of meteorites, which, if many authorities are correct, are asteroid fragments that have fallen on the earth. Meteorites are fragments of bodies that have in large part melted; the time elapsed since the subsequent solidification is about 4,500,000,000 years. The parent bodies appear to have been asteroidal in size: they were large enough to permit the accumulation of radioactive heat until melting set in and to later cause very slow cooling during crystallization; but they were small enough to prevent vigorous gravitational separation of the iron phase and the silicate phase of the melt as is seen from silicate inclusions in the iron phase and vice versa. It is true that very small diamonds have been found in some meteorites and, since laboratory production of diamonds requires high pressures, it has been assumed that the parent bodies were nearly the size of Mars. However, there is no evidence of such large mass concentrations in the asteroid ring and the presence of diamonds is not definite proof of the action of high pressures, since asteroidal pressures operating over long periods of time may be sufficient for their production. The study of asteroids through meteorite

fragments is one of the most fascinating and productive fields in astrochemistry. The orbital characteristics of the meteorites also present challenging problems, such as the application of gravitational perturbation theory involving very long intervals of time.

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ASTHENIA, lack or loss of strength, is a condition in which the body lacks or has lost strength either as a whole or in any of its parts. General asthenia occurs in many chronic wasting diseases such as anemia and cancer. It is probably most marked in diseases of the adrenal gland, where it dominates the whole picture. Asthenia may be limited to certain organs or systems of organs. Thus there is asthenopia (*q.v.*), which is characterized by ready fatigability of vision and myasthenia gravis, in which there is progressive increase in the fatigability of the muscular system until death results from inability of the heart muscle to continue its work. In neurasthenia and psychasthenia there is a strong subjective sense of fatigue in the absence of real weakness.

ASTHENOPIA is a condition in which the eyes are weak and tire easily. It may be brought on by disorders in any of the various complicated functions involved in the visual act. Thus imbalance between the muscles that keep the eyes parallel leads to fatigue in the constant effort to prevent double vision. Errors in refraction lead to fatigue of the muscles of accommodation in the continued compensation demanded of them. Clouding of the lens or of the media that transmit the light may bring it about, and finally disorders of the retina, where the impressions are received, will lead to fatigue.

The symptoms are pain in the eyeball, frontal headache, blurring of vision and smarting and watering of the eye. These are usually worse toward evening and are aggravated by close work such as reading and sewing.

ASTHMA, a lung condition that owes its name to its predominant clinical symptom, shortness of breath. The word "asthma" means panting. If asthma is caused by obstructed airways, it is said to be bronchial; if red blood cells fail to carry oxygen away from the lungs, it is cardiac.

Asthma has a high morbidity but a surprisingly low mortality, and asthmatics can lead useful lives. The long-term problem is prevention, not treatment. Since multiple factors—heredity, environment, hormones, stress—determine its course, successful care requires adequate control not only of the respiratory tract but more or less of the patient as a person.

Normally, air is carried into the lungs through airways—bronchi and, as they become smaller, bronchioli—to blind terminal sacs, the alveoli. The alveolar walls consist of a thin membrane interwoven with elastic fibres. On the outer wall of each sac, red blood cells move slowly through tiny blood vessels and, as they move, exchange carbon dioxide for oxygen through the membrane. If blood stagnates, this exchange is halted and cardiac asthma results.

Bronchial asthma is caused by any obstruction of the airways that prevents oxygen from reaching the alveoli. Circular muscles control the width of the bronchi and, thus, the flow of air; simultaneously, blood vessels, like radiators, adjust the temperature, and mucous glands provide humidification. The proper functioning of these air-conditioning structures is maintained by autonomic nerves that can, when the need arises, excite or inhibit them. Allergic patients, during allergic episodes, produce histamine, a substance that overrules this physiological balance and incites muscles, blood vessels and mucous gland to work, regardless of need, at maximal capacity.

Allergy as a Cause.—The chain of events culminating in an allergic asthmatic attack begins with the peculiar, inherited ability of the allergic individual to become sensitive to allergens, particles in the air that are innocuous for nonallergic people. Common allergens include pollens of certain trees, grasses and other plants, especially ragweed; spores of molds; small scales (dander) from the hair or feathers of animals; house dust; and certain chemicals; *e.g.*, components of hair dyes or insecticides. Food not infrequently causes bronchial asthma in children, rarely in adults.

Once sensitivity exists, re-exposure to the allergen releases histamine, which, in a three-fold action: (1) increases vascular permeability so that the tissue becomes waterlogged; (2) induces profuse secretion of mucus; and (3) constricts circular muscles. Many people are allergic, but most of them have nasal rather than bronchial symptoms. In the lungs, histamine produces the three cardinal features of bronchial asthma: (1) shortness of breath and other signs of oxygen want, such as laboured breathing, blueness of lips or a rapidly beating heart; (2) wheezing—a unique sound made by air passing through narrowed, mucus-filled bronchi; and (3) coughing, a reflex that produces expectoration.

Nonallergic Bronchial Asthma.—Bronchial asthma is not always allergic. In some patients, the autonomic nerves induce constriction of muscles or secretion of mucus when neither is required. Asthma from this cause usually begins after middle age and has been called intrinsic to distinguish it from extrinsic allergic asthma, which generally begins before adolescence. Infection complicates bronchial asthma; there is some evidence that infection might actually cause it, but the exact mechanism by which infection affects asthmatics is not known.

Effects on Lungs.—Oxygen deficiency compels the asthmatic to force air into his lungs. As the pressure increases, the stretched alveoli become choked with air. The pressure may tear the tender membrane and produce scar tissue, which is tough but useless. This stretching and scarring produces the inflated, ineffective lung of pulmonary emphysema. Yet, some patients may have bronchial asthma throughout their lives without scarring, while others develop early irreversible changes.

Treatment.—Treatment of cardiac asthma demands mobilization of the stagnating blood through treatment of the heart rather than the lung.

Specific treatment of bronchial asthma consists of (1) prevention of initial exposure, *i.e.*, sensitization, of allergic individuals; (2) prevention of re-exposure of those already sensitized; and (3) immunization procedures that may decrease an existing sensitivity.

Symptomatic treatment can reverse the effect of histamine. This treatment consists of administering epinephrine (adrenaline) or drugs similar to epinephrine, the chemical produced in the body that widens bronchi and inhibits mucous glands. Epinephrine originates in the marrow of the adrenals, small glands that overlie the kidneys. The outer layer of the adrenals produces a different hormone, hydrocortisone, which, through a different mechanism, also controls bronchial asthma. Hydrocortisone eliminates waterlogging but does not influence the disease itself, which recurs after withdrawal of the hormone. Administration of hydrocortisone is not without risk, although the newer synthetic derivatives appear to be safer.

In some patients it may be necessary to administer oxygen in higher-than-air concentration for limited periods, until tenacious mucus liquefies. Breathing exercises are often helpful. Weather influences bronchial asthma, but its importance tends to be exaggerated; only a few patients will benefit from a change in climate. Emotional stress alone is unlikely to give rise to bronchial asthma, but it may make the patient asthma-prone. Moreover, the patient who has recovered from severe attacks may be apprehensive; he needs reassurance and, particularly, a clear understanding of measures that provide immediate relief. Bronchial asthma cannot be cured, but it certainly can be controlled.

See HISTAMINE; RESPIRATION: *Ventilation of the Lungs in Man;* RESPIRATORY SYSTEM, ANATOMY OF: *Lungs.* (M. SA.)

ASTI, a city of northwest Italy, capital of the Asti province in the region of Piedmont, lies on the Tanaro river 35 mi. by road east-southeast of Turin. Pop. of commune (1961) 62,172. The 14th-century cathedral is in Gothic style, the collegiate church of S. Secondo (15th century) has a Romanesque campanile, the Trojan tower (13th century) is the highest medieval tower in Piedmont, and other interesting buildings include the eight-sided

baptistery of S. Pietro (10th century), and the churches of S. Giovanni and S. Atanasio with crypts of the 7th and 8th centuries. Asti is noted for its fine wines, of which the best-known are Asti spumante, Barbera, Grignolino and Freisa; and for its fruits. The town was called Hasta Pompeia by the Romans. It is the birthplace of the Italian tragedian Vittorio Alfieri (*q.v.*).

ASTIGMATISM, a form of aberration in optical systems, as a result of which rays proceeding from a point source form an area instead of a point and thus cause blurred vision. In the eye it is caused by uneven and unequal curvatures on the various refractive surfaces (*i.e.*, the cornea and lens) that diffuse the rays and interfere with a sharp focus at a point on the retina.

See OPTICS; VISION; *see* also Index references under "Astigmatism" in the Index volume. (F. L. A.)

ASTIN TAGH (ALTYN TAG), the northernmost range of the Kunlun mountains (*q.v.*), in Sinkiang, China. It extends from the Tokuzdavan pass (86° E.) in a northeasterly and easterly direction to the borders of Kansu, where the Tangyn pass (94° E.) separates it from the Humboldt range. In the west it rises steeply above the Takla Makan desert of the Tarim basin; at this end of the range there are extensive glaciers. Maximum height 17,716 ft. Lake Lobnor lies north of the centre of the range, while the eastern half of the range limits the Tsaidam depression, forming its northeastern boundary. (R. E. F. S.)

ASTLEY, JACOB ASTLEY, BARON (1579–1652), English soldier, who was a royalist commander in the English Civil War, came of a Norfolk family. He served under Maurice and Henry of Orange in the Netherlands in 1598 and afterward fought under Frederick V of the Palatinate and under Gustavus Adolphus in the Thirty Years' War. Returning to England with a well-deserved military reputation, he was employed by Charles I in various capacities. At the outbreak of the Civil War (1642) he was made major-general of the foot. His battle prayer at Edgehill (Oct. 1642) has become famous: "O Lord, Thou knowest how busy I must be this day. If I forget Thee, do not Thou forget me. March on, boys!" He led the infantry of the royal army in the first battle of Newbury (Sept. 1643) and gallantly defended Shaw house in the second (Oct. 1644). In Nov. 1644 he was created baron. At Naseby (June 1645) he commanded the main body of the royalist foot. Later in 1645 he was commander in south Wales, afterward serving in the west. With 1,500 men he fought stubbornly but vainly for the king in the last battle of the first phase of the war, at Stow-on-the-Wold (March 1646). His remark to his captors has become as famous as his words at Edgehill: "You have now done your work and may go and play, unless you will fall out amongst yourselves." Because he had given his parole at Stow-on-the-Wold, his scrupulous honour forbade him to take any part in the second phase of the Civil War. He died at Maidstone, Kent, in Feb. 1652. (S. R. BT.)

ASTON, FRANCIS WILLIAM (1877–1945), English scientist, was the recipient of the Nobel prize in chemistry (1922) for his development of the mass spectrograph, discovery of many isotopes, and formulation of the whole number rule. He was born in Harborne, Birmingham, on Sept. 1, 1877, and educated at Malvern college and the universities of Birmingham and Cambridge. His early training and employment was as a chemist, but the rebirth of physics following the discovery of X-rays and radioactivity (1896) was too exciting to miss. He returned to the University of Birmingham in 1903 to study gaseous discharges, the method then used for the production of X-rays. In 1909 he accepted an assistantship at Cambridge university with J. J. Thomson, who was investigating the positively charged rays emanating from gaseous discharges. It was during the period of Aston's assistantship that Thomson obtained, from experiments with neon, the first evidence for isotopes (*q.v.*) among the stable elements. Aston set out to verify or disprove Thomson's evidence. Returning to Cambridge after World War I Aston constructed a new type of positive ray apparatus which, because of its similarity to optical spectrographs, he named a mass spectrograph. (*See* MASS SPECTROSCOPY.)

The mass spectrograph was an immediate success. Not only did it show that neon is indeed a mixture of isotopes, but that many elements are mixtures of isotopes. Aston's success is illustrated by the fact that of 287 naturally occurring isotopes, he discovered 212. A second success, which illustrates the importance of his background in chemistry, was the calculation of chemical atomic weights from the physically determined isotopic masses and abundances. A third success was the formulation of the whole number rule; *i.e.*, with the mass of the oxygen isotope defined as exactly 16, all other isotopes have masses that are very nearly whole numbers (*e.g.*, U^{235}). Aston continued to measure, with ever greater precision, the exact masses of the isotopes. These masses are fundamental to nuclear theory. In the mid-20th century there were few fields of scientific research that did not depend on his work.

Aston's achievements were recognized by his election as a fellow of Trinity college (1920) and as a fellow of the Royal society (1921); and his receipt of the Nobel prize and the Hughes medal (1922), the John Scott medal and the Paterno medal (1923), the Royal medal (1938) and the Duddell medal (1945). He was an honorary member of the Russian academy of sciences and the Accademia dei Lincei. He died in Cambridge, Nov. 20, 1945. (M. G. I.)

ASTON, HUGH (*c.* 1490–*c.* 1550), English composer of church music. Various spellings of his surname are found, and his identity has been long obscured by the fact that there was at the same period a prominent ecclesiastic of the same name, a canon of York and of St. Stephen's, Westminster. It has been established that the composer, born *c.* 1490, supplicated for the degree of B. Mus. at Oxford in 1510 and was master of the choristers at St. Mary's college, Leicester, from some time before 1525 until its dissolution in 1548. He was already well enough known in 1525 for the bishop of Lincoln to recommend him to Cardinal Wolsey for the latter's lavish new foundation at Oxford (Cardinal college, later Christ Church); he refused the offer, however, and the post went to John Taverner. Aston died sometime after 1549.

The style of Aston's music (most of it reprinted in *Tudor Church Music*, vol. X, 1929) in its rich, largely nonimitative counterpoint is very close to that of Taverner, though Aston lacks Taverner's melodic suppleness and control of large-scale designs. (J. J. N.)

ASTOR. The name of an Anglo-American family founded by JOHN JACOB ASTOR (1763–1848), who was born near Heidelberg, Ger., on July 17, 1763, emigrated to America in 1783 and entered the fur business in 1786. He devoted many years to organizing the fur trade from the Great Lakes to the Pacific ocean and from there to China and Japan, exchanging fur for tea at great profits. His American Fur company was the first American business monopoly. The greater part of the family fortune, however, was obtained by acquiring and developing real estate in New York city. Astor was a leader in chartering the 2nd Bank of the United States. He died on March 29, 1848, his wealth then being estimated at over $25,000,000. His principal benefaction was $400,000 for the foundation and endowment of a public library.

His son WILLIAM BACKHOUSE ASTOR (1792–1875), who was born in New York city on Sept. 19, 1792, added greatly to the family fortune, erecting about 700 stores and dwellings in New York city. He died on Nov. 24, 1875, leaving the bulk of his estate to his two oldest sons. JOHN JACOB ASTOR 3rd (1822–1890) was born in New York city on June 10, 1822. Inheritances from his father and grandfather made him the largest private owner of real estate in New York city. In the Civil War he served for a year on the staff of Gen. George B. McClellan. WILLIAM ASTOR (1830–1892), brother of the above, became interested in Florida development, where a town was named for him. He built the first of the "Nourmahal" yachts and augmented the properties of his family. WILLIAM WALDORF ASTOR (1848–1919), great-grandson of the founder and son of John Jacob Astor 3rd, from whom he inherited $100,000,000, was born in New York city on March 31, 1848. From 1882 to 1885 he was U.S. minister to Italy. In 1890, after unsuccessful political attempts, he moved to England and became a naturalized citizen. His name is remembered by the building of the Waldorf-Astoria hotel in New York city. In 1917 he was created 1st viscount Astor. He died on Oct. 18, 1919.

His eldest son WALDORF ASTOR (1879–1952), who succeeded to the title, was born in New York city on May 19, 1879, and was educated at Oxford. In 1906 he married Nancy Witcher Langhorne (1879–1964) of Virginia, U.S., who in 1919 became the first woman member of the British parliament. Waldorf Astor was a member of parliament from 1910 to 1919. During World War I he was inspector in the quartermaster-general service. In 1915 he became proprietor of *The Observer*. He was private secretary to David Lloyd George (1918), parliamentary secretary to the ministry of foods (1918–19) and chairman of the Royal Institute of International Affairs (1935–49). He died on Sept. 30, 1952. The younger son of the 1st viscount Astor JOHN JACOB ASTOR (1886–) was born May 20, 1886, and educated at Oxford. He served as aide-de-camp to the viceroy of India (1911–14) and with the British army in World War I. In 1922 he became chief owner of the *Times* Publishing company. He was a member of parliament and director of railways and banks in England. In 1956 he was created baron.

In the American branch of the family, JOHN JACOB ASTOR 4th (1864–1912), great-grandson of the founder, was born in Rhinebeck, N.Y., on July 13, 1864, and graduated from Harvard in 1888. He built four of the largest hotels in New York city and several large office buildings and apartments. In the Spanish-American War he organized and equipped a battery which served in the Cuban campaign. When he died in the "Titanic" disaster on April 15, 1912, his fortune was estimated at $87,218,000. His son WILLIAM VINCENT ASTOR (1891–1959), born on Nov. 15, 1891, in New York city, attended Harvard and served in the U.S. navy in World Wars I and II. Under his direction the real-estate holdings of the family changed significantly. For the first time major portions of the Astor property in the heart of New York city were sold, including the site for the Empire State building. William Vincent Astor died in New York city on Feb. 3, 1959; most of his fortune was willed to the Astor foundation, a philanthropic agency he had established.

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ASTOR, NANCY WITCHER, VISCOUNTESS (1879–1964), first woman to sit in the British house of commons, was born on May 19, 1879, at Danville, Va., the daughter of Chiswell Dabney Langhorne. In 1897 she married Robert Gould Shaw of Boston, Mass., from whom she obtained a divorce in 1903, and in 1906 she married Waldorf Astor, great-grandson of John Jacob Astor (1763–1848). When her husband succeeded to the viscountcy and thus relinquished his seat in the commons, Lady Astor, who had been his constant comrade-in-arms in his constituency at Plymouth, was adopted as Unionist candidate in his place, and after a stirring campaign was elected by substantial majority on Nov. 28, 1919. Lady Astor was returned for Plymouth at subsequent general elections until her retirement from parliament in 1945. A sympathetic and tireless champion of women's interests, she arranged as soon as she entered parliament for a deputation to interview the prime minister on the subject of women's pensions. She advocated the amendment of the legitimacy laws, and the equal guardianship of children; and in 1924 supported the Guardianship of Infants bill, which became law in that year. Lady Astor served on the joint select committee of both houses of parliament for the consideration of criminal law amendment, and on the home office committee on the employment of women in police duties in Feb. 1920. Apart from questions relating exclusively to women, her chief parliamentary work was done for a progressive educational policy, for temperance and for the extension of the Trade Boards acts. She constantly advocated the raising of the school-leaving age, and in 1923 carried through the Intoxicating Liquor (Sale to Persons under 18) bill. She also maintained a continuous agitation for improved conditions in certain branches of the distributive and catering trades. No less potent was her role as hostess at Cliveden, the Astors' country house, where she maintained a *salon* that exercised considerable influence in many fields, notably foreign affairs. All in all her vitality, trenchancy, courage, and gaiety made her one of the noteworthy figures of her generation. She was created a companion of honour in 1937. She died at Grimsthorpe castle, Lincolnshire, on May 2, 1964.

See M. Collis, *Nancy Astor: an Informal Biography* (1960). (H. G. N.)

ASTORGA, EMANUELE GIOACCHINO CESARE RINCON, BARON D' (1680–*c.* 1757), Italian composer, known for his dignified and pathetic *Stabat Mater* and for his chamber cantatas, of which about 170 survive. He was born at Augusta, Sicily, March 20, 1680, of noble family. His first opera, *La moglie nemica*, was performed privately at Palermo in 1698. Later he quarrelled with his father and left home. In Rome he met Sebastiano Biancardi, whose *Rime* (1732) contains valuable information on Astorga. At Genoa in 1709 poet and composer were robbed and the opera *Dafni* was written to raise money. After adventures under an assumed name Astorga was summoned to Barcelona by Charles III, Austrian claimant to the Spanish throne. Charles became emperor in 1711 and Astorga lived for a time in Vienna. When his father died in 1712 the family estates were sequestrated; Astorga reclaimed them in 1715, and settled at Palermo, where he married and became a senator, but in 1721 he left in unexplained circumstances after restoring his wife's dowry. Between 1721 and 1726 he was in Lisbon; according to Sir John Hawkins, the musical historian, he then went to London, en route to Bohemia. In 1744 his estates were sold to pay his wife's debts. According to a note on a manuscript he died in Madrid in 1757.

See H. Volkmann, *Emanuele d'Astorga*, 2 vol. (1911–19); O. Tiby *Emanuele d'Astorga: Aggiunte e correzioni da apportare alle ricerche del prof. Hans Volkmann* (1952). (FR. WA.)

ASTORIA, a city and a port of entry, the seat of Clatsop county, Ore., U.S. Located on the south bank of the Columbia river, 12 mi. from the open sea, it commands a spectacular view of the wide estuary. Its harbour facilities, under a port manager handle grain, lumber and general merchandise. Fishing, lumbering, pulpwood manufacture, dairy and diversified farming are its main industries. The city was chartered in 1867, and adopted a council-manager form of government in 1923.

Astoria is the site of the oldest settlement in Oregon. In 1805 the Lewis and Clark exploring party wintered on the nearby river which bears their names. In 1810–11 John Jacob Astor sent out sea and land parties to establish Fort Astoria (1811) as a depot for the Pacific Fur company's Indian, Russian, Alaskan and China trade. Two years later, war between the United States and Great Britain cut off its supply ships and the fort's trading stock was sold to the company's Canadian rival, the North West company. The same year a British man-of-war took possession of the fort, renamed Fort George. In subsequent peace negotiations, the site was restored to the United States, but Americans did not again occupy it until the mid-1840s. In 1847 the first post office west of the Rocky mountains was established in Astoria. A disastrous fire in 1922 destroyed most of the city's business district. Rebuilt, Astoria failed to recapture industries favourable to population growth, except during World War II when Tongue Point naval station was activated. Its population peak was reached in 1920 with 14,000. For comparative population figures *see* table in OREGON: *Population*. The 125-ft. Astor column and the Fort Clatsop National Memorial commemorate the historic past of the city and its surroundings. (D. O. J.)

ASTRAEA, in ancient Greek mythology, the "star maiden," daughter of Zeus and Themis, or of Astraeus the Titan and Eos ("the dawn"), in which case she is identified with Dikē. During the golden age she remained among men distributing blessings, but when the iron age began, she left the earth in disgust and was placed among the stars as the constellation Virgo. She is represented with a pair of scales and a crown of stars.

ASTRAGALUS, a very large genus of the pea family (Leguminosae [*q.v.*] or Fabaceae), widely distributed throughout the world, except in Australia, but most numerous in the steppe region of northern Asia, the high plains of western North America and the tropical Andes. The common species of the eastern United States, Canada and Great Britain are called milk vetch. They are mostly low herbs, though some are shrubby, with leaves usually divided into many narrow leaflets. *Astragalus* contains about 1,600

species. More than 275 of these are found in North America, 95% occurring west of the Mississippi river.

Although in number of species *Astragalus* ranks among the largest of plant genera, only a few are of economic importance. Gum tragacanth is derived from *A. gummifer* and other related low spiny shrubs native to Asia Minor. In Iran a sort of manna is obtained from *A. florulentus*. In northern Europe *A. boeticus* is cultivated for its seeds, which are used as a substitute for coffee, sometimes called Swedish coffee. The long roots of *A. aboriginum*, which occurs from Saskatchewan to Alaska and southward to British Columbia, Nevada and Colorado, are used for food by the Crees and other North American Indians. In the plains region of the United States, extending from Nebraska and Wyoming southward to Texas and New Mexico, *A. mollissimus* and other related species, called locoweed, are poisonous to grazing animals. Many highly ornamental old-world species of *Astragalus* are in cultivation, and several native to North America are sparingly planted.

ASTRAKHAN, an *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., lies in a long relatively narrow strip along the lower Volga, from just below Volgograd to the Caspian sea. Pop. (1959) 702,000. Area 17,027 sq.mi. The axis of the *oblast* is the floodplain of the lower Volga and its parallel distributary, the Akhtuba. The floodplain, with marshes, groves of trees and meadows is cut up by innumerable arms of the rivers and oxbow lakes. Soils are a fertile alluvium. The Volga and Akhtuba terminate in a large delta of sluggish distributaries and stagnant or semistagnant lakes, with wide areas of reeds and enormous numbers of wild birds, especially pelicans, herons, ducks, geese, swans, sea gulls and cormorants, and also the lotus (*Nelumbium caspicum*). A reserve was established in the delta for the protection of the wild life. Outside the belt of floodplain and delta the oblast consists of dry steppe in the northwest, giving way toward the Caspian to semidesert. There are extensive areas of bare, shifting sand dunes, many salt lakes and frequently saline soils. There is only a sparse vegetation of sage, although in places attempts have been made to fix the sands by plantation. The climate is dry, with an annual rainfall of only 8–9 in. Average temperatures are 19° F. for January and 77° F. for July.

In the lower Volga region the capital of the Tatar khanate of the Golden Horde was located at Sarai and later at Astrakhan city. In 1556 Ivan the Terrible captured Astrakhan and Russian colonization followed, pushing out most of the previous Kalmuck (Kalmyk) population. Many Russians and Ukrainians migrated there in the late 19th century. Most of the population is concentrated along the fertile floodplain and in the delta; about 52% are urban, living mainly in the administrative centre of Astrakhan.

Fishing is the major industry of the *oblast*, particularly in the delta and along the Caspian shores. Sealing has been carried on for over two centuries. Agriculture is concentrated almost entirely in the floodplain, where melons, tomatoes, vegetables and fruit are grown. Floods, however, restrict the area that can be cultivated. Cattle and sheep rearing is carried on in the steppe and semidesert areas. Salt is obtained from Lake Baskunchak, near Vladimirovka. Industry is mainly food processing and canning, in Astrakhan city and a number of smaller places. A large volume of trade, especially in oil and timber, uses the Volga, while railways run from Astrakhan south to Baku and along the Volga to Volgograd (Stalingrad) and Engels. (R. A. F.)

ASTRAKHAN, a town and the administrative centre of Astrakhan *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., is situated in the delta of the Volga, 62 mi. from the Caspian sea. It lies on several islands on the left bank of the main (westernmost) stream of the Volga. Pop. (1959) 294,000, is of mixed character, with Russians, Armenians, Tatars, Jews, Kalmyks (Kalmucks) and Kazakhs. The town's greatest importance is as a port and transshipment point, petroleum and timber being the major cargoes handled. The actual river port is in the town itself, but, because of the extreme shallowness of the Caspian off the Volga delta, sea-going craft have to transship at the 12-Foot Roads about 45 mi. out in the Caspian sea and 125 mi. from Astrakhan, which is reached by a dredged channel. A railway from the town runs parallel to the Volga to Volgograd (Stalingrad) and Engels, while another line runs to Baku. The town is the base of a large fishing fleet and it is important as a fish canning and caviar-preserving centre. Food processing is the chief industry and includes meat and vegetable canning. Other industries are the manufacture of cotton, woolen and leather goods, and boots and shoes, ship-repairing and cooperage. Astrakhan fur, which comes from the karakul lamb of central Asia, is named after the town because it was first brought to Russia by Astrakhan traders.

Astrakhan was formerly the capital of a Tatar khanate, a remnant of the Golden Horde, when it was located on the higher right bank of the Volga. It was captured in 1556 by Ivan IV ("the Terrible") and two years later it was moved to its present site, as being more easily defensible. The kremlin, built shortly afterward, is still in existence. Thirty-one bridges link the different parts of the town. There are medical and pedagogical institutes and a technical institute of fisheries and the food industry. (R. A. F.)

ASTRINGENT, a term comprising a group of agents that tend to shrink mucous membranes and raw surfaces and to dry up secretions. They are usually classed according to their mode of action into: (1) those that decrease the blood supply by narrowing the small blood vessels (adrenaline and cocaine are in this group); (2) those that abstract water from the part, as glycerin and alcohol; and (3) those that coagulate the superficial layers and form a crust, as the metallic astringents. They are used in medicine to reduce swollen mucous membranes in inflammations of the nasal, alimentary and urinary passages. They are frequently employed in attempts to dry up excessive secretions and to stop the oozing of blood.

ASTROLABE, an instrument used for the taking of altitudes of celestial bodies, from which time and latitude are deducible. The planispheric astrolabe, to which the name is commonly restricted, is believed to have been a Greek instrument invented by Hipparchus (150 B.C.), or even by Apollonius of Perga (*c.* 240

AUTHENTICATED NEWS

BRASS ASTROLABE MADE IN 1462 BY REGIOMONTANUS, GERMAN ASTRONOMER KNOWN ORIGINALLY AS JOHANN MÜLLER

Face view showing the alidade, or sight rule, and the *rete*, or star map

B.C.). It was revived by Prof. Charles Jenkin of Oxford as a useful educational instrument, so with a history of 2,000 yr. it may claim to be the oldest scientific instrument in the world, and has played a correspondingly important part in the history of civilization. Seamen from the time of Martin Behaim (*c.* 1480) to the middle of the 18th century, when the astrolabe and cross-staff were superseded as navigational instruments by John Hadley's reflecting quadrant (*see* SEXTANT), relied largely upon such instruments and tables of the sun's declination for finding their latitude.

In its most usual form it consisted of an evenly balanced circle or disk of metal or wood, hung by a ring and provided with a rotatable alidade or a diametral rule with sights, turning within a circle of degrees, for measuring the altitudes of sun or stars. On the back was a circular map of the stars, the *rete,* often beautifully designed in fretwork cut from a sheet of metal, with named pointers to show the positions of the brighter stars relative to one another and to a zodiacal circle showing the sun's position for every day of the year. Lying below the *rete* were one or more interchangeable plates engraved with circles of altitude.

To obtain the time, the user first measured the altitude of the sun, then, having noted the sun's position for the day in the zodiacal circle, rotated the *rete* until the sun's position coincided with a circle on the plate corresponding to the observed altitude. A line drawn through this point of coincidence and the centre of the instrument to a marginal circle of hours showed the time.

Among the accessories often introduced in the earlier astrolabes were shadow scales, for simple surveying and measuring heights and distances; calendar scales showing the sun's place in the zodiac for every day of the year; magnetic compasses, usual in instruments of the 16th and 17th centuries; and various lines and tables of use to astrologers.

See Robert T. Gunther, *The Astrolabes of the World* (1932); Derek J. Price, "Precision Instruments: To 1500," in Charles Singer *et al., A History of Technology,* vol. 3 (1957). (R. T. G.; X.)

ASTROLOGY is the art or science which claims to forecast events on earth by observation of the fixed stars and of the sun, moon and planets. It originated in Mesopotamia, perhaps in the 3rd millennium B.C., but attained its full development only much later, within the orbit of Greek civilization of the Hellenistic period. In its older Mesopotamian form it spread to India in the 6th century B.C. and reached China not long after. It is probable, however, that only the idea of prognostication by the stars was adopted in China and not the specifically astronomical knowledge, which seems to have had an independent development there. In its fully developed Greek form astrology was a vast, complex and apparently scientific system which for about 2,000 yr. exerted a dominant influence on the religion, philosophy and science first of pagan and then of Christian Europe. Islamic culture likewise absorbed it as part of the Greek heritage; and in the middle ages, when western Europe was strongly affected by Islamic science, astrology also acquired an Arabian colour.

Astrology in Mesopotamia and in Egypt.—In Mesopotamia the magicians and astrologers practised divination in two ways. In the first, they scrutinized the livers of sacrificial sheep for omens likely to concern the king or his kingdom. In the second and, eventually, far more important method, omens were drawn from celestial phenomena. Systematic observation of the celestial bodies was begun, records were kept and arithmetical procedures were developed to correlate these data. Believing, as they did, that the heavenly bodies were powerful gods, the astrologers began to associate with their belief this growing body of astronomical knowledge, which constitutes the earliest exact science known to history.

The Greek astronomer Ptolemy says that Mesopotamian records of eclipses were available from a date expressed as 747 B.C., and excavation confirms that early in the 1st millennium B.C. accurate knowledge existed of the sun's annual course, of the phases of the moon and of the periodicities of certain planets. It was on this combination of religion and science that the astrologers based their prognostications; and it was this form of divination, roughly corresponding to what was called mundane astrology in later times, that spread to India and China and also provided a starting point for later Greek developments. Astrology's original association with the ruling family explains its title of the royal art.

The Egyptians also contributed, though less directly, to the rise of astrology. They constructed a calendar of 12 months of 30 days each with five days added at the end of the year. This calendar, which avoids all the irregularities of lunar or lunar-solar calendars, was taken over by the Greeks as a standard of reference for astronomical observations and has proved of great historical importance. Another of their contributions is of more mixed quality. In order that the starry sky might serve them as a clock, the Egyptians selected a succession of 36 bright stars whose risings were separated from each other by intervals of ten days. These stars, which served to indicate the time throughout the year, came to be called *decans* by Latin writers. Each of them was conceived of as a spirit with power over the period of time for which he served; and when these 36 *decans* later entered the zodiac (*q.v.*) as subdivisions of its 12 signs they signally contributed to that conception of a different quality for each moment of time which is characteristic of astrology. The Greek term *hōroskopos,* from which the word horoscope is derived is, in one of its meanings, a synonym for "decan star."

Greek Speculation and Catasterism.—The fact that men discover signs of future events in the stars does not necessarily mean that they believe the stars cause these events. But before the Greeks learned astrology from the Mesopotamian priests the development of their own speculation had strongly inclined them toward this view. Basing their thought on such obvious phenomena as the dependence of the earth upon the sun for its life-giving heat, various schools taught the view that the divine source of terrestrial happenings was situated in the sky. When the astral gods of Mesopotamia were introduced to the Greeks in the 4th century B.C., many leaders of thought embraced them eagerly. Greek planetary lore was derived from Mesopotamia, and the Mesopotamian planets, as already seen, were not only stars but gods. The Greeks were at this time making rapid advances in astronomy by the application of new geometrical techniques, and were thus ready for the view that their growing knowledge of the motion of the stars was identical with a growing knowledge of the divine. Many were also ready for the further idea that the stars not only indicated but caused terrestrial events.

But long before the 4th century B.C. the fertile popular imagination of the Greeks had peopled the world with a host of gods in human shape, who had little or nothing to do with the stars. These gods of the popular imagination were more powerful than men and exempt from death, but in all else they were human. They were male and female, young and old; they ate and drank; they fought and loved; they married and begot children. Furthermore, they were enshrined in a rich national literature and worshiped in innumerable cults. Philosophers, in turning toward the star-gods, could not abolish the gods of popular belief; by choice or by necessity they identified the two. Plato, in the middle of the 4th century B.C., proposed as the supreme object of worship for the state which he outlined in his *Laws* a composite god, Apollo-Helios. By this means he united the god of mythology, the patron of Delphi and Delos, with the sun. His contemporary, the astronomer Eudoxus, was similarly engaged in a process known as catasterism; *i.e.,* the identification of the stars with the personages of mythology. Later astronomers continued the task. The Greek heavens assumed a dual character. The astronomers not only revealed the celestial bodies as wheeling eternally in their circular orbits according to the laws of Greek spherical geometry; they also showed them palpitating with the life and passions of the familiar anthropomorphic gods. By a slow process of cultural evolution the mentality had been prepared which would trace in the physical and mental constitution of individual men and in every detail of their lives the effect of starry influences. The astrological age was about to be born. The old mundane astrology of Mesopotamia was about to be transformed into the personal astrology of Hellenistic Greece.

The Zodiacal Belt and the Horoscope.—In the casting of a person's horoscope everything depends on the determination of

the configuration of the heavens at the moment of his birth. In this calculation the zodiacal belt plays the leading role; for the history of astrology it is therefore of supreme importance to determine the date when the belt was invented. In antiquity, practitioners of the art had an interest in putting this date as far back as possible, and extravagant claims were made that the Chaldeans, or Mesopotamian star-clerks, had had knowledge of the zodiac tens or even hundreds of thousands of years before. Modern scholarship does not support this view, but suggests rather that the constitution of the zodiacal belt was an achievement of Greek science slowly perfected over several centuries.

Pliny ascribes the first steps to Anaximander and Cleostratus in the 6th and 5th centuries B.C. But the tracing out of the annual path through the constellations of the sun with its attendant planets, the division of the belt into 12 signs of 30° each and the tailoring of the older constellations to fit so far as possible into the 12 signs was an enterprise probably carried out in stages. On its completion might well have depended the discovery by Hipparchus in the 2nd century B.C. of the precession of the equinoxes (*q.v.*). The divisions of the year governed by the 12 signs are as follows:

Aries, the Ram March 21–April 19	Scorpio, the Scorpion Oct. 24–Nov. 21
Taurus, the Bull April 20–May 20	Sagittarius, the Archer Nov. 22–Dec. 21
Gemini, the Twins May 21–June 21	Capricornus, the Goat Dec. 22–Jan. 19
Cancer, the Crab June 22–July 22	Aquarius, the Water Carrier Jan. 20–Feb. 18
Leo, the Lion July 23–Aug. 22	Pisces, the Fishes Feb. 19–March 20
Virgo, the Virgin Aug. 23–Sept. 22	
Libra, the Balance Sept. 23–Oct. 23	

These divisions are still adhered to, despite the gradual loss of correspondence between the signs and the actual constellations due to precession.

In the elaboration of their scheme the Greeks were indebted to the Mesopotamians for their records of planetary motions, and there is evidence that by the 5th century the Mesopotamians had some idea of the belt. Already at this date Greek and Mesopotamian astronomy were influencing each other. Nevertheless, the zodiac is a product of Greek geometry rather than of Mesopotamian arithmetic.

It was in the 3rd century that the Mesopotamian practice of divination by the stars was introduced to the Greeks. If the special mental climate of Greek civilization be borne in mind (*i.e.*, the effect of the intimate blending of the Greeks' own personal gods with the borrowed astral gods, and the intellectual prestige given to this new religious conception by the brilliant new geometrical astronomy with which it was combined), it can be readily understood that the Greeks transformed astrology into something unknown in the land of its origin. In Mesopotamia, astrology had been a royal institution in which omens concerning the welfare of king and country had been drawn from signs in the sky. With the Greeks it became a supposedly scientific means of ascertaining the future, and its use was no longer confined to heads of state but extended to give personal information concerning his character and his future career to every individual who cared, or who could afford, to pay for it. The system was illusory, but in this illusion were involved the speculative thought and the scientific achievement of a uniquely gifted people.

It is in the 2nd century B.C. that evidence of this personal, or genethlialogical, astrology is first found; the first known textbook came from Ptolemaic Egypt and dates probably from the end of that century. For the casting of an individual horoscope it is necessary to determine the configuration of the heavens at the moment of birth, and the ascendant, *i.e.*, the point where the ecliptic intersects the eastern horizon at that moment, marks the start of the whole calculation. A chart of the heavens is completed in which the positions of sun, moon, planets and constellations are plotted. Their influence on the newborn child is deduced from the mythological character of the celestial bodies, and this influence is modified by the geometrical relationship between them; *i.e.*, by their relative positions in conjunction, in opposition, in quintile, sextile or other aspects. The sun, moon and planets, being living beings, had their preferred situations or abodes among the stars. These are referred to as houses. The influence of the planets is therefore further modified by these houses. According to one system the zodiacal belt was divided into 12 such houses, and these were ingeniously allotted to the seven competing tenants on the assumption that the sun, who gives light by day, and the moon, who gives light by night, need only one house each, while the other five planets need two houses each, one for use by day, the other for use by night. Another arrangement of 12 houses was made by means of a geometrical construction, starting from the point of intersection of the ecliptic and of the horizon, which divided the whole sphere of the fixed stars (not merely the zodiacal belt). To these houses, however determined, were assigned the several departments of human life, the planets of the various houses giving information about the matters pertaining to their sphere of influence, such as wealth, dignities, marriage, children, friendship, enmities or death.

Scientific Acceptance of Astrology by Greeks and Romans.—By such arbitrary correspondences was it made possible, and plausible, to elicit from the motions of the stars advance information about all the circumstances of life. It may seem inconceivable that so great a man as Hipparchus, one of the greatest in the history of science, should support and encourage this delusion. His intellectual climate must be remembered. The number mysticism of the Pythagoreans and the astral theology of Plato offered a prepared foundation for the erection of the astrological system and, in a world in which small political units with their local gods were being absorbed into great empires, the stars formed an object of worship acceptable to all. As the psalmist said of them, "There is no speech nor language where their voice is not heard." Of the two great philosophical schools which divided the allegiance of later centuries the Epicureans, it is true, rejected the astral gods and fought the astrological illusion, but the Stoics, who proved the more influential in ruling circles, accepted it from the first, strengthened it by their firm logic and preached it with fervour.

Once established, the astrological conception of causation invaded all the sciences. Medicine with its allied disciplines affords the most instructive example of this process. To the believer it appeared obvious that the mental and physical constitution of a man, as well as his fortune, was determined by the configuration of the heavens at the moment of his birth, for that was the decisive moment when the tender new life was fully receptive to the manifold influences raining down upon it from the great gods of the sky.

The Stoics' doctrine of a universal "sympathy" linking the little world of man, the microcosm, with the great world of nature, the macrocosm, was illustrated by astrology, which provided a picture of the process at work. A new branch of astrology, *melothesia*, put each limb, each organ, each function of the human body under the domination of the several planets and of the signs of the zodiac. Thus the concepts of planetary man and of zodiacal man created a pseudomedicine which continued at least until the 17th century A.D. to confuse the true science. Botany, zoology and mineralogy suffered the same fate as medicine.

When the Romans began to absorb Greek culture they did not at once welcome astrology. They had their own native methods of divination, and the established soothsayers and augurs resisted the innovation. At the close of the republic not only the Epicurean poet Lucretius but also his great opponent Cicero rejected astrology. But Nigidius Figulus, the most learned man of their generation, supported it and introduced to the Romans both the Greek zodiac and the Egyptian *decans*, the *sphaera graecanica* and the *sphaera barbarica*. With the empire, astrology triumphed. Augustus favoured the older conception of the art as a royal prerogative; or so may be interpreted Virgil's allotment to him of a place among the stars and the astrological design of the Pantheon, first erected by Agrippa, his minister of public works. To Augustus' age also belongs the beginning of the full exposition of the art in all its aspects by the poet Marcus Manilius. As a police measure astrologers (*mathematici*) were repeatedly banished, their influence on the fickle populace being feared, but the addiction of

later emperors (Tiberius, Nero) to the superstition and its persistence among the masses is abundantly supported.

Astrology in the Christian World.—The reception of astrology by Christianity is a most curious page in its history. As against the omnipotence of the stars Christianity taught the omnipotence of their Creator. To the determinism of astrology Christianity opposed the freedom of the will. But within these limits the astrological world view was accepted. To reject it would have been to reject the whole heritage of classical culture, which had assumed an astrological complexion. It was in the 2nd century A.D. that Ptolemy summed up in his *Almagest* the whole achievement of ancient astronomy; yet, as his extant *Tetrabiblos* shows, he was a determined astrologer, defending the system with a zeal beneath which the modern reader may perhaps detect evidence of embarrassment and even of bad faith. So compelling at this period was the astrological view. But evidence of the criticism to which Christianity subjected it may be found in a terminological change which took place at this time. Throughout pagan antiquity the words astronomy and astrology had been synonymous terms; in the first Christian centuries the valuable modern distinction between astronomy, the science of the stars, and astrology, the art of divination by the stars, began to appear. But though various Christian councils condemned astrology, the belief in the world view it implies was not seriously shaken. The persistence of the astrological week with its seven days named after the sun, moon and planets, and the choice of an astrological date for Christmas are examples of its power.

The overthrow of the western empire involved a decline of astrology. But it revived with Charlemagne, and then, with the spread of Islam into Europe, became dominant in every department of knowledge. Up to the 12th century, knowledge of the art in western Europe had depended on late Latin (5th century) sources like Macrobius. After this date the original Greek sources, enriched by their Arab commentators, became available in Latin translations often made by Jewish scholars familiar with both the Islamic and the Christian worlds.

The strength of astrological ideas in 13th century Europe is shown by the fact that both Dante and St. Thomas Aquinas admit into their Christian philosophy a modified form of the astrological conception of causation. Great princes and prelates now again begin to have astrologers to advise them. In the 14th century a number of universities, among them Paris, Padua, Bologna and Florence, had chairs of astrology. The revival of ancient studies by the humanists only encouraged this interest, which persisted into the Renaissance period. Nor did the Reformation bring any change. Melanchthon, Tycho Brahe and Kepler all accepted the astrological world view.

The Decline of Astrology.—The study of such a pioneer of modern science as Kepler throws light upon the mentality of the great scientific astrologers of the preceding 2,000 yr. Hipparchus, who laboured in the tradition of his Greek and Mesopotamian predecessors to discover the precession of the equinoxes; Ptolemy, who on the basis of Hipparchan astronomy created the system which goes by his name and which was only superseded after 1,500 years by that of Copernicus; Kepler, who worked on materials accumulated by Tycho Brahe to arrive at his theory of planetary motion; all were astrologers as well as scientists. But it is certain that, with the ancients as with Kepler, the casting of horoscopes took second place to philosophic and scientific interests. Impatience with the superstitious aspect of astrology is natural, but it is still possible to be moved by the spectacle of Kepler's excusing himself from the labour of casting horoscopes in order to save time for his scientific work, and of his sustaining himself in his lifelong endeavour by the conviction that to solve astronomical problems was to enter into the very mind of the Creator and discover truths which must serve both to unite all mankind and raise the individual above his selfish personal concerns. At the dawn of the 19th century, when astrology had become an exploded superstition, Friedrich Schiller, engaged in writing his tragedy of *Wallenstein*, was embarrassed at the prospect of putting on the stage a figure so ridiculous as that of the astrologer whom the historical Wallenstein had kept in his employ, until Goethe reminded him of the nobler aspects of a belief which could once commend itself to great minds as the perfect blend of religion and science.

As a popular pastime or superstition, however, astrology still engages the attention of millions of civilized people, this interest being catered for by articles in the daily press, by special almanacs and by manuals, large and small, devoted to various aspects of the subject. But, as a serious and systematic world view claiming the allegiance of many of the best intellects in every rank of society, astrology is dead. If it be asked what dethroned astrology the answer lies in the general progress of science and scholarship. Astrology had been born in a geocentric world, and the Copernican revolution dealt it a shattering blow. The predictions of the astrologers do not survive the test of the experimental method. Scholarship, in its concern with the history of ideas, shows how easily genuine elements of knowledge can combine with illusory notions to form grandiose systems of thought in which the mind is content to dwell for a time.

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ASTRONAUTICS, the science and technology of space flight. See NAVIGATION; ROCKETS AND GUIDED MISSILES; SPACE EXPLORATION.

ASTRO-NAVIGATION: *see* NAVIGATION.

ASTRONOMY (ARTICLES ON). The article ASTRONOMY reviews the role of this science in the history of civilization, its insights into the nature of the universe, and the development of its methods for bringing the investigation of celestial bodies within the scope of the laboratory.

ASTROPHYSICS describes the techniques by which the light emanating from the outer layers of the heavenly bodies is used as raw material for the extraction of significant information.

COSMOGONY discusses various concepts of the evolution of the universe, or the origin of individual galaxies, stars, planetary systems and satellites, and of the elementary particles of which these bodies are composed. COSMOLOGY deals with efforts to explain the constitution and dynamics of the universe by organizing the available data into a logical pattern. The points of view represented in this article range from the mythological cosmos of the ancients to such post-Einsteinian models as the steady state theory, which postulates a still-continuing process of the creation of matter.

GALAXY describes the rotating system of stars within which the sun and its planets, including the earth, are located, and around the centre of which the sun revolves in a "cosmic year," or period, of approximately 200,000,000 earth years. NEBULA describes the study of other galaxies with the help of light that in some instances started from its source hundreds of millions of years ago.

STAR discusses the visual and physical properties of these remote suns; similarly, STAR CLUSTER treats of the groups of stars that are considered to have a common physical origin. The variable stars are discussed in NOVA AND SUPERNOVA; and many articles are devoted to individual stars, such as ALDEBARAN, BETELGEUSE and SIRIUS. The visual patterns of groups of stars and nebulae are treated in CONSTELLATION and in articles on individual constellations, such as ANDROMEDA, CASSIOPEIA, ORION.

The dwarf star around which the earth revolves has been studied from many points of view, ranging from its subatomic particles to prominences extending at times 500,000 mi. into space; the findings of these studies are presented in SUN.

Among the articles devoted to other bodies in the solar system are ASTEROIDS; COMET; METEOR; MOON; PLANETS; and the articles on individual planets, including EARTH. The minuscule but significant particles of unknown origin that are sparsely distributed through outer space are discussed in INTERSTELLAR MATTER. METEORITES treats of the extraterrestrial objects that constitute a material link between the chemistry of our planet and other planetary bodies.

The conjectures of astronomers concerning the possibility of life on planets other than the earth are presented in a section of COSMOGONY under the caption *Origin of Planetary Systems;* in *Habitability of the Planets,* in PLANETS; and in MARS.

Articles on astronomical phenomena include: ABERRATION (OF LIGHT); AURORA POLARIS; CHROMOSPHERE; CORONA; ECLIPSE; ORBIT; PARALLAX; PRECESSION OF THE EQUINOXES; QUASI-STELLAR RADIO SOURCES; ZODIACAL LIGHT; etc.

Articles dealing with astronomical equipment and techniques include ASTROLABE; CELESTIAL MECHANICS; EPHEMERIS; OBSERVATORY (ASTRONOMICAL); PHOTOGRAPHY, CELESTIAL; PHOTOMETRY, CELESTIAL; PLANETARIUM; RADIO ASTRONOMY; SEXTANT; SPECTROHELIOGRAPH; SPECTROSCOPY, ASTRONOMICAL; TELESCOPE; TELESCOPE, RADIO; etc. Some of the familiar applications of astronomy are discussed in CALENDAR; NAVIGATION; SUNDIAL; TIME MEASUREMENT; and TIME, STANDARD.

ASTROLOGY and ZODIAC deal with the great visual configurations of the heavens in terms of the body of legendary pseudoscience that is related to astronomy as alchemy is to chemistry.

Much of the knowledge of the earth and phenomena affecting it is derived from the growing collaboration between astronomical and terrestrial studies. Among the articles concerned with various phases of this interrelationship are: COSMIC RAYS; GEOCHEMISTRY; GEODESY; SPACE EXPLORATION; QUANTUM MECHANICS; RELATIVITY; SPACE-TIME; TIDE; and LIGHT, VELOCITY OF.

Many biographical articles help set in perspective the work of the great astronomers, from ARISTARCHUS OF SAMOS, the first man known to have reasoned that the earth revolves around the sun, to such modern pioneers as EDDINGTON, SIR ARTHUR STANLEY; HALE, GEORGE ELLERY; RUSSELL, HENRY NORRIS; and SHAPLEY, HARLOW.

ASTRONOMY deals with the origin, evolution, composition, distance and motion of all bodies and scattered matter in the universe.

Astronomy is the most ancient of sciences, having existed since the dawn of recorded civilization. Because it is essentially a nonutilitarian science, few practical uses have been found for it, but those uses have been of primary importance. As long ago as 2000 B.C. the Egyptians and Babylonians were using calendars based on the regularity of certain astronomical events. In later years, astronomy was utilized in telling precise time, locating the positions of ships at sea and geographical features on land, predicting seasons of the year and, more recently, computing the orbits of artificial satellites.

This article is divided into two main sections. The first section traces the historical development of astronomy and the second discusses modern descriptive astronomy. The material in the two sections is arranged under the following main headings:

I. HISTORY OF ASTRONOMY

The development of astronomy can be divided into three periods: (1) Ancient astronomy, dating from the first significant contributions of the earliest civilization to the *Almagest* of Ptolemy; (2) medieval astronomy, from the decline of Alexandrian culture to the Renaissance; (3) modern astronomy, from the Copernican revolution to the present time; and overlapping it the new astronomy of astrophysics, mainly a product of the 20th century.

A. ANCIENT ASTRONOMY

1. Mesopotamia.—Much of the ancient knowledge of the celestial bodies and their ways is frequently credited to people who dwelt in the valleys of the Euphrates and Tigris rivers, the region that is now Iraq. These were the Babylonians, Assyrians and Chaldeans, and before them a pre-Semitic population, the Sumerians. Some confusion is avoided by referring to them all as the Babylonians. Our understanding of what these people learned about the heavens comes partly from the recovery from the sites of their cities of texts inscribed by their priests in cuneiform script on clay tablets. Some of their astronomical lore is identified in information they seem to have transmitted to neighbouring peoples, particularly the early Greeks.

The world viewed by the Babylonians is presumed to have consisted of a disk-shaped earth surrounded by a moat of sea beyond which the inverted bowl of the sky came down all around. It had similarities to the sort of world portrayed later in the *Iliad* of Homer. The story of creation recited in some of their tablets suggests the belief that the dry land emerged by supernatural means from the waters of the sea. There was also the account of a great flood that threatened to return the land to the sea. The celestial bodies rose over the rim of that world, moved across the sky, and set.

Although the stars always remained in fixed formations, seven planetary bodies moved among the stars, thus demonstrating their importance. The sun, moon, and five known planets were believed to be gods whose movements could reveal their intentions concerning the world and its people.

It was the duty of the Babylonian priest-astrologers to watch the seven wandering bodies so that they might predict and warn the king of any disasters the gods might be preparing for the nation. Such observations promoted knowledge of occurrences in the heavens; the interpretation of these observations required familiarity with constellations, particularly the constellations of the zodiac through which the planetary bodies moved. A second incentive for acquaintance with the heavens was the usefulness of celestial bodies in serving as guides to travelers through the desert and over the sea, in telling the time of day or night and in regulating a calendar.

People in Mesopotamia are believed to have recognized a number of prominent constellations as early as 3000 B.C. and to have named them after animals, such as the Lion, and representatives of certain occupations, such as the Herdsman. This plan was transmitted to the Greeks and, with changes of names and additions of other constellations, has descended to us. The Babylonians are credited with inventing the signs of the zodiac; these 12 divisions of equal size could serve better for describing the positions of the sun, moon and planets than could the 12 constellations of the zodiac of unequal lengths, for which the signs were named. These people seem to have recognized the precession of the vernal equinox, the point on the sun's path around the heavens from which the signs are marked off. They accordingly knew that the signs are shifting westward gradually with respect

to the corresponding constellations.

2. Egypt.—Ancient Egypt, where civilization began at about the same time as in Mesopotamia, devised the first solar calendar, in which the length of the year remained fixed at 365 days. From observations of the first appearance of the star Sirius (their Sothis) before dawn, an event with which the beginnings of the Nile floods were associated, the Egyptians learned that the length of the year is actually more equal to 365¼ days. This value was first employed for calendar purposes by Gaius Julius Caesar in his reform of the Roman calendar (*see* CALENDAR). The Egyptians' picture of the universe was less scientific than that of the Babylonians, being peopled with gods and goddesses. The sky itself was identified with the goddess Nut.

3. Greece and Alexandria.—Greek cosmology seems to have started with ideas comparable to those of the Babylonians. More rational ideas about the universe were held by Greek philosophers from Pythagoras (6th century B.C.) to Aristotle (384–322 B.C.). Our information about their thinking is derived mainly from Aristotle's *De caelo*. The earth came to be regarded as a globe, and proofs were given to support this view. Although Aristotle supposed that the earth was stationary, certain other philosophers believed that it was moving. Aristarchus of Samos (3rd century B.C.) is said to have advocated the earth's annual revolution around the sun and its daily rotation on its axis; but whatever he may have written on the subject has been lost. In the same century, Eratosthenes, librarian of the museum at Alexandria, determined the circumference of the earth with remarkable accuracy, considering the simple means employed.

The sky of the later Greek philosophers was a hollow globe surrounding the earth and having the stars set like jewels on its inner surface. The sky was supported on an axis thrust through the earth; on this axis the sky rotated westward daily, causing the celestial bodies to rise and set. This conception of a rotating celestial sphere persisted to the time of Copernicus and is useful as a convention today. There was then the necessity of accounting for the independent movements of the sun, moon and five planets, which changed their places among the stars. These wanderers were believed to move in the space between the earth and the celestial sphere at distances from the earth corresponding to the periods of their eastward revolution around the heavens. It was known that the sun and moon move nonuniformly, and that the planets also turn at intervals and retreat westward for a time before resuming the eastward progress.

By what combinations of uniform circular motions centred in the earth may the movements of the seven wanderers among the stars be represented? This famous problem was proposed not to explain celestial motions but to portray them by mathematical machinery. A successful plan could predict the places of these bodies among the stars at any time and also the times of occurrences such as eclipses of the sun and moon. One solution of

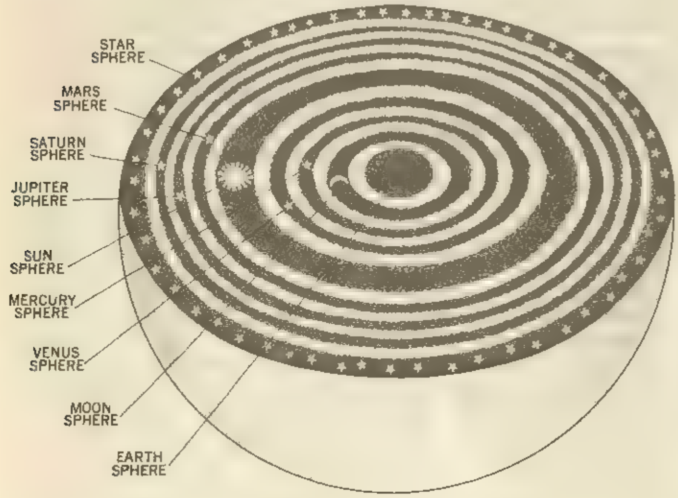


FIG. 1.—AN ANCIENT CONCEPTION OF THE SPHERICAL COSMOS

the problem was devised by the mathematician Eudoxus of Cnidus (4th century B.C.). Each body was moved by a set of rotating spherical shells connected by a sort of gimbal arrangement (see fig. 1). The outermost shell of a set was attached to the long axis on which the celestial sphere rotated; it gave the planet its daily westward motion along with the stars. The shell next inside turned slowly eastward on the first, imparting to the planet its principal motion among the stars. Other inner shells turning independently produced other movements. The planet itself was attached to the innermost shell of the set and partook of the motions of them all. This solution was adopted by Aristotle, who employed 55 shells in all, including the sphere of the stars. It accounted for the motions of the wanderers because they were not very accurately observed at that time, but it kept each planet always at the same distance from the earth and therefore could not explain its observed variation in brightness. As an example, the planet Mars is at times second only to Venus in brightness and at other times may not be much brighter than the pole star. Since it was unable to explain these and other occurrences, the first solution failed.

A more enduring solution of the problem of the seven wanderers was devised by another mathematician, Apollonius of Perga (3rd century B.C.), who worked mainly at Alexandria; he is also known for his treatise on the conics. His method was adopted by Hipparchus of Bithynia (2nd century B.C.), the most persistent observer among the Greek scholars. Hipparchus attempted to adjust the method to interpret the motions of the sun and moon, but had found the positions of the planets and stars observed by his predecessors too scanty and inaccurate for him to make much headway with the motions of the planets themselves. The records of his own observations provided the data with which Ptolemy was later able to put the whole plan in workable order.

Alexandria, founded in 332 B.C. by Alexander III, (the Great), was the centre of Hellenistic culture for several centuries. Its last distinguished astronomer was Ptolemy (Claudius Ptolemaus, 2nd century A.D.); he was the author of *Megale syntaxis tes astronomias*, later known to the Arabs as the *Almagest*. In this book Ptolemy explained in detail the geometrical interpretation of the celestial motions known as the Ptolemaic system. In the simplest form of the system, each planet moved in a small circle, the epicycle, in the period of its actual revolution around the heavens relative to the sun's place. Meanwhile, the centre of this circle moved eastward around the earth on a larger circle in the observed period of the planet's revolution relative to the stars. An alternative and less favoured method of eccentrics had the planet moving in a large circle whose centre circled around the earth. Such combinations of circular paths could produce the looped courses of the planets and the variable speeds of all seven wanderers. With initial conditions it would be possible to predict the positions of these bodies among the stars at any future time. If one of them was then not in the expected position, the plan could be revised by adding more epicycles or by making other changes in the specifications. It was hoped that the appropriate plan of celestial clockwork might be perfected by trial and error. *See* PTOLEMY; PTOLEMAIC SYSTEM; ALMAGEST.

B. MEDIEVAL ASTRONOMY

Greek astronomy, at least until its later years, was based mainly on philosophical thinking rather than observational data, and it made slow progress. It did, however, produce a rational picture of the universe that might be improved later, but any considerable improvement in the picture, except in the details of the Ptolemaic system, was to be delayed all through the dark ages. After the time of Ptolemy and especially after the fall of the Roman empire, the civilized world was to be divided between two movements: Christianity and Islam, that for many centuries were unfavourable to modification of the Greek picture.

Astrology, although banned by the Christian church, continued in strength in a form that the Babylonian priest-astrologers would scarcely have recognized. Theirs had been an astrology requiring attention to the heavens and leading to astronomical discoveries, whereas the post-Christian type was more concerned with divina-

tion than with observation. The scholasticism of these times led to neglect of other ways of thinking and, particularly at first, of the learning of the Greek scholars. People lived again on a flat earth under an inverted bowl of the sky.

The followers of Mohammed, who founded Islam in the 7th century A.D., needed observers to determine by sights on the stars the direction of Mecca from various parts of their dominions so that the faithful might face in these directions in their prayers. Several observatories were built for this purpose. The practical astronomers of Islam also employed their calculating skills to perfect the Ptolemaic system of the planetary motions. Their textbook was the *Almagest*, which they had translated into Arabic.

Toward the close of the middle ages, certain European rulers began to attract to their kingdoms Muslim and Jewish scholars, who introduced the use of Arabic numerals, divisions of the circle, and algebra. Some of these scholars were asked to translate the *Almagest* and other books on astronomy from the Arabic. King Alfonso X of Castile kept a number of scholars occupied for ten years constructing tables (the Alphonsine tables, *c.* 1270) for predicting positions of the planetary bodies. By this time each planet had been provided with from 40 to 60 epicycles to represent after a fashion its complex movement among the stars. Amazed at the difficulty of the project, Alfonso is credited with the remark that had he been present at the Creation he might have given excellent advice. After surviving for more than a millennium, the Ptolemaic system had failed; its geometrical clockwork had become unbelievably cumbersome and without satisfactory improvement in its effectiveness. The way was open for a new approach not only to the problem of the planetary motions but to that of the structure of the universe as well.

In the early part of the 16th century the scientific ignorance of Europe began to be lessened. Columbus had sailed far to the west to discover the new world; he had not fallen into an abyss beyond the edge of the world, nor had he been destroyed by monsters reputed to operate in that vicinity. The companions of Magellan had returned from their voyage around the world. Johann Gutenberg's invention, in the mid-15th century, of printing from movable type gave wider dissemination to the works of Aristotle and other classical scholars. Copernicus was one of those eager to take advantage of the new opportunities to study. Copernicus was convinced that the complex plan of epicycles of the Ptolemaic system would become unnecessary if the earth is itself a planet moving with the others around the sun. In his reading of classical works he had learned that several scholars were said to have considered the earth as in motion in specified ways.

C. The Founding of Modern Astronomy

1. The Copernican Revolution.—Nicolaus Copernicus (1473–1543) in Polish Prussia disposed of much of the complexity of the Ptolemaic system by assigning the central position to the sun. In the new system the earth, attended by the moon, became one of the planets revolving around the sun. Certain epicycles of the Ptolemaic system were still required, however, to compensate for the retention of the traditional idea that the planetary orbits were circles. Copernicus also proposed the daily axial rotation of the earth from west to east, so that the daily circling of the celestial bodies around us became simply the apparent motion of the scenery. He published the heliocentric theory in his book *De revolutionibus orbium coelestium*, which first appeared in 1543, the year Copernicus died. (*See* Copernicus, Nicolaus.)

The theory of the earth in motion was an abrupt departure from the view that with few exceptions had persisted since the beginnings of reflections about it. Religious leaders abhorred the new idea as a doctrine that seemed to demote man from his central position in the universe to a place of lesser importance. Some scholars opposed the new idea because it was not then supported by convincing proof; its greater simplicity in accounting for the observed celestial motions was the only argument offered in its defense. Indeed, the theory seemed to be disputed by the evidence of the celestial bodies themselves, as Tycho presently discovered.

Tycho Brahe (1546–1601), a native of the extreme south of Sweden, then a part of Denmark, was the first noted astronomical observer of modern times. He spent the most productive years of his life, from 1576 to 1597, at the fine observatory the king of Denmark had helped to finance for him on the island of Hven, 20 mi. N.E. of Copenhagen. Because this period preceded the invention of the telescope, Tycho's instruments had only plain sights instead of lenses; but they had metal circles that were larger and more accurately divided than ever before, and the observed positions of the celestial bodies were corrected for the first time for effects of atmospheric refraction. These improvements, together with allowances for the errors inherent in his instruments, made it possible for Tycho and his associates to measure the places of stars and planets in the heavens with the remarkably small average error for naked-eye observations of scarcely more than a minute of arc.

Tycho and other observers of his time had the mistaken idea that the brightest, and presumably the nearest, stars showed appreciable disks, having diameters about $\frac{1}{30}$ of the sun's apparent diameter. If the stars were actually as large as the sun, their distances from us would then be only about 30 times the sun's distance. At such small distances these stars should show conspicuous annual parallax oscillations if the earth revolves around the sun. Observing the directions of some of the brightest stars through the year, Tycho was unable to detect any oscillations at all. Either the stars were thousands of times more remote than the sun's distance, which seemed impossibly great at the time, or else the Copernican theory of the earth's revolution was untrue. Tycho proposed as a compromise that the sun revolved around a stationary earth, while all the other planets went around the sun. Late in his life, Tycho moved from Hven to Prague, taking his instruments and records with him. There he obtained the assistance of Kepler, who was as skilled in calculation as Tycho was in precise observation. (*See* Brahe, Tycho.)

Johannes Kepler (1571–1630) inherited Tycho's records of observed positions of planets over many years. He began with Mars and devised a simple way of transforming its directions seen from the earth to corresponding places in its orbit around the sun. After much experimenting with traditional epicycles to represent the orbit, he concluded that the planet's path was simply an ellipse. As applied at first only to Mars, Kepler announced in his *Astronomia nova* of 1609 the first two of his three laws of planetary motions: (1) The orbit of each planet is an ellipse with the sun at one of its focuses; (2) Each planet revolves so that a line joining it with the sun sweeps over equal areas in equal intervals of time. The remaining law was given in his *De harmonice mundi* of 1619; (3) The squares of the periods of revolution of any two planets are in the same proportion as the cubes of their mean distances from the sun. The first and second laws assert that the planets revolve in ellipses, not circles, and therefore at nonuniform rates around the sun. The third, or "harmonic," law gives a useful proportion from which to calculate very nearly the mean distances of the other planets from the sun when the distance of one planet is known. The known distance is usually considered that of the earth, and this distance is accordingly called the astronomical unit. (*See* Kepler, Johannes.)

While Kepler was engaged in his studies of planetary motions, his contemporary, Galileo Galilei (1564–1642) in Italy, heard a rumour that a spectaclemaker in Holland had combined lenses in such a way as to make a distant object look nearer and clearer. Galileo fitted two lenses into a tube and went out, in 1609, to view the heavens. The stars appeared no larger through this "optic tube," but fainter ones could be seen. He also saw the mysterious Milky Way as a "mass of innumerable stars." Some of the nearer celestial objects appeared larger as well as clearer; Galileo observed mountains on the moon, phases of Venus like those of the moon, and the four bright satellites of Jupiter. Later he saw dark sunspots carried across the disk of the sun by its rotation. The earliest discoveries were first reported in his small *Sidereus nuncius* (1610). Other European observers, notably David Fabricius, Simon Marius and Christoph Scheiner, had small telescopes at about the same time and participated in some of these discoveries, but did not dramatize them as effectively. Much

that Galileo saw in the heavens with the telescope seemed in harmony with the Copernican theory of the revolving and rotating earth, a theory he ably defended in his great *Dialogue of the Two Chief Systems of the World* (1632).

Galileo was an experimental scientist whose conclusions were based on observation rather than on the traditional fitness of things. His predecessors had supposed with Aristotle that rest was the natural state and motion an enforced one; the continued motion of a body had required an explanation of how it was kept in motion. Galileo's experiments with falling bodies led to the radically different law of inertia: A body under no constraint continues to move uniformly in a straight line or else to remain at rest. Only change of motion, either in speed or direction, or both, now required explanation. This was the beginning on which Newton would formulate the laws of motion of bodies on the earth and in the heavens. (*See* GALILEO GALILEI.)

2. Dynamical Astronomy.—Isaac Newton (1642–1727) was born in England in the year of Galileo's death. His persistent curiosity concerning a variety of perplexing matters in physical science was matched by his remarkable ability to supply the reasons for them. At the age of 24 he set out to interpret motions in the universe as controlled by a single force. From the early Greek scholars to Kepler, these motions had been represented only by geometrical means without interpretation. The principle of inertia, grasped in greater or lesser degree by Galileo, René Descartes and Robert Hooke, received its classic formulation in the second of the three laws of motion which Newton prefixed to his *Philosophiae naturalis principia mathematica* (1687). These laws were based on the concept of force. The amount of the force exerted on a body is directly proportional to the mass of that body multiplied by its acceleration, or rate of change of velocity. Because velocity is speed in a specified direction, acceleration may appear as changing speed or changing direction, or both. A falling stone picks up speed as it falls. A planet revolving around the sun is continuously accelerated; its fall keeps changing the direction in which it revolves. In both cases a force is operating. This is the substance of Newton's second law of motion. The first law is the obvious corollary that if no force is exerted there is no acceleration; and the third law is concerned with the equality of action and reaction.

Newton sought to interpret the motions of the planets, as described by Kepler's laws, on the basis of the three laws of motion. Given an initial motion in a particular direction, an otherwise undisturbed planet would go on moving uniformly in a straight line forever. The planet is continuously attracted by the sun, however, and keeps departing from a straight line course in the sun's direction. Thus a planet revolves. Newton showed that the force of the sun's attraction is proportional directly to the product of the masses of the sun and planet, and inversely as the square of the distance between them. Next, on comparing the acceleration toward the earth of a stone near the earth's surface with that of the moon approximately 60 times as far away, he found a similar rule for the force of the earth's attraction. Newton then concluded that he had discovered the law that applies to the attractive force exerted by any body anywhere, and so announced it as the law of universal gravitation: Every particle of matter in the universe attracts every other particle with a force that is proportional directly to the product of their masses, and inversely as the square of the distance between them. (*See* NEWTON, SIR ISAAC.)

The law of gravitation made it possible to represent and predict the motion of a planet relative to the sun as though the planet were influenced only by the sun's attraction. This problem of two bodies could now be solved directly and completely. The resulting elliptical orbit could serve as a first approximation, because the sun has the dominant mass in the solar system and also because each planet is widely separated from any of the others. The planet considered, however, is subject to the perturbations, that is, the departures, from the two-body orbit caused by the attractions of all the other members of the sun's family. Thus the problem to be solved for a more precise representation of the planet's motion is that of many bodies. Progress in this complex problem in England through the 18th century was retarded by the retention of the less explicit notations that Newton had preferred to employ. This important work passed into the hands of a succession of able continental mathematicians, who developed and applied the more powerful operations of the calculus. Especially noteworthy among these mathematicians were L. Euler (1707–83), A. C. Clairaut (1713–65), J. D'Alembert (1717–83), J. L. Lagrange (1736–1813) and P. S. Laplace (1749–1827). Laplace summed up the achievements of his predecessors and himself in his great *Mécanique céleste* (5 vol., 1799–1825).

Among the more prominent results of the work of these investigators in dynamical astronomy, Euler in 1753 applied the method of the variation of parameters in the treatment of perturbations; the orbit of a body remains an ellipse having its elements, such as the size and eccentricity of the ellipse, continuously changing under the disturbing forces. D'Alembert, in 1749, established the earth's precession on a sound basis of theory. Lagrange introduced methods of great generality into mechanics. He and Laplace investigated the limits within which the elements of the planetary elliptic orbits must lie, and they demonstrated the very long life expectancy of the solar system. C. F. Gauss (1777–1855) published in his *Theoria motus* (1809) the method of least squares, by which the most probable value of a result can be inferred from observational data. He also described a mode of calculating the orbit of a planet from three observed positions in the heavens and afterward employed it to recover the first discovered asteroid, Ceres, which had seemed likely to be lost. The complex theory of the moon's motion, the work of many investigators, was given its present form by E. W. Brown (1866–1938).

3. Development of the Telescope.—The earliest form of the telescope, having a convex object glass and a concave eyepiece, gave an erect image but a small field even with low powers. This Galilean telescope was soon replaced for astronomical purposes by one in which both lenses were convex; this gave an inverted image but a larger field. In either form, however, the single lens of the object glass did not give a clear image of the object examined. The difficulty was mainly chromatic aberration; a single lens disperses the light, bringing its component colours to focus at different distances from the lens. A partial remedy was effected by greatly increasing the length of the instrument. Telescopes of the 17th century became so excessively long, sometimes much more than 100 ft., that the problem of supporting and controlling them was serious; the two lenses were either contained in long wooden tubes or else were supported separately. With such unwieldy apparatus, however, Christiaan Huygens (1629–95) in Holland discovered Saturn's brightest satellite, and in 1659 concluded that the planet is encircled by a thin ring; and G. D. Cassini (1625–1712) at Paris, in addition to making other noteworthy observations of planets, saw in 1675 the division in Saturn's rings that bears his name.

Newton's opinion that the colour dispersion of a lens was independent of the kind of glass of which it was made discouraged for half a century attempts to compensate the chromatic difficulty with a second lens of different composition. The opinion did inspire Newton, however, to construct, in 1668, a model of a telescope that is free from chromatic aberration; it was a reflecting telescope having a concave mirror as its objective. At about the same time, J. Gregory and N. Cassegrain suggested somewhat different designs of the new telescope. Increase in size and improvement in performance of early reflecting telescopes is peculiarly associated with the name of William Herschel (1738–1822) in England; he constructed many mirrors of various diameters, culminating in the 48-in. mirror of a telescope 40 ft. long. Herschel's many achievements with his telescopes, especially with some of more moderate dimensions, included the discovery of the Planet Uranus. He is also known as a pioneer in sidereal astronomy. William Parsons, third earl of Rosse, in Ireland, possessed the giant among the early reflectors; its mirror was 72 in. in diameter. This telescope was first used in 1845. Among its limited triumphs was the revelation of the spiral form of the galaxy M51, a form now known to be characteristic of many

galaxies.

Meanwhile, the development of the refracting telescope was made possible by the invention of the achromatic object glass, a combination of a convex lens of crown glass and a concave lens of flint glass. First designed in 1729, the combination was improved by John Dolland in England in 1758. Joseph von Fraunhofer (1787–1826) in Germany designed and constructed some of the largest refractors of the early 19th century, including a 9½-in. instrument for the Dorpat observatory, Tartu, Estonia. Construction of refracting telescopes in the United States began in earnest around the middle of the century. Alvan Clark and Sons, near Boston, became especially famous as makers of very large lenses. They made the objectives for the 36-in. telescope of the Lick observatory, on Mt. Hamilton, Calif., completed in 1888, and the 40-in. telescope of the Yerkes observatory, Williams Bay, Wis., in 1897, still the largest of all refractors. The Yerkes telescope approaches the limiting diameter for instruments of this type, where the object glass, which is supported only around its circumference, may become heavy enough to sag under its own weight.

The shift back to the reflecting telescope toward the end of the 19th century was encouraged by the substitution of glass for the original speculum metal for the mirror. Silver coating of the glass was achieved in 1856, and coating with more effective and durable aluminum began in 1932. The reflecting telescope with the greatest diameter at mid-20th century was the 200-in. Hale telescope on Palomar mountain in California, completed in 1948. The second in size was the 120-in. telescope (1959) of the Lick observatory, and the third was the 100-in. telescope (1917) on Mt. Wilson near Pasadena, Calif. These and many other reflecting telescopes were employed primarily as cameras, and they served this purpose admirably for very limited areas of the heavens. The Schmidt reflecting telescope, designed by Bernhard Schmidt (1879–1935) at the Hamburg observatory in Germany and first described by him in 1932, was used as a high-speed astronomical camera. The largest of the numerous instruments of this and allied types was at the Palomar observatory; it has a correcting plate 48 in. in diameter and a 72-in. mirror.

Efforts to increase the power of optical telescopes by constructing larger instruments became limited by the mid-20th century owing both to physical difficulties in constructing and mounting anything larger than a 200-in. mirror and the immense costs involved. Alternatives were to make existing instruments more efficient by using improved techniques or by operating them above the obstructing effects of the earth's atmosphere. Experiments with electronic image-producers also were in progress, and photographs were taken from manned and unmanned balloons and rockets above the most troublesome levels of the atmosphere. Proposals were heard for space stations and even for an observing station on the moon. The alternative of employing receiving apparatus of new types met with significant success in the radio telescope. The radio telescope is analogous to the optical instrument, having an antenna for receiving and concentrating the radiation from the celestial source, and a receiver to record the strength of the radio signal. One type of radio telescope employed a flat array of collectors; an example was the "Mills cross" inferometer radio telescope in Sydney, Austr. A second type had a paraboloidal antenna resembling the mirror of the optical telescope. One example of the second type was the great radio telescope completed at the Jodrell Bank experiment station of the University of Manchester with a "dish" 250 ft. in diameter. (*See* TELESCOPE; TELESCOPE, RADIO.)

4. The Sun.—Astronomy of the 19th century and into the beginning of the 20th century had become to a considerable extent a description of the celestial bodies combined with extraterrestrial surveying. Physics for its part had become a bookkeeping of past achievements where the hope of progress, as a distinguished physicist remarked, seemed to be the evaluation of the next decimal place. Early in the present century came such novelties as the quantum theory (1900) of Max Planck and inquiries about the structure of the atom. Astronomers began in earnest to employ apparatus and techniques in the study of the heavens similar to those of the terrestrial physical laboratory. The new astronomy, or astrophysics, initiated exciting inquiries in which physicists collaborated with profit to both.

The cause of the dark lines in the solar spectrum, first observed by J. von Fraunhofer, in 1814, remained unknown until 1859, when G. R. Kirchhoff (1824–87) announced the basic laws of spectroscopy. These laws showed that the dark lines are abstracted from the sunlight by gases above the sun's surface at characteristic wave lengths which reveal the chemical composition of the gases. In the following year, dark bands in the spectrum were explained as abstracted by molecules in the earth's atmosphere. With the effective use of the spectroscope, former fantastic ideas about the sun gave way to the findings of the new solar physics; the sun came to be regarded as composed of hot gas throughout. At the total solar eclipse of 1868 the chromosphere, prominences and corona were definitely shown to belong to the sun and not to the eclipsing moon; and P. J. C. Janssen (1824–1907) had thought of a way to observe the prominences with the spectroscope at times other than during an eclipse. The American astronomer C. A. Young (1834–1908) observed the bright-line "flash spectrum" of the chromosphere at an eclipse of 1869, and at the same eclipse the English astronomer J. N. Lockyer (1836–1920) found in the spectrum of a prominence a yellow line of a hitherto unrecognized element, which he called helium. The tables and atlas of the solar spectrum, published by the physicist H. A. Rowland (1848–1901), have served as the basis for subsequent investigations. With its revisions and extensions into the ultraviolet and infrared, it lists the wave lengths and intensities of 26,000 lines. More than 60 chemical elements are recognized in the sun, and 18 chemical compounds are identified, mainly in the cooler regions of sunspots.

The invention of the spectroheliograph by G. E. Hale (1868–1938) in the U.S., in 1891, and of a similar device by H. Deslandres (1853–1948) in France permitted photography of the sun in the light of a single element and at different levels above the surface. Hale later devised the spectrohelioscope to promote continuous monochromatic surveys of the sun. This instrument improved the chances of observing sudden changes such as the outbursts of solar flares. The flares, which had been reported sporadically since 1859, are likely to break out in the vicinities of large sunspot groups; they are sources of intense ultraviolet radiations, high-speed particles and bursts of emission at radio wave lengths. The spectroheliograph has much value in studies of the chromosphere and prominences. Its use with motion-picture films, initiated at the McMath-Hulbert observatory, Lake Angelus, Mich., by R. R. McMath, greatly improved the understanding of the prominences and their motions.

The discovery that sunspots vary in frequency in cycles of about ten years was announced in 1843 by an amateur German astronomer, H. S. Schwabe (1789–1875), after he had made systematic counts of the spots for 17 years. Correlation with the frequency of geomagnetic storms was soon established. R. Wolf (1816–93) and his successors at Zürich determined the overall average interval between spot maxima as 11.1 years, but in the first half of the 20th century it was more nearly 10 years. R. C. Carrington (1826–75) in England discovered in 1859 that the period of the sun's rotation increases with distance from its equator and that the zones of sunspot activity shift from higher latitudes toward the equator in the course of each sunspot number cycle, an effect observed soon afterward by G. F. W. Spörer (1822–95) and usually connected with his name. W. S. Adams, at Mount Wilson in 1906, extended the spectroscopic determination of the sun's rotation to high latitudes and found that it increases from 25 days at the equator to 33 days in latitude 75°. Hale, in 1908, observed the splitting of lines, known as the Zeeman effect, in the spectra of sunspots, showing that the spots have a strong magnetic field. In bipolar spots the leader and follower spots were found to have opposite magnetic polarities, and the signs for the southern hemisphere were opposite to those in the northern hemisphere. These relations continued until the sunspot minimum of 1913. When spots of the following cycle then began to appear in the higher latitudes, the polarity relations were completely reversed; and

the reversal has continued with each new cycle since that time. An effective scanning process, employed by H. W. and H. D. Babcock at the Hale solar laboratory in Pasadena, Calif., since 1952 for mapping magnetic fields over the sun, has revealed persistent general magnetic fields of 1 or 2 gauss of opposite polarity around the two solar poles.

Systematic photography of the sun's corona at total solar eclipses began with an eclipse of 1869. The form of the corona was soon found to be quite different at sunspot maximum and minimum. Photography of the corona and its spectrum at times other than during an eclipse began in 1930 with B. Lyot's use of the coronagraph at the Pic du Midi observatory, Hautes-Pyrénées, France. A dozen or more similar instruments have since begun operation at mountain stations in various parts of the world. Special monochromatic filters have also proved effective for viewing and photographing the corona and the prominences as well. Since the green line in the spectrum of the corona was first observed at the eclipse of 1869, 27 bright lines have been photographed. These lines were identified in 1941 by B. Edlén in Sweden. They are unusual lines of from 9 to 15 times ionized atoms of iron, nickel, calcium and argon; their degrees of ionization and their considerable widths indicate for the corona a kinetic temperature of 1,000,000° C. (*See* SUN; CORONA.)

5. The Solar System.—The five bright planets, Mercury, Venus, Mars, Jupiter and Saturn, have been recognized from very early times. The earth was formally added as the sixth by Copernicus in 1543. Uranus was discovered in 1781 and Neptune in 1846. The discovery of Pluto in 1930 completed the list of the nine known principal planets. Ceres, the first of the multitude of minor planets to be recognized, was found in 1801. The moon was the only satellite that could be observed prior to the invention of the telescope.

Some modern contributions to knowledge of the planets and their satellites are the following.

The globular form of the earth, proved by early Greek scholars, was first revealed clearly in photographs from rockets; an example was a photograph from a height of 101 mi. from a V-2 rocket launched in 1947 from White Sands, N.M. The dimensions of the oblate earth, reduced to sea level, were standardized in the international spheroid (1909) calculated by the U.S. coast and geodetic survey. New information about the earth and its atmosphere was obtained by means of artificial earth-satellites; the first of these were launched in 1957–58.

The earth's daily rotation was first demonstrated to the public by J. B. L. Foucault at Paris (1851) by the behaviour of the Foucault pendulum. It was later shown that the speed of the rotation is decreasing slowly, with accompanying periodic and irregular variations, and that the poles of the rotation axis wander over very small areas of the surface. The earth's annual revolution around the sun was first demonstrated by J. Bradley's discovery of the aberration of starlight in 1727. The solar parallax, which determines the earth's mean distance from the sun, has been derived mainly from the observations of planets nearer us than the sun's distance. Noteworthy contributions were the parallax deduced by D. Gill at the Cape of Good Hope, in 1895, from a program for several minor planets and the parallax calculated by E. Rabe in the U.S., in 1950, from the motion of the minor planet Eros. By international agreement the most probable value of the solar parallax is 8.803 seconds, and the earth's mean distance from the sun is accordingly 92,900,000 mi.

The mapping of the moon's visible face began with Galileo in 1610. Noteworthy among the selenographers of the 19th century were W. Beer and J. H. Mädler at Berlin (1837) and J. F. J. Schmidt at Athens (1878). A map by H. P. Wilkins in England (1955) shows at least 90,000 formations. An early photographic atlas was prepared by M. Loewy and P. Puiseux at Paris (1896–98). Two causes assigned to the origin of the lunar formations were meteoritic impact, advocated by R. A. Proctor in 1873, and vulcanism, by J. Nasmyth in 1874.

The rotation period of Mercury long remained in doubt because of the faintness of the surface markings. It was first determined by G. V. Schiaparelli (1835–1910) at Milan as 88 days, equal to the period of revolution, but radar studies in 1965 indicated it to be 58.6 days. The rotation period of Venus was found by the same method to be 247 (±5) days. W. S. Adams and T. Dunham at Mount Wilson concluded that water vapour and free oxygen are very scarce in the atmosphere of the planet, but that carbon dioxide is surprisingly abundant. G. P. Kuiper concluded more recently that the clouds which obscure the planet's surface may consist of carbon suboxide formed by action of the sun's ultraviolet radiation on the carbon dioxide. The U.S. spacecraft Mariner 2 passed Venus at about 21,600 mi. in 1962 and indicated a surface temperature of about 700° K.

The status of the surface markings of Mars was clarified by photographic and spectroscopic inquiries in the first half of the 20th century. The white polar caps were identified by Kuiper as rather thin deposits of ice crystals. The red areas are deserts, their colour resembling that of pulverized limonite, according to A. Dollfus. The green blotches may be coloured by something like lichens growing in the lava basins, or they may have a different cause. A network of fine markings, reported in 1877 by Schiaparelli and called by him *canali*, was interpreted by P. Lowell (1855–1916) as artificial waterways. A number of other observers, however, have not succeeded in detecting the canals. The two small satellites of Mars were discovered in 1877 by A. Hall with the then-new 26-in. refracting telescope of the U.S. Naval observatory, Washington, D.C. The inner satellite, Phobos, proved to be unique among the satellites of the solar system in having a period of revolution shorter than the planet's rotation period. The U.S. spacecraft Mariner 4 passed Mars at 6,118 mi. in 1965 and transmitted 21 photographs covering about 1% of the Martian surface. The pictures revealed an arid, crater-pocked surface.

Ceres, the first known of the minor planets, or asteroids, was discovered incidentally by G. Piazzi (1746–1826) at Palermo, Italy, in 1801; it is the largest of all, having a diameter of 480 mi. Ceres proved to have the same distance from the sun as a planet for which astronomers were then searching to fill a vacancy in a series of planetary distances known as Bode's law. Minor planets having reliably determined orbits exceeded 1,600 by the middle of the 20th century. Although they revolve mainly in orbits of rather small eccentricity between the orbits of Mars and Jupiter, a number have orbits of considerable eccentricity, and some of these come near the earth. Eros, discovered in 1898, may come within 14,000,000 mi. of the earth, and some minor planets discovered more recently make closer approaches. The minor planet Icarus, which left its trail on a Palomar photograph of 1949, passes within the orbit of Mercury; another asteroid, Hidalgo, retreats from the sun as far as the distance of Saturn. The majority vary in brightness in periods of a few hours, which are the rotation periods of these irregularly shaped bodies. According to one 20th-century theory, the smaller minor planets are fragments produced by collisions, and some of the larger ones were nicked by the collisions. The collisions have also caused the erratic orbits of these bodies, some of which fall onto the earth as meteorites.

Until well into the 20th century the giant planets, Jupiter, Saturn, Uranus and Neptune, were believed to be gaseous throughout, and Jupiter in particular was described as a sort of smaller replica of the sun. Later, however, measures of the temperature showed that these planets are about as cold as solar heating can allow them to get and that the high compression must make the interiors solid. Theoretical models of Jupiter by R. Wildt and W. C. DeMarcus in 1958 assigned a preponderant mass of hydrogen to the planet with helium second, as with the sun. Of the 12 known satellites of Jupiter, the four bright ones were discovered by Galileo in 1610, and the fifth and innermost satellite was detected by E. E. Barnard (1857–1923) in 1892. The other satellites, faint and much more distant from the planet, were found in the 20th century. Three of these were discovered by S. B. Nicholson, who showed that the orbits of the outermost satellites change rapidly because of strong perturbations by the sun.

Saturn's rings, regarded as solid by Laplace, were shown mathematically by J. Clerk Maxwell in 1857 to be composed of a multitude of small bodies, and their discrete character was confirmed spectroscopically by J. E. Keeler in 1895. Kuiper concluded that

the small bodies are either snow-covered or else composed mainly of ice; he reported from his inspection of Saturn with the Hale telescope that the only real break in the ring system is the division discovered by G. D. Cassini in 1675. Saturn's nine known satellites were all discovered prior to the 20th century. The largest and brightest satellite, Titan, has an atmosphere; its orange hue is probably caused by atmospheric action on the surface material, according to Kuiper, as seems to be true of the deserts of Mars.

Uranus, the first principal planet to be discovered in historic times, was found by W. Herschel in 1781. One of its five satellites, Miranda, was first detected by Kuiper, in 1948. Neptune was first seen at the Berlin observatory in 1846, near the place predicted for it by U. J. Leverrier in France from his calculations based on its disturbances of the motion of Uranus. J. C. Adams' contemporaneous prediction in England did not receive equally effective telescopic co-operation. Neptune's faint second satellite, Nereid, discovered by Kuiper in 1949, proved to have the most eccentric orbit, 0.75, of any known satellite.

Pluto, the most distant planet, was found in 1930 by C. W. Tombaugh in his photographs at Lowell observatory, Flagstaff, Ariz., where a search for such a planet had long been in progress. Its small size is in striking contrast to the giant statures of the other outer planets, and its orbit has the greatest eccentricity and inclination to the ecliptic of any principal planet. Kuiper has considered it definitely established that Pluto was originally a satellite of Neptune.

Comets were described by Newton as celestial bodies subject to the control of gravitation. Edmund Halley (1656–1742) in 1705 had calculated parabolic orbits of 24 comets from recorded positions in the sky. He noticed a similarity between the orbits of the great comet of 1682 and of two previous comets, decided that all three were of the same comet traveling in an elliptic orbit around the sun in a period of about 76 years and predicted the comet's return to view in 1758. This, the first recognized periodic comet, came to be known as Halley's comet. Encke's comet, discovered in 1786, was shown by the German astronomer J. F. Encke at its return in 1818 to be moving in an elliptical orbit with a period of 3.3 years; it was the second periodic comet to be established and the first of Jupiter's family of comets to be recognized. S. Arrhenius, in 1900, explained that the tails of comets are directed away from the sun because their material is repelled by the pressure of the sun's radiation, a reason that Kepler had suggested in his *Treatise on Comets* (1619). An important contribution on comets was proposed by F. L. Whipple in 1950. According to his theory, a comet far from the sun is a porous structure of ices a mile or so in diameter, in which small metallic and rocky particles are imbedded; the ices are mainly frozen methane, ammonia and water. Whenever a comet approaches the sun, some of the ices thaw. Gases issue explosively from the nucleus to form the coma and are then driven out through the tail. The solid particles released in the thaw are scattered along the comet's orbit as a meteor stream. (*See* COMET.)

E. F. F. Chladni, a German, in 1794 gave his opinion that "shooting stars" are produced when small celestial objects fall into our atmosphere and are heated by friction to incandescence. Falls of groups of stones at L'Aigle, France, in 1803 and later at Weston, Conn., were reliably reported. Yet the idea that stones fall from the sky was generally discredited until well into the 19th century. The spectacular shower of Leonid meteors in 1833 and its repetition in 1866, which had been predicted by H. A. Newton (1830–96) two years earlier, aroused much interest in meteors. Schiaparelli announced in 1866 that the stream of Perseid meteors has the same orbit around the sun as that of comet 1862 III, and in the following year the identity of the orbits of the Leonids and of comet 1866 I was established. Since then the search for parent comets of meteor streams has been rewarded in more than a dozen cases. Beginning in 1947, radar was used for observing meteor trails and measuring the speeds of the bodies. Records by D. W. R. McKinley and others at Ottawa of more than 10,000 meteors showed no speeds high enough to definitely suggest that any of these meteors came from outside the solar system. Similar results were obtained at the Jodrell Bank experiment station in Cheshire, Eng., where daytime meteor showers have also been recorded. Meanwhile, the Harvard meteor program of F. L. Whipple and associates began to employ stereoscopic photographs of meteor trails, from which the orbits of streams and their identities with orbits of parent comets were determined. Specimens from 1,600 falls of meteorites have been recovered, and 55 of these objects weigh more than a ton. More than a dozen craters or groups of craters in various parts of the world have been recognized as the work of meteorites. A meteorite large enough to have caused earth tremors to be recorded throughout the world fell in Siberia in 1908. Another example is the well-known Meteor crater in Arizona. (*See* METEOR; METEORITES.)

The first noteworthy hypothesis of the origin of the planetary system was published by Laplace in *Exposition du système du monde* (1796). His account began with a flattened nebular envelope revolving around the sun. As the nebula contracted, it abandoned successive gaseous rings that condensed into planets and their satellites. Widely acclaimed during the 19th century, this hypothesis eventually gave way to others designed to explain features of the system discovered in the meantime. An example is the protoplanet hypothesis of Kuiper. (*See* COSMOGONY.)

6. Stars and Nebulae.—The problem of measuring the very small annual parallaxes of stars and their distances therefrom was first solved by visual means in 1837–39 by F. G. W. von Struve for Vega, F. W. Bessel for 61 Cygni and T. Henderson for Alpha Centauri. Photographic methods of high precision were devised by F. Schlesinger in 1903. Because the amount of the parallax diminishes with increasing distance, reliable direct parallaxes are restricted to stars within something like 300 light-years from the sun.

Other basic data of observation are the apparent brightness of stars. In Ptolemy's early catalogue the lucid stars were divided in order of brightness into six classes, or magnitudes. This plan was adapted to modern purposes by N. Pogson, in 1856. The apparent magnitudes of standard stars at a variety of wave lengths and determined most accurately by photoelectric measures are available to investigators. The absolute magnitudes of stars, or the apparent magnitude at the distance of 10 parsecs (32.6 light-years), can be calculated when the observed magnitudes and distances are known. Where the absolute magnitudes are known independently and the apparent magnitudes have been observed, the distances can be calculated; this is the photometric means of extending the known distances of stars beyond the limit for the direct parallaxes.

A third category of basic observational data is concerned with the spectra of stars. J. von Fraunhofer, in 1823, was the first to observe dark lines in stellar spectra. E. C. Pickering (1846–1919) and associates at Harvard observatory, Harvard, Mass., began in 1885 the photographic program that resulted in the *Henry Draper Catalogue,* which with its extensions lists the positions, magnitudes and spectra of 400,000 stars. The spectra are described by means of spectral classes, mainly the work of Annie J. Cannon (1863–1941); the principal classes are lettered O, B, A, F, G, K, and M in order of decreasing surface temperatures or increasing redness of the stars.

A diagram in which the spectral classes of stars are arrayed with respect to their absolute magnitudes was constructed by H. N. Russell at Princeton observatory, Princeton, N.J., in 1913. It is often known as the Hertzsprung-Russell, or H-R, diagram, because the Danish astronomer E. Hertzsprung in 1905 had recognized that some red stars are much brighter intrinsically than others and had called the two groups giant stars and dwarf stars respectively. In Russell's diagram the majority of the plotted points form a band that extends from the very luminous B-type stars to the M-type dwarfs; this is known as the main sequence. The giant stars lie above this sequence in the diagram and the supergiants far above it. White dwarf stars were later discovered and added below the main sequence. The H-R diagram inspired and guided subsequent researches on the stars. In appropriate cases, as for star clusters, the H-R diagram is replaced by the colour-magnitude diagram because the colour indexes of stars can be determined more readily and more precisely than the spectral

classes.

A fourth category of basic data comprises the masses of stars; these can be calculated for binary stars where their period of revolution and size of orbit are known. Castor, the first of the very numerous visual binaries, was found to be revolving by W. Herschel in 1803. The binary character of Mizar, the first-known spectroscopic double, was discovered by Harvard astronomers in 1889 from the doubling of its spectral lines. The periodic decline in the brightness of Algol, the first-known eclipsing binary, was correctly explained by J. Goodricke (1764–86). The masses of single stars may also be derived, with certain exceptions, from the mass-luminosity relation discovered in 1924 by A. S. Eddington (1882–1944).

The distances of celestial objects more remote than the limit for reliable direct parallaxes are found by photometric means when these objects are, or are associated with, recognized distance indicators. Cepheid variable stars are such indicators; they are yellow supergiant pulsating stars that can be observed even as far away as the nearer exterior galaxies. H. S. Leavitt at Harvard reported in 1912 that the period in which their brightness varies increases as the observed median magnitude of the star is brighter. H. Shapley, in 1913, established the corresponding standard period-luminosity relation applicable to Cepheids anywhere. W. Baade's announcement in 1952 that the absolute magnitudes of classical Cepheids are all 1.5 magnitudes brighter than previously supposed resulted in the doubling of all celestial distances previously determined by means of Cepheids. More recently, H. C. Arp showed that the period-luminosity relation of the Cepheids may be a band rather than a line. Another type of pulsating variable stars, the RR Lyrae variables, have also been useful as distance indicators because all their median luminosities are believed to be the same; but these stars are intrinsically less bright than the Cepheids and cannot be seen as far away.

Star clusters and nebulae began to be discovered in large numbers by the Herschels and to be listed in catalogs of increasing extent. Dreyer's *New General Catalogue* (1888) and its extensions in 1895 and 1908 included over 13,000 such objects. Because the members of a star cluster are all practically at the same distance from the earth, they may be compared fairly one with another. The clusters accordingly have added to the understanding of the relations between the different kinds of stars and of their places in the evolution of stars. The colour-magnitude diagrams of clusters differ in a remarkable way that suggests differences in the age of the clusters. Very young clusters have the main sequence practically intact. With increasing age of the clusters the stars break away from the main sequence at lower and lower points, as shown by H. L. Johnson and Allan Sandage in 1954, and move into the giant sequences. For the oldest clusters and the globular clusters, which are believed to be as old as the galaxy itself, the remaining main sequence begins with stars nearly as yellow as the sun and goes on into the red stars. Sandage's semiempirical evolution tracks of stars in the globular cluster M3 leave the main sequence at spectral type F5, extend up and to the right, and finally go back to the left to the region of the blue stars. (*See* STAR.)

Stationary hazy spots among the stars were all known as nebulae in former times. The "great nebula" in Andromeda had been recognized before the invention of the telescope. Huygens thought he had discovered the Orion nebula in 1656, but it had been seen before. Halley worked on the nebulae as early as the second decade of the 18th century. Although the idea had developed that all nebulae were really star clusters, W. Huggins' observation in 1864 of bright lines in the spectrum of a planetary nebula in Draco showed that some of these objects must be gaseous. Eventually a numerous class of spiral and associated nebulae, which seemed to avoid the Milky Way, were given the name "extragalactic nebulae" to distinguish them from the nebulae proper, which congregate toward this band of the heavens; the former proved later to be exterior galaxies. E. P. Hubble (1889–1953), in 1922, showed that nebulae are made luminous by involved or neighbouring stars. Where the stars are cooler than spectral type B1, the nebulae shine mainly by reflected starlight; where the stars are very hot, they ionize the gases of the nebulae and set them glowing. Prominent bright lines in the spectra of emission nebulae were explained by I. S. Bowen in 1927 as "forbidden lines" of oxygen and nitrogen. In the absence of neighbouring stars the nebulae are practically dark. M. Wolf (1863–1932) and E. E. Barnard had previously shown that the dark rifts in the Milky Way are areas of dark nebulae and not vacancies. In 1904, J. Hartmann observed "stationary lines" in the spectrum of the binary star Delta Orionis; and eventually these and similar lines in the spectra of other stars were understood to be interstellar lines caused by absorption of the starlight by intervening cosmic gases. R. J. Trumpler's studies of galactic clusters showed in 1930 that starlight is also dimmed and reddened by interstellar dust, which is widespread in the heavens and relatively concentrated in the vicinity of the Milky Way. (*See* NEBULA.)

The idea, pioneered by Kant and Laplace in the 18th century that stars condense from nebulae has persisted. Contraction was believed in the early theories to be the sole process that kept the stars shining thereafter; but it proved insufficient to account for the long lives of many stars. Interest in the problem of stellar evolution reawakened in the 1920s with the work of J. Jeans and A. S. Eddington, the latter suggesting subatomic means for the generation of stellar energy, while in 1938 H. A. Bethe proposed the fusion of lighter into heavier chemical elements in the interiors of stars as an important supplement to contraction; and a new evolution theory presently appeared. After condensing from a cosmic cloud, according to the theory, a group of stars goes on contracting and moves to the left in the colour-magnitude diagram until the stars are arrayed in order of mass along the main sequence. Contraction is then replaced by fusion of hydrogen into helium in the cores of the stars. The stars grow hotter and begin to expand, leaving the main sequence to become giant stars. When the available fuel is exhausted, the stars contract again until they become white dwarfs. Hydrogen fusion is the main process and may be the only one of importance in stars like the sun. More massive stars may continue to build up heavier elements at least as far as iron, as W. A. Fowler and others explained in 1956; these stars may attain central temperatures of several billion (milliard) degrees and may explode as supernovae before they begin to decline.

7. The Galactic System.—The system of the Milky Way has come to be known as "our galaxy," and the term "Milky Way" is applied usually only to the luminous band around the heavens. A number of scholars in the 18th century believed the system of stars around us to have a much-flattened structure. W. Herschel reached the same conclusion in 1784 from his star "gauges," but he decided later that the depth of the system in space was unfathomable. The statistical treatment of star counts remained about the only means of trying to determine the galactic structure until well into the 20th century, and it made little progress. Shapley's measures of the distances of globular star clusters, basically by means of their RR Lyrae variable stars, led to his conclusion, in 1917, that the galaxy has finite extent and that the sun is far from its centre. The original dimensions that he gave were considerably too large and could not be corrected until Trumpler's work, in 1930, on the effect of the cosmic dust in magnifying the photometric distances of stars. The diameter of the disk of the galaxy is usually given as 80,000 light-years and the distance of the galactic centre from the sun as about 33,000 light-years in the direction of Sagittarius, where Shapley placed it.

Although the flattened disk of the galaxy, as evidenced by the appearance of the Milky Way, suggested a centrifugal effect of the galactic rotation, no other effect was recognized until B. Lindblad, in Sweden in 1926, demonstrated a general rotation around a centre also in the direction of Sagittarius. J. H. Oort, in the Netherlands in 1927, reported a differential effect of the rotation from his studies of the radial velocities of stars in the sun's vicinity. Oort's studies showed that the disk rotates in a longer period as the distance from the centre increases.

The sun is moving in the rotation in the direction of Cygnus with a speed of 134 mi. per second, as determined by Dutch radio astronomers in 1954. The double-armed spiral pattern of stars gas and dust imbedded in the disk of the galaxy was first definitely

traced in the heavens, in 1951, by W. W. Morgan, S. Sharpless and D. E. Osterbrock at Yerkes observatory with the collaboration of other astronomers. They located many emission nebulae and associated blue stars in various regions of the Milky Way, objects that outlined parts of two spiral arms and the suggestion of a third arm. This important tracing of the arms was soon extended by radio astronomers. (*See* Galaxy.)

8. Radio Astronomy.—Cosmic radiations at radio wave lengths were first detected by K. G. Jansky in 1931. Grote Reber, an electronics engineer at Wheaton, Ill., employed a fixed 31-ft. paraboloidal antenna in 1936 to make recordings of radio emission from various areas of the Milky Way as they crossed his meridian. Radio reception from the sun was recorded at British radio stations in 1942, when a large sunspot group with associated solar flares was passing near the centre of the sun's disk and was first announced in 1946. J. S. Hey and associates in England, in 1946, discovered the first-known discrete cosmic radio source, in the constellation Cygnus. Also in England and in that year, A. C. B. Lovell and associates at the Jodrell Bank experiment station made extensive recordings by radar of the shower of Giacobinid meteors; and in the following year they began daytime recordings of meteor showers.

Following Reber's pioneer radio map of the sky, other such maps were made at various wave lengths of the continuous radio spectrum and with improved resolving power. As an example, a map by H. C. Ko and J. D. Kraus, in 1957, based on their observations at Ohio State university, showed the Milky Way prominently and also the positions of the brightest discrete radio sources. Only a few discrete sources had by mid-20th century been identified with optical instruments, particularly by W. Baade and R. Minkowski with the 200-in. Palomar telescope; these include an emission nebula in Cassiopeia, a pair of colliding galaxies in Cygnus, the Crab nebula and the nucleus of our galaxy. The only recognized emission line in the radio spectrum, at the wave length of 21 cm., was discovered in 1951 by Harvard physicists H. I. Ewen and E. M. Purcell; the line is produced by a slight change at the lowest energy level of the hydrogen atom and has also been observed as an absorption line. Tracings of the spiral arms of the galaxy by use of this line were accomplished especially by observers at the Leiden observatory, in the Netherlands in 1954, and at the Radiophysics laboratory, Sydney, Austr., at about the same time. Absorption lines of molecular hydrogen and the hydroxyl radical, OH, were discovered by A. H. Barrett and his colleagues at Massachusetts Institute of Technology in 1964. (*See* Radio Astronomy.)

9. The Exterior Galaxies.—Although Kant, as early as 1755, had thought that the nebulae might be "other universes," his speculation was not generally received with favour. It remained for E. P. Hubble to establish in 1924 the status of the hitherto mysterious spiral structures and other extragalactic nebulae. His photographs with the 100-in. Mt. Wilson telescope showed separate stars and among them Cepheid variable stars in some of these objects. The distances derived from the Cepheids ran into millions of light-years. These were galaxies beyond our own. Meanwhile, the scale of distances derived originally for the exterior galaxies required revision, as Hubble suspected might be the case. The distances of galaxies in which Cepheid variable stars were employed have been multiplied by the factor 2 by Baade's revision in 1952, and the distances originally assigned to more remote galaxies may need to be multiplied by a factor as great as 10, as Sandage showed in 1958.

Studies of the great spiral in Andromeda, which except for its larger dimensions resembles our spiral system quite closely, provided the pattern for interpreting features of our own galaxy. In 1943, Baade announced that the stars generally are grouped in two distinct populations. Population I comprises young stars, represented by the stars right around us in the dusty arm of our galaxy and in the arms of the Andromeda spiral. Population II comprises old stars, represented by stars of the globular clusters and those in the central regions of galaxies like ours. Because these are extreme populations, three additional types have since been proposed tentatively to include stars of intermediate ages.

From his researches on the spectra of galaxies, Hubble announced in 1929 that the spectral lines are displaced to the red in direct proportion to the distances. Here began the spectacular picture of the expanding universe. M. L. Humason later extended the inquiry to the Hydra cluster of galaxies at about the spectroscopic limit of the 200-in. telescope; he discovered that the red shifts for these galaxies correspond to a recession velocity of $\frac{1}{5}$ the speed of light.

W. A. Baum's photoelectric measures with the same telescope, in 1957, extended the limit to the most remote clusters of galaxies then definitely recognized; he found that there the red shifts of the spectral lines correspond to a velocity of recession equal to $\frac{2}{5}$ the speed of light.

The discovery by M. Schmidt in 1963 of quasi-stellar objects (*see* below) greatly extended the boundaries of the known universe; with velocities of recession equal to and exceeding $\frac{4}{5}$ of the speed of light, these objects were apparently by far the most remote from the earth. Their discovery seemed to support those who favoured the "big bang" model of the origin of the universe, as opposed to those favouring the "steady state" theory (*see* further Cosmogony). (R. H. Br.; X.)

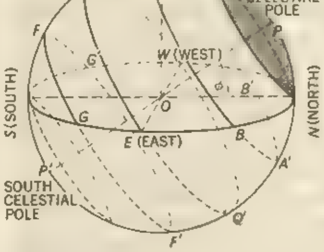
II. MODERN DESCRIPTIVE ASTRONOMY

A. The Celestial Pageant

1. The Celestial Sphere.—To an observer, ancient or modern, the night sky appears as a hemisphere resting on the horizon. Consequently, the simplest descriptions of the motions of the heavenly bodies are those presented on a sphere. Fig. 2 illustrates the daily circuits of celestial bodies.

As the earth rotates from west to east, the celestial sphere appears to rotate from east to west on its axis, PP'; in other words, the point, P, remains stationary and Polaris, the bright star which is close to the north pole, moves in a very small circle around it. All objects that lie in the shaded area remain above the horizon at all times, slowly circling the pole, although, of course, they are invisible in daytime. A star situated at some point on the circle $BAB'A'$ will move along that circle, rising at B and setting at B'. A star on the circle $EQWQ'$ will rise at the east point and set at the west point just 12 hours later; this circle is the celestial equator. Stars south of the celestial equator are above the horizon for less than 12 hours daily as seen from the northern hemisphere of the earth; this would be the case for a star on the circle $GFG'F'$. Finally, the circle $NPAS$ is known as the celestial meridian. Notice that stars reach their greatest elevation above the horizon when they pass across the meridian.

The diagram assumes the observer is located at a northern latitude which is equal to the angle ϕ on the diagram, or approximately 35°. If the observer is at a very different latitude the diagram should be redrawn. Thus, for an observer on the equator, the north celestial pole is on the horizon and all stars rise vertically from the horizon and set just 12 hours later; on the other hand, for an observer at the south pole of the earth, the south celestial pole is directly overhead in the zenith and the stars of the southern celestial hemisphere complete their daily circles always parallel to the horizon, never rising or setting.

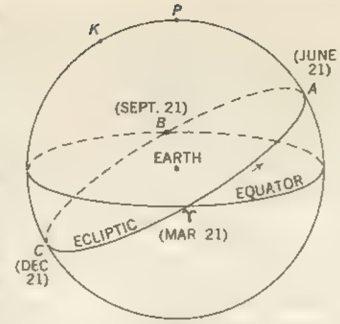


FROM CHARLES A. YOUNG, "A TEXTBOOK OF GENERAL ASTRONOMY"; BY PERMISSION OF GINN AND CO. (1898)

FIG. 2.—APPARENT DAILY MOTIONS OF CELESTIAL BODIES BECAUSE OF EARTH'S ROTATION. *O* REPRESENTS POSITION OF OBSERVER ON EARTH

2. The Seasons.—The sun, the moon and the planets move perceptibly among the stars. The moon moves approximately 13° every day in a general easterly direction. The sun moves much more slowly, progressing about 1° every day in its easterly journey. The planets move more irregularly. One feature that all of these apparent motions have in common is that the bodies travel along a rather narrow belt of the sky known as the zodiac. The central line of this belt is called

the ecliptic; it is the path the sun follows among the stars, making an angle of 23° 27′ with the celestial equator as illustrated in Figure 3. On March 21 the sun is at the intersection of the ecliptic and the equator traveling east and north; the symbol of the ram's horns (♈) traditionally used to designate this point is of ancient origin; the point is known as the vernal equinox, since, when the sun is there, the length of the day is equal to the length of the night. During the next three months the sun continues to move northeast until it reaches the summer solstice at *A*. At this point it is 23° 27′ north of the celestial equator and consequently (cf. fig. 2) nights are at their shortest on the northern hemisphere of the earth and at their longest on the southern hemisphere. From this point the sun's path turns southeast past the autumnal equinox at *B* to the winter solstice at *C*. It is because the sun's apparent path is so much inclined to the celestial equator that the seasons are so pronounced. Actually, it is the earth's annual circuit around the sun which makes the sun appear to be moving among the stars as seen from the earth. Furthermore, the fact that the earth's axis of rotation is directed 23° 27′ away from the pole of the earth's orbit around the sun accounts for the inclination of the ecliptic to the celestial equator.



FROM W. M. SMART, "TEXTBOOK ON SPHERICAL ASTRONOMY," CAMBRIDGE UNIVERSITY PRESS, PUBLISHERS (1931)

FIG. 3.—APPARENT YEARLY MOTION OF SUN AMONG THE STARS. NORTH POLE OF THE EQUATOR IS AT *P*, THE POLE OF THE ECLIPTIC AT *K*. DIRECTION OF SUN'S APPARENT MOTION IS INDICATED BY ARROW

The ancients divided the zodiac into 12 equal constellations or "signs," each sign bearing the name of the fancied pattern the stars in that portion of the sky appeared to resemble. Thus, there was Aries the ram, Taurus the bull, Gemini the twins, etc. It is a simple matter to follow the motion of the moon or of the planets along the zodiac but much more difficult in the case of the blindingly bright sun. Despite this fact, Hipparchus (fl. 146–126 B.C.) was able to establish that there is a very slow shift in the position of the ecliptic on the celestial sphere amounting to about 1° 15′ per century. Two thousand years later, in 1888, it became clear that there are irregular changes in the position of the pole of the earth; and in 1926 it was found that there are variations in the rate of the earth's rotation over a period of a decade or so. The development of much more accurate timepieces, such as the crystal clock, have immensely improved observations since 1940; as a result it has been established that there are also short-term fluctuations in the rate of the earth's rotation.

3. Time.—The astronomer sets his clock by the stars. The moment the vernal equinox crosses the meridian is zero hours and sidereal clocks are timed to follow the course of this point on the sky. Thus, at 6 hours it is setting on the west point on the horizon and at 18 hours it is rising at the east point. Now, according to the sidereal clocks, the sun reaches the meridian some four minutes later every day since it is traveling eastward among the stars; more precisely, solar clocks run 3 min. 56.56 sec. slow per day as compared with sidereal clocks.

The orbit of the earth around the sun is not quite circular, being closest to the sun on Jan. 2. The earth moves most rapidly when closest to the sun; consequently, the sun's apparent motion among the stars is most rapid on Jan. 2. Because of this and because the sun travels along the ecliptic, rather than straight eastward, apparent solar time as measured on the sundial runs 10 or 15 minutes fast in May and November as compared with mean solar time, a time based on a fictitious mean sun; similarly, apparent solar time is slow in February and July. (*See* TIME MEASUREMENT.)

4. Stellar Positions and Names.—The time shown by the sidereal clock when a particular star crosses the meridian is called the star's right ascension; this defines the star's position in the sky in the east-west direction. The declination of a star is its angular distance north or south of the celestial equator. Together, the two co-ordinates completely define the position of any star. The positions of hundreds of thousands of stars have been measured and listed in catalogues. The oldest such catalogue still existing is contained in the *Almagest* of Claudius Ptolemaus (fl. 127–151 A.D.), usually referred to as Ptolemy.

Thirty or 40 bright stars are still commonly referred to by the names given them by the Arabs, the Romans, the Greeks, etc. About 1,000 are designated by a Greek letter followed by the name of the constellation in which they appear. But most stars are known by their serial number in a catalogue. Thus, BD +24° 1382 refers to star No. 1382 in declination zone +24° of the *Bonner Durchmusterung* catalogue.

5. Eclipses and Occultations.—Two other phenomena with which the ancients were well acquainted were eclipses and occultations. If the moon crosses the line between the earth and a planet or a star, an occultation is said to occur. On the other hand, if the moon comes between the earth and the sun, it is said to eclipse the sun, either partially or totally, depending on the location of the observer on the earth and the position of the moon. Similarly, if the earth crosses between the sun and the moon, the moon is darkened by the earth's shadow and a lunar eclipse occurs. It was the spectacular eclipses and occultations that gave man his first positive evidence that the celestial bodies are not all at the same distance from us. He could deduce that the moon must be nearer to us than the sun, the planets and the stars. This marked the beginning of a new phase of astronomy. Hipparchus determined the distance to the moon by observing the size of the earth's shadow on the moon during a lunar eclipse, a method first suggested by Aristarchus of Samos (*c.* 250 B.C.). (*See* ECLIPSE.)

B. THE OBJECTS IN OUTER SPACE

1. The Solar System.—At this point it will be useful to have something in the nature of a road map, one which has been adapted from John Herschel (1792–1871). The sun, a huge self-luminous body, has a few insignificantly small, nonluminous bodies in its entourage, namely, the planets, of which the earth is one. On a drastically reduced scale the sun may be pictured as a brightly shining sphere 2 ft. in diameter. The planet Mercury on this scale will be the size of a rather large pinhead revolving around the sun in a circle of 82-ft. radius; Venus is a pea on a circle of radius 142 ft.; the earth, also a pea, at 215 ft.; Mars, a small cherry stone at 327 ft.; the minor planets (also called asteroids), fine grains of sand at distances of 500 to 600 ft.; Jupiter, a fair-sized orange on a circle of nearly 0.25 mi. radius; Saturn, a small orange at 0.4 mi.; Uranus, a walnut at more than 0.75 mi.; Neptune, also a walnut, at 1.25 mi.; and finally, Pluto, a pea revolving around the sun at a distance of 1.6 mi. On this scale the nearest star would be more than 10,000 mi. away.

Six of the planets have satellites revolving around them in the way the moon revolves around the earth. In addition, there are comets and meteoric matter. All of these bodies move in orbits under their mutual attraction in accordance with the law of gravitation, but since the sun is nearly 1,000 times more massive than all the others, it exerts a controlling influence.

It took much scientific controversy and insight to establish this picture. A theory that the earth rotated on its axis and revolved about the sun had been advanced in the 3rd century B.C., probably by Aristarchus of Samos, but failed to win acceptance. Indeed, it was not until more than 100 years after the death of Copernicus that his heliocentric theory finally triumphed over the various apparently valid objections to it. Johannes Kepler accepted the central position of the sun and based his three remarkable laws of planetary motion upon it, three laws that completely accounted for the complicated motions of all the planets. Kepler's third law sufficed to establish the relative distances of the planets from the sun in terms of the earth's distance. That distance, however, was exceedingly difficult to establish with any accuracy.

The Distance Scale.—From his observation of a lunar eclipse Hipparchus had found that the distance to the moon was 59 times the radius of the earth; this amounts to 230,000 mi., exceedingly close to the modern value of 238,860 mi. Three centuries later Ptolemy confirmed Hipparchus' value using the surveyor's method

of triangulation. Thus, assuming the stars are exceedingly far away, he used the position of the moon among the stars as observed simultaneously from two points far from one another on the earth's surface. The distance between the two points formed his base line and the angle between the two observed positions of the moon is equal to the angle subtended by this base at the moon.

The distance to the sun is much more difficult to measure. Since the stars are invisible in daytime they cannot be used as reference points; besides, the sun's heat affects measuring instruments. The first reliable value resulted from a determination of the distance of Mars in 1671–73 by the same surveyor's method which Ptolemy used for the moon's distance. This provided the yardstick for an approximate scale of the solar system. The most modern value of the mean distance from the earth to the sun is 93,000,000 mi. with a probable error of 11,000 mi. This resulted from an intensive international effort to measure the distance of the minor planet, Eros, in 1930–31 when it was relatively close to the earth. With the astronomical unit, or the distance of the sun, well determined, it is possible to compute the dimensions of the various members of the solar system.

The Sun.—The immense size of the sun can be understood when it is realized that its radius of 432,700 mi. is nearly twice the distance of the moon from the earth. Its mass, as measured by its gravitational pull on the earth, is 333,420 times the mass of the earth, or about 2×10^{27} tons (the number may be written as 2 followed by 27 zeros). Its mean density is 1.41 times the density of water, or only a little over a quarter of the earth's mean density. The sun rotates on its axis as do all principal members of the solar system. Its temperature on the surface is approximately 6,000° C. and the vast amount of energy constantly radiated from it is believed to arise from nuclear reactions deep in its interior where temperatures may be as high as 20,000,000° C. The surface is far from uniform in appearance and dark spots appear on it frequently; the diameters of these spots range from 500 to 50,000 mi. Sunspots have great influence on the earth's magnetic field and can even disrupt radio service; the number of spots varies greatly over an 11-year period. The relative abundance of chemical elements in the sun's outer layers as determined spectroscopically is remarkably similar to that in the earth's outer crust, with the important exception that hydrogen and helium are much more abundant in the sun.

The Earth-Moon System.—The earth and moon revolve around their common centre of gravity, which is 2,900 mi. from the earth's centre, the mass of the moon being $\frac{1}{81}$ times that of the earth. Since the diameter of the moon is about $\frac{1}{4}$ the earth's diameter (2,160 *v.* 7,921 mi.), it follows that the moon's mean density is less than that of the earth (3.34 *v.* 5.52 times that of water). The surface gravity on the moon is about $\frac{1}{6}$ the force of gravity on the earth's surface. A man who can throw a baseball 400 ft. here would be able, on the moon, to throw it nearly half a mile. Furthermore, the "velocity of escape" is much less on the moon. To escape from the earth's gravitational pull, a rocket must travel upward at a speed of about 24,000 miles per hour whereas on the moon it would require a speed of only 5,400 miles per hour. However, if the sun and moon are approximately in line with the direction in which the rocket is fired from the earth, their gravitational pull reduces somewhat the speed required for escape. The moon is without atmosphere and without life on its rugged mountainous surface.

The Planets.—Mercury, Venus, Mars, Jupiter and Saturn appear as bright stars to the naked eye and were known to the ancients. Uranus appears as a very faint star to the unaided eye and was discovered in 1781; Neptune, which can be seen with field glasses, was found in 1846; Pluto, discovered in 1930, is so faint that it was found only by means of long exposure photographs with a powerful telescope at Lowell Observatory.

Mercury, the smallest of the planets, is much of the time so near the sun that it is not noticed; it is never more than 28° away from the sun.

Venus is by far the brightest planet of all, so bright that it is easily visible in the daytime when far enough away from the sun; it is never more than 48° away from the sun. Through a telescope both Mercury and Venus exhibit phases similar to the phases of the moon, with the illuminated portion facing the sun. Venus, almost the earth's twin in size, density and surface gravity, has sufficient atmosphere to conceal its surface markings.

On the other hand, the surface markings of the reddish planet, Mars, and their seasonal changes can be fairly well observed because it has very little atmosphere. In 1965 excellent photographs of Mars were secured by the U.S. spacecraft, Mariner 4, which showed that its surface is covered with craters similar to those on the moon. On the evidence of these photographs it seemed doubtful that even rudimentary vegetable life exists there. Mars has two small satellites revolving rapidly around it.

Jupiter is the largest and most massive of the planets with a diameter of 89,000 mi., but its mean density is only 0.25 the earth's. The irregular belts that constitute its apparent surface markings vary in number, breadth and position from year to year.

Saturn is unique among the observed heavenly bodies, a great globe surrounded by a system of rings. The rings are composed of a vast aggregation of separate particles, each moving in its own orbit around the planet. In addition, there are nine larger satellites. Saturn's mean density is only 0.7 the density of water.

Uranus and Neptune, on the other hand, are similar to Jupiter in their mean densities but are much smaller.

Pluto, the most distant of the planets, revolves around the sun once every 248 years; its mean distance from the sun is 3,675,000,000 mi. or nearly 40 astronomical units.

Minor Planets, Comets, Meteors.—The minor planets (asteroids) within the reach of modern telescopes must number many thousands. More than 2,000 have been photographed and more than 1,600 have been sufficiently observed for their orbits to be determined. Ceres, the largest, is 480 mi. in diameter; the majority probably range from one to 50 mi. in diameter. Icarus, only 0.6 mi. in diameter, comes closer to the sun than any other known minor planet. It passes within 4,000,000 mi. (in 1968) of the earth, and might pass much closer some time in the future.

One of the most spectacular and rare of all celestial phenomena is a bright comet. Occasionally, one can be seen in daytime with a nebulous head as large as the moon accompanied by a long tail. But the great majority of comets are mere wisps of light, visible only with a telescope; a dozen or so are picked up every year but relatively few return to visibility near the sun in a thousand years. They are "airy nothings" of immense volume and very small mass. Their orbits are mostly very elongated.

Meteors are small pieces of matter seen only when, falling into the earth's atmosphere, they appear as shooting stars. There is evidence that some meteors were once associated with comets.

Underlying Implications.—Kepler's three laws of planetary motion sufficed to describe and predict the motions of all the planets with an accuracy adequate to the observations existing in the 17th century. When Isaac Newton published his law of gravitation it was realized that Kepler's laws were a consequence of Newton's more general principle. Various slight discrepancies which later appeared in the planetary motions were satisfactorily accounted for by the relativity theory of Albert Einstein (1879–1955). There is another notable feature, however, namely that the nine planets revolve around the sun in the same direction that the sun rotates. Moreover, all but Venus rotate on their axes in the same sense and, with few exceptions, the minor planets and planetary satellites also conform to the pattern, although not all of them move close to the plane of the ecliptic.

2. The Stars.—The fact that the stars are other suns at immense distances from us was exceedingly difficult to establish with certainty although Newton and others believed it probable. The first actual evidence that stars are not at an infinite distance came in 1718 when Edmund Halley discovered that a few of the brightest stars had definitely moved from their positions given in Ptolemy's catalogue. The inference that the stars are subject to the law of gravitation was suggested by the discovery of William Herschel that the two components of a double star were moving around one another. In 1838, the first successful measurement of a stellar distance was made by Friedrich Bessel (1784–1846) and others.

Distances.—Measurement of stellar distances by the method of triangulation from different sides of the earth's orbit had been attempted many times before Bessel used it. At six-month intervals the position of a comparatively close star is measured relative to a much more distant star which is apparently close to it on the celestial sphere. As seen from opposite sides of the earth's orbit, the nearby star shifts slightly with respect to the distant star. Stellar distances turned out to be so enormous that a new unit, the light-year, was devised; *i.e.*, the distance light travels in one year. Thus, one light-year is equal to 6.33×10^4 astronomical units, or 5.88×10^{12} (5,880,000,000,000) mi. Accordingly, the distance to Proxima Centauri, the nearest star, is 4.3 light-years. The triangulation method has been used in finding the distances of about 6,000 stars but is not suitable for distances greater than 100 light-years. Other methods have been developed to measure greater distances. (*See* PHOTOMETRY, CELESTIAL.)

Stellar Characteristics.—Stars are the primary bodies in which the light of the universe is generated. Spectroscopic studies have shown that stars generally have roughly the same chemical composition, with hydrogen predominating. The studies have also shown that the surface temperatures vary from approximately 1,500° C. for the very red stars to perhaps 50,000° C. for the bluest of them. Stars rotate on their axes, as does the sun, and very occasionally when the rate of rotation is very fast a star becomes unstable and splits into two parts.

Stellar masses are well known from studies of double stars; relatively few stars are known to have less than 0.1 of the mass of the sun and few have more than 20 times the solar mass. It appears that if the mass exceeds a certain value the star tends to become unstable; on the other hand, if the mass is less than a certain value the body is not self-luminous.

The total amount of energy radiated by a star is a function of the star's mass, the most massive stars radiating the most energy. The stars of faintest intrinsic brightness radiate less than $\frac{1}{100,000}$ as much visible light as the sun, whereas the brightest pour forth more than 20,000 times as much. Only a small percentage of all the stars are more than 10 times as luminous as the sun whereas a great many are less than $\frac{1}{10}$ as luminous.

Stars' densities also vary over a wide range; the densest are known as dwarfs and those with lowest densities are called giants or even supergiants. In certain dwarfs mean densities may reach 50,000 times that of water; at the other extreme, they may be as low as $\frac{1}{8,000}$ that of air in certain supergiants.

As seen from the sun, stars move in all directions and with velocities ranging up to more than 50 mi. per second. The sun itself moves among its neighbours with a speed of 12 mi. per second. The more massive stars with high surface temperatures move relatively slowly. Stars with low surface temperatures, whether giants or dwarfs, move at much greater speeds.

Variable Stars.—Not all stars shine with constant steady light. The medieval Arabs must have observed the variability of the light of the star, Algol, since the name means "blinking demon." Algol is an example of an eclipsing variable star in which one component of a double star periodically obscures the light from the other component. Most variable stars, however, are in an unstable state, periodically expanding and contracting. The periods range from 80 minutes to more than a year. Of great importance to astronomers are the Cepheid variable stars; a strong correlation exists between their luminosities and their periods of pulsation. The Cepheids are an important tool in measuring great distances since they are very massive and of high luminosity.

The most unstable of all the variables are the explosive stars known as novae. Very occasionally, an originally faint star expands so rapidly that its outer layers are completely driven off into space. Simultaneously its brightness increases perhaps 10,000 times, after which it gradually returns to its original brightness in the course of a year or so. As a result of the explosion, however, nebulous wisps occasionally are visible expanding rapidly away from the star. Even more rare in occurrence are the supernovae. Three of these have been observed since the year 1000 A.D. Apparently the entire star explodes leaving only a gaseous nebula behind. These nebulae are the source of very strong radio emission as in the so-called Crab nebula, which is all that remains of the supernova of 1054 A.D.

3. The Milky Way System.—The unearthly beauty of the Milky Way, spread irregularly across the sky on a clear moonless night, is enhanced by the realization that it is a galaxy of stars seen edge-on from a point within its bounds. The centre of the Milky Way system is hidden from our sight by clouds of obscuring matter in the constellation of Sagittarius. However, it can be perceived in infrared light to which the eye is not sensitive; it can also be located by the use of radio waves. Before either of these methods were used, however, its position had been inferred from the distribution in the sky of the compact swarms of stars known as globular clusters. The sun is in the outskirts of the system, approximately 30,000 light-years from the centre, while the overall equatorial diameter of the galaxy is perhaps 80,000 light-years. The total mass of the galaxy is estimated to be of the order of 10^{11} times the solar mass. The galaxy mass, of which less than 10% is interstellar matter, is heavily concentrated toward the centre of the system. One of the most notable features of our galaxy is its flatness; an overwhelming majority of the stars are fairly close to the equatorial plane of the galaxy as is most of the diffuse matter between the stars. However, in the case of certain types of stars, and of globular clusters, the distribution is more nearly spherical with respect to the galactic centre.

Rotation.—The entire galaxy rotates about its centre in a manner somewhat analogous to that of the solar system; thus, the outer parts lag behind the inner parts, forming great spiral arms as "seen" by radio waves. The period of rotation for stars in the vicinity of the sun is 230,000,000 years, with a probable error of 16,000,000 years. The stars that are concentrated most strongly toward the central plane, such as the very massive blue stars, move in nearly circular orbits around the galactic centre. Those that are relatively little concentrated toward the Milky Way plane, such as the RR Lyrae variables, move in a great variety of orbits, many of them very elongated. The sun, like the great majority of stars in our neighbourhood, is in an intermediate category, moving in a slightly eccentric, *i.e.*, flattened, orbit.

Stellar Populations.—The variety in the distribution and motions of different kinds of stars is connected with their time and manner of origin. The very massive blue stars, found predominantly in the spiral arms together with clouds of interstellar matter, are apparently of recent origin, being perhaps no more than 10,000,000 years old; these are exceptional, however. The sun, a yellow star of intermediate mass, is thought to be about 4,500,000,000 years old. Stars of certain other types, such as the RR Lyrae variables, are probably older still. In general, the stellar population of the globular clusters and in the region near the galactic centre consists of older stars than the population in the outlying portions, such as the neighbourhood of the sun.

Interstellar Matter.—Although the space between the stars is a far higher vacuum than anything ever achieved in laboratories it is not completely empty. There are vast aggregations of fine dust particles mixed with neutral and ionized gases, particularly hydrogen. The dust reddens and obscures the light of distant stars. The gases are frequently made luminous by the young blue stars associated with the clouds as in the Pleiades. The extremely low densities in the clouds enable astrophysicists to study the radiation of highly ionized gases in conditions never encountered on earth, a circumstance that has furthered the understanding of various atomic phenomena. The vast amounts of neutral hydrogen in the interstellar clouds emit a definite radio wave length and can be detected by radio receiving equipment.

4. The Universe of Galaxies.—That the Milky Way is a galaxy of stars was not established until the invention of the telescope, although several astronomers had previously speculated that it was probably so. In 1924, about three centuries after the invention of the telescope, photographs taken with the newly installed 100-in. telescope at Mt. Wilson established that the Andromeda nebula is actually another galaxy of stars. This brought to an end a lively debate of the preceding decade as to whether all the so-called nebulae were members of the Milky Way system. The spectroscope had revealed that certain nebulae close to the plane

of the Milky Way are luminous clouds of gas and that the spectra of a great many others are rather similar to stellar spectra. The Andromeda nebula falls in this second category; it is referred to as an external galaxy or as an extragalactic nebula.

The Andromeda Nebula.—Cepheid variable stars were soon recognized among the brightest stars of the Andromeda nebula and, since their intrinsic luminosities are known fairly well, it is possible to compute the distance of the galaxy as roughly 1,500,000 light-years. It is the largest of the nearer external galaxies and is faintly visible to the naked eye as a small luminous patch in the sky. On well exposed photographs it shows beautiful spiral structure around a large, bright central mass. There are also great rifts of dark obscuring matter analogous to the dark clouds in our own galaxy. Spectroscopic observations show that Andromeda is rotating with the central portions moving like a wheel and the outer portions lagging behind. The overall dimensions are comparable to those of the Milky Way system. (*See* ANDROMEDA.)

Other Galaxies.—Perhaps 1,000,000,000 galaxies are within reach of the 200-in. Palomar telescope. Several thousand are close enough to show details of their structure; they vary widely in appearance. There are chaotic mottled-looking systems named irregular galaxies, such as the Clouds of Magellan in the southern sky; these irregular galaxies make up 2%–3% of the total number. There are also perfectly smooth symmetrical systems called elliptical galaxies, which constitute about 20% of the total number; these galaxies show no trace of interstellar dust or gas and have no young blue stars. The great majority of galaxies, however, show some evidence of spiral structure. It is believed that the irregular galaxies are the youngest, and the elliptical galaxies the oldest; it is possible to divide the spiral types into age groups.

The Expanding Universe.—With the 200-in. Palomar telescope it is possible to photograph galaxies at a distance of approximately 2,000,000,000 light-years. The most remarkable single feature of the universe of galaxies is its expansion. Individual galaxies may show wide diversity in their motions; but statistically, the farther the galaxy is situated from the Milky Way system, the more rapidly it is receding. Recession speeds of more than 35,000 mi. per second have been observed.

Quasi-stellar Objects and Quasi-stellar Galaxies.—Two new types of objects have been discovered which are, as yet, not well understood. The so-called quasi-stellar objects (QSS) cannot be distinguished on photographic plates from ordinary faint, very blue stars; however, they are sources of intense radio waves and they are receding from the earth at such enormous velocities that it is inferred they must be exceedingly distant and unusually luminous objects. Relatively few of these objects are known. The quasi-stellar galaxies (QSG) are much more numerous and resemble the QSS except that they emit no radio waves.

5. **Astronomical Instruments.**—For the great variety of astronomical investigations many types of instruments have been devised. Two principal types of optical receiving instruments are used; those which collect light through large lenses, known as refracting telescopes, and those using concave mirrors, known as reflecting telescopes. Similarly, there are two principal types of radio receivers; those depending on an array of half-wave dipoles, and those which use a small antenna at the focus of a parabolic reflector, known as a radio "dish." Since radio waves are 1,000,000 times as long as optical waves, it is necessary that radio receivers be very much larger than telescopes to obtain satisfactory resolution. Thus, the largest optical reflector has a mirror 200 in. across and the diameter of the lens of the largest refractor is only 40 in., whereas the largest radio dish is 1,000 ft. in diameter. Many kinds of auxiliary equipment are also used, such as interferometers, spectrographs, polariscopes and photometers.

Telescopes for Amateurs.—The amateur should choose his telescope according to the uses he has in mind. A small refractor with a 2-in. objective lens is more easily handled than is a reflector. However, most amateurs soon outgrow such a telescope and desire more light-gathering power. A 6-in. reflector is very satisfactory if it has an equatorial mounting and a driving clock, the entire apparatus weighing less than 50 pounds. The equatorial mounting enables the observer to point to an object whose position on the sky is known although it is not visible to the naked eye; the driving mechanism compensates for the earth's rotation and keeps the object in the field of view, even permitting photography if desired.

See CONSTELLATION; MOON; PLANETS; ASTEROIDS; CELESTIAL MECHANICS; ASTROPHYSICS; STAR CLUSTER; OBERVATORY (ASTRONOMICAL); PHOTOGRAPHY, CELESTIAL; SPECTROSCOPY, ASTRONOMICAL; COSMOLOGY. *See* also references under "Astronomy" in the Index. (A. N. V.)

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ASTRONOMY, RADIO: *see* RADIO ASTRONOMY.

ASTRONOMY, SOCIETIES OF. This article lists the major astronomical societies, professional and amateur, that have been founded throughout the world together with their publications.

The Royal Astronomical society was founded in 1820 as the Astronomical Society of London and was incorporated March 7, 1831. Its headquarters are at Burlington house, London, and *Memoirs of the Royal Astronomical Society* (1882 *et seq.*) and *Monthly Notices of the Royal Astronomical Society* (1827 *et seq.*) are published.

The International Astronomical union, organized at Brussels in 1919, has held meetings in Rome (1922), Cambridge, Eng. (1925), Leiden, Neth. (1928), Cambridge, Mass. (1932), Paris (1935), Stockholm (1938), Zürich (1948), Rome (1952), Dublin (1955) and Moscow (1958). *Transactions of the International Astronomical Union* have been published following each meeting.

The American Astronomical society was originally founded in 1899 as the Astronomical and Astrophysical Society of America, and has published the *Astronomical Journal* since 1944. The Astronomical Society of the Pacific was founded in 1889 and publishes *Publications of the Astronomical Society of the Pacific* (1889 *et seq.*) and *Leaflet* (1925 *et seq.*). The American Association of Variable Star Observers, composed mostly of amateur astronomers, was organized in 1911. It publishes the *Quarterly Report of Variable Star Observation* and the *Bulletin*.

Other astronomical societies and their publications: British Astronomical association, *Journal of the British Astronomical Association* (1890 *et seq.*), *Memoirs of the British Astronomical Association* (1893 *et seq.*) and *Observer's Handbook* (1908–21); Royal Astronomical Society of Canada, Toronto, Ont. (1890), *Transactions* (1890), *Proceedings* (1902) and *Journal of the Royal Astronomical Society of Canada* (1906 *et seq.*); Société Astronomique de France, Paris (1887), *Astronomie* (1911 *et seq.*); Königliches Astronomisches Recheninstitut, Berlin (1897); Astronomische Gesellschaft, Hamburg (formerly in Leipzig; 1863), *Publikationen der Astronomischen Gesellschaft, Leipzig* (1865–1912) and *Vierteljahrsschrift der Astronomischen Gesellschaft, Leipzig* (1866 *et seq.*); Società Astronomica Italiana, Milan (1920), *Memorie della Società astronomica italiana, Rome* (1920 *et seq.*); Société Belge d'Astronomie, de Météorologie et de Physique du Globe (1895), *Ciel et Terre* (1880 *et seq.*); Société d'Astronomie, Antwerp (1905), *Gazette astronomique* (1908 *et seq.*); Sociedad Astronómica de México (1902), *Boletín de la Sociedad astronómica de México* (1902 *et seq.*). (F. K. E.)

ASTROPALIA: *see* ASTYPALAIA.

ASTROPHYSICS is a science concerned with the physical properties of the celestial bodies. It is a part of physics because it provides new information on (1) the behaviour of matter and radiation under conditions of temperature, pressure, magnetic force and gravitation that cannot be realized in a laboratory; (2) laws of nature discovered in the laboratories when such laws operate over very long intervals of time (up to several billion years) and over enormous distances (up to about 30,000,000,000,000,000,000 mi.); (3) the existence of new laws of nature which might remain forever undetected under terrestrial conditions. Astrophysics is also a part of classical astronomy because it derives much valuable information from measurements of the motions of stars, nebulae, planets, satellites, etc., all of which constitute the subject matter of "positional astronomy." It depends upon chemistry for the study of the behaviour of various types of molecules in the atmospheres of the planets and the cooler stars, the formation of simple molecules and dust (or smoke) particles in interstellar space, the internal constitution of the planets and the chemical composition of meteorites.

Astrophysics is related to geology and geophysics, not only in the study of the surface features of the moon with its meteoric craters, extinct volcanoes and mountain chains, but with the interpretation of the surface markings of the planet Mars and the "red spot" of Jupiter. There is also a connection with biophysics, especially with regard to the origin and evolution of living organisms on the earth and (probably) on other planets in our solar system and on planets belonging to the families of other stars.

Mathematics is an important tool in nearly all branches of astrophysics; many modern mathematical theories have found applications to the study of stellar atmospheres and interiors and of the evolution of stars and nebulae, and certain astrophysical problems have stimulated new research in analytical mathematics. Several complicated problems of stellar pulsations and stellar evolution would have remained intractable were it not for the development of fast electronic computers of different types which are capable of performing in a few hours calculations that would require many thousands of hours of work with ordinary desk calculators.

Engineering knowledge and skill are of the utmost importance in the construction of astrophysical instruments. The parabolic mirror of a large reflecting telescope must be true to shape at every point of its surface to better than one-millionth of an inch, and it must be so supported in its cell that it is not perceptibly distorted by the elasticity of the glass in any of its orientations; thermal distortion must be eliminated through the use of low expansion glass, such as Pyrex, and by means of special devices that prevent rapid temperature changes in the observatory dome. The mounting of the telescope must be balanced in all positions and must be provided with a guiding mechanism that will automatically follow the apparent rotation of the celestial sphere around the observer. Electronics plays an important role in the construction of photoelectric photometers that are capable of recording the light of a star too faint to be registered on a photographic emulsion with the largest existing telescope (stellar magnitude about +24) and of measuring changes in brightness of a variable star amounting to only 0.001 stellar magnitude (the human eye can detect changes of the order of 0.1 magnitude; the photographic emulsion gives at best a precision of about 0.04 magnitude). Various modifications of commercial television techniques are used for the construction of electronic "image convertors" which record on a screen (or a photographic emulsion) a photoelectric image of an entire field of stars and nebulae.

New engineering problems constantly arise in the construction of different types of radio telescopes. The largest steerable parabolic antennas are exceedingly heavy and must be so built that they will not sag in any orientation. Their electronic receivers must be of the highest sensitivity and must be accurately tunable to any predetermined frequency. Special types of radio telescopes, such as the "Mills Cross" in Australia, consist of separate arrays of small antennas with each beam of the cross about one mile in length. Entirely new engineering problems arose in connection with the exploration of outer space from artificial earth satellites and other space vehicles. Astrophysical instruments had to be designed to fit within the permissible limits of weight and cubic footage inside a space vehicle, and to withstand shock during the fast acceleration of the rockets in the launching process. Telemetering devices had to be designed to radio back to the earth the readings of the instruments, and a source of power in the form of solar batteries had to be constructed to operate the telemetering devices.

The word "astrophysics" is of relatively recent origin. Although it had been used occasionally by several astronomers since the middle of the 19th century, it became a standard expression through the efforts of George Ellery Hale, in the United States, who founded, at Williams Bay, Wis., the Yerkes observatory of The University of Chicago in 1892 and, near Pasadena, Calif., the Mt. Wilson observatory of the Carnegie Institution of Washington in 1904 as astrophysical research centres, and who started the *Astrophysical Journal* in 1895 as the world's most distinguished "international review of spectroscopy and astronomical physics." Although the word did not exist, the study of astrophysics began long before the middle of the 19th century. Much of the work of Galileo (his drawings of sunspots, of the ring of Saturn and of the map of the moon) was pure astrophysics, and so was Sir Isaac Newton's work on optics. An important new stimulus for the study of astrophysics came in 1814 when Joseph von Fraunhofer started observing the spectra of the stars with a simple spectroscope. It came into even greater prominence in the third quarter of the 19th century when William Huggins in England and Angelo Secchi in Italy started classifying the spectra of the stars, and toward the end of the century when H. C. Vogel in Germany introduced photography into the field of stellar spectroscopy and started measuring the radial velocities of the stars from the Doppler displacements of their spectral absorption lines. Since about 1950 there has been a trend to replace the photographic emulsion by a photoelectric surface and to "scan" the spectra of the celestial bodies in order to take advantage of the enormous sensitivity of the photoelectric cell to small differences in the intensity of the radiation.

During the 100-year period of modern astrophysics we detect chronologically five principal stages of development:

1. From about 1859, when G. Kirchhoff identified the element sodium as the source of a close pair of yellow absorption lines in the solar spectrum, until about 1888, the main emphasis in astrophysics was to observe, record and classify the great variety of stellar and nebular spectra (including those of the sun and planets).

2. From 1888, when Vogel succeeded in obtaining high-resolution photographs of stellar spectra, until about 1915, most astrophysicists were primarily interested in measuring radial velocities of stars, in studying the spatial arrangements of the stars in our galaxy and in discussing the kinematical properties of the stellar system in the vicinity of the sun.

3. From about 1915, when W. S. Adams and A. Kohlschütter discovered the correlation between the luminosities of the stars and the intensities of certain pressure-sensitive absorption lines in stellar spectra, until 1930, there was a return to a problem previously studied by N. Lockyer and others; namely, the determination of the abundances of the chemical elements in different celestial objects. This stage culminated in the now-famous "ionization" theory of Meghnad Saha, E. A. Milne, H. N. Russell and many others, which led to the establishment by Russell of a reliable table of atomic abundances in the sun that was then often, but incorrectly, labeled as the "cosmic abundance scale of the elements."

4. Between about 1930 and 1950 astrophysicists finally succeeded by various methods (some purely observational and others theoretical in character) in discovering large differences in the chemical compositions of many stars and nebulae. Russell's solar abundances, though amply confirmed and improved upon by later workers, are approximately duplicated in many stars of the "main sequence." But there are many other stars which are rich in helium and poor in hydrogen, and there are others in which some other chemical elements (for example, lithium or technetium or carbon) are much more abundant than in the sun, while other ele-

ments are less abundant.

5. Since 1950 the most spectacular development has been the unraveling of the principal processes of stellar evolution and the recognition of "evolutionary tracks" of stars in the Hertzsprung-Russell diagram (in which the intrinsic luminosity of each star, or its total energy production, is plotted against its surface temperature, or colour equivalent). The phenomenal success of this work (which is based upon earlier work by A. S. Eddington, S. Chandrasekhar, R. J. Trumpler, G. P. Kuiper and many others) was primarily associated with the names of M. Schwarzschild, B. Strömgren, F. Hoyle, A. Sandage and others. It rests upon the recognition that certain groups of stars, the galactic and globular star clusters, have different H–R diagrams and may be arranged into a sequence of different ages: the youngest clusters, such as the double cluster in Perseus, may be only a few million years old; the oldest, such as Messier 67 and all the globular clusters, are five or six billion years old. We reason that a young star, such as Vega in the constellation Lyra, may after several hundred million years resemble Deneb in the constellation Cygnus. The former is a main sequence star with a central temperature not much above the 20,000,000° central temperature of the sun; the latter is a supergiant with a central temperature of perhaps several hundred million degrees—or even one billion degrees, at which many nuclear processes are active in producing the heavy elements of the periodic table. We believe that the supergiant will probably ultimately become a "subluminous" blue star with an atmosphere containing mostly helium and heavier gases and little hydrogen. It may even become a "white dwarf" (a celestial body of planetary dimensions and of immense density) after one or more explosive processes of the nova or supernova outburst type. The important thing about this stage of astrophysical thought is that it is not based upon observing the very slow evolutionary change in any individual star but upon comparing several different stars which are believed to be of different ages but nearly identical masses. (The present theories of stellar evolution predict only a very small loss of mass, less than 1%, as a result of the conversion of mass into radiation by nuclear fusion.)

If we are permitted to speculate upon what the next stage of astrophysics will be, it is reasonable to expect: (1) that with the development of space science there will be at first a reversion to the character of the first stage—the more or less chaotic accumulation of many new and unexpected observational results and discoveries such as have already been made by means of high-flying rockets; these have given totally unexpected data on the extreme ultraviolet spectrum of the sun and of certain new kinds of nebulae (for example, the one surrounding the star Spica in the constellation Virgo) and on the existence of luminous hydrogen atoms in interplanetary space; and (2) that methods will be developed to record systematic evolutionary changes in a few individual stars. If a star like Vega or, in this context, a star like β Canis Majoris, should ultimately become a supergiant it must increase in radius and volume. We cannot measure the change in radius directly: it is much too small to be detected after intervals of hundreds or even thousands of years. But if such a star vibrates—and β Canis Majoris does vibrate, with a period of six hours—then as the volume increases the period of the vibration should become longer. The precision with which the period can be measured is so great that even a minute change in radius—say one that may occur after 50 or 100 years—should produce a measurable increase in the period.

The field of astrophysics is highly diversified. It is, therefore, useful to subdivide it into several groups, according to some suitable criteria. The conventional criterion is that of the method employed in carrying out the research. On this basis we distinguish between observational and theoretical astrophysics. The former is conducted at 100 or more observatories and other research centres distributed all over the earth. In most of them use is made of the light-gathering power of a telescope, such as a parabolic reflector, in order to concentrate as much radiation as possible from a faint astronomical source in a small spot in the focal plane. This radiation is then analyzed with various types of auxiliary instruments—a photographic plate placed directly in the focal plane of the telescope to obtain a direct picture of the object, the photoelectric surface of a photometer to measure the brightness of the source, a radiometer to record the heat (in all wave lengths transmitted by our atmosphere) of the source or the slit of a spectrograph which disperses the radiation into its constituent wave lengths. Although the light-gathering power of the telescope is usually its most important property, the scale of the image in the focal plane (or for visual observations the magnification) also may be important. For example, the scale of the 40-in. refractor of the Yerkes observatory is 10 sec. of arc per millimetre. A small nebula, such as the Ring nebula in Lyra, may thus be investigated not only in its integrated light (as would be the case with a telescope of short focal length) but with respect to its structural details. There are, however, some special fields of observational astrophysics in which the telescope plays little or no role. In solar research, because of the brilliance of sunlight, the scale of the image is often more important than the light-gathering power. Hence, many solar tower telescopes have small apertures (12 in. at Mt. Wilson) but very great focal lengths (150 ft. at Mt. Wilson). The very long-wave radio radiation of astronomical sources often requires for its study antennas which so little resemble an ordinary telescope that it requires an unusual imagination to think of them as radio telescopes. Finally, for the study of cosmic rays and of the chemical composition of meteorites, and for the measurement of X-ray radiation from the sun, no telescopes of any kind are required.

Theoretical astrophysics is usually conducted in university departments which have no large telescopes and auxiliary instruments. But the work of the observational and the theoretical astrophysicist often overlaps. In fact, the conventional division into an observational and a theoretical branch is quite unsatisfactory. It is true that some theoreticians have claimed that the properties of the universe could have been predicted from a systematic, theoretical discussion of the known laws of nature. Yet, it is doubtful that by this process even the existence of stars in the universe could or would have been predicted. Equally unrealistic are the claims of those observers who believe that all important discoveries were "unexpected." It is true that some discoveries were not predicted by theory, and the observer must at all times be prepared to find something entirely new on his records. But it is equally true that some of the greatest advances were the result of searching for effects that had previously been predicted by a theoretician. Among the most spectacular discoveries of this type was W. S. Adams' measurement of the gravitational red shift of the lines of the white-dwarf companion of Sirius, a phenomenon which had previously been predicted by Einstein's theory of relativity.

On the other hand, the discovery by A. Hiltner and J. S. Hall of the interstellar polarization of the light of very distant stars was totally unexpected and came as the result of a search for stellar polarization (produced in the atmosphere of a partially eclipsed star) which had been predicted by Chandrasekhar and is also known to exist.

It is probably better to subdivide the field of astrophysics into several branches according to the nature of the problem under study rather than the method of investigation. On this basis astrophysics can be subdivided into the following fields:

Solar physics, including the structure of the sun's atmosphere and interior; solar activity; nuclear processes inside the sun and on its surface; solar magnetism; solar-terrestrial relationships; and cosmic rays from the sun.

Physics of the solar system, including the physical properties of planets, satellites, comets, zodiacal light and interplanetary gas; cosmogony.

Physics of the stars, including stellar atmospheres and interiors, energy generation by nuclear processes; stellar origin and evolution; distribution of stars in the Milky Way and their kinematical properties; star clusters and population differences; stellar magnetism and rotation; abundances of the elements.

Physics of the interstellar medium, including properties of gas and dust in the Milky Way and their chemical composition; polarization of starlight produced by interstellar dust; reddening

of starlight; distribution in the spiral arms of the Milky Way; interaction between stars and interstellar medium; distribution of cold hydrogen from radio observations of the 21-cm. emission line; gaseous nebulae.

Peculiar stars, including novae and supernovae; radio emission and visible light produced by synchrotron radiation from the Crab nebula and other old supernovae; high-energy cosmic rays from old supernovae; pulsating variable stars; binaries and multiple stars, including the evolution of close pairs which lose mass to interstellar space.

Galaxies, including structure and evolution of the Milky Way and other galaxies; the distance scale of the universe and its age; the problem of the expansion of the universe and the "cosmological constant"; interaction between close pairs of galaxies and processes in colliding galaxies; the mysterious "central nucleus" of the Milky Way and the outflow of cold hydrogen from the central bulge; intergalactic matter; origin of spiral arms in galaxies.

Since astrophysics is closely connected with physics it is of interest to discuss by means of several examples the three aspects mentioned in the first paragraph of this article.

The behaviour of matter and radiation under physical conditions that cannot be realized in a laboratory:

1. The internal temperature of the sun is about 20,000,000° and the density is roughly 150 g. per cubic centimetre. Under these conditions hydrogen is fused into helium at a rate which is given by the energy production of the entire sun, 4×10^{33} ergs per second. Very massive stars—about 50 times the mass of the sun—produce about 1,000,000 times as much energy per second as does the sun.

2. A white dwarf (like the companion of Sirius) has a mass resembling that of the sun, but a radius more nearly resembling that of the earth. Hence its *mean* density is about 1,000,000 times greater than the mean density of the sun, which is 40% greater than the density of water. At such enormous densities gases are said to be "degenerated," and obey an equation of state which differs from that of a "perfect gas."

3. The elements lithium, beryllium and boron are of very low abundance on the earth and in the atmosphere of the sun. Presumably they have mostly disappeared because of the relatively low temperatures (of the order of a few hundred thousand degrees) that are required to cause their nuclear transformations. But in the atmospheres of some stars the lithium lines are very strong. It is probable that surface phenomena on the stars, and even on the sun (perhaps those associated with the magnetic fields of sunspots), result in the production of new lithium atoms to replace those that disappear through the action of thermonuclear reactions.

4. The density of the interstellar gas is on the average about one hydrogen atom per cubic centimetre (or about 10^{-24} g./cm.^{3}). The temperature of the gas in some regions may be about 10,000° K. The state of ionization and excitation of such a gas differs greatly from that encountered under conditions resembling thermodynamic equilibrium.

The operation of known laws of nature at great distances and over long intervals of time:

1. The properties of the force of gravitation can best be examined by means of astronomical observations. Newton proved that this force keeps the moon in its orbit around the earth, and the planets in their orbits around the sun. The same law acts between the component stars of binary systems, and determines the galactic orbits of stars around the galactic nucleus. It almost certainly acts between galaxies, and causes remarkable tidal disturbances (or "bridges") between neighbouring galaxies. Observations of solar eclipses over several thousand years show that the force of gravitation is not absorbed by intervening bodies, and that the force is independent of the composition or the physical state of the attracting bodies. Nothing is as yet known regarding the speed of the propagation of the gravitational force but, presumably, astronomical observations alone could be used to study this question. Einstein's modification of the Newtonian concept of gravitation has been verified by means of astronomical observations (gravitational bending of light rays passing close to the sun, red shift of spectral lines, advance of the perihelion of Mercury).

Important experiments on the gravitational measurement of time may be carried out by means of two atomic clocks, one located in an artificial earth satellite, the other on the surface of the earth.

2. The constancy of the velocity of light in a vacuum from moving sources and for all wave lengths has been established from observations of distant spectroscopic and eclipsing binaries.

3. The effect of aberration of light has also been established by means of observations of distant stars and galaxies.

New laws of nature:

1. The most spectacular effect of this sort, presumably involving a new law of nature, concerns the observed recession of the galaxies and has led to the theory of the expanding universe. The red shifts of the spectral lines of distant galaxies have been found by A. E. Lilley and E. F. McClain to be proportional to the wave length over an interval of 500,000 to 1 in the electromagnetic spectrum (between wave lengths of about 4,000 Å and 21 cm.). This is the law of the Doppler effect.

2. Astronomical observations may lead to the discovery of a new law involving the phenomenon of "continuous creation" of matter as suggested by F. Hoyle and others. It may even be possible to establish how the local environment (spiral arms of galaxies, magnetic field, etc.) influences this process.

3. Astronomy, more than physics, is concerned with the ultimate fate of the radiation emitted into space by billions of stars in billions of galaxies: Does it disappear forever and is the aging process of the universe irreversible?

See also ASTRONOMY; GALAXY; STAR; PLANETS.

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ASTURA, a tiny peninsula on the Tyrrhenian coast approximately 37 mi. S.E. of Rome, was once an island; a river of the same name enters the sea a few hundred yards east of the peninsula. Astura was a station on the Via Severiana, the coast road from Anzio to Terracina, and the present castle is built on the foundations of a Roman villa, with fish tanks and harbour still preserved. The Frangipani built the medieval castle, where Conradin, grandson of Frederick II of Hohenstaufen, sought refuge after his defeat at Tagliacozzo in 1268. Giovanni Frangipani, owner of the castle, betrayed Conradin and handed him over to Charles of Anjou, to be beheaded in Naples. In Roman times there were several villas along the coast between Astura and Antium (Anzio). According to Suetonius, both Augustus and Tiberius contracted malaria there, of which they died. (G. Kh.)

ASTURIAS, a region of Spain consisting of the northern half of the modern province of Oviedo, was, from 718 to 910, the only independent Christian kingdom in the Iberian peninsula. The kingdom was formed by a number of Visigothic nobles and officials who, after the Muslim invasion of Spain, retired to this area, as high mountain ranges to the east, south and west made it a small and easily defended enclave. They elected Pelayo, a Visigothic prince, as king and set up a capital at Cangas de Onís. The new kingdom managed to survive repeated attacks by the armies of the amirate of Córdoba and extended its frontiers to include Galicia and Cantabria before the end of the 8th century. The capital was transferred first to Pravia (*c.* 780) and thence, in the reign of Alfonso II (791–842), to a strategically sited new city constructed for the purpose at Oviedo. During the reign of Alfonso III (866–910) the frontiers of Asturias were pushed south to the line of the Duero from the Atlantic to Osma. By this time, the kings of Asturias, with the aid of Mozarab (Christian) immigrants from the amirate, commanded sufficient manpower to garrison and repopulate the areas south of the Asturian mountains. The kings made alliances with dissident Muslim leaders and sometimes established a *modus vivendi* with the amirs of Córdoba, but always retained their independence. An important

factor in building up a sense of national identity was the discovery, early in the 9th century, of the supposed tomb of St. James at Padrón, in Galicia. The shrine subsequently established at Santiago de Compostela was soon to become the spiritual centre of the nation. By the 10th century the kingdom was too large to be effectively controlled from the mountain capital at Oviedo, and García I (909–914) made León his administrative centre in 910.

Self-conscious Visigothicism was a feature of the Asturian kingdom, whose princes claimed direct descent from the Visigothic rulers of Spain and whose earliest chroniclers stressed the duty of the kingdom to proceed to the early and total reconquest of the whole peninsula. Church organization was re-established on the Visigothic model, aided by the immigration of Mozarabic priests, and the many churches built in Asturias adhered closely to Visigothic architectural tradition. Similarly the secular administration of the Asturian kings continued, although in attenuated form, the system of the Visigothic rulers, and the *Forum judicum* remained the basis of Asturian law. Some Frankish influence is evident in the administration and in architecture, and there are traces of diplomatic contacts with Charlemagne and his successors, but, generally, the Asturian kingdom lived in total isolation from the rest of Christian Europe.

Asturias was created a principality by John I of Castile for his eldest son, Henry, in 1388. This principality survived during the existence of the Spanish monarchy as a title (in modern times purely honorific) borne by the sovereign's eldest son. *See* also SPAIN: *History*.

See L. Barrau-Dihigo, "Recherches sur l'histoire politique du royaume asturien (718–910)," *Revue hispanique*, vol. lii (1921); R. Menéndez Pidal (ed.), *Historia de España*, vol. vi (1956). (P. E. R.)

ASTYAGES (Babylonian ISHTUMEGU) (reigned *c.* 584–*c.* 550 B.C.), the last king of the Median empire. According to Herodotus, he was the son of Cyaxares and reigned 35 years; his wife was Aryenis, the daughter of Alyattes of Lydia; and Cyrus (*q.v.*) of Persia was his grandson through his daughter Mandane. The relationship with Cyrus is probably legendary, but the Harpagus who figures in Herodotus' account as a general of the Median army who went over from Astyages to Cyrus seems to be a historical person, as the family of Harpagus afterward held a high position in the Persian empire. According to Babylonian inscriptions Cyrus, king of Anshan (in southwestern Iran), began war against Astyages in 553 B.C.; in 550 the troops of Astyages rebelled and he was taken prisoner. Then Cyrus occupied and plundered Ecbatana, the Median capital. Herodotus states that the captive king was treated fairly by Cyrus. The story of the war was also related by Ctesias, according to whom the leading figure in the insurrection against Astyages was Oebares, known from Babylonian sources as Ugbaru. Ctesias says that Astyages was made satrap of Barcania or Hyrcania by Cyrus, but was later slain by Oebares. (I. M. D.)

ASTYPALAIA (Italian STAMPALIA, modern ASTIPÁLAIA, Latin ASTYPALAEA), an island of the Dodecanese (*q.v.*), Greece, lies 80 mi. (129 km.) WNW of Rhodes. Pop. (1961) 1,539; area 37 sq.mi. (97 sq.km.). Perhaps a Cretan possession before 1400 B.C., it was later colonized by Dorians from Epidaurus (not Megara as one tradition says). As a member of the Athenian empire its annual tribute of two talents is evidence for a modest prosperity, probably agricultural. Although for a time subject to Macedon and Egypt, it remained on the whole independent, even during the supremacy of Rome, whose fleet used its harbours against the pirates (after 105 B.C.). The Venetian family, the Quirini, who held the island in the Middle Ages, built the fortress (now restored) which dominates the chief town, Castello (Astropalia or Astipálaia), on its southeast shore.

See Inscriptiones Graecae, xii (2), the main evidence for the history and antiquities of the island; L. Ross, *Reisen* (1841). (W. G. F.)

ASUNCIÓN, capital and port of the republic of Paraguay, on the eastern bank of the Paraguay river near its confluence with the Pilcomayo. The population of the city (1962) was 305,160. The surrounding district is a rich agricultural and pastoral area producing cotton, sugar, maize, tobacco, fruit and cattle products.

Asunción is built on a picturesquely wooded red sandy promontory (the westernmost point of the Paraguayan extension of the Brazilian plateau) descending to the Paraguay river. Summer temperatures are high, frequently exceeding 100° F., but in winter frosts are not uncommon, although average weather conditions from May to September are warm and relatively dry. Most of the annual rainfall of some 50 in. falls in summer thunderstorms. The city is noted for its abundant and beautiful flowering trees, and for its numerous large parks, especially the Botanical garden along the Paraguay river, the estate of a former president. The architecture of the older part of the city adjacent to the river is colonial in style—one-story, red-tiled, pastel-coloured houses, with trees and creeper-covered patios set in cobbled streets. The centre of the town is well modernized, particularly the Calle Palma with business blocks, stores, amusement places and government offices. The cathedral, the presidential palace and the National Pantheon (a smaller replica of Les Invalides at Paris), all built in the 19th century, and the modern Bank of the Republic are among the notable buildings. The large church of La Encarnación is atop the highest hill in the city centre, but the town is spreading into the surrounding hills. Until 1955 houses were dependent on wells, cisterns and horse-drawn tanks for water supply, but a piped supply was then installed, and a new electricity plant provides adequate power and light for domestic and industrial needs.

River steamers of 9 ft. to 12 ft. draft, depending on seasonal river depths, are the principal means of importing and exporting freight. Some 75% of this trade is handled by a state-owned Argentine company, although a Paraguayan company and some small ocean-going vessels from the Netherlands and Great Britain also serve Asunción. The 1,000-mi. passage to and from Buenos Aires takes three to four days in each direction and considerably increases the cost of goods transshipped by this route. It is also the terminus of the Central Paraguayan railway which connects with the Argentine rail systems via a train ferry across the Paraná river, linking Encarnación with Posadas. Another ferry connection across the Paraguay provides trunk-road communication with Buenos Aires. Its transportation facilities and modern U.S.-built docks and warehouses, although inadequate for its needs, make it the principal distributing centre and export port of the most densely populated region of Paraguay. Its central location and significance as a junction in the southern half of the continent have also made it an important air route point, with regular flights between Rio de Janeiro, Braz.; Buenos Aires, Arg.; Santiago, Chile; La Paz, Bol.; and Lima, Peru. Its industrial plants, while not large, are numerous and active and produce textiles, vegetable oils, footwear, flour, canned meat, beverages, yerba maté, processed foods, small river craft and tobacco products. It is the financial centre of the nation.

As the home of the national government, Asunción has extensive political, military and naval activities and it is the seat of the archbishop of Paraguay. The National University of Paraguay was founded in 1889; among the other educational institutions of the city are the national military academy, a normal school, an agricultural school and a Roman Catholic seminary. The French Salesian order maintains a boys' school (the College of San José), and U.S. Congregational churches maintain a grade school and high school (International college). In all aspects of Paraguay's social, cultural and economic life the significance of Asunción is dominant.

The city was so named when Juan de Salazar y Espinosa, acting for his superior, Martínez de Irala, completed a stockade fort there on Assumption day, Aug. 15, 1537. When Buenos Aires was evacuated in 1541 under attack of the Pampa Indians, the inhabitants joined the earlier colonists in Asunción, which thus became for nearly half a century the headquarters of Spain's colonial activities in eastern South America. As such it furnished 60 Paraguayan Spanish families to the expedition of 1580, sent by the Spanish government to found anew the city of Buenos Aires. With the coming of the Jesuits to Asunción in 1588, the city became the base for the conversion of the Indian population in the mission settlements of the Paraná basin. The Guaraní Indians living in the Asunción district intermarried with the Spanish troops and

colonists and established the mestizo character of the Paraguayan people. After the official separation of Buenos Aires from Asunción in 1617, the latter city declined in importance and, partly because of its remoteness from the mother country, nationalist and separatist movements started early. Independence from Spain and from Argentina was declared in Asunción on May 14, 1811. Its strategic position at the head of a great river system linking its three enemies in the War of the Triple Alliance (1865–70) invited its capture by Argentine, Brazilian and Uruguayan forces in 1868, and it was under Brazilian occupation and administration until 1876. In the succeeding years it has been the scene of more revolutions and *coups d'état* than any other South American capital city. (G. J. B.)

ASVINS (Sanskrit *asvina*), twin Vedic deities, are the gods most frequently invoked after Indra, Agni and Soma. They are gods of light, probably representing the morning twilight or the morning and evening star, although their connection with any definite natural phenomenon is obscure. They are awakened by Dawn, whom they follow across the sky in their golden chariot, and may have been conceived originally as deities who rescued the light of the vanishing sun. They are accompanied by the Daughter of the Sun and are known as "golden-pathed" and "drinkers of honey." They succour the distressed, restoring sight and youth and curing the sick; in this benevolent guise they appear in Brahmanical literature as Nasatya and Dasra. Although Indian in name (literally "horse possessors") they have unquestionable Indo-European parallels in the Greek Dioscuri (*see* CASTOR AND POLLUX) and in Lettish mythology. (J. B.-P.)

ASWAN (ASSUAN), a town of Upper Egypt on the east bank of the Nile, 555 mi. (893 km.) S of Cairo by rail. It is situated opposite Elephantine Island (Jazirat Aswan) below the First Cataract, and has benefited commercially from its position as the southern frontier town of Egypt, being the entrepôt of a substantial trade with Sudan and Ethiopia. Pop. (1960) 48,393. A broad embankment flanks the river and provides the site of the principal buildings, including modern hotels and an English church. Aswan is a popular tourist centre and a winter health resort. It is the capital of Aswan governorate, which has an area of 341 sq.mi. (883 sq.km.), and a population (1960) of 385,350.

On the granite outcrop at the beginning of the cataract 3½ mi. above the town, the Aswan Dam stretches across the Nile and, when full, converts the river for 150 mi. (241 km.) upstream into a vast lake. Completed in 1902, and heightened during 1907–12 and 1929–34, this dam holds back in the late autumn from the tail of the Nile flood about 4,000,000 ac.ft. (4,900,000,000 cu.m.) of water and, with the smaller Jabal al Awliya' (Jebel Aulia) Dam upstream in Sudan, stores the water which permits summer cultivation in Middle and Lower Egypt. When filled, the Aswan reservoir raises the level of the water nearly 120 ft. (37 m.) and submerges for nine months each year a number of islands including Philae with its exquisite temple of Isis. Vessels can negotiate this change of level by locks on the western side. The dam's massive wall of granite, 1½ mi. long, is pierced by 180 sluices which can pass the whole Nile flood practically without checking its flow, permitting the heavy load of silt to be passed through. Once one of the largest dams in the world, the boldness of its design and its enormous benefit to humanity give it a high place in the list of the world's great engineering works. Hydroelectric power installations began operating in 1960.

Four miles above the Aswan Dam is the site of the Aswan High Dam, begun in 1960, with a planned storage capacity of 125,600,000 ac.ft. (154,930,000,000 cu.m.). Designed substantially to increase Egyptian farmland and make the country virtually independent of the annual fluctuations of the Nile, the High Dam, scheduled to be completed by the late 1960s, would flood the valley for about 400 mi. (644 km.) upstream. This necessitated the transfer of about 90,000 Egyptian and Sudanese peasants to new agricultural settlements at Kawm Umbu, Egypt, and Khashm al Qirbah, Sudan.

The High Dam will submerge sites of great archaeological value, notably the temples at Abu Simbel (*q.v.*), so the government of the U.A.R. appealed to UNESCO for help in saving them. A rescue operation involving about 20 temples and shrines was launched in 1960 with the cooperation of many states (*see* NUBIA, *Excavation and Preservation of Nubia's Sites and Monuments*).

A few miles south of Aswan, above the cataract, at Ash Shallal on the east bank opposite Philae, the railway from Cairo terminates and communication with Sudan was maintained by steamer. The High Dam necessitated the replanning of these communications. Extensive deposits of good quality hematite, lying about 30 mi. (48 km.) E of Aswan in the Arabian Desert, are worked and shipped downstream for processing near Cairo. In ancient times Yeb, capital of the frontier nome, the first of the upper country stood on Elephantine (*q.v.*) Island, guarding the entrance to Egypt. Near the granite quarries on the eastern bank, which supplied the material for many magnificent monuments, there grew up another city, at first dependent on, and afterward successor to, the island town. This city was called Swan, the mart, whence came the Greek Syene and Arabic Aswan. Syene is twice mentioned (as Seveneh) in the prophecies of Ezekiel, and papyri, discovered on the island and dated in the reigns of Artaxerxes I (465–424 B.C.) and Darius II (423–404 B.C.), reveal the existence of a colony of Jews, with a temple to Yāhû (Yahweh, Jehovah), which had been founded at some time before the conquest of Egypt by Cambyses II in 525 B.C. In Roman times Syene was strongly garrisoned to resist the attacks of the desert tribes. In virtual banishment, the poet Juvenal, according to one tradition, was sent there by Domitian as prefect. In the early days of Christianity the town became the seat of a bishopric, and numerous ruins of Coptic convents are in the neighbourhood. On the conquest of Egypt by the Turks in the 16th century, Selim I placed a garrison there, from whom, in part, the present townspeople descend. During the Mahdia (1884–99) it was occupied by British and Egyptian troops.

See also NILE. (A. B. M.)

ASYLUM, a place of refuge. The derivation is of interest. In classical Greece it was the right of seizing the ship or cargo of a foreign merchant to cover losses incurred through him, and so came generally to mean the right of seizure or reprisal. In ancient Greece the term meant "the right of sanctuary," so that an asylum was an inviolable refuge for persons in search of protection. All Greek temples and altars were inviolable; that is, it was a crime against religion to remove by force any person or thing once under the protection of a deity. But this protecting right of a deity was recognized by common consent only in the case of a small number of temples. The right of sanctuary appears to have become limited to a few temples in consequence of abuses of it. Asylums in this sense were peculiar to the Greeks. The asylum of Romulus cannot be considered as such. Under Roman dominion the rights of existing Greek sanctuaries were at first confirmed, but their number was considerably reduced by Tiberius. Under the empire the statues of the emperors and the eagles of the legions were made refuges against acts of violence. Generally speaking, the classes of persons who claimed the rights of asylum were slaves who had been maltreated by their masters; soldiers defeated and pursued by the enemy; and criminals who feared a trial or who had escaped before sentence was passed.

With the establishment of Christianity, the custom of asylum or sanctuary (*q.v.*) became attached to the church or churchyard. In modern times the word asylum came to mean an institution providing shelter or refuge for any class of afflicted or destitute persons, such as the blind, deaf and dumb, etc., but more particularly the insane.

ASYLUM, RIGHT OF. In international law the right of asylum designates the protection granted by a state to a foreign citizen against his own government. The person for whom asylum is established, however, has no legal right to demand it, while the state as the agency that has the legal right to grant asylum is under no obligation to give it. Asylum is therefore a right of the state, not of the individual. This right of the state falls into three clearly defined categories: territorial, extraterritorial and neutral asylum.

Territorial.—Territorial asylum is an exception to extradition (*q.v.*), and it is granted within the territory of the state that gives it. It stems from the principle of territorial sovereignty. Occasionally it is granted to fugitives from justice in the absence of

an extradition treaty, and most nations, with the notable exception of the United States and the countries of the British Commonwealth, claim the right to grant asylum to their own nationals. But it is for the protection of persons accused of a political offense that the right of asylum is primarily designed. The category "political offense" specifically includes treason, desertion, sedition and espionage. Moreover, with the signing of the armistice agreement of July 27, 1953, which terminated the war in Korea, it was agreed that a detaining power might grant asylum to prisoners of war not wishing repatriation. The rule that political offenders are entitled to asylum is the product of the development of constitutionalism and democracy in the 19th century, and the usual operating motive is the unwillingness of governments to assume the unpleasant obligation of handing over such refugees to political vengeance in their own countries. Accordingly, most extradition treaties explicitly exempt from surrender persons charged with the commission of political offenses. This generally accepted practice is reflected in art. 14 of the Universal Declaration of Human Rights adopted by the United Nations general assembly on Dec. 10, 1948, which specifically guarantees the right of asylum to those fleeing from persecution. In the sphere of domestic law, the constitution of France adopted in 1946, the constitution of Italy adopted in 1947 and the constitutions of a substantial number of Latin-American countries and of countries behind the "iron curtain" have similarly recognized this right. But in the effort not to enlarge excessively the content of a political offense, it has become a widespread practice to exclude from this category the murder of the head of a state, anarchism, collaboration with the enemy in time of war and, after the Nuremberg trials of 1945, crimes against peace, war crimes and crimes against humanity. Closely related to the last, the Convention on the Prevention of the Crime of Genocide adopted by the United Nations general assembly on Dec. 9, 1948, and ratified by a number of states, provides in art. 7 that genocide is not considered a political offense.

Extraterritorial.—Extraterritorial asylum refers to asylum granted in legations, consulates, warships and merchant vessels in foreign territory. It is therefore granted within the territory of the state from which protection is sought. Its most controversial expression is to be found in the asylum granted in legations, and generally known as diplomatic asylum. The latter was formerly based on the principle of exterritoriality of legations, which meant that the official residences of diplomatic agents were excluded from the territory of the receiving state. It is significant that this principle similarly supported the practice of asylum in consulates and warships. With the abandonment of this fiction, however, diplomatic asylum became a practice founded upon humanitarian grounds when a person's life was in imminent danger from mob or other violence. In an attempt to regulate this practice adequately, the 21 American republics signed a number of conventions carefully defining its scope. Among such efforts, the Havana convention of Feb. 20, 1928, the Montevideo convention of Dec. 26, 1933, and the Caracas convention of March 26, 1954, deserve notice. Significant as these conventions are, they have remained largely unratified, thereby leaving diplomatic asylum without any legal support. Instead, where asylum is practised, it is not a right of the legate state but a custom invoked or consented to by the territorial government in times of political instability. Actually, diplomatic asylum is frequently resorted to in the countries of Latin America, the near and far east and occasionally in Europe, but has never existed in the United States and Great Britain.

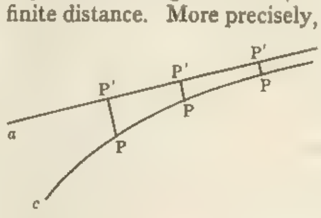
Specific instances of asylum took place during the Spanish civil war of 1936–39, when, it is estimated, between 3,000 and 4,000 persons were given asylum in the embassies and legations at Madrid. Also, on Sept. 20, 1955, the overthrown dictator of Argentina, Juan Domingo Perón, was granted asylum in the Paraguayan embassy in Buenos Aires; and during the Hungarian revolt of Nov. 1956 against the Communist regime, the United States government granted asylum to Joseph Cardinal Mindszenty in its legation in Budapest. This last action is particularly striking, for the United States government strongly disapproves of diplomatic asylum, and its embassies are not authorized to give it unless clearly required by considerations of humanity.

The legality of diplomatic asylum was widely discussed in 1949 when asylum was granted by the Colombian government to Víctor Raúl Haya de la Torre, a prominent Peruvian political figure. Having been indicted for complicity in an unsuccessful attempt to overthrow the Peruvian government in 1948, Haya de la Torre sought and was granted asylum in the Colombian embassy in Lima on Jan. 3, 1949. The refusal of Peru to recognize this asylum, alleging the nonpolitical nature of the offense, led the parties to resort to the International Court of Justice at The Hague for a decision. On Nov. 20, 1950, the International court denied that any general right of diplomatic asylum existed in international law and that if it existed in Latin America it was only on the basis of treaty law and not of customary law. In a decision of June 13, 1951, the court intimated that the asylum granted to Haya de la Torre was illegal and strongly suggested that it be brought to an end. It was not until April 8, 1954, after the controversy had risen to a new pitch of intensity in a flurry of notes and protests from other Latin-American governments supporting the Colombian position, that the Colombian and Peruvian governments reached an agreement permitting Haya de la Torre to leave Peru, thus ending five years and three months of asylum in the Colombian embassy in Lima. Though the case was finally settled, the position of diplomatic asylum remains far from satisfactory.

Neutral.—As regards neutral asylum, a state neutral in time of war is considered to possess the right to offer asylum within its territory to belligerent troops provided they submit to internment for the duration of the war. This matter was regulated by art. 11, 12, 13 and 14 of the Hague convention v of Oct. 18, 1907. Similarly, warships of belligerents have a right to temporary asylum in neutral ports. However, art. 12–19 of the Hague convention xiii of Oct. 18, 1907, provide that in the absence of local regulation to the contrary, the normal period of sojourn in the neutral port, roadsteads or territorial waters is limited to 24 hours. This period, however, may be extended in the case of damaged ships if the condition of the ship is such that more time is needed to repair it. Thus, during World War II, the celebrated German battleship "Admiral Graf Spee," which entered the port of Montevideo on Dec. 14, 1939, in a damaged condition resulting from engagement with enemy war vessels, was granted 72 hours within which to make the necessary repairs. This, however, is a matter largely falling within the discretion of the neutral power. *See* also ASYLUM; SANCTUARY.

BIBLIOGRAPHY.—Manuel R. García-Mora, *International Law and Asylum as a Human Right* (1956); John Bassett Moore, *Asylum in Legations and Consulates and in Vessels* (1892). (M. R. G.-M.)

ASYMPTOTE, in geometry, a line which approaches continually nearer to a given curve, but which does not meet it within a finite distance. More precisely, if a curve, *c*, has an infinite branch and if there is a straight line, *a*, such that the distance PP′ to *a* from a point P on *c* approaches zero as a limit, as P moves toward infinity, then *a* is called an asymptote to this curve. Geminus of Rhodes, writing in the 1st century B.C., remarked that some lines exist which approach indefinitely and yet remain apart. Elsewhere he gives the cases of the hyperbola (*q.v.*) and conchoid, each with its asymptote. The asymptote is often spoken of as a tangent to a curve at a point infinitely distant.



ASYUT, the chief town of a governorate of the same name and one of the largest towns in upper Egypt, is situated on the west bank of the Nile 235 mi. south of Cairo by rail; pop. (1962 est.) 134,000. Important for its schools and as a centre of the Copts, it also has a reputation for its fine pottery, inlaid woodwork, carved ivory, leatherwork and rugs. Just below the town is the Asyut barrage, constructed in 1902, consisting of an open weir of limestone 2,691 ft. long, with 111 sluices each 16½ ft. wide and a lock on the western side. This barrage raises the summer water level of the Nile to feed from its western side the Ibrahimiya canal. It is this canal, nearly 200 ft. wide and 200 mi. long, that

supplies irrigation water to middle Egypt and Al Fayyum. The canal is skirted by a magnificent tree-lined embankment leading from the river to the town.

Asyut is the successor of the ancient Egyptian Syût (later Lycopolis), capital of the 17th nome of upper Egypt and centre of the worship of the jackal-headed god Wepwawet. The habitable part of the governorate is mainly confined to a narrow strip, generally three to five miles wide, flanking the Nile. The town owes its importance to its central position in a broadening of this fertile strip and to being the terminus of a trade route leading to the oases of the Libyan desert and thence to Darfur and Sudan. Modern buildings, including a museum, cover the old city, but the slopes of the limestone hills behind contain a number of rock tombs of which the most important is that of Hepzefa (12th dynasty). Near Badari, about 20 mi. upstream on the east bank, the remains of one of the two earliest known prehistoric civilizations of Egypt have been discovered and named after it the Badarian.

Asyut governorate has an area of 597 sq.mi. with a population (1960) of 1,325,000. *See* NILE. (A. J. AL.; A. B. M.)

ATACAMA, a province of northern Chile noted for mining, was created in 1843. Present boundaries were fixed in 1927. Except for San Félix and San Ambrosio islands, which lie about 500 mi. W. of Chañaral, the province's 30,219 sq.mi. lie within 25° 18′ and 29° 44′ south latitude and 68° and 71° 38′ west longitude. Pop. (1960) 116,309. Although the area is largely desert, scrub vegetation in the south permits pastoral activity. Farming, chiefly in Copiapó and Huasco valleys, is notable for production of fresh and dried subtropical fruits, raisins, and pisco, a distilled drink made from grapes.

The oasis trading centres of Copiapó (*q.v.*) and Vallenar also benefit, respectively, from operation of copper and lead smelters. Ore and concentrates come from scattered, small, locally owned mines or government mills. The foreign-owned 100,000-ton-per-year copper operation at Potrerillos is integrated. Copper reserves at El Salvador and iron ore at Algarrobo promise sustained large-scale mining. Gold and silver, associated with 19th-century provincial wealth and fame, and lead and apatite are secondary to copper.

Chañaral, outlet for Potrerillos, and Caldera and Huasco are ports and rail terminals. (J. T.)

ATACAMA DESERT (DESIERTO DE ATACAMA), a Chilean segment of the west-coast South American arid region that lies between latitudes 5° and 30° S. There are differing concepts as to its areal extent, but the nucleus of the Atacama desert may be identified with the land between the south bend of the Loa river and the mountains separating the Chañaral-Copaipó drainage basins. Elements of coastal range, interior depression and Andean cordillera are present. The straight, abrupt coast may rise 2,000 to 3,000 ft. from the sea or from narrow terraces. The zone of coastal mountains has elevations to 9,000 ft. Hills interrupt the continuity of the longitudinal depression, creating a number of bolsons or basins of interior drainage (2,400–3,000 ft. elevation). The basins, also present in the coastal mountain area, are saline. Among the salts present are the nitrate compounds which give rise to the region's major industry. Across the longitudinal depression the alluvial fans or cones of the Cordillera de Domeyko slope from the east. To the east of the Domeyko range lies a second, higher, structural trough with saline basins (as Salar de Atacama). Eastward of the trough the land is about 10,000 ft., and climate, vegetation, geology and terrain are identified with highland *puna* or altiplano (as Puna de Atacama). The desert has a narrow coastal phase of extremely sparse vegetation. Fog, stratus clouds, high relative humidity and moderate diurnal and annual temperature ranges prevail. Inland the desert is barren, except at higher elevations where infrequent summer showers occur; clear sky, low relative humidity and comparatively wide temperature ranges prevail. It lies within Antofagasta and Atacama provinces (*qq.v.*). The bulk of the Atacama desert was ceded (1883–84) by Bolivia following the War of the Pacific. *See* PACIFIC, WAR OF THE. (J. T.)

ATACAMEÑO (ATACAMA, KUNZA), an extinct American Indian culture of northern Chile and northwestern Argentina. The Atacameñan language (Likan-antai) was possibly related to Diaguita, and J. Alden Mason proposed the joint name Ataguitan. Early assimilated by the Spaniards and seldom mentioned by historians, the Atacameño are known largely through archaeology. They irrigated maize, quinoa, potatoes, squash, beans, cotton and tobacco and kept llamas and alpacas at the rare oases. Their implements were typically of wood, but they traded gold, copper and bronze objects from the north. Villages consisted of rows of stone houses surrounded by a fortifying wall. Each probably was a localized patrilineal clan Lances, clubs, knuckle-dusters, slings, doublets and helmets evidence warfare which was probably defensive. Religion was largely shamanistic; burial, typically in a roofed-over cylindrical cyst.

See Wendell C. Bennett, "The Atacameño," in J. H. Steward (ed.), *Handbook of South American Indians*, vol. 2, pp. 599–618 (1946, 1963). (J. H. So.)

ATACAMITE, a mineral found originally in the desert of Atacama in Chile. It is an oxychloride of copper and its colour presents various shades of green. Some of the finest crystals have been yielded by the copper mines of South Australia, especially at Wallaroo. It occurs also, with malachite, at Bembe, near Ambriz, in west Africa. From one of its localities in Chile, Los Remolinos, it was also termed remolinite. Small quantities of atacamite have been found in Arizona. The basic chloride of copper, it is of frequent occurrence in the green patinas of Egyptian bronzes but is unstable in moist climates. Atacamite has the formula $CuCl_2.3Cu(OH)_2$, and crystallizes in the orthorhombic system. Its hardness is about 3 and its specific gravity 3.7.

ATAHUALPA (ATABALIPA) (*atahu*, "virile," and *allpa*, "sweet") (*c.* 1502–1533), "the last of the Incas" of Peru, so called because he was the last ruler of that great Indian empire, was the favourite son of the Inca Huayna Capac. His mother was Pacchas, the daughter of the conquered sovereign of Quito. His half-brother, Huascar, succeeded Huayna Capac in 1525, for, since Atahualpa was not descended on both sides from the line of the Incas, Peruvian law considered him illegitimate. His father left him, however, the kingdom of Quito. In 1530 a quarrel arose between the brothers over the suzerainty of an interjacent province. Civil war broke out, and by 1532, about the time that the Spanish conqueror Francisco Pizarro (*q.v.*) was beginning his march inland from the coast, Huascar had been defeated and thrown into prison, and Atahualpa had become Inca. Pizarro set out from San Miguel in Sept. 1532 enroute to Cajamarca, a favourite resort of the Incas, where Atahualpa had his headquarters. Messengers passed frequently between them, and the Spaniards on their march were hospitably received by the inhabitants. On Nov. 15 Pizarro entered Cajamarca and sent his brother Hernando and Hernando de Soto to request an interview with the Inca On the evening of the following day Atahualpa entered the great square of Cajamarca, escorted by 3,000 or 4,000 of his followers. who were either unarmed or carried only short clubs and slings concealed under their garments. Pizarro's artillery and soldiers were strategically arranged in the buildings and streets opening on to the square. The interview was carried on by the priest Vicente de Valverde through an interpreter. He stated briefly and dogmatically the history and tenets of the Christian faith and the Roman Catholic policy, and called upon Atahualpa to become a Christian and to acknowledge Charles V as his master. To this extraordinary harangue the Inca pointed out to him vehemently certain difficulties in the Christian religion, acknowledged the obvious greatness of the emperor and declined to accept either Christianity or Spanish sovereignty. He then took the Bible from the priest's hands, looked at it and flung it resentfully to the ground. The priest retired to give an account of the interview to Pizarro, and Pizarro immediately gave the prearranged signal for attack. The Spaniards rushed out from all sides, and the Peruvians, astonished and defenseless, were cut down in hundreds. Pizarro himself seized the Inca, and, in endeavouring to preserve his life, received the only wound inflicted that day on a Spaniard.

Atahualpa, thus treacherously captured, offered in ransom the famous roomful of gold and silver. He fulfilled his promise and the Spaniards received $4,000,000 of bullion, but Pizarro still de-

tained him until reinforcements should arrive. While in captivity Atahualpa was accused of giving secret orders for the assassination of his brother, Huascar, and also of plotting the overthrow of the Spaniards. In February of 1533 Diego de Almagro arrived from the coast; rumours soon spread through the camp of an invasion; and Pizarro ordered the Inca to be brought to trial. He was condemned to death, and, as an idolator, to death by fire, an act of treachery that called forth the protest of the most influential of Pizarro's advisers—except the priest Valverde. But Pizarro feared the anger of his soldiery if he retracted, and Atahualpa, although he professed himself a Christian and received baptism, died by strangulation on Aug. 29, 1533. With him died the Peruvian empire. *See* ANDEAN CIVILIZATION.

The standard authority for these events is still W. H. Prescott's *History of the Conquest of Peru* (1847; 1948). Where there is a discrepancy of opinion, he offers comparisons in his voluminous footnotes. In 1966 a complete English translation by Harold V. Livermore of Garcilaso de la Vega's 17th-century *Royal Commentaries of the Incas and General History of Peru* was published. *See* also J. H. Rowe, "Inca Culture at the Time of the Spanish Conquest" in J. H. Steward (ed.), *Handbook of South American Indians*, Bureau of American Ethnology, bulletin 143, vol. 2 (1946). (W. B. P.)

ATALANTA, a heroine, probably a by-form of Artemis, variously said to be daughter of Schoeneus of Boeotia or of Iasus and Clymene, of Arcadia. She was a renowned and swift-footed huntress. From her complex legend the following incidents are of interest: (1) She was exposed at birth, as her father wanted a son, but suckled by a she-bear (a beast connected with Artemis). (2) She took part in the Calydonian boar hunt (*see* MELEAGER). (3) She offered to marry anyone who could outrun her; those who lost were to be killed. Hippomenes (or Milanion) was given three of the apples of the Hesperides (*q.v.*) by Aphrodite; when he dropped them, Atalanta stopped to pick them up, and so lost the race. Their son was Parthenopaeus, one of the Seven against Thebes. (4) She and her husband, proving ungrateful to Aphrodite, were led to profane a shrine with their loves, for which Cybele turned them into lions.

ATARGATIS, the great goddess of northern Syria; a Greek variant of the name is DERCETO. Her chief sanctuary was at Hierapolis-Bambyce (modern Membidj), northeast of Aleppo, where she was worshiped together with her consort, Hadad, and a youthful male divinity. Her ancient temple there was rebuilt about 300 B.C. by Queen Stratonice, and it was perhaps partly as a result of this royal Greek patronage that the cult, carried by returning Greek merchants and mercenary troops, as well as by Syrian slaves and traders, spread to various parts of the Greek world, where the goddess was generally regarded as a form of Aphrodite. Outside Syria her male companions seldom appear. The Roman west was somewhat less receptive, but Nero was briefly a devotee of the cult, and Roman soldiers carried the Dea Syria (Syrian goddess) even to northern Britain.

Knowledge of the cult derives chiefly from the mock-serious essay of the satirist Lucian, "On the Syrian Goddess," and on the unflattering picture of her mendicant servitors, the self-castrated Galli, in the *Metamorphoses* of Apuleius, books viii–ix. The sanctity of fish, peculiar to her cult, is also attested by inscriptions and archaeological evidence. Her nature closely resembles that of her Phoenician counterpart, Astarte, though as befits her geographical position she also shows some kinship with the Anatolian Cybele. Primarily she is a goddess of fertility, but as the Baalat (mistress) of her city and people she is responsible for their protection and well-being on all scores. Hence she is commonly portrayed wearing the mural crown and holding a sheaf of grain, while the lions who support her throne suggest her strength and her power over nature. *See* also articles on the related figures APHRODITE; ASTARTE; GREAT MOTHER OF THE GODS; ISHTAR. *See* also HIERAPOLIS. (F. R. WN.)

ATASI, HASHIM AL- (HASHEM ATASSI) (1875–1960), Syrian politician who played a leading part in establishing Syrian independence, was born in Homs in 1875, while his country was still part of the Ottoman empire. In early life he held positions in the Ottoman administration. After World War I he was prominent in the short-lived government of Amir Faisal and then became one of the leaders of nationalist opposition to the French occupation and mandate. In 1936 he headed the Syrian delegation which negotiated the Franco-Syrian treaty promising Syria independence, and in the same year was elected president of the republic. The agreement with France broke down and in 1939 he resigned. Following a military coup in 1949 he became prime minister, then again president. The political group supporting him favoured union with Iraq, but this tendency was reversed when in late 1949 Adib Shishakli seized power. Atasi continued in office, but effective power was in Shishakli's hands and in 1951 he resigned. In 1954 a further coup ended Shishakli's regime and Atasi was restored to the presidency. After the 1955 election he retired into private life. He died in 1960.

See S. H. Longrigg, *Syria and Lebanon under French Mandate* (1958); N. A. Ziadeh, *Syria and Lebanon* (1957). (A. H. H.)

ATATÜRK, MUSTAFA KEMAL: *see* KEMAL ATATÜRK, MUSTAFA.

ATAULPHUS (ATAWULF; ATAULF) (d. A.D. 415), chieftain of the Visigoths from 410 to 415, the successor of his brother-in-law Alaric (*q.v.*). In 412 he left Italy and tried to settle his people in southern Gaul. In 414 he married at Narbonne the Roman princess Placidia (sister of the emperor Honorius), who had been captured by the Goths at Rome in 410. Driven from Gaul he retreated into Spain early in 415 and was in that year assassinated at Barcelona. The most important fact known about him is his statement, recorded by Orosius, that his original aim had been to overthrow the Roman empire and replace it by a Gothic empire, but that later, recognizing the savagery of his people, he decided to restore Roman power by means of Gothic arms. His ambition to fuse Romans and barbarians together in a revitalized empire was not realized. (E. A. T.)

ATBARA ('ATBARAH), a town in the Northern province, Sudan, lies on the right bank of the Nile, 195 mi. N. of Khartoum by rail and 201 mi. by river. Pop. (1965 est.) 48,250. It is situated at the point where the Atbara river enters the Nile and is also at the junction of the two main railway lines to Khartoum, from Wadi Halfa and from Port Sudan. The Atbara bridge carries the Khartoum-Atbara line over the Atbara river and is also used by road traffic. The town is the headquarters of the Sudan government railways administration and workshops. There is a cement factory 5 mi. to the south. The occupation of the majority of the inhabitants of the town is connected directly or indirectly with railway services and maintenance. Upstream 12 mi. from Atbara on the Nile is the provincial capital, Ed Damer. (A. EL-S. O.)

ATBARA RIVER (NAHR 'ATBARAH), the last tributary of the Nile, is nearly 500 mi. long. It joins the Nile at the town of Atbara, Sudan, about 17° 40′ N. As the Takazze, the main stream rises near the eastern escarpment of Ethiopia and crosses the northern basalt plateau in a steeply incised ravine which attains a maximum depth of nearly 2,000 ft. only 10 mi. from the river source. After turning north near Debra Tabor the Takazze is joined by numerous large streams which, like itself, run very low or are intermittent from November to May but rise with the summer rains to maximum volume in July and August and carry a heavy load of silt when in spate.

Turning westward to form the southern frontier of Eritrea, the Takazze becomes the Setit and after entering the Sudan is joined by the smaller Atbara to form the main Atbara 310 mi. distant from the Nile. From this point onward the Atbara gains little water from its tributaries, small seasonal *khors*, and after Khashm al Girba it loses volume by evaporation and by seepage into the coarse silt of its own bed, so that the monthly discharge from February to May is negligible. By May most of the visible water has sunk to separate pools used as watering places by the nomads. Even the July discharge into the Nile averages about 700 cu.m. (916 cu.yd.) per second, against 2,150 (2,812 cu.yd.) in August and 1,190 (1,557 cu.yd.) in September, after which it falls rapidly again; but the August figure represents a steady flow amounting to 22% of the total Nile discharge below Atbara.

At the rapids of Khashm al Girba (*i.e.*, "Bottleneck") a dam was being built (1961) for storage of floodwater and irrigation. Firm banks of solid rock at the narrows and locally quarried stone

favour the project, as they did the building of the Butana bridge for the Khartoum-Kassala railway and for cars. Trucks must use the dry-season fords. There is little permanent settlement along the Atbara. The gravels contain some semiprecious stones, but riparian land with fertile new silt is generally lacking, for the bed is cut down into the clay plain, the banks are often badlands and from 10,000,000 to 15,000,000 tons of silt are swept annually straight into the Nile (*q.v.*).

See H. E. Hurst and P. Phillips, "The Topography of the Blue Nile and Atbara," *The Nile Basin* (1950); H. E. Hurst, *A Short Account of the Nile Basin* (1944); H. Bell, *Irrigation by Gravity from the River Atbara* (1956). (M. T. P.)

ATCHISON, a city of Kansas, U.S., 42 mi. N.W. of Kansas City, on the Missouri river; seat of Atchison county. (For comparative population figures *see* table in KANSAS: *Population.*) The surrounding territory is an exceedingly rich agricultural area, and it contains deposits of the loess soil which is especially favourable to fruit growing. The city's industrial establishments include large iron and steel foundries, flour mills and clothing plants. Atchison is an important wholesale centre for hardware, drugs, groceries, athletic equipment, fruit and candy.

At Atchison are St. Benedict's college for men (founded in 1859) and Mount Saint Scholastica college for women (founded in 1863).

Atchison was founded in 1854 by a group of proslavery settlers and was named after their leader, David R. Atchison, U.S. senator from Missouri. The town was chartered in 1858, and the following year a charter was granted for the Atchison and Topeka railroad which later was named the Atchison, Topeka and Santa Fe. A council-manager form of government was adopted in 1921.

ATE, Gr. "ruin," "disaster," including material loss, but coming to mean a state of infatuation in which evil appears good. Personified as a mythological figure, Ate made Zeus take a hasty oath that resulted in Hercules' becoming subject to Eurystheus (*see* HERCULES). Zeus thereupon cast Ate by the hair out of Olympus, after which she remained on earth, working evil and mischief. She is followed by the Litai ("prayers"), the old and crippled daughters of Zeus, who repair the harm done by her (see *Iliad*).

In some Elizabethan writers (*e.g.*, Edmund Spenser) and other moderns she becomes a kind of fiend. (H. J. R.)

ATELLANA FABULA, a kind of farce, popular in republican and early imperial Rome. (*Fabula* was the general term for a play.) The ancients derived the name from the town Atella in Campania; if they were right, then the farces were of Oscan origin, perhaps influenced by the Greek farces of Tarentum and other cities. Strabo mentions that in his own day (in the time of Augustus), although the Oscans had died out, metrical pieces in Oscan were produced on the Roman stage at a certain traditional festival; perhaps he meant no more than that the language was rustic Latin, spiced with Oscan words. According to Livy the *Atellanae* were often acted by amateurs, and to be an actor of *Atellanae* did not involve loss of civic status. Other evidence, however, indicates that the actors may have been professionals. In the last century B.C. the *Atellanae* became a literary genre, and there are some fragments by L. Pomponius of Bononia, Novius and other writers; *see* Otto Ribbeck, *Scaenicae Romanorum Poesis Fragmenta* (Leipzig, 1897–98). There seem to have been four stock masked characters: Maccus, the Clown; Bucco ("Fatcheeks"), the Simpleton; Pappus (in Oscan, "Casnar"), the Old Fool; and Dossennus, whose name (perhaps from *dorsum*) has been taken to mean "hunchback." Manducus, the ogre with champing jaws, is also mentioned by some, but he may not have been an Atellan character. Many of the recorded titles of plays suggest everyday Italian life, but some are reminiscent of the *fabula palliata* (adaptations of Greek new comedy: *see* DRAMA), and some suggest burlesque. The language was rustic and coarse. The *Atellanae* finally disappeared because of the popularity of the mime.

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ATESTE: *see* ESTE.

ATHABASCA, a river and lake in midwestern Canada. The river, which lies in the province of Alberta, rises at the continental divide in the Columbia ice field, in the Canadian Rocky mountains, at the southern end of Jasper National park. It flows 765 mi. diagonally across Alberta to Lake Athabasca in the northeast corner of the province. Important tributaries include the McLeod, Pembina, Lesser Slave (which drains the lake of that name) and Clearwater. Navigation above McMurray (formerly Fort McMurray) is limited. The main shipping route is from McMurray (and Waterways, 2 mi. upstream on Clearwater river) via Slave river and Great Slave lake to Mackenzie river and north to the Arctic ocean. Large deposits of bituminous tar sands outcrop for 120 mi. along the Athabasca in the McMurray area.

Lake Athabasca, 208 mi. long and about 32 mi. wide, is 699 ft. above sea level and has an area of 3,120 sq.mi., of which 2,165 sq.mi. are in the province of Saskatchewan and 955 sq.mi. in Alberta. Formerly, the lake extended west to include the basins of Mamawi and Claire lakes, but the Athabasca and Peace rivers, by building deltas into Lake Athabasca, have cut off the two lakes. Athabasca and Peace river waters make the western part of Lake Athabasca turbid. The lake usually begins to freeze in early October; discharge from Athabasca river may open the west end in early May, but ice may linger in the lake until mid-June. Most of the lake is within the geological region of the Canadian Shield with important mining areas at Uranium City and Goldfields. Fort Chipewyan, a small settlement, is on the west end of the lake. (J. R. M.)

ATHALIAH (in the Douai version of the Bible, ATHALIA), in the Old Testament, the daughter of Ahab and Jezebel, and wife of Jehoram (*qq.v.*), king of Judah. After the death of Ahaziah, her son, she usurped the throne and reigned for seven years. She massacred all the members of the royal house of Judah (II Kings xi, 1–3). The sole survivor, Joash, was concealed in the temple by his aunt, Jehosheba, wife of the priest Jehoiada. These organized a successful revolution in favour of Joash (II Kings xi; II Chron. xxii, 10–12, xxiii, xxiv, 7). The story of Athaliah forms the subject of one of Racine's best tragedies. *See* AHAZIAH; JOASH.

ATHAMAS, in Greek mythology, king of the prehistoric Minyae in the ancient Boeotian city of Orchomenus. His first wife was Nephele (*see* ARGONAUTS). Athamas and his second wife, Ino, incurred the wrath of Hera, because Ino had nursed Dionysus. Athamas went mad and slew one of his sons, Learchus; Ino, to escape, threw herself into the sea with her other son, Melicertes. Both were afterward worshiped as marine divinities —Ino as Leucothea, Melicertes as Palaemon. Athamas, with the guilt of his son's murder upon him, was obliged to flee from Boeotia. He was ordered by the oracle to settle in a place where he should receive hospitality from wild beasts. This he found at Phthiotis in Thessaly, where he surprised some wolves eating sheep; on his approach they fled, leaving him the bones. The legend is perhaps founded on a very old custom of human sacrifice among the Minyae.

ATHANARIC (d. 381), a Visigothic chieftain from 364 to 376, who fiercely persecuted the Christians in his territories (approximately the modern Rumania) between 369 and 372. His most famous victim was St. Sabas the Goth. Utterly defeated by the Huns in 376, he fled with a few followers to Transylvania. The bulk of his people, however, took refuge under their leader, Fritigern, in the Roman empire. Athanaric, too, took refuge there in 381, but died at Constantinople a fortnight after his arrival. (E. A. T.)

ATHANASIUS, SAINT, THE GREAT (*c.* 295–373), bishop of Alexandria and doctor of the church, was an Egyptian, probably an Alexandrian, by birth. Associated with the Alexandrian chancery at an early age, he was ordained a deacon by the year 318, with priesthood following shortly after. Despite his early brilliance, it is difficult to believe that he composed his *Sermon Against the Arians* and *The Incarnation of the Word* at this period, as has been claimed. It was during the episcopacy of Alexander of Alexandria

(312–328) that the Arian heresy reached its height. Arius (*q.v.*), an elderly, ascetic priest of Alexandria, had been dealt with by Alexander in a kindly way, but his heretical teaching spread despite his condemnation at a local synod about the year 318. Arius' position was an attempt to explain the doctrine of the Trinity in a Gnostic (*see* GNOSTICISM) or Neoplatonic way, in order to preserve the uniqueness of God the Father and to avoid, as he thought, the heresy of Sabellianism (that is, that the three Persons were only names or modes of the divine nature; *see* SABELLIANISM). Though the doctrine was born at Antioch, where Arius had studied, Alexandria was indeed its proper soil. According to Arius, the Father, Son and Holy Spirit were three separate essences (*ousiai*) or substances (*hypostaseis*); the Father was God in a unique sense, whereas the divinity of the Son and Spirit was only derivative, for they had been created in time. Many of the monks and consecrated women throughout Egypt, as well as the excitable populace of Alexandria, were attracted by Arius' teaching. As the controversy spread beyond Egypt, the emperor Constantine sensed the danger of the religious conflict; his defeat of Licinius in 323 presented a favourable opportunity, and under the pressure of the episcopacy he convoked the first general council of the church at Nicaea in 325. The emperor was hardly a theologian, and his interest was primarily civic peace; his role, therefore, should not be exaggerated, for, if in the matter of the creed he exerted influence upon the hierarchy, it must be admitted that he was also influenced by them. (*See* ARIANISM.)

Athanasius accompanied Alexander to the council as the bishop's private secretary. Despite the remarks of the 5th-century church historian Socrates in his *Ecclesiastical History*, Athanasius' role at this time would appear to have been relatively unimportant; nonetheless, his support of Alexander and the orthodox position won him many future enemies in the Arian and semi-Arian camp. The records of the great council have not been preserved, but some idea of it may be formed from the eulogy on *The Life of Constantine* by Eusebius of Caesarea, from Socrates, Theodoret and fragments of Philostorgius. The account compiled by Gelasius of Cyzicus in the latter part of the 5th century contains much that is untrustworthy. Eusebius, who was present at the council, tells that more than 250 bishops attended; of these, the majority, together with the emperor, sided with the views of Alexander of Alexandria. Arius and his party were condemned and the famous creed of Nicaea, or Nicene creed—which may have been an older Palestinian formula, revised by Bishop Hosius and other Fathers at the council—was finally drawn up (*see* CREED, where it is quoted). The last lines read: "As for those who assert that there was a time when He was not; and that before He was begotten He was not; and that He was made out of nothing; or that He is of a different substance (*hypostasis*) or essence (*ousia*); or that the Son of God is created, changeable, mutable—these men the universal Church declares anathema." (*See* also COUNCIL.)

Although it is an exaggeration to suggest, with Gustave Bardy, that Athanasius found the formula of his life at Nicaea, this was nonetheless the doctrine that was to be at the heart of religious controversy for the next two centuries. Here, too, it is unfair to suggest that in all of this the state was the decisive force; actually the emperors were themselves manipulated by the quarreling factions. As yet, however, the implications of the Nicene doctrine remained undefined: the distinction between homoousios and homoiousios had not yet been established; and the final formula, "Three persons (*prosopa, hypostaseis* in Greek; *personae, hypostases* in Latin), one essence (*ousia, substantia* or *essentia*)," had not yet been theologically canonized.

Philostorgius, an Arian historian, says in his *History of the Church* that "seeing that Arius and his followers refused their assent to the Council, the emperor declared that all who did not accept the common formula were to be exiled." Arius fled to Palestine, but he was far from being subdued. Abetted by sympathetic followers, he circulated his *Thalia* ("Banquet"), a miscellany of songs and other pieces by which he aimed to communicate his heretical message to the masses.

At Bishop Alexander's death in 328, Athanasius, about 30 years of age, succeeded to his uneasy throne over the opposition of Arians and Meletians (*see* MELETIUS). Arius' friend, the wily Eusebius of Nicomedia (*q.v.*), continued to conduct a campaign against the young bishop, especially at the court of Constantine at Constantinople. When Arius in a personal interview had reassured the emperor of his acceptance of the Nicene formula, Athanasius received an imperial order to reconcile all Arians who might wish to make their peace. Still suspicious, Athanasius refused. At the local synod of Tyre, however, in 335, Arius was formally reinstated—he died mysteriously in 336 before he could be reconciled—and Athanasius was banished to Treves in Germany, where he remained until after Constantine's death in 337. This was his first exile. Even after his return his enemies did not remain idle, and he was again banished by a synod held at Antioch in 337; a certain Gregory, "a monster from Cappadocia," as Gregory of Nazianzus calls him, was made bishop of Alexandria in his stead. Athanasius, however, evaded arrest, and with the help of sailors slipped unwatched out of the port and sailed off to Rome to present his case before Pope Julius I. The Roman pontiff submitted the problem to an assemblage of bishops who upheld Athanasius; a council called at Sardica in 343 also declared in his favour; but Athanasius returned to Alexandria only after the violent death of the usurper Gregory in 345.

The ten-year period (346–355) which followed his second exile was one of comparative peace. Athanasius took the occasion to build up Alexandria and the dependent dioceses, appointing many loyal Egyptian monks to episcopal sees. But another blow soon fell. In 355 the emperor Constantius convoked a synod at Milan, and the council, controlled by Athanasius' enemies, once more deposed him. Athanasius tells in his *Apology for My Flight* that more than 5,000 Roman soldiers surrounded the Church of St. Theonas while he was celebrating the sacred liturgy. In the riot which followed, women were attacked and sacred vessels desecrated; but Athanasius managed to escape. This time he took refuge with the fathers of the Egyptian desert, whose way of life he profoundly admired. It was in their honour that he composed the *History of the Arian Heresy*, a curious, forthright book which reflects Athanasius' vehemence as well as his ironic humour. Indeed, to the period of his third exile belong perhaps his greatest works. After Constantius' death in 361, Athanasius returned to his see and straightway convoked a council at Alexandria to reaffirm the doctrines of Nicaea and to conciliate the semi-Arians. The semi-Arians were divided into three main factions, the Anomoeans, the Homoeans and the Homoiousians. The first group, under the leadership of Aetius and Eunomius, were the doctrinal successors of Arius, and taught that the Son was unlike (*anomoios*) the Father; it was against this group that Basil the Great and Gregory of Nyssa (*qq.v.*) wrote important treatises. The second group, under Acacius of Caesarea, remained in favour at the court of Constantius. Acacius seems to have continued the work of Eusebius, his predecessor, and attacked the orthodox group as teaching Sabellianism. The central point of their doctrine was that the Son was distinct but like (*homoios*) the Father. The third group, or Homoiousians, were closest in their teaching to Athanasius and his party. Under Basil of Ancyra, they stanchly opposed the extreme semi-Arians under Eunomius, and attempted to bridge the gulf which separated the heretics from the orthodox. Their differences were primarily of a linguistic sort, and their suggestions were treated by Athanasius with great sympathy, especially in his work *On the Synods* and in the council of 362. The view of the Homoiousians was that the term *homoousios*, "of the same, identical substance," which had perhaps arisen as a translation of the Latin term *consubstantialis*, did not sufficiently stress the distinction between the Persons and thus favoured Modalism or Sabellianism. They therefore wished to substitute the word *homoiousios*, meaning "distinct, but of a similar nature." Unfortunately Basil of Ancyra and his followers tended at the end to deny the divinity of the Holy Spirit, and Athanasius' overtures were in vain. In any case, within a few years the terminological differences were to be reconciled: the Son was *of like nature* because, though distinct, He was *of one substance* with the Father. The Nicene term had absorbed the other. The way was now prepared for the doctrinal advances of the Cappadocians, Basil the

Great, Gregory of Nyssa and Gregory of Nazianzus.

Only by understanding Athanasius' readiness for reasonable compromise can a correct insight into his character and personality be achieved. But the storm was still not allayed. The toleration with which Julian began his reign in 361 was soon transformed into almost hysterical measures in an effort to regenerate the pagan religion. Athanasius was caught up with many other victims of Julian's revivalist whims: in the autumn of 362, the emperor forced him into exile once more—"this notoriously troublesome man," as Julian wrote of him, "and hardly a man." But he was soon to return after the emperor was mortally wounded in June 363. Athanasius enjoyed comparative calm under Jovian (363–364) and Valentinian (364–375); but under Valens, as Theodoret relates, the incense burned once again on pagan altars. In Oct. 365 Athanasius was removed from his see, to remain in exile about four months. Recalled by Valens in Feb. 366, the elderly bishop was at last allowed to live out his life in peace. The end came on May 2, 373 (his feast day is May 2). It had been an incredible chapter in the history of the church.

Great as he was, Athanasius is one of the most tragic figures of early Christianity. A small, energetic man, he was at heart a monk, unworldly and sometimes uncompromising. To the emperors, who were little interested in theological speculation, he represented a storm centre of civil and religious strife. As for his ecclesiastical enemies, it is perhaps not too difficult to understand the religious bickering of an earlier day. In any case, this man, whom Gibbon thought more capable of ruling Rome than all the sons of Constantine, aroused fiercer loyalties and hatreds than any other Father of the church. A contemporary letter preserved in a British museum papyrus (*P. Jews* 1914, ed. by H. I. Bell, 1924) paints him as cruel and despotic; but coming as it does from the hand of a Meletian cleric, it cannot be accepted as totally reliable. In his theological doctrine Athanasius was clear and uncomplicated, more conservative than profound, and gifted with a stubborn sense of tradition. His teaching on the Atonement was intimately bound up with his Trinitarian theology: we are redeemed by Christ's life and death because in Him God and man are united in one Person. The Atonement is achieved by the union of God with man in the life, death and glorification of Christ. Indeed, "if Christ had not of Himself been the substantial image of the Father, He could not have formed the divine image in any man." The actions of Christ belong to both God and man; there are two natures, but one Person. In fighting against the Pneumatomachi, who denied the consubstantiality of the Holy Spirit, he insisted the Spirit was also truly God, "proceeding from the Father through the Son." His extant writings do not deal extensively with sacramental theology; but in an *Epistle to Serapion* he asserts that after the prayers of the liturgy "the bread and wine, which had before been ordinary food and drink, become the Body and Blood of the Lord." Athanasius' theology was fundamentally Pauline and Johannine.

His encouragement of the Egyptian monastic movement had widespread consequences. Whether or not the *Life of Antony* is from his own hand, he was largely responsible for its circulation; through the Latin version made about 361 by Evagrius of Antioch and used, for example, by Augustine, it introduced eastern ascetic ideals to the Latin world. The *Life* is a subtle fusion of historical details and symbolic presentation of the spirit of early monasticism. The core of the work may be found in sec. 16–43, in which a series of discourses are put into the mouth of Antony on the monk's struggle as a "martyr in conscience" against the evil forces of this world, and on the witness he must bear to the truth of Jesus' message until the final coming. Although Athanasius insisted on sobriety and celibacy, he emphasized the importance of moderation and the internal spirit in the tradition of Methodius' *Symposium on Chastity*—a work on which, incidentally, the pseudo-Athanasian *Life of Syncletica* in part depends. Athanasius' authentic doctrine is focused on the restoration of the divine image in man: this is ideally achieved by the practice of evangelical perfection; and the union with the Word, he teaches, will bring about a special illumination of the mind as well as the conquest of man's lower impulses. Thus his ascetic teaching is a logical complement to his doctrine on the Trinity and the Atonement. The divine image impressed on man at creation had been destroyed—or at least tarnished—by man's estrangement from God. Thus an authentic model must once more be presented to the human race; and this was achieved by the Incarnation and Atonement. The Word, as true God is both the exemplar and the cause of our redemption. It is this restoration of the divine image, entailing mystical knowledge, love and purification, which is the ultimate goal of all Christian asceticism. Though Athanasius' doctrine is here dependent upon Alexandrian Platonism, its main outlines are coherent and clear.

Athanasius' authentic works may be divided into four groups.

1. The dogmatic, controversial works, such as the *History of the Arians*, the *Discourses Against the Arians*, the *Treatise on the Synods of Rimini and Seleucia*, and various apologies written in the heat of controversy.

2. The letters, which are today perhaps the most interesting section of his works. These include the *Festal* (*Paschal*) *Letters*, written over the years 329–348 to exhort his flock on the occasion of the Lenten fast and the approach of Easter; four *Letters to Serapion* dealing especially with the divinity of the Holy Spirit, doctrinal letters *On the Teaching of Dionysius*, *On the Decrees of Nicaea* and several others dealing with the Incarnation. There are many more, including a number of official episcopal documents; to these should be added the *Letter to Paphnutius* preserved in a British museum papyrus which may be from Athanasius' own hand (*P. Jews* 1929, ed. by Bell).

3. The ascetic corpus includes the *Life of Antony;* a number of treatises *On Virginity* preserved in whole or in part, whose authenticity is still disputed; and the pseudo-Athanasian *Life of Syncletica*. The Greek treatise *On Virginity* (ed. by Von der Goltz, 1905), surely reflects Athanasian teaching, but its use of the term *hypostasis* in the sense of divine Person makes the attribution somewhat doubtful. There are fragments of other treatises on the subject in Coptic, Syriac and Armenian translations. Further, a Coptic ascetic epistle *On Love and Self-Control* may be authentic.

4. Of what must have been a considerable exegetical corpus there remains a short treatise *On the Interpretation of the Psalms* and some fragments of an allegorical exegesis of the psalms preserved in catenae.

Among the inauthentic works must be mentioned a sermon *On the Devil* along with other short pieces. The *Interpretation of the Creed* and *On the Unity of Christ* are recognized as inauthentic; and the 12 books of *De Trinitate* preserved in Latin, though derived in part from Athanasius, probably comprise five distinct works which originated in Italy or northern Africa toward the end of Athanasius' life and after his death. Finally, the so-called *Athanasian Creed*, the *Quicumque*, consisting of 40 rhythmic Latin *cola*, though attributed to Athanasius since the 7th century, undoubtedly comes from a later period. It is, again, a Latin work, and originated perhaps in the area of northern Italy or southern France; some have plausibly linked it with the school of Lerins, others with the Ambrosian chancery at Milan. In any case it represents orthodox Trinitarian doctrine of the post-Nicene period.

In connection with the Greek text of Athanasius, the critical work of H. G. Opitz, R. P. Casey and others has drawn attention to the various recensions which existed even in his authentic works, the result of competitive editorial activity by Athanasius' followers on the one side and by his enemies on the other.

See also references under "Athanasius, Saint" in the Index.

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ATHAPASKAN (Athabaskan), a large and widespread family of North American Indian languages which included, during the aboriginal period, 50 or more distinct idioms. More than half of these, the Northern Athapaskan languages, were spoken in the whole interior of Canada and Alaska northwest of the Churchill river. A second major division, Pacific Coast Athapaskan, included 16 languages spoken in southwestern Oregon and adjacent northern California, from the Umpqua river in Oregon to the head of the Eel in California. The third division, Southern Athapaskan or Apachean, contained only seven languages. These were spoken by the Navaho and six Apache tribes in Arizona, New Mexico, Texas and the Mexican states of Chihuahua and Coahuila.

This geographical classification is not entirely consistent with a strictly linguistic classification—only Pacific Coast Athapaskan and Apachean are both geographic and linguistic units. In the north there are at least seven linguistic subfamilies. Four of these—Tanaina, Koyukon, Ahtena and Ingalik—lie wholly within Alaska. The fifth, Kutchin-Han, occupies the territory on both sides of the northern half of the Alaskan-Canadian boundary. The sixth subfamily includes Tanana and Nabesna, spoken in Alaska south of the Kutchin-Han; Carrier, spoken in central British Columbia; and Hare-Dogrib, Slave and Chipewyan, which occupy a continuous area in northern Canada from the Mackenzie river to Hudson bay. Those of the seventh subfamily—the Beaver, Sarsi, Kaska and Sekani—live south of the Hare, Slave and Chipewyan and north of the Carrier. Finally there are a number of northern languages which cannot be classified for lack of sufficient data: Tutchone, Mountain, Tagish, Tahltan and Tsetsaut.

The Pacific coast subfamily includes Umpqua, Coquille, Galice, Applegate, Chasta Costa, Euchre Creek, Tututni and Chetco in Oregon, and Tolowa, Hupa, Mattole, Kato, Wailaki, Nongatl, Lassik and Sinkyone in California. There are seven Apache (*q.v.*) languages: Navaho, San Carlos, Chiricahua, Mescalero, Jicarilla, Lipan and Kiowa Apache.

The northern languages are more diverse than the Pacific coast group or the Apache. This means that the original Athapaskan homeland lay in the north and that both the Pacific coast peoples and the Apaches migrated southward from the Canadian-Alaskan region. Chronological studies indicate that the breakup of the original Athapaskan speech community began about 200 B.C. and that the movement southward began about four hundred years later. These short time periods help to account for the great similarity between the northern languages and those in the south. The difference between Kutchin and Navaho, for example, is little greater than that between English and German.

The Athapaskan languages differ markedly from most of the Indian languages spoken near them. There are, however, a number of features of similarity between Athapaskan, Tlingit, on the northern coast of British Columbia, and Haida, on Queen Charlotte Island. Edward Sapir in 1915 examined these similarities and concluded that all three groups were members of a single larger family called Nadene. Although detailed proof of his hypothesis has not been published, it is accepted by most of the scholars who have reviewed Sapir's data.

Athapaskan speech communities have always been small. The total population in the northern area, with its 25 or more tribes, never exceeded 30,000. European colonization reduced the Indian populations of the Americas and altered the language habits of the groups that survived. Thus, by mid-20th century, most of the Pacific Coast languages were either extinct or spoken only by a few older people. Only Hupa (*q.v.*) was still active and it had fewer than 200 speakers. Similar changes occurred in the north and among the Apaches but not to the same degree. Navaho (*q.v.*) had at that time the largest number of speakers (about 80,000) of any Athapaskan tongue but most of these spoke English as well. It is probable that most and perhaps all the Athapaskan languages will become extinct.

See also references under "Athapaskan" in the Index.

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ATHEISM, the denial of "God" or of "the gods." As such, it is the opposite of theism (*q.v.*), which affirms the reality of the divine and seeks to demonstrate its existence. Atheism is to be distinguished from agnosticism (*q.v.*), which leaves open the question whether there is a god or not, professing to find the question unanswered or even unanswerable. For the atheist, the question has been answered, and in the negative: "There is no god."

To include all that is designated as atheism, it is necessary to distinguish between theoretical atheism and practical atheism. Theoretical atheism is the denial, in principle, that there is a god. Most often, the term is used polemically to label the position of an opponent who denies one's conception of the divine. Thus the Jews and the early Christians were accused of atheism by the Romans, despite the obvious theism of Jewish and Christian beliefs, because they refused to acknowledge the Roman gods, including the emperor, as truly divine. Orthodox Christians, on the other hand, employed the term atheist in their polemics against various heretics, notably against those who, while affirming the existence of God, denied the doctrine of the Trinity (*q.v.*). Thinkers like Spinoza (*q.v.*) earned the label because they seemed not to distinguish accurately enough between God and the world and thus appeared to deny the transcendence of the divine. From these examples it is evident that theoretical atheism in the absolute sense is not so common as the frequent use of the term might suggest. At the same time, it is not accurate to maintain, as some have, that there are no atheists. A thoroughgoing materialism or mechanism (*q.v.*) has led some to the flat declaration that there is no Being that deserves the title or the attributes of deity. If it is maintained that the universe is fully self-explanatory, this seems to be an atheistic philosophy. Similarly, a thoroughgoing humanism (*q.v.*) appears to require the adjective atheistic, for it asserts that man neither has nor needs the help of any Holy to which to turn in penitence, prayer or adoration. Nevertheless, the effort of certain modern philosophers to posit a "finite God" and the pantheism (*q.v.*) or panentheism of others tend to limit the applicability of the label "theoretical atheism" in modern thought.

Practical atheism, on the contrary, is not limited to the intelligentsia, but represents the working philosophy of large numbers of men. Practical atheism is the denial, in practice, that there is a god. For such a philosophy, the question of the existence of God is irrelevant to the meaning of life and the decisions of human existence. The discovery of scientific explanations for phenomena formerly attributed to supernatural causes has helped to bring about the "disenchanted world" of many modern men. Similarly, the elimination of the influence of organized religion from spheres of activity such as medicine, education and the arts has prompted men to construct for themselves a world view in which ideas of God and of a life after death play no significant

role. The term secularism was coined in the middle of the 19th century to identify such a philosophy of life. When pressed in a debate, its adherents may assert their belief in God, that is, their acceptance of the idea that there is a god. Apart from such debate, of course, they have no need for this hypothesis. Most theologians would claim that this is in fact atheism. For if the term god has any meaning, they would argue, that meaning must include the obligation of man to enter into significant relations with the divine, whatever form those relations may assume. As many observers have noted, however, "practical atheists" may still be deeply religious in their outlook on the universe, regarding with reverent awe both the processes of nature and the functioning of society. Even without the idea of divine sanction and law, they hold to their moral ideals with deep conviction and strive earnestly to live up to them. Thus they are ethical without being religious, or perhaps religious without having an explicit faith in God.

The presence of such an atheism, whether in its primitive or its modern forms, has compelled the revision of the very definition of religion to include nontheistic faiths such as Marxism, which elicit a religious loyalty from their faithful even as they deny the reality of divine Being. Meanwhile, both theists and agnostics (and perhaps even atheists) would agree that whatever God there is does not depend for his reality or sovereignty upon the efforts of theologians and philosophers to attack or defend his existence.

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ATHEL, the name given to the tree *Tamarix aphylla* (*T. articulata*) of the Tamaricaceae. Originally a native of northeastern Africa and western Asia, it has become naturalized in several other parts of the world, including arid regions of southwestern United States, where it is well established. The tree, which resembles certain conifers, occasionally attains a height of 60 ft. and is readily distinguished by its jointed twigs with minute, ensheathing leaves and small sessile flowers borne in terminal panicles.

The bark is rich in tannin. Reproduction is accomplished equally well by seeds, cuttings or coppice. (E. S. HR.)

ATHELNEY, a slight eminence of small extent, formerly an island and now rising from the drained marshes about the junction of the rivers Tone and Parrett in Somerset, Eng. Early in 878 King Alfred, hard pressed by the Danish advance, took refuge amid the marshes of Somerset, constructing a stronghold at Athelney. Using this as a base he broke out to win a decisive victory at Edington, near Chippenham. The Danish king, Guthrum, sought terms and was received and baptized at Aller on the mainland opposite Athelney. Alfred founded a monastery on the island as a thank offering for his victory. The Alfred jewel, now in the Ashmolean museum, Oxford, was found at Athelney in 1693. It is an elaborate gold ornament with an enameled plaque covered with crystal and an inscription recording that it was made for the king (*see* JEWELRY). The story of Alfred minding the cakes for the mistress of the hut in which he was sheltered is credibly recorded as an illustration of the straits to which he was reduced; details, including his negligence in allowing them to burn, were later literary embellishments.

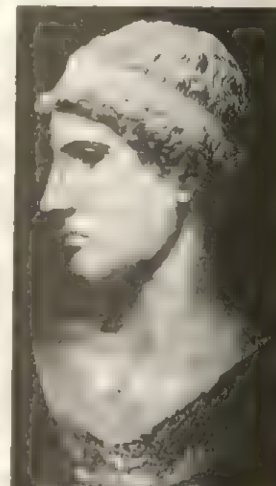
(C. A. R. R.)

ATHELSTAN: *see* AETHELSTAN.

ATHENA (ATHENE), the Greek city-protectress, goddess of war, handicraft and practical reason, identified by the Romans with Minerva (*q.v.*). The portrait of Athena found in poetry and art from Homer onward is accurate for her cult generally, largely because her activities were especially appreciated by the society of poets and artists. She was essentially urban and civilized, the antithesis in many respects of Artemis (*q.v.*), goddess of the outdoors.

When, during the 2nd millennium B.C., the Greeks settled the peninsula to which they later gave their name, they probably found Athena's worship already established, in Crete if not on the mainland. Her certainly non-Hellenic name apparently belongs to the language of the Greeks' predecessors. The pre-Greek Minoan Cretans, as M. P. Nilsson showed, worshiped a snake-goddess who protected the home and who, like other Minoan deities, was thought to appear among men in the shape of a bird; snake and bird attributes as well as bird epiphany are especially characteristic of Athena as she appears in Homer and afterward. The Minoans worshiped their goddess in recessed sanctuaries in homes and palaces, her priest being the master of the house or, in palaces, the king. The Greeks of the Mycenaean age at the end of the millennium included such sanctuaries in their palaces. Yet their economy, unlike that of the Minoans, was largely military, so that Athena, while retaining her domestic functions, became in answer to her worshipers' demands a goddess of war. The name Athena Potnia, "Lady Athena," has been read on one of the Mycenaean tablets, though unfortunately difficulties remain in the way of its complete acceptance. But archaeology confirms the continuity of her worship, for Athena's temples on the acropolises of Athens and Mycenae stand directly on the ruins of the Mycenaean palaces. The locale remained holy while later societies succeeded the Mycenaean, and doubtless owed its sanctity to the presence of the same goddess throughout the centuries.

Athena was very early associated with the acropolises of a number of other cities as well. This has led some to style her a "mountain mother" similar to the Asiatic Magna Mater and a Cretan goddess who is sometimes called the Mother of the Mountains (*see* ARTEMIS). But Athena's choice of the acropolis as a dwelling place more likely stems from the location there of the king's palace, while the theory that Athena was originally a mother-goddess depends upon a most unscientific generalization from a handful of exceptional references. She has no consort and, worse yet, no offspring, unless wild interpretations of one or two relatively late myths are accepted. She need not have been a virgin from the beginning, but the characteristic was very early acquired, and thus were her epithets Pallas and Parthenos ("Maiden," which exhibits the same ambiguity as the Greek words) generally interpreted.


ALINARI
HEAD OF ATHENA, PROBABLY A COPY OF THE LEMNIAN, IN THE MUSEO CIVICO, BOLOGNA, ITALY

The fifth Homeric hymn expressly states that Aphrodite cannot affect Athena, but the idea is older: for a war-goddess to accept domination, or a palace-goddess violation, seems intolerable. The old theory that she was a water-goddess and perhaps of Libyan origin rested largely on a doubtful interpretation of her epithet Tritogeneia ("Water-Born") and can be discarded with the same confidence with which the epithet can be declared unexplained. Ulrich von Wilamowitz' view that Athena was originally a shield-goddess has not found general acceptance, though his account of her later development is a masterful exposition.

In the *Iliad* Athena as war-goddess inspires and fights alongside the Greek heroes, notably Diomedes in his defeat of Ares in book v. To possess her aid is synonymous with military prowess and is not, as readers occasionally feel, considered an unfair advantage.

In the *Iliad* Zeus specifically assigns to Ares and Athena the sphere of war. Ares, the Trojan war-god, is generally pictured as delighting in blood lust and death. It is unsafe, however, to hold that in contrast Athena represents the noble and rational side of war; her moral and military superiority to Ares derives in part from the vastly greater variety and importance of her functions, in part from the patriotism of Homer's predecessors, Ares being of foreign origin. Athena proclaims her nationalism in book xxi of the *Iliad*, where she wishes that all who help the Trojans might be

vanquished as she has just vanquished Ares and Aphrodite: "So we should long ago have ceased from battle, having destroyed the strong-founded city of Ilium."

The qualities that lead to victory are found on the aegis (*q.v.*) Athena carries when she goes to war: fear, strife, defense and assault, but not reason or prudence. On it too is the Gorgon's head, terrifying indeed but scarcely remarkable for its acumen (*Iliad*, v).

As palace-goddess Athena was bound to preserve the sanctity of Menelaus' household, and the pre-Homeric tradition probably attributed her violent and apparently unreasonable hatred of everything Trojan to her anger at Paris's rape of Helen. The obscurity of the *Iliad* on this point may be due to a dimming awareness at that time of Athena's role as palace-goddess; later poetry supplied her motivation through the story of the judgment of Paris (*q.v.*).

The Minoan house-goddess would have been interested in the household arts, and such female skills are Athena's domain. She moves symbolically from domestic to bellicose role when, in book v of the *Iliad*, before donning the aegis, she removes a robe woven by her own hands. To say that a woman "rivalled Athena in handicrafts" (cf. *Iliad* ix, 390) was high praise.

Behind the moral problem of the *Odyssey*, the hero's restitution of his home, Athena the palace-guardian is faintly visible, but as tutelary deity of the king she presses Odysseus to assert his rights and rid his palace of Penelope's suitors; she likewise undertakes his son Telemachus' moral education. Somewhat surprisingly she bestows beauty—*charis*—upon her protégés, but since mankind generally fails to benefit from these attentions they must be ascribed to the manifold relation between herself and the royal family. Myths from later sources portray her similarly as helper of Perseus and Heracles, perhaps originally Mycenaean priest-kings, suggesting that her efforts were extended to all who held the office. Yet the kingship as such did not claim her protection; this charge fell upon the more remote Zeus. Athena, the "ever-near," in W. Otto's phrase, guarded rather the king's person, and in so doing became goddess of good counsel as well as war. The goddess of good counsel is found in the *Iliad* also; she prevents Achilles from carrying out his threat to Agamemnon and warns Odysseus against assaulting Sarpedon and his retinue.

In post-Mycenaean times the city, especially its citadel, replaced the palace as Athena's domain; the city-goddess has begun to emerge in book vi of the *Iliad*. Later epic poetry symbolized this role with the palladium (*q.v.*), an armed statue of Athena that Odysseus and Diomedes had to steal from Troy before the city could fall, and that several Greek cities later claimed to possess.

Athena was widely worshiped, but in modern times she is associated primarily with Athens, to which she gave her name. Her emergence there as city-goddess, Athena Polias, accompanied the transition from monarchy to democracy. She retained her association with birds, particularly the owl, which became famous as the city's own symbol. The snake continued to live in the Erechtheum, a temple of Athena Polias named after an early hero, Erechtheus. The *Odyssey* tells how Athena visited Erechtheus' house, and the scene is interpreted as the goddess's epiphanic descent to the Athenian priest-king, whose house may be the palace upon which the Old Temple on the Acropolis (perhaps an earlier Erechtheum) was built. More famous is the Parthenon, with its statue of Athena Parthenos and its pediments depicting Athena's birth and her contest with Poseidon for the suzerainty of the city. With each pediment frieze is connected a myth, neither satisfactorily explained. Hesiod, in the *Theogony*, tells how Athena sprang from Zeus's forehead, and Pindar adds that Hephaestus struck open his head with an ax. Pindar's version has been referred to the ritual of the Buphonia (*q.v.*), wherein an ox was sacrificed by splitting its skull. Others, reflecting that the Greek word *koruphe* means both "forehead" and "summit," have interpreted the myth as presupposing Athena's birth from mountain or acropolis. But birth from male limbs without female assistance is a common folk motif, perhaps adopted because Athena had no known or, in the light of her stature and independence, suitable mother. The contest between Athena and Poseidon on the west pediment featured her offer to the Athenians of the olive, his of the horse or a spring of water. As chief goddess Athena naturally supervised the economically vital olive culture, but the contest itself remains baffling. Theories hypothesizing a conflict between an invading Greek god, Poseidon, and the native goddess founder on the difficulty that the victors' god was defeated; Poseidon occupied a quite secondary role at Athens.

Erechtheus' alter ego, Erichthonius, was said to have instituted Athena's worship at Athens as well as her birthday festival, the Panathenaea (*q.v.*). The story that Athena entrusted the daughters of Cecrops with a chest containing the infant Erichthonius, and that for opening it in defiance of her command they were driven mad, is an etiological myth for another rite, the Arrephoria. Two maidens carried secret objects from Athena's temple on the Acropolis to the sanctuary of Aphrodite and returned similarly burdened; they may have borne snake symbols and, for Aphrodite's benefit, phalluses. The rite concerned the growth of vegetation, the sphere of Erichthonius and of the daughters of Cecrops, who were dew spirits. The similarly purposed Procharisteria celebrated the goddess's rising from the ground with the coming of spring. But Athena's connection with vegetation was an accidental by-product of her general civic duties.

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PROMACHOS ("CHAMPION") ATHENA IN THE NATIONAL MUSEUM, ATHENS

Mythology made Erichthonius the issue of an abortive attempt by Hephaestus upon Athena's virginity, the seed impregnating the ground instead. Scholars as little impressed with her virtue as Hephaestus have seen behind this story another in which his desire was not frustrated, in which he was her consort. But Erichthonius, as a vegetative spirit, was probably always thought to be born of the earth or an earth-goddess such as Athena never was. Her relationship with Hephaestus derives from the similar functions of the smith-god and the goddess of industry, Athena Ergane ("Working," a very common epithet).

Two Athenians, Phidias and Aeschylus, contributed significantly to Athena's spiritual development. She inspired three of Phidias' masterpieces: the archaistic Promachos ("Champion"), in which her military character doubtless predominated; the Lemnian, where the maiden superseded the warrior; and the chryselephantine Parthenos, where the warrior, tempered by pensive majesty, was felt to represent perfectly the city-goddess. In Aeschylus' *Eumenides* she founds the Areopagus (*q.v.*), and by breaking a deadlock of the judges in favour of Orestes, the defendant, she sets the precedent that in Athenian jurisprudence a tied vote signified acquittal. As goddess of wisdom she pleads for justice tempered with reason and mercy, as against the blind vengeance demanded by the Furies. Though she and Zeus strive for the same end, she alone appears on the stage; symbolizing the city's striving toward this higher concept of justice, she still does not leave the realm of men. *See* NIKE; *see* also Index references under "Athena" in the Index volume.

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ATHENAEUM, a name originally applied in ancient Greece to buildings dedicated to Athena, and specially used as the designation of a temple in Athens, where poets and men of learning were accustomed to meet and read their productions. The academy for the promotion of learning that the emperor Hadrian

built (about A.D. 135) at Rome, near the Forum, also was called the Athenaeum. Poets and orators still met and discussed there, but regular courses of instruction were given by a staff of professors in rhetoric, jurisprudence, grammar and philosophy. The institution, later called Schola Romana, continued in high repute until the 5th century. Similar academies were founded in the provinces and at Constantinople by the emperor Theodosius II. In modern times the name has been applied to various academies, as those of Lyons and Marseilles and the Dutch high schools; and it has become a very general designation for literary and scientific clubs, the most famous club of the name being that founded in London by Sir Walter Scott and Thomas Moore in 1824. In the United States the well-known Boston Athenaeum, founded in 1807, is the home of George Washington's library. The word is also familiar as the title of several literary periodicals, notably of the London weekly founded in 1828.

ATHENAEUS (fl. *c.* A.D. 200), Greek rhetorician and grammarian, whose *Deipnosophistai* is a storehouse of varied information, much of it drawn from works no longer extant, was born at Naucratis in Egypt. He himself states that he wrote a treatise on the *thratta*—a kind of fish—and a history of the Syrian kings, both now lost. The *Deipnosophistai* ("Authorities on banquets," not, as sometimes incorrectly translated, "Philosophers at dinner"), in 15 books, belongs to the genre of symposium literature of which Plato's *Symposium* is the first example. The first two books, and parts of the 3rd, 11th and 15th, are extant only in epitome, but the rest has survived complete.

It professes to be an account of a banquet held at the house of Laurentius, a scholar and wealthy patron of art. Among the guests are historical persons such as Galen the doctor and Ulpian the jurist. The conversation ranges from the dishes before the guests and information about food to literary matters of every description, including points of grammar and criticism, with remarks on music, song, dances, games and courtesans. The plan is clumsy, but the work is an invaluable repertory of fragments from nearly 800 writers.

The *Deipnosophistai* was edited by G. Kaibel in three volumes in the "Teubner Series" (1887–90) and by C. B. Gulick with an English translation in the "Loeb Series" in seven volumes (1927–41). The epitome was edited by S. P. Peppink in three volumes (1936–39).

See F. A. Wright, *History of Later Greek Literature*, pp. 283–288 (1932). (G. B. Kd.)

ATHENAGORAS (2nd century A.D.), Greek Christian Platonist who wrote an apology for the Christian religion, was an Athenian and probably taught in Alexandria. His apology, styled "embassy" (*Presbeia*), was addressed to the Roman emperors Marcus Aurelius and L. Aurelius Commodus between 176 and 180. It deals with the stock charges of atheism, cannibalism and incest or promiscuity alleged against the Christians, giving incidentally a survey of famous statues of Greek gods and one of the first statements on Christian sexual morality. In the earliest manuscript (dated 914) this work is followed by a treatise on resurrection (*Peri anastaseos*), also ascribed to Athenagoras, whose authenticity some modern speculation has questioned. It shows the same tenderness for Plato and the same use of Platonic terms as the apology, and the Christian doctrine of bodily resurrection for all (here grounded on arguments from the motive of creation, the nature of man and the need for rewards and punishments for body and soul in another life) is precisely the one that a Platonist would find most novel and provocative. Athenagoras' writing is clear and forcible, and he is a pioneer in the fashioning of technical terms for the concepts of Christian theology. *See* also Apologists, Early Christian.

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ATHENODORUS, an ancient Greek personal name, the bearers of which include two sculptors, two philosophers and a physician.

The Sculptors.—The earlier of the two sculptors was Athenodorus of Cleitor, who executed the statues of Apollo and Zeus which the Spartans dedicated at Delphi after their victory at Aegospotami (405 B.C.) in the Peloponnesian War. The second was Athenodorus of Rhodes, who collaborated with his father Agesander, on the celebrated Laocoon group (*see* Greek Art).

The Philosophers.—Athenodorus Cordylion (1st century B.C.), a Stoic, born at Tarsus in Cilicia, became keeper of the library in Pergamum but finally settled in Rome, where he died, an old man, in the house of the younger M. Porcius Cato.

Athenodorus Cananites (also called Athenodorus son of Sandon; *c.* 74 B.C.–*c.* A.D. 7), also a Stoic, was born at Canana, near Tarsus. After studying under Poseidonius in Rhodes, he went to Apollonia in Illyria, where the young Octavian (afterward the emperor Augustus) was his pupil. Athenodorus acquired a lasting influence over Octavian and followed him to Rome in 44 B.C., but was later allowed to return to Tarsus to remodel the city's constitution. There he succeeded (*c.* 15–10 B.C.) in setting up a government of property owners in the Roman interest. Strabo, a friend of his, and Cicero, whom he helped in the composition of the *De Officiis*, provide the main sources of information about him, as none of his writings are extant. Strabo describes him as a learned scientist. Sir William Ramsay, in an article in the *Expositor* (Sept. 1906), suggested that the influence of Athenodorus may account for the resemblances discernible between St. Paul and the younger Seneca, as St. Paul can hardly not have known his doctrine.

The Physician.—Another Athenodorus (1st century A.D.) was the author of a work *On Epidemics*.

ATHENRY (Baile Átha an Ríogh), a market town of County Galway, Republic of Ireland, lies on the river Clarin, 15 mi. E. of Galway by road. Pop. (1956) 1,287. Its Gaelic name means "the town of the king's ford" and after the Anglo-Norman invasion it grew to importance as the first town of the De Burghs and De Berminghams. There are remains of walls erected in 1211 and of a castle of 1238. A Dominican monastery was founded by Myler de Bermingham in 1241 and repaired in 1893. Of the Franciscan monastery of 1464 little is left. The town returned two members to the Irish parliament from the time of Richard II to the Union; but it never recovered from the wars of the Tudor period during which it was successfully besieged by "Red" Hugh Roe O'Donnell in 1596.

ATHENS (Lat. Athenae; mod. Gr. Athinai; modern colloquial Greek Athena), the capital of the kingdom of Greece and of the nome (department) of Attica, lies toward the southern end of the central and principal plain of Attica (*q.v.*). It is the political, economic and cultural centre of Greece. There have been various theories with regard to the origin of the name, which is now held to be derived from the patron goddess Athena, whose name, like others with the same ending, is thought to be pre-Hellenic.

This article is divided into the following sections and subsections:

I. TOPOGRAPHY AND ANTIQUITIES

The Attic plain slopes gently toward the coast of the Saronic gulf on the southwest; on the east it is overlooked by Mt. Hymettus (*q.v.*; 3,369 ft.); on the northeast by Mt. Pentelikon (*q.v.*; 3,638 ft.) (Pentelicus); on the northwest by Mt. Parnes (Parnis) (4,636 ft.); and on the west by Mt. Aegaleos (Aigaleos) (1,534 ft.), which descends abruptly to the bay of Salamis. In the centre a ridge, now known as Turcovuni, runs from northeast to southwest and culminates in the sharply pointed Mt. Lycabettus (1,112 ft.), the most prominent feature in the Athenian landscape, which directly overhung the ancient city but was not included in its walls. This range separates the valleys of the Cephisus (Kifissos) and Ilissus (Elisson) rivers. The former, rising in Mt. Pentelicus, enters the sea at Phaleron (Faliron), but in summer dwindles to an insignificant stream. The latter, coming from Mt. Hymettus, skirts the city on the southwest and is now usually dry owing to denudation caused by the destruction of the forests. Separated from Mt. Lycabettus by a depression to the southwest, through which flows a brook (probably the Eridanus river), stands the remarkable oblong rocky mass of the Acropolis (512 ft.), rising precipitously on all sides except the western; it served as a fortress and also as the sacred sanctuary of its tutelary goddess, Athena (*see* below). Close to the Acropolis on the west is the lower rock (370 ft.) of the Areopagus (*q.v.*), the seat of the famous council. Farther west are three elevations: to the northwest the so-called "Hill of the Nymphs" (348 ft.), on which the modern observatory stands; to the west the Pnyx (351 ft.); and to the southwest the loftier hill known as the Mouseion or Museum hill (482 ft.). A cavity to the west of the observatory is supposed to be the ancient barathron or place of execution. The distance from the Acropolis to the nearest point of the seacoast at Phaleron is a little more than three miles.

1. Influence of the Geographical Position.—The situation of Athens naturally favoured the growth of a powerful community. The Attic plain, notwithstanding the lightness of the soil, furnished an adequate supply of cereals; olive and fig groves and vineyards were cultivated from the earliest times, and pasturage for sheep and goats was abundant. The surrounding mountains are broken toward the northeast by an opening between Mt. Hymettus and Mt. Pentelicus toward Marathon, and are traversed by the passes of Decelea, Phyle and Daphne on the north and northwest, but the distance between these and the city was sufficient to obviate the danger of surprise by an invading land force. On the other hand Athens was sufficiently far from the sea to enjoy security against the sudden descent of a hostile fleet. Yet the three natural harbours, the ancient Piraeus (Piraievs or Peiraicus), Zea (Kea) and Munychia, favoured maritime commerce and the sea power which formed the basis of Athenian hegemony. The climate is temperate but liable to sudden changes; the mean temperature is 63.1° F., the maximum (in July) 99.01°, the minimum (in January) 31.55°. The clear, bracing air, according to ancient writers, fostered the intellectual and aesthetic character of the people and endowed them with mental and physical energy. For the architectural adornment of the city the finest building material was procurable in abundance; Mt. Pentelicus forms a mass of white, blue-veined marble; another variety, somewhat similar but generally of a bluer hue, was obtained from Hymettus. For ordinary purposes gray limestone from Lycabettus and the adjoining hills, limestone (the so-called poros stone) from the promontory of Acte (Akti) and conglomerate were largely employed. For the ceramic art admirable material was at hand in the district northwest of the Acropolis. The water supply then, as now, being insufficient for a large and growing city, was supplemented by an aqueduct constructed in the time of the Pisistratids and by others of the Roman period. A great number of wells were also sunk and rain water was stored in cisterns.

2. Sources for Athenian Topography.—First in importance for the purpose of scientific topography is the evidence of the natural features of Attica and the architectural remains; to these may be added the testimony of inscriptions often of decisive importance. Next comes the evidence derived from ancient literature and especially from descriptions of the city or its different localities. The earliest known description of Athens was that of Diodorus of Athens (4th century B.C.). Among his successors were Polemon of Ilium (2nd century B.C.), who gives a minute account of the votive offerings on the Acropolis and the tombs on the Sacred way, and Heliodorus (probably of the 2nd century B.C.), who wrote 15 volumes on the monuments of Athens. Of these and other works of the earliest topographers only some fragments remain. About A.D. 150 Pausanias (*q.v.*) visited Athens at a time when the monuments of the great age were still in their perfection and the principal embellishments of the Roman period had already been completed. The first 30 chapters of his invaluable *Description of Greece* are devoted to Athens, its ports and environs. His account, based mainly on personal observation, possesses an especial value because of his method of describing each object in the order in which he saw it during his walks. The literature of succeeding centuries furnishes only isolated references. Pausanias' accuracy was remarkably vindicated in the 20th century by excavations at Athens and elsewhere.

The notices of Athens during the earlier middle ages are scanty in the extreme. In 1395 Niccolo da Martoni, a pilgrim to the Holy Land, visited Athens and wrote a description of a portion of the city. Of the work of Cyriacus of Ancona, written about 1450, only some fragments remain, which are well supplemented by the contemporaneous description of the capable observer known as "Anonymus of Milan." Two treatises in Greek by unknown writers belong to the same period. The Dutchman Johannes Meursius (1579–1639) wrote three disquisitions on Athenian topography. The conquest by Venice in 1687 led to the publication of several works in that city, including the descriptions of R. de la Rue and Francesco Fanelli and the maps of Vincenzo Maria Coronelli and others. Systematic study was begun in the 17th century by French residents at Athens, the consuls J. Giraud and F. Chataignier and the Capuchin monks. The visit of the French physician Jacques Spon and the Englishman Sir George Wheler (or Wheeler) (1650–1723), fortunately took place before the partial destruction of the Parthenon in 1687; Spon's *Voyage d'Italie, de Dalmatie, de Grèce et du Levant*, which contained the first scientific description of the ruins of Athens, appeared in 1678; Wheler's *Journey into Greece* in 1682. A period of British activity in research followed in the 18th century. The monumental work of James Stuart and Nicholas Revett, who spent three years at Athens (1751–54), is still indispensable, owing to the demolition of ancient buildings which began about the middle of the 18th century. To this period also belong the labours of Richard Pococke and Richard Dalton, Richard Chandler, E. D. Clarke and Edward Dodwell. The great work of W. M. Leake (*Topography of Athens and the Demi*, 2nd ed., 1841) brought the descriptive literature to an end and inaugurated the period of modern scientific research.

3. Scientific Research.—Since the mid-19th century, excavations by the Greek archaeological service and by foreign archaeological schools, not to mention accidental discoveries during building operations in the modern town, have transformed our knowledge of the ancient city. At first Athenian topography became a speciality of German scholars, chief among them Wilhelm Dörpfeld, but after World War I members of the American School of Classical Studies began to work on the Acropolis and in 1931 the school began its momentous excavation of the agora (*q.v.*); the painstaking campaign, financed by the Rockefeller foundation, Marshall Aid funds, the Greek government and others, not completed until 1960, was in many ways the most remarkable achieve-

ment of archaeology in Greece. (For explanation of the architectural terms used below *see* GREEK ARCHITECTURE.)

4. Prehistoric Athens.—The natural advantages of the Acropolis were exploited from the earliest times. Remains of the Neolithic period are succeeded by plentiful traces of Early and Middle Bronze Age habitation and in the Late Bronze Age the rock was fortified, like the citadels of Mycenae and Tiryns. A Cyclopean wall ran around the natural edge of the rock, best preserved behind the temple of Nike and east of the Erechtheum (*q.v.*) where a postern gate gave access to the royal palace; two column bases of the palace hall were discovered in the foundations of the old temple of Athena nearby. West of the Erechtheum a staircase led down to an underground reservoir in the north face to provide a water supply in time of siege. The western approach to the Acropolis was further protected by a complex of walls called Enneapulon, "Nine-Gate" wall, but no certain traces survive. It seems probable, however, that it extended some way round the flanks of the rock to enclose the spring Clepsydra to the north or others unnamed to the south, and perhaps to give some protection to the clusters of dwelling houses on the north slope. Tradition ascribed the construction of this and the circuit wall to pre-Hellenic Pelasgians (*q.v.*), but later Athenians used the name Pelargicum to describe only the area once covered by Enneapulon, an area in their day thought to be under a curse. The apparent connection between the name and the reputed builders of the walls has caused much confusion, but the confusion is largely etymological and mythological and need not be discussed here.

The only substantial traces of prehistoric (chiefly Mycenaean) houses so far discovered are on the northern slope of the Acropolis, but tombs and other remains have been found in the Ceramicus, the agora, by the Hill of the Nymphs and elsewhere, the most notable being a series of Mycenaean rock-cut chamber tombs on the northern slope of the Areopagus. All this makes it clear that in the last phase of the Bronze Age Athens was a settlement of some wealth and importance.

5. The Dark Age.—Athens survived the Dorian invasion and as a result her culture developed without a break through the sub-Mycenaean, proto-Geometric and Geometric periods (*c.* 1200–700 B.C.). The rich pottery finds from tombs in the outer Ceramicus, already apparently the chief cemetery, give a clear picture of the poverty which followed the collapse of the Mycenaean world and of the gradual return to prosperity in the following centuries, a return accompanied by the development of a pottery style which by the 8th century was well in advance of anything else in Greece: Athenian Geometric (*see* GREEK ART). Of the city itself little or nothing is known. On the Acropolis there would have been, no doubt, a primitive temple to Athena Polias (Athena as protector of the city) and to Erechtheus (Homer *Odyssey* vii, 81), but no solid traces survive. The northern slope was still a residential area, as was the Areopagus, on the northwestern slope of which a complete house of the Geometric period has been excavated. Negatively, the rich harvest of tombs from the agora area shows that this was not yet set aside as a public place.

6. Archaic Athens.—By about 560 B.C. the city had taken on its classical shape. There was no doubt a circuit wall (Thucydides vi, 57, 1), although its course cannot now be traced, from the gates of which the roads from the country converged on the Acropolis. On the west side of the agora, by then established as the centre of civic life, the excavators uncovered an early 6th-century building, which they plausibly identify as the headquarters of the Solonian council (*see* SOLON), and a small temple of Apollo Patrous ("Ancestral Apollo") of similar date. A few hundred yards away, on the hill from which it took its name, sat the rival aristocratic council, the Areopagus, but no traces survive and only a small cleft in the northeastern face marks the site of the sanctuary of the Eumenides (*q.v.*), so memorably associated by Aeschylus with the foundation of the council.

The reign of Pisistratus and his sons (*c.* 560–510 B.C.) transformed the city. In the agora the council's quarters were greatly enlarged and remodeled and on the south side a large building was erected, perhaps to serve as a meeting place for Solon's popular court of appeal, the Heliaea. The water supply was improved by the construction of the southeastern fountain house in the agora and of another east of the Pnyx—the first supplied by a pipe running along the north slope of the Acropolis, from a source as yet unknown, the other by a tiled conduit connected with a stone aqueduct which came from the upper Ilissus river past the southern slope of the Acropolis. Outside the Dipylon gate the Academy, later the School of Plato, was laid out as a gymnasium. The gods, too, received their due: near the agora fountain house was built the Eleusinium, an urban branch of the great sanctuary of Demeter and Kore (Persephone) at Eleusis (*q.v.*); Pisistratus, the tyrant's grandson, celebrated his archonship in 522–521 B.C. by constructing an altar to the Twelve Gods, now hidden under the railway which cuts across the north side of the agora but securely identified by a corner of its surrounding fence which projects into the excavated area and by which was found a dedication to these deities; work was begun on a gigantic dipteral temple to Olympian Zeus southeast of the Acropolis, work which was interrupted by the fall of the tyranny and only resumed, on a different plan, in 174 B.C. (*see* below); another shrine in the same area received a new altar from Pisistratus the younger to commemorate his archonship; and about the same time his father, Hippias, completed the building of a new and splendid temple to Athena Polias on the Acropolis, the Early or so-called Old Temple, between the later sites of the Parthenon and Erechtheum.

This Pisistratean building program introduces two topographical problems of long standing and some importance: (1) Pausanias (i, 14, 1) says that the fountain Enneacrunus ("the fountain of the nine spouts") was embellished by Pisistratus. He places it firmly in the agora, near the Eleusinium; in other words he is almost certainly speaking of the southeastern fountain house mentioned above. On the other hand Thucydides, in a passage of great importance for Athenian topography (ii, 15), puts Enneacrunus, which he says was also called Callirrhoe, just as firmly to the south of the Acropolis together with the sanctuaries of Zeus Olympius, Apollo Pythius, Ge and "Dionysus in the Marshes"; the last two cannot be certainly identified but both may be near the theatre of Dionysus; the first two are firmly fixed near the north bank of the Ilissus and by an apparently happy chance there is a fountain on its opposite bank, called to this day Callirrhoe. Alternatively with a liberal interpretation of Thucydides Enneacrunus might be found in the fountain house east of the Pnyx, near which Dorpfeld found what he claimed to be the appropriate sanctuary of Dionysus. In either case there is a conflict between Pausanias and Thucydides. Some scholars would alter Thucydides' text to read "to the north of the Acropolis" and proceed to reduplicate sanctuaries of Zeus, etc., on the north slope, but this drastic solution fails to convince and there remains a choice between the authority of Thucydides and that of the conscientious but fallible traveler of the 2nd century A.D.

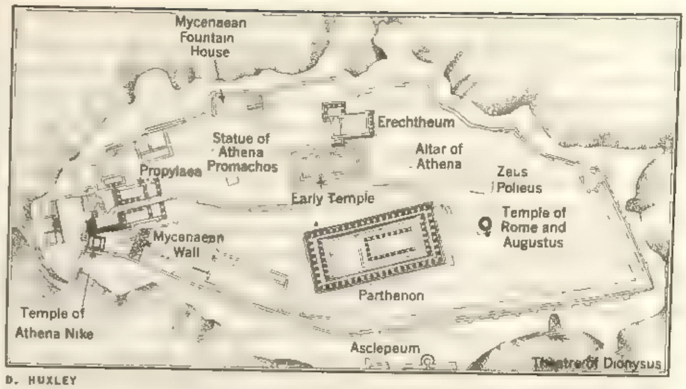
(2) It is impossible here to do more than hint at the problems which surround the history of the early temples on the Acropolis. The archaeological elements are three: (*a*) the foundations of the Old Temple and some fragments of its architectural members (of about 520 B.C.); (*b*) the foundations of an earlier temple, begun about 490 B.C. but never completed, on the site of the Parthenon; and (*c*) some fragments of pedimental sculpture of the first half of the 6th century, on a scale which indicated that they must have belonged to a substantial building. Most scholars accept in some form the following economical and attractive solution. Certain peculiarities in the construction of (*a*) suggest that the inner part once stood alone as a simple cella, distyle in antis; to this early structure the sculpture could be fitted. The Pisistratids would then have added the imposing colonnade round it and after the institution in 508 B.C. of the new democracy the construction of a yet more impressive building on an entirely new site would have begun. But according to an American architect, W. B. Dinsmoor the whole of the Old Temple is Pisistratean and to accommodate the sculpture he postulates an even earlier structure on the Parthenon site, "the grandfather" of the Parthenon. This grandfather left no trace on the ground but according to Dinsmoor bequeathed his name to his successors. This name, the Hecatompedon or "Hundred-footer," has usually been thought to belong to the Old

Temple in its earlier form (the measurements are approximately correct) and to have been transferred thence to the Parthenon, of which the cella proper is of similar length. Dinsmoor prefers to restrict the name to one site and would have it first applied to the earliest Parthenon. Many of Dinsmoor's arguments are weak (especially those for the unity of the Old Temple) but the problem was still far from final solution in the 1960s.

7. Classical Period.—The almost complete destruction of the buildings on the Acropolis and in the city in the Persian invasion of 480 B.C., among them many shrines which religious sentiment might have preserved, facilitated the magnificent architectural designs of Themistocles, Cimon and Pericles (*qq.v.*), while the rapid growth of the Athenian empire provided the necessary means for their execution. After the departure of the Persians the first necessity was the reconstruction of the defenses. The walls, then built under the direction of Themistocles, embraced a larger area than the previous circuit, with which they coincided at the Dipylon gate on the northwest where the Sacred way to Eleusis was joined by the carriage route to the Piraeus and roads to the Academy and Colonus. The other important gates were the Piraic and Melitan on the west; the Itonian on the south leading to Phaleron; the Diomean and Diocharean on the east; and the Acharnian on the north. The wall, strengthened with numerous towers, enclosed the quarters of Collytus on the north, Melite on the west, Limnae on the southwest and south and Diomea on the east. By mid-20th century the remains had not been systematically excavated except near the Dipylon; sepulchral monuments built into the masonry illustrate the statement of Thucydides with regard to the employment of such material in the hasty construction. The circuit has been ascertained in its general lines; it is given by Thucydides (ii, 13, 7) as 43 stades (about $5\frac{1}{2}$ m.), exclusive of the portion between the points of junction with the long walls to the Piraeus, but the whole circumference cannot have exceeded 37 stades.

8. The "Long Walls."—The design of connecting Athens with the Piraeus by long parallel walls is ascribed by Plutarch to Themistocles. Of these the north and Phaleric walls were actually built between 461 and 456 B.C. in the early years of the administration of Pericles; the middle wall may be as late as 444–442 B.C. The north wall, leaving the city near the modern observatory, ran from northeast to southwest near the present road to the Piraeus until it reached the Piraeus walls a little to the east of their northernmost bend. The middle wall, beginning south of Museum hill, gradually approached the northern wall and, following a parallel course at an interval of 550 ft., diverged to the east near the modern New Phaleron and joined the Piraeus walls on Munychia where they turn inland from the sea. The course of the Phaleric wall has been much disputed, but it must have left the city wall near Museum hill and then have run either directly to the eastern corner of Phaleron bay or in a rough semicircular sweep to rejoin the middle wall near the defenses of the Piraeus. It may have been abandoned toward the end of the Peloponnesian War; it was certainly destroyed with the others in 404 B.C. and was not rebuilt by Conon in 393. The parallel walls fell into decay during the Hellenistic period and were finally demolished by Sulla. For a detailed account of the Piraeus and its fortifications which completed the defensive system of Athens, see PEIRAEEUS.

9. The Acropolis.—The "Pelasgian" fortifications of the Acropolis were destroyed by the Persians and all its major monuments razed or severely damaged. Soon after their departure the existing north wall was hastily erected with many fragments from the sack built into it. The fine walls on the south and east were built by Cimon after the victory of Eurymedon, 468 B.C.; they extend considerably beyond the prehistoric circuit, the intervening space being filled up with the debris of the ruined buildings so as to increase the level space, an operation which produced a priceless collection of archaic statuary and vases. Cimon also completed the wall on the north side at both ends and added to its height; the ground behind was leveled up on this side also, the platform of the Acropolis thus receiving its present shape and dimensions. At the southwestern corner, on the right of the old entrance, an early bastion was encased in a rectangular projection which formed



D. HUXLEY

PLAN OF THE ACROPOLIS, ATHENS

a base for the temple of Nike.

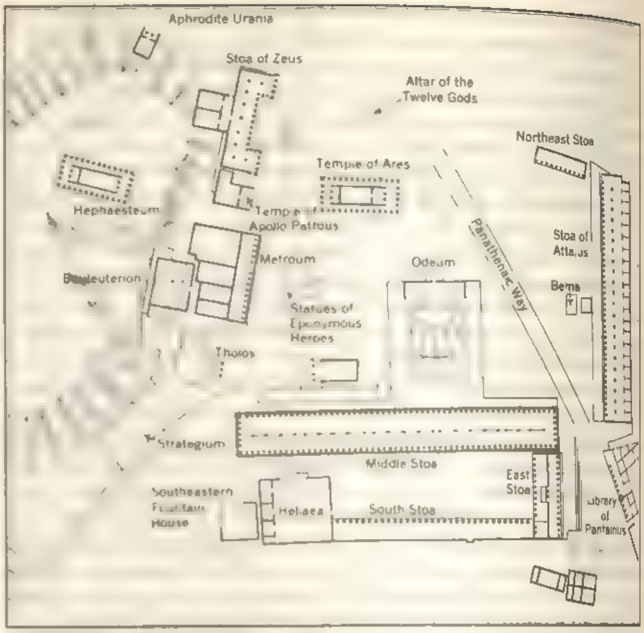
The greater monuments of the classical epoch on the Acropolis are described in separate articles. (*See* PARTHENON; ERECHTHEUM; PROPYLAEA.) Next in interest to these is the beautiful little temple of Athena Nike, wrongly designated "Nike Apteros" (Wingless Victory), standing on the bastion mentioned; it was begun in 449 B.C. and was probably finished toward the end of the Archidamian War (421 B.C.). The temple, which is entirely of Pentelic marble, is amphiprostyle tetrastyle, with fluted Ionic columns, resting on a stylobate of three steps; its length is 27 ft., its breadth $18\frac{1}{2}$ ft. and its total height, from the apex of the pediment to the bottom of the steps, 23 ft. The frieze represents on the east a number of deities; on the north and south Greeks fighting with Persians and on the west Greeks fighting with Greeks. Before the east front was the altar, beneath which an earlier altar has been found. The irregularly shaped precinct was enclosed by a parapet about 3 ft. 2 in. in height, decorated on the outside with beautiful reliefs representing winged victories engaged in the worship of Athena. The temple was still standing in 1676; some eight years later it was demolished by the Turks and its stones built into a bastion; on the removal of the bastion in 1835 the temple was reconstructed faultily by L. Ross, but was dismantled and more accurately rebuilt between 1935 and 1940. At either corner of the Propylaea entrance were equestrian statues dedicated by the Athenian knights; the bases with inscriptions have been recovered. From the Propylaea a passage led eastward along the north side of the Parthenon; facing the entrance was the colossal bronze statue of Athena Promachos by Phidias (*q.v.*), a dedication from the spoils of the Persian War. The statue, 30 ft. high, represented the goddess fully armed; the gleam of her helmet and spear could be seen by the mariners approaching from Sunium (Pausanias i, 28, 2). On both sides were numerous statues, one of Athena Hygeia (whose altar lies at the southeast angle of the Propylaea), set up by Pericles to commemorate the recovery of a slave injured during the building of the Parthenon; a colossal bronze image of the wooden horse of Troy; and Myron's group of Marsyas and Athena. Another statue by Myron, the Perseus, stood near the precinct of Artemis Brauronia, lying between the southeastern corner of the Propylaea and the wall of Cimon. Adjoining it to the east was a large rectangular building, which was apparently fronted by a colonnade; this has been identified with the *Chalcothece*, a storehouse of bronze implements and arms. Beyond the Parthenon, a little to the northeast, was the great altar of Athena, and near it the statue and altar of Zeus Polieus. Immediately west of the Erechtheum is the Pandroseum or *temenos* of Pandrosos, the daughter of Cecrops, seen there by Pausanias (i, 27, 2). This precinct, in which the sacred olive tree of Athena grew, was fixed by an inscription. Between it and the Propylaea were a number of statues, among them the heifer of Myron and perhaps his Erechtheus, the Lemnian Athena of Phidias and his effigy of his friend Pericles.

10. The Dipylon and Ceramicus.—The Ceramicus ("Potters' quarter") gives the best opportunities for studying both the cemeteries and the walls of Athens. The latter divide the region into the inner and outer Ceramicus and three stages are clearly seen:

the wall of Themistocles, the restoration by Conon in 393 B.C. and a reconstruction by Lycurgus (*c.* 396–325 B.C.; *q.v.*) some 60 years later. The Dipylon gate belongs to the last stage and consists of an inner and outer double gate separated by a rectangular court and flanked by towers on either side. Immediately to the south lay the Pompeum, built in the 4th century B.C. to serve as an assembly point for the Eleusinian and Panathenaic processions but noted also as a haunt of philosophers. Destroyed by Sulla in 86 B.C., it was later reconstructed on a different plan, probably in the time of Hadrian. South again lay the Sacred gate, the starting point of the Sacred way to Eleusis and at the same time an exit for the brook called Eridanus. Outside were tombs of every period, private and (from 464 B.C.) public. Inside lay the real commercial centre of Athens—crowded streets of shops and colonnades, cut by two main roads; the Panathenaic way, the route of Athena's great procession, which started from the Dipylon, passed the altar of the Twelve Gods and crossed the agora to mount the col between the Acropolis and Areopagus; and a continuation of the Sacred way, which skirted the small sanctuaries of Aphrodite Urania and of the People and of the Graces at the northern tip of the hill called Colonus Agoraeus and so entered the agora at its northwest corner.

11. The Theseum.—On Colonus, dominating the whole agora, stood the temple of Hephaestus and Athena as patroness of the arts and crafts. Its style indicates that this, the best preserved Greek temple in the world, is slightly older than the Parthenon (*i.e.*, *c.* 450–440 B.C.), and the unknown architect may even have changed his plan for the interior after seeing Ictinus' designs for the Parthenon. It has been known as the Theseum since the middle ages, apparently because some of its sculptures represent the exploits of Theseus, but its identification with the temple of Hephaestus seen by Pausanias (i, 14; 6) is practically certain. The temple is a Doric peripteral hexastyle in antis, with 13 columns at the sides; its length is 104 ft., its breadth 45½ ft., its height, to the top of the pediment, 33 ft. Some fragments of the east pedimental sculpture have been discovered, enough to recover the theme, the apotheosis of Heracles. The frieze contains sculptures only in the metopes of the east front and in those of the sides immediately adjoining it; the frontal metopes represent the labours of Heracles, the lateral the exploits of Theseus. As in the Parthenon, there is a sculptured frieze above the exterior of the cella walls; this, however, extends over the east and west fronts only and the east ends of the sides. The eastern represents a battle scene with seated deities on either hand, the western a *kentauromachia* (battle of centaurs). The temple is of Pentelic marble, except the foundations and lowest step of the stylobate, which are of Piraic stone, and the frieze of the cella, which is in Parian marble. The preservation of the temple is due to its conversion into a church in the middle ages.

12. The Agora.—Immediately beyond the entrance to the agora (or central market place) from the Sacred way could be seen the altar of the Twelve Gods. Beyond it and slightly to the north, beneath the modern railway, was the *Stoa poikile* (the "Painted portico"), the earliest of the stoas (*c.* 460 B.C.), which later enclosed the open space on all four sides. It took its name "painted" from the battle scenes which were hung around its walls, the work of Polygnotus (*q.v.*) and other noted artists, and gave its name, in part, to the Stoic school of philosophy founded by Zeno (*q.v.*), who practised there *c.* 300 B.C. The open space was dotted with statues, clustering most thickly along each side of the Panathenaic way, most notable among them those of the tyrannicides, Harmodius and Aristogiton, who in 514 B.C. killed Hipparchus, son of Pisistratus. This group was the work of Critius and Nesiotes (*q.v.*), a replacement of the earlier work of Antenor which the Persians had carried off in 480 and which was returned to the agora by Alexander the Great. Southward along the street which skirted the west side was first of all the Stoa of Zeus, built toward the end of the 5th century to replace an older shrine. This stoa was in the form of a colonnade with, a rare feature, two projecting wings between which stood an altar to the god. Pausanias' account (i, 14, 6) suggests that it may also have been known as the *Stoa Basileios* or Royal stoa, the seat of the



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PLAN OF THE AGORA, ATHENS

court of the archon basileus (*see* ARCHON), where the revised law codes of Solon and Draco (*qq.v.*) were displayed at the end of the 5th century; but some scholars reject this identification and postulate another stoa beneath the railway to the north. Next was the tiny temple of Zeus Phratrius and Athena Phratria (*c.* 350 B.C.) and the temple of Apollo Patrous, a limestone structure, tetrastyle in antis, of about 330 B.C. Together these deities presided over the tribal past of Athens—Apollo as the ultimate ancestor of the Ionians (*q.v.*), the others as patrons of the gentilitial association known as phratries. At Apollo's temple all citizens were registered and to him the magistrates swore their oaths on entering office. After a gap, giving access to the Hephaesteum (temple of Hephaestus) above, stood the complex of buildings which housed the chief administrative offices of Athens. Early in the history of the new democracy (*c.* 500 B.C.) a new and more splendid meeting place for the council (boule; *q.v.*) was built on top of Solon's tiny rooms, and some years later (*c.* 470 B.C.) came a replacement for Pisistratus' additions. This was the Tholos, a simple circular structure some 60 ft. in diameter, the roof supported on six interior columns, designed as living quarters for the standing committee of the council, the fifty prytanes. By about 400 B.C. the accumulation of state papers in the council house left no room for the councilors and another meeting room (the *bouleuterion*) was constructed at the rear, to which a covered approach and portico were added in the great building program of the time of Lycurgus the orator, carried out from 338–326 B.C.

Alongside the roadway on the east ran a great stone-lined drain of about 500 B.C. carrying rain water from the Areopagus northward to the channel of the Eridanus. Beyond this, and opposite the council house, was a small oblong enclosure surrounding a base on which were set statues of the eponymous heroes of the ten post-Cleisthenic tribes (*see* CLEISTHENES); the sides of the base served as an official notice board. A little farther south beyond the Tholos, both road and drain divided and there was a stone pillar carrying the words "I am the *horos* (the 'boundary stone') of the agora." Straight ahead and to the left were the Pisistratean fountain house and Heliaea, the gap between them filled by the rather shoddy South stoa of the late 5th century, a long two-aisled colonnade fronting a row of small rooms, probably designed to shelter the numerous courts into which the Heliaea was now divided; in the extreme southeast corner, at the side of the Panathenaic way, lay a small 5th-century building which the excavators plausibly identify with the *Argyrokopeion* (the mint). A branch left the road immediately after the *horos*, leading past a structure which probably served as the *strategeion*, headquarters of the strategoi (*see* STRATEGUS), toward the Hill of the Nymphs;

the main road carried on round the west end of the Areopagus with a branch mounting from there to the Pnyx.

In the 6th century the popular assembly had met in the agora, but Cleisthenes' democracy of 508 B.C. soon had to construct for itself a quieter meeting place on the gentle northeast slope of the Pnyx. In the first period use was made of the natural theatre-like shape of the hillside and the speaker faced up the hill toward his audience; toward the end of the 5th century the arrangement was reversed: the speaker stood on a bema or rostrum above the front rows of his audience while artificial terracing raised the outer edge of the semicircular auditorium to a slightly higher level. Somewhat less than a century later, again perhaps on the initiative of Lycurgus, the whole structure was extended and improved to produce the impressive form which can still be seen on the ground. The bema, a cube of rock, stood in front of two walls cut from the solid rock which met at an angle of about 158°. The ends of these were then connected by a semicircular retaining wall on a radius of approximately 70 yd. Immediately above the bema was an altar and behind it two stoas backing on the city wall which at this point ran along the crest of the hill.

13. The Dionysiac Theatre and Asclepeum.—The Dionysiac theatre, situated beneath the south side of the Acropolis, was partly hollowed out from its declivity. The representation of plays was transferred there from an original orchestra in the agora by the beginning of the 5th century B.C.; it afterwards superseded the Pynx as the meeting place of the assembly. There the first structures were provisional and of wood, and traces were found of the early orchestra and auditorium which had its seats in straight lines. This was replaced by a stone theatre during the administration of Lycurgus but the present arrangement of stage and orchestra date from Roman times. The stage building consisted of a rectangular hall with square projections on either side; in front of this was built in late Greek or early Roman times a stage with a row of columns which intruded upon the orchestra space. A later and larger stage, dating from the time of Nero, advanced still farther into the orchestra, and this was finally faced (probably in the 3rd century A.D.) by the bema of Phaedrus, a platform wall decorated with earlier reliefs, cut down to suit their new position. The remains of two temples of Dionysus have been found adjoining the stoa of the theatre, as well as an altar of the same god adorned with masks and festoons; the smaller temple probably dates from the 6th century B.C. and the larger from the end of the 5th or the beginning of the 4th century.

West of the theatre is the precinct of Asclepius, established in 420 B.C., where were discovered the foundations of the temple together with several inscriptions and a great number of votive reliefs offered by grateful invalids. A Doric colonnade with a double row of columns extended along the base of the Acropolis for a distance of 54 yd.; behind it in a chamber hewn in the rock is the sacred well mentioned by Pausanias. The colonnade was a place of resort for the patients; a large building close beneath the rock was probably the abode of the priests. East of the theatre and closely related to it was the odeum (concert hall) of Pericles, the only building which can be assigned to him, though he may have designed the first plan of the theatre too. This was a large rectangular hypostyle with probably six rows of six marble columns which would have replaced the original wooden columns at its restoration by Ariobarzanes of Cappadocia after its destruction by Sulla in 86 B.C. Plutarch says that the odeum imitated the tent of Xerxes, referring no doubt to the pointed roof of the building.

14. The Choragic Monument of Lysicrates.—The beautiful choragic monument of Lysicrates, dedicated in the archonship of Euaenetus (335–334 B.C.), is the only survivor of many such structures which stood in the "Street of the Tripods" to the east of the Dionysiac theatre, bearing the tripods given to the successful choragi at the Dionysiac festival. It owes its preservation to its former inclusion in a Capuchin convent. The monument consists of a small circular temple of Pentelic marble, 21½ ft. in height and 9 ft. in diameter, with six engaged Corinthian columns and a sculptured frieze, standing on a rectangular base of Piraic stone. The delicately carved convex roof, composed of a single block, was surmounted by the tripod. Another choragic monument was that of Thrasyllus, which faced a cave in the rock of the Acropolis above the Dionysiac theatre. A portion of another, that of Nicias, was used to make the late Roman gate of the Acropolis. In one of these monuments was the famous Satyr of Praxiteles.

15. Hellenistic Period.—After the age of Alexander Athens was adorned with many new buildings, a tribute paid to her intellectual renown by foreign potentates or dilettanti who desired to add their names to the list of its illustrious citizens and patrons. Among the first of these benefactions was the great gymnasium of Ptolemy II Philadelphus (*see* PTOLEMIES), built northeast of the agora about 250 B.C. Attalus I of Pergamum (*see* ATTALUS) set up a number of bronze statues on the Acropolis; Eumenes II of Pergamum (*see* EUMENES) built the long portico west of the Dionysiac theatre; Attalus II erected the magnificent stoa which closes the east side of the agora and which was completely rebuilt on the ancient plan in the closing stages of the American excavations in order to serve as a museum for the site. The stoa consisted of a row of 21 single-roomed shops, fronted by a double colonnade, the outer Doric and the inner Ionic. At each end there was a staircase approached through an arched opening—the earliest use of a visible arch in Athens—leading to a second story, again with shops, and a double colonnade—double Ionic at the front joined by a balustrade and Pergamene behind. About the same time the whole of the south side of the agora was drastically remodeled. A stoa (now known as the Middle stoa) some 160 yd. long was built between the southern end of the Stoa of Attalus and the Tholos, offering two colonnades, one facing north into the square and the other south toward the old South stoa; soon afterward a second stoa was added at right angles to its east end, again facing outward (to the Panathenaic way) and inward to what became a new enclosure; the replanning was then completed by the replacement of the old South stoa by a new one at right angles to the East stoa and connecting it with the Heliaea. The whole complex thus created a separate area for the conduct of Athens' legal business. A few years later the civic offices themselves were improved. The old complex had included, to the north of the council house, a small archaic temple (*Metroön*) dedicated to the Mother of the Gods; a building was then designed to fulfill the functions of both—one small room remaining as the sanctuary of the goddess, two others serving as deposits for the archives, while a spacious two-storied section to the north may have been an official residence. The whole was fronted with an elegant colonnade in Pentelic marble.

The greatest monument, however, of the Hellenistic period, the colossal temple of Olympian Zeus, stood by the Ilissus, southeast of the Acropolis. Its foundations were laid on the site of a small ancient shrine by Hippias, but the building in its ultimate form was for the greater part constructed, under the auspices of Antiochus IV Epiphanes, king of Syria, by the Roman architect Cossutius between 174 and 164 B.C., the date of the death of Antiochus. The work was apparently resumed under Augustus and finally, in A.D. 129, completed and dedicated by Hadrian, who set up a chryselephantine statue of Zeus in the cella. The building was octostyle; its length was 318 ft. and its breadth 132 ft. With the exception of the foundations and two lower steps of the stylobate, it was entirely of Pentelic marble and possessed 104 Corinthian columns, 56 ft. 7 in. in height, of which 48 stood in triple rows under the pediments and 56 in double rows at the sides; of these, 16 remained standing in 1852, when one was blown down by a storm.

16. Roman Period.—An earlier building of this period is the Horologium of Andronicus of Cyrrhus (otherwise known as the "Tower of the Winds"), still standing near the eastern end of the Roman agora. This may belong to the 2nd or 1st century B.C. It is an octagonal marble structure, 42 ft. in height and 26 ft. in diameter; the eight sides, which face the points of the compass, are furnished with a frieze containing inartistic figures in relief representing the winds; below it, on the sides facing the sun, are the lines of a sundial. It was surmounted by a weathercock in the form of a bronze Triton and contained a water clock to record the time when the sun was not shining.

The new, or Roman, agora to the north of the Acropolis, per-

haps mainly an oil market, was constructed after the year 27 B.C. It consisted of a large open rectangular space surrounded by an Ionic colonnade into which opened a number of shops or storehouses. The eastern gate was adorned with four Ionic columns on the outside and two on the inside, the western entrance being the well-known Doric portion of Athena Archegetis with an inscription recording its erection from donations of Julius Caesar and Augustus. On one theory the site of this agora had previously been occupied by a 5th-century temple of Ares (almost a twin of the Hephaesteum and undoubtedly the work of the same architect). There is no positive evidence for this but it is a curious coincidence that Ares' temple was dismantled and reassembled block by block in the old agora about the same time as the new agora was being built. Its foundations and a few architectural fragments can now be seen in the area between the temple of Apollo and the Panathenaic way. Space was further restricted by the construction (about 15 B.C.) of a massive odeum to the southeast of the temple on the site of the primitive orchestra. This, the gift of M. Vipsanius Agrippa, was a rectangular structure, entered from the terrace of the Middle Stoa, which contained seating for about 1,000 people on semicircular tiers of marble benches. The auditorium had a span of 27 yd. and this was roofed without any interior support—unwisely, for about A.D. 150 the roof collapsed. In the reconstruction which followed a crosswall was introduced which cut the capacity by about a half; at the same time the north front was adorned by the insertion of six colossal statues of giants and tritons supporting an architrave to form a colonnade in place of the original projecting porch. At the eastern end of the Acropolis a charming circular temple of white marble with a peristyle of nine Ionic columns was dedicated to Rome and Augustus. The conspicuous monument which crowns Museum hill was erected as the mausoleum of Antiochus Philopappus of Commagene, grandson of Antiochus Epiphanes, in A.D. 114–116. It was nearly square, but the only portion remaining is the slightly curved front, with three niches between Corinthian pilasters; in the central niche is the statue of Philopappus.

The emperor Hadrian was a lavish benefactor to Athens. He enlarged the circuit of the city walls to the east and so created the City of Hadrian (Hadrianopolis) or New Athens (Novae Athenae), a handsome suburb with numerous villas, baths and gardens; its walls were fortified with rectangular towers. The Arch of Hadrian near the Olympeum marked the boundary between the new and old cities. A vast rectangular enclosure immediately north of the new agora was identified as the library of Hadrian. A portion of its western front, adorned with monolithic unfluted Corinthian columns, is still standing—the familiar "Stoa of Hadrian"; another well-preserved portion, with six pilasters, runs parallel to the west side of Aeolus street. The interior consisted of a spacious court surrounded by a colonnade of 100 columns, into which five chambers opened at the eastern end. A portico of four fluted Corinthian columns on the western side formed the entrance to the quadrangle. A pantheon, a gymnasium and temples of Hera and Zeus Panhellenius were likewise built by Hadrian; the aqueduct, which he began, was completed by Antoninus Pius (A.D. 138–161); it is still in use. About the same time the generosity of one T. Flavius Pantainus provided a splendid library adjoining the Stoa of Attalus.

The stadium, in which the Panathenaic games were held, was first laid out by the orator Lycurgus (*see* above) about 330 B.C. It was an oblong structure filling a depression, partly natural, partly artificial, near the left bank of the Ilissus beneath the eastern declivity of the Ardettus hill. The immense building, however, which was restored in 1896 and the following years, was that constructed in Pentelic marble about A.D. 143 by Herodes Atticus, a wealthy Roman resident. The seats, rising in tiers as in a theatre, accommodated about 44,000 spectators; the arena was 670 ft. in length and 109 ft. in breadth. The odeum, built beneath the southwest slope of the Acropolis after A.D. 161 by Herodes Atticus in memory of his wife Regilla, is comparatively well preserved. The plan is that of the conventional Roman theatre; the semicircular auditorium, which seated some 5,000 persons, is, like that of the Dionysiac theatre, partly hollowed from the rock. The orchestra is paved with marble squares. The façade in Piraic stone, displays three stories of arched windows. The whole building was covered with a cedar roof. The structure without the roof has now been restored and is again in use as an open-air concert hall and theatre.

In the raid of the Heruli (*q.v.*), A.D. 267, much of the city was destroyed. The Athenians then abandoned the old defenses and a much smaller circuit was constructed, the so-called Valerian wall. This began at the present entrance to the Acropolis, followed the line of the Panathenaic way to the library of Pantainus, where a part is preserved, then incorporated the surviving shops of the Stoa of Attalus, turned east for about 500 yd. through the library of Hadrian and then returned to the Acropolis circuit. The material came from the shattered buildings outside, in the surviving portion of the agora which had lain desolate for a hundred years. Then, about A.D. 400, the old fortifications were resumed and the city came to life again; from this time dates the vast gymnasium complex in the agora covering the site of Agrippa's odeum (and incorporating the giants in a new stoa) and much of the Middle, East and South stoas. This probably served as part of the university of Athens until it was closed in A.D. 529.

See also GREEK ARCHITECTURE; GREEK ART; POTTERY AND PORCELAIN.

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(J. D. B.; A. J. B. W.; W. G. F.)

II. HISTORY

1. Prehistoric Period.—Archaeology supplies the early history of Athens, for it is barely mentioned by Homer and the numerous legends have little historical value. Its Neolithic inhabitants, of the race that occupied most of Greece and was related to that of the Danubian and Carpathian areas, were followed by a bronze-using folk akin to the islanders and Cretans, possibly a non-Hellenic people. Next (perhaps at the turn of the Early and Middle Bronze Age) came the irruption of Hellenic peoples into the Aegean area, including Greece (*see* AEGEAN CIVILIZATION), and in the Late Bronze Age Athens became a strong castle like Tiryns with traces of a "palace" remaining unconquered though not unshaken by the Dorian invasion. Rich finds of Geometric vases indicate prosperity in the Early Iron Age.

At the dawn of history proper the independent communities of Attica were absorbed into a central state of Athens under a monarchy of Ionian affinities, for the people were divided into four tribes whose names—Geleontes, Hopletes, Argadeis and Aegicoreis—recur in several true Ionian towns. The centralization (synoecism), to which many Greek peoples never attained, laid the foundations of Athenian greatness; but in other respects the new constitution tended to arrest development. When the monarchy was supplanted in the usual Greek fashion by a hereditary nobility, all power was appropriated by a privileged class of Eupatridae (*q.v.*), who owed their predominance to their control over legal procedure; the Geomoroi and Demiourgoi, who formed the bulk of the community, enjoyed no political rights. The aristocratic council of the Areopagus (*q.v.*) constituted the chief criminal court and nominated the magistrates, among whom the chief archon (*q.v.*) passed judgment in family suits and controlled admission to the genos or clan and consequently the acquisition of the franchise. This system was further supported by religious prescriptions which the nobles retained as a corporate secret. The Eupatridae also tended to become sole owners of the land, reducing the original freeholders or tenants to the position of serfs. During this period Athens seems to have made little use of its militia, commanded by the polemarch, or of its navy, which was raised in special local divisions known as naucraries; hence no

military *esprit de corps* could arise to check the Eupatrid ascendancy. Nor did the commons obtain relief through any commercial or colonial enterprises as in many other Greek states. The first attack upon the aristocracy proceeded from a young noble named Cylon, who endeavoured to become tyrant about 630 B.C. The people helped to crush this movement; yet discontent must have been rife for, in 621, the Eupatrids commissioned Draco (*q.v.*) to draft and publish a code of criminal law. By this notable concession the nobles lost that exclusive legal knowledge which had formed one of their main instruments of oppression.

2. The Rise of Athens.—A still greater danger grew out of the widespread financial distress, which was steadily driving many of the agricultural population into slavery and threatened the entire state with ruin. After a protracted war with the neighbouring Megarians accentuated the crisis, the Eupatrids gave to one of their number, the celebrated Solon (*q.v.*), free power to remodel the whole state (594 B.C. or perhaps slightly later) and revise the Draconian code, a revision which was the basis for all later Athenian law and found many imitators elsewhere (*see* GREEK LAW). By his economic legislation Solon placed agriculture once more upon a sound footing and encouraged commercial enterprise, thus laying the foundation of material prosperity. His constitutional reforms proved less successful, for, although he put into the hands of the people safeguards against oppression, he could not ensure their use in practice. After a period of party feud among the nobles the new constitution was superseded by the autocratic rule of Pisistratus and his sons Hippias and Hipparchus. The age of despotism, which lasted, with interruptions, from 560 to 510, was a period of great prosperity. The rulers fostered agriculture, stimulated commerce and industry (notably the famous Attic ceramics), adorned the city with public works and temples and rendered it a centre of culture. Their vigorous foreign policy first made Athens an Aegean power and secured connections with mainland powers. They also weakened the undue influence of the nobles and created a national Athenian spirit in place of the ancient clan feeling.

The equalization of classes was already far advanced when, about 509, an Alcmaeonid named Cleisthenes (*q.v.*), who had taken the chief part in the final expulsion of the tyrants, acquired ascendancy as leader of the commons. His constitution (508–507) expressed the change of political feeling by providing a national basis of franchise and a new state organization. By making effective the powers of the ecclesia (popular assembly), the boule (council) and heliaea (judicial assembly or people's law court), Cleisthenes became the true founder of Athenian democracy.

This revolution was accompanied by a conflict with Sparta and other powers, but in the ensuing wars Athens worsted powerful enemies like Thebes and Chalcis (506). A bolder stroke followed in 500, when a force was sent to support the Ionians in revolt against Persia (499–494) and helped sack Sardis. After the failure of this expedition the Athenians became absorbed in a struggle with Aegina (*q.v.*). In 493 the prospect of a Persian invasion brought into power men like Themistocles and Miltiades (*qq.v.*), to whose firmness and insight the Athenians largely owed their triumph in the great campaign of 490 against Persia. After a second political reaction, the prospect of a second Persian war and the naval superiority of Aegina led to a strong policy: Themistocles overcame the opposition of Aristides (*q.v.*) and passed his famous measure providing for a large increase of the Athenian fleet.

In the great invasion of 480–479 the Athenians displayed a resolution which could not be shaken even by the evacuation and destruction of their native city. Though the traditional account exaggerates the services of Athens, ultimate victory was chiefly due to the numbers and efficiency of its fleet and the wise policy of Themistocles. (*See* GRECO-PERSIAN WARS.)

3. Imperial Athens.—After the Persian retreat and the reoccupation of their city the Athenians continued the war with unabated vigour. Led by Aristides and Cimon they rendered such prominent service as to receive in return the formal leadership of the Greek allies and the presidency of the newly formed Delian league (*q.v.*). The ascendancy acquired in these years eventually raised Athens to the rank of an imperial state. For the moment it tended to impair the good relations which had subsisted between Athens and Sparta since the first days of the Persian peril. But so long as Cimon's influence prevailed the ideal of "peace at home and the complete humiliation of Persia" was steadily upheld. Similarly the internal policy of Athens continued to be shaped by the conservatives. The only notable innovations since the days of Cleisthenes had been the reduction of the archonship to a routine magistracy appointed partly by lot (487), and the rise of the ten elective strategoi (generals; *see* STRATEGUS) as chief executive officers. But the triumph of the navy at Salamis in 480 and the great expansion of commerce and industry had shifted the political centre of gravity from the moderate democrats to the more radical party. Though Themistocles soon lost his influence, his party eventually found a new leader in Ephialtes and, after the failure of Cimon's foreign policy (*see* CIMON), triumphed over the conservatives. The year 462–461 marks the reversal of Athenian policy at home and abroad. By canceling the political power of the Areopagus and multiplying the functions of the popular law court, Ephialtes abolished the last checks upon the sovereignty of the commons. His successor, Pericles, merely developed the full democracy so as to secure its effectual as well as its theoretical supremacy.

The foreign policy of Athens was now directed toward an almost reckless expansion (*see* PERICLES.) Besides securing its Aegean possessions and its commerce by the defeat of Corinth and Aegina, its last rivals at sea, Athens acquired an extensive dominion in central Greece and for a time quite overshadowed the Spartan land power. The rapid loss of the new conquests after 447, however, proved that Athens lacked a sufficient land army to defend permanently so extensive a frontier. Under the guidance of Pericles the Athenians renounced the unprofitable rivalry with Sparta and Persia and devoted themselves to the consolidation and judicious extension of their maritime influence.

The years of the supremacy of Pericles (443–429) are the most glorious in Athenian history. In actual extent of territory the empire had receded somewhat, but in point of security and organization it now stood at its height. The Delian league lay under Athenian control, and the points of strategic importance were largely held by cleruchies (*q.v.*; *see* also PERICLES) and garrisons. Out of a citizen body of more than 50,000 freemen, reinforced by mercenaries and slaves, a superb fleet exceeding 300 sail and an army of 30,000 trained soldiers could be mustered. The city, with its fortifications extending to the port of Piraeus, was impregnable to a land attack. Athenian commerce extended from Egypt and Colchis to Etruria and Carthage, and Athenian manufactures, which attracted skilled operatives from many lands, found a ready sale all over the Mediterranean. With tolls and the tribute of the Delian league (*q.v.*), a large reserve was amassed in the treasury.

Yet the material prosperity of Athens under Pericles was less notable than its brilliant attainments in every field of culture. No city ever adorned itself with such an array of temples, public buildings and works of art as the Athens of Pericles and Phidias. Its achievements in literature were hardly less great. The Attic drama of the period produced many masterpieces, and the scientific thought of Europe in the departments of logic, ethics, rhetoric and history mainly owes its origin to a new movement of Greek thought which was largely fostered by the patronage of Pericles himself. Besides producing numerous men of genius itself Athens attracted all the great intellects of Greece. The brilliant summary of the historian Thucydides in the famous funeral speech of Pericles (delivered in the winter of 431–430), in which the social life, the institutions and the culture of his country are set forth as a model, gives an ideal picture of Athens in its greatest days.

The payment for public service which Pericles had introduced may have contributed to raise the general level of culture of the citizens, but it created a dangerous precedent and incurred the censure of notable Greek thinkers. Moreover, all this prosperity was obtained at the expense of the confederates, whom Athens exploited in a somewhat selfish and illiberal manner. The cry of "tyrant city" roused public opinion in Greece against

Athens and brought on the Peloponnesian War (*q.v.*), which ruined the Athenian empire (431–404). The issue was determined less by any intrinsic superiority on the part of its enemies than by the blunders committed by a people unable to carry out a consistent foreign policy and served since Pericles by none but selfish or shortsighted advisers. It speaks well for the patriotism of its commons that Athens, weakened by plague and military disasters, should have withstood for so long the blows of enemies from without and the damage inflicted by traitors within. (*See* THERAMENES.)

4. 4th Century B.C.—After the complete defeat of the Athenians by land and sea, it was felt that their former services on behalf of Greece and their high culture should exempt the city from total ruin. Though stripped of the empire, Athens obtained very tolerable terms of peace. The democratic constitution, which had been supplanted for a while by a government of oligarchs, was restored in 403 after the latters' misrule had brought about their own downfall. (*See* CRITIAS; THERAMENES; THRASYBULUS.) Indeed the spread of democracy elsewhere increased the prestige of the Athenian administration, which had now reached a high peak of efficiency. Athenian art and literature in the 4th century declined but slightly from their former standard; philosophy and oratory reached a standard which was never equaled in antiquity. Athens took a prominent part with a view to upholding the balance of power, joining the Corinthian league in 395 and assisting Thebes against Sparta from 378 and Sparta against Thebes from 369. Athenian generals and admirals—Conon, Iphicrates, Chabrias, Timotheus (*qq.v.*)—distinguished themselves and partially recovered their country's predominance in the Aegean, with a temporary renewal of the Delian league. When Philip of Macedonia began to grow formidable Athens seemed called upon once more to champion the liberties of Greece. This ideal, when put forward by Demosthenes (*q.v.*) and other orators, created great enthusiasm among the Athenians, who at times displayed their old vigour, notably in the campaign of 338, though this culminated in Philip's decisive victory at Chaeronea (*q.v.*). But popular opinion repeatedly veered back in favour of the peace party. With diminished resources Athens could not indeed hope to cope with the great Macedonian king. However much one may sympathize with the patriots, it must be admitted that in the light of hard facts their conduct appears quixotic.

5. Hellenistic Period.—Philip and Alexander, who sincerely admired Athenian culture and courted a zealous co-operation against Persia, treated the defeated city with marked favour. But the people would not resign themselves to playing a secondary part and watched for every opportunity to revolt. For an outbreak after Alexander's death (323) the regent Antipater punished Athens by the loss of the city's remaining dependencies, the proscription of the chief patriots and the disfranchisement of 12,000 citizens. The Macedonian garrison prevented the city from taking a prominent part in the wars of the Diadochi, the successors of Alexander. Cassander first placed Athens under Demetrius Phalereus (317–307); Demetrius Poliorcetes liberated it in 307; after the battle of Ipsus (301) it fell under the control of Lachares, who made himself dictator in 295 but lost the city to Poliorcetes next year. The Athenians regained their liberty while Macedonia was thrown into confusion by the Celts and in 279 rendered good service against the invaders with a fleet off Thermopylae. When Antigonus Gonatas threatened to restore Macedonian power in Greece, the Athenians, supported perhaps by Ptolemy II Philadelphus, formed a defensive coalition; but in the ensuing Chremonidean War a naval defeat off Andros led to the siege and fall of Athens (262) and the imposition of a Macedonian garrison. The latter was withdrawn in 229 by the good offices of Aratus of Sicyon (*q.v.*).

At this period Athens was altogether overshadowed by the great Hellenistic monarchies and even by the new republican leagues of Greece; but the prestige of past history now perhaps attained its zenith. The democracy was respected by the Macedonian kings; the rulers of Egypt, Syria and especially of Pergamum courted Athens by gifts of buildings and works of art, to which the citizens replied by unbecoming flattery, even to the extent of creating new tribes named after their benefactors. If Athens lost supremacy in the fields of science and scholarship to Alexandria, the city became more than ever the home of philosophy, while Menander and the other poets of the "new comedy" made Athenian life known throughout the civilized world.

6. Relations With the Roman Republic.—Athens entered into friendly intercourse with Rome in 228 and in the Roman interest endured the desperate attacks of Philip V of Macedonia (200–199). In return for help against King Perseus Athens acquired some new possessions, notably the great mart of Delos (*q.v.*), which became an Athenian cleruchy (166). Athens indirectly brought about the conflict between Rome and the Achaean league which resulted in the loss of Greek independence but the city itself yet remained free, with rights secured by treaty. In spite of the favours of Rome, the more radical section began to chafe at the loss of importance. This discontent was skilfully fanned by Mithradates VI Eupator, king of Pontus (*see* MITHRADATES), at the outset of his campaigns against the Romans. His emissary, the philosopher Aristion, induced the people to declare war against Rome and to place him in chief command. The town with its port stood a long siege against Sulla, but was stormed in 86. The conqueror allowed his soldiers to loot, but inflicted no permanent punishment upon the people. This war left the Athenians poverty stricken and stripped of their commerce; the city's only importance now lay in the philosophical schools, which were frequented by many young Romans of note (Cicero, Atticus, Horace, etc.) as a sort of university. In the great Roman civil wars Athens sided with Pompeius (Pompey), but received a free pardon "in consideration of her great dead." Similarly the triumvirs after the battle of Philippi condoned its enthusiasm for the cause of Brutus; and Mark Antony repeatedly made Athens his headquarters and granted it several new possessions, including Eretria and Aegina—grants which Augustus subsequently revoked.

7. The Roman Empire.—Under the new settlement Athens remained a free and sovereign city—a favour which was repaid by zealous Caesar worship. The emperor Hadrian displayed his fondness for the city by constructing new buildings and relieving financial distress; he also amended the constitution and instituted a new national festival, the Panhellenica. Under the Antonines the endowment of professors out of the imperial treasury gave Athens a special status as a university. The city's whole energies seem henceforth devoted to academic pursuits. The military training of youth was superseded by courses in philosophy and rhetoric; the chief organs of administration, the revived Areopagus and the senior strategus, became an education office. Save for an incursion by Goths in A.D. 267 and a temporary occupation by Alaric in 395, Athens spent the remaining centuries of the ancient world in quiet prosperity. The rhetorical schools experienced a revival under Constantine the Great and his successors, when Athens became the school of many notable men, including Julian, Libanius, Basil and Gregory of Nazianzus. The professors teaching there may be regarded as the last representatives of a humane and moralized paganism. The freedom of teaching was first curtailed by Theodosius I; the edict of Justinian (529), forbidding the study of philosophy, dealt the deathblow to ancient Athens.

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8. Byzantine Period.—The city now sank into the position of a provincial Byzantine town and is rarely mentioned in the chronicles. Already it had been robbed of many of its works of art, among them the "Athena Promachos" and the "Parthenos" of Phidias, for the adornment of Constantinople; and further spolia-

tion took place when the church of Hagia Sophia was built in 532. The Parthenon, the Erechtheum, the Theseum and other temples were converted into Christian churches and were thus preserved throughout the middle ages. The emperor Constans II spent several months there in 662–663. In 869 the see of Athens became an archbishopric. In 995 Attica was ravaged by the Bulgars under their tsar Samuel, but Athens escaped; after the defeat of Samuel at Belasitsa (1014) the Byzantine emperor Basil II came to Athens and celebrated his triumph by a thanksgiving service in the Parthenon (1018). From the runic inscription on the marble lion from the Piraeus it has been inferred that Harald Haardraade (*q.v.*) and the Norsemen in the service of the Byzantine emperors captured the Piraeus in 1040. Like the rest of Greece Athens suffered greatly from its Byzantine administrators. The letters of Michael Choniates, archbishop of Athens in the last quarter of the 12th century, bewail the desolate condition of the city.

9. Latin Rule: 1204–1458.—After the Latin conquest of Constantinople in 1204 Otto de la Roche was granted the lordship of Athens by Boniface of Montferrat, king of Thessalonica, with the title of *megaskyr* (*megas kyrios* = "great lord"). His nephew and successor, Guy I, obtained the title duke of Athens from Louis IX of France in 1258. On the death of Guy II, last duke of the house of La Roche, in 1308, the duchy passed to his cousin, Walter of Brienne. Walter, however, became involved in a quarrel with the mercenary bands of the Grand Catalan company (*see* ALMOGÁVARES), who overthrew him in the battle of the Cephissus (1311) and occupied his territories. At first they tried to set up their own government under Roger Deslaur (a friendly knight from Roussillon whom they had taken prisoner in the battle), but in 1312 they put themselves under the protection of Frederick of Aragon, king of Sicily, who sent his son Manfred to be duke of Athens. Catalan rule under nominees of the Aragonese-Sicilian dynasty continued for the greater part of the 14th century; it was shaken, however, by the attack of the Navarrese company (another band of mercenaries) in 1379 and was terminated in 1388, when the Florentine Nerio Acciajuoli, lord of Corinth, took the Acropolis. Nerio secured recognition as duke from Ladislaus of Naples in 1394, and the Acciajuoli dynasty lasted till 1458, when the Acropolis was taken by the Turks under Omar, the general of the sultan Mohammed II, who had occupied the lower city in 1456. When the sultan entered Athens he was greatly struck by its ancient monuments and treated its inhabitants with comparative leniency.

See K. M. Setton, *Catalan Domination of Athens, 1311–1388* (1948).

10. Turkish Rule: 1458–1833.—After the Turkish conquest Athens disappeared from the eyes of western civilization. The Parthenon was transformed into a mosque; the Propylaea served as the residence of the Turkish commandant and the Erechtheum as a house. In 1466 the Venetians succeeded in occupying the city but failed to take the Acropolis. About 1645 a powder magazine in the Propylaea was ignited by lightning and the upper portion of the structure was destroyed. Under Francesco Morosini the Venetians again attacked Athens in Sept. 1687; a shell fired during the bombardment of the Acropolis exploded a powder magazine in the Parthenon and the building was rent asunder. After capturing the Acropolis the Venetians employed material from its ancient edifices in repairing its walls. They withdrew in the following year when the Turks set fire to the city. The central sculptures of the western pediment of the Parthenon, which Morosini intended to take to Venice, were unskilfully moved and, falling to the ground, were broken to pieces. Several ancient monuments were sacrificed to provide material for a new wall with which the Turks surrounded the city in 1778.

11. Athens After Greek Independence.—Greek insurgents surprised the city in 1821 and captured the Acropolis in 1822; but in 1826 Athens again fell into the hands of the Turks, who bombarded and took the Acropolis in the following year (the Erechtheum suffered greatly, and the monument of Thrasyllus was destroyed). The Turks remained in possession of the Acropolis till 1833, when Athens was chosen as the capital of the new kingdom of Greece. Its subsequent history is that of the kingdom. In World War I it was the scene of the incidents of 1916–17 that led to the deposition of King Constantine by the Allies. Athens was spared aerial bombardment during World War II; the German occupation lasted from April 27, 1941, to Oct. 12, 1944. *See* also GREECE: *History*. (M. C.; A. J. B. W.)

III. THE MODERN CITY

1. Population.—Facing the Saronic gulf and islands of Salamis and Aegina to the south, the modern city is built around the ancient Acropolis and the crag of Mt. Lycabettus. With the increase in population and building activity since World War II, the suburbs have extended in a somewhat ragged fashion across the plain, in some places reaching the foothills of the amphitheatre of mountains. The area covered by the capital, together with its suburbs and port, the Piraeus, is 155 sq.mi.

The population of Greater Athens (comprising 57 communes) increased considerably after the War of Independence: from about 5,000 in 1834 to 1,124,109 in 1940 and to 1,852,709 in 1961. The population of the city proper in 1961 was 627,564. This rapid growth was largely due to the great influx of refugees from Asia Minor in 1922 and the migration of rural inhabitants from the provinces during World War II and the Communist rebellion (1946–49). By the 1960s Athens had become a bustling cosmopolitan city.

2. Layout and Principal Buildings.—At the conclusion of the War of Independence Athens was little more than a village of the Turkish type, the poorly built houses clustering on the slopes of the Acropolis. A few of the narrow, crooked lanes of this quarter still remain, contrasting with the regularly laid out streets of the modern city, which was for the most part designed by the German architect Eduard Schaubert (1804–68). It contains numerous squares and avenues and two big parks. Large apartment blocks replaced the older private residences. The old palace, beneath which is the monument to the Unknown Soldier, is a dull and uninspiring structure, now converted into a parliament house. It was designed by Friedrich von Gärtner (1792–1847), one of the many German architects working in Athens during the reign of King Otto (Otho) who were responsible for the construction of numerous 19th-century buildings in the capital. The adjoining palace garden, now open to the public, was laid out by the landscape gardener Friedrich Schmidt (1811–89) at the request of Queen Amalia. To the southeast, in Herodes Atticus street, lined with false pepper trees, is the new palace, built in 1891–97. Beyond lies the reconstructed stadium, scene of the revived Olympic games in 1896 (see *Topography and Antiquities*, above).

The academy, a typical example of neoclassical architecture designed by Theophil Hansen (1813–91), is constructed of Pentelic marble with richly coloured and gilded colonnades and pediments. Close by is the National and Capodistrian University of Athens (founded 1837), with a colonnade adorned with paintings, and the National library with a Doric portico. In the main public garden is the Zappeion, a large semicircular edifice with a Corinthian portico built in 1896. The Vouli (*i.e.*, Boule), or parliament house, possesses a good library. Other public buildings are the National Technical university (Polytechnic institute), the National theatre, the Gennadeion library, attached to the American School of Classical Studies, and many hospitals, schools and orphanages. The Byzantine museum, built around an atrium, was one of the residences of the duchesse de Plaisance (1785–1854). The 19th-century cathedral is devoid of architectural merit but some of the smaller, early Byzantine churches are interesting and beautiful, particularly the church of St. Theodore (mid-11th century), the Kapnikarea (mid-12th century) and the Old Metropolis (early 13th century). The Holy Synod, a permanent council representing the government of the church of Greece, is presided over by the archbishop of Athens and 12 metropolitans who must all reside in the city during their tenure of office.

The streets of the capital, with the exception of some main thoroughfares, such as University, Stadium, Academy and Patissia streets, are generally narrow and overcrowded. Queen Sophia and Syngrou (Singros) avenues link Syntagma square, the heart of the city, with the northern suburbs and the Phaleron coast respectively. From the west the city is approached along a magnificent highway,

running parallel to the ancient Sacred way.

After the successive extensions of the boundaries of Greece in 1881, 1912 and 1920, Athens increased rapidly as the focus of society, politics and trade. After 1922 whole new districts sprang up to house the great influx of refugees from Asia Minor, and marked improvements of the roads have made them popular residential suburbs. There is an electric railway to the Piraeus and a suburban line to the fashionable resort of Kiphissia.

3. Museums and Societies.—The museums are well arranged, and the remnants of ancient art which they contain have fortunately escaped injudicious restoration. The National Archaeological museum, founded in 1866, contains, among many notable works of art, the bronze youths from Marathon and Cerigotto, the Zeus of Artemisium, the colossal archaic Apollo from Sunium, the Scopaid heads from Tegea and the Demeter relief from Eleusis. Its unrivaled collection of prehistoric antiquities contains the treasures of Mycenae, found by H. Schliemann in the 1870s, by A. J. B. Wace in 1950–55 and by J. Papadimitriou in 1952. There are also terracottas from Tanagra and Asia Minor and numerous painted vases. The Epigraphical museum contains valuable historical inscriptions, while the Acropolis museum (opened in 1878) possesses an interesting collection of sculptures belonging to the archaic period, all found on the Acropolis. In the Polytechnic there is a historical and ethnological museum. The Numismatic museum is in the academy. The Byzantine museum is rich in examples of Byzantine painting, sculpture and embroidery. In the Benaki museum there are specimens of Byzantine, Coptic, Muslim and Chinese art, and a magnificent collection of national costumes. The reconstructed Stoa of Attalus serves as a museum for the agora. There are also a museum of decorative art, a national historical museum and a national gallery. Among Greek societies for encouraging the study of various branches of the arts and other learned subjects is the Greek Archaeological society, which is becoming increasingly active in the conduct of excavations. Foreign archaeological schools in Athens include those of France, Germany, the United States, Great Britain, Austria, Italy and Sweden.

4. Communications and Industry.—Athens, together with the Piraeus, is the terminus of all steamship and railway lines (the Peloponnesian and the main line which connects with Salonika and the direct route to central and western Europe). There are express-train services with London (via Ostend) and Paris. There are regular sailings of passenger steamers between the Piraeus and the main Italian, Turkish and Egyptian ports, as well as Marseilles and New York. Thanks to its geographical position, air communications from the Central airport 8½ mi. from the city link Athens, a centre of tourism, with practically all parts of the world, including London, New York and Paris. There are daily bus services to all important provincial cities, while small steamers from the Piraeus serve the islands of the Aegean and Ionian seas.

Since World War I Athens has become the hub of all mercantile business, export and import. With the Piraeus, it is the most important manufacturing town in Greece. There are cloth and cotton mills, distilleries, breweries, potteries, flour mills, soap factories, tanneries, chemical works, carpet factories, the last an industry established by the refugees from Asia Minor. Exports are tobacco, wine, oil, currants, marble and, more recently, bauxite and magnesite. Publishing is significant. The principal imports are coal, grain and manufacturing articles of all kinds. The city's water is supplied from the Marathon reservoir, built of Pentelic marble.

See also references under "Athens" in the Index.

Bibliography.—M. Hürlimann and R. Warner, *Athens* (1956) C. Biris, *The Rehabilitation of Athens and its Suburbs* (1946).

(P. B. De J.)

ATHENS, a city of Georgia, U.S., 70 mi. E. by N. of Atlanta, on hills overlooking the Oconee river; seat of Clarke county. (For comparative population figures *see* table in Georgia: *Population.*)

Athens was founded in 1801 as the seat of the University of Georgia, which had been chartered in 1785 (*see* Georgia: *Education*).

In 1953 the U.S. navy supply corps school moved to Athens from Bayonne, N.J., occupying what was formerly a part of the university campus.

Among the early 19th-century homes are the Benjamin Harvey Hill home, now the residence of the president of the University of Georgia; the Henry W. Grady residence; and the Lumpkin home where the Ladies' Garden club, the first garden club in the United States, was organized.

Athens is an important wholesale trade centre for northeast Georgia, and after mid-20th century, grew in importance as a manufacturing centre. It is located in a rich agricultural area which produces dairy and beef cattle and poultry. (M. B. Po.)

ATHENS, a city of Ohio, U.S., 75 mi. S.E. of Columbus on the Hocking river; seat of Athens county. (For comparative population figures *see* table in Ohio: *Population.*) It is adjacent to a large conservancy and recreational district which includes Wayne National forest, Zaleski State forest, the scenic Hocking hills and several artificial lakes. The principal manufactured products of the city are business machines and equipment, hand and bench tools, midget motors for scooters, small cars and trucks and printed publications. The Athens State Mental hospital and several area offices of federal and state agencies are located there.

Athens was platted as a university townsite in 1799 by the surveyors of the Ohio company under the direction of Gen. Rufus Putnam, and was chartered as a town by the territorial legislature in 1800. It became the seat of Ohio university, a state-supported institution, the outgrowth of American Western university established there in 1802 under the provisions of the Northwest ordinance of 1787. In 1804 the legislature of Ohio approved the charter and renamed the institution Ohio university (the first collegiate institution in the Northwest territory). It was opened to students in 1808.

Athens was made the county seat in 1805, incorporated as a village in 1811 and as a city in 1911. (G. J. Bl.)

ATHERTON, an urban district of Lancashire, Eng., lies 13 mi. W.N.W. of Manchester by road. Pop. (1961) 19,756. Area 3.5 sq.mi. The name of the old part of the town is Chowbent. The manor was held by the Athertons from King John's reign to 1738, when it passed by marriage to Robert Gwillym and subsequently to Lord Lilford. It is an early Presbyterian centre with a chapel built in 1645 (since demolished) and replaced by another (1722) which is now the Chowbent Unitarian chapel. During the rebellion of 1715 the pastor led some of his congregation against the Old Pretender. The lord of the manor held a court-leet and court-baron annually up to 1891, but in that year Lord Lilford sold to the local board the market tolls, stallages and pickages, and thereafter the courts lapsed. The earliest manufactures were the making of nails or "sparrow bills" and cotton spinning, the latter causing the rapid industrialization of the district. In time the chief sources of employment became cotton mills, collieries, iron foundries and the manufacture of nuts and bolts.

ATHETOSIS, the medical term for certain slow, purposeless and involuntary movements of the hands and feet. The fingers are separately flexed and extended, abducted and adducted in an entirely irregular way. The hands as a whole are also moved and the arms, toes and feet may be affected. The condition is usually caused by some lesion of the brain. The movements may or may not continue during sleep. They cannot be arrested for more than a moment by will power, and are aggravated by voluntary movements. (*See* Nervous System, Diseases of.)

ATHIS-SUR-ORGE, TREATY OF, the treaty concluded on June 23, 1305, between King Philip IV of France and the count of Flanders, Robert de Béthune, after the king's victory at Mons-en-Pévèle (1304) over the Flemings, who in 1302 had defeated the French at Courtrai. By it the count of Flanders, his brothers, the nobility of Flanders and the Flemish towns agreed to swear an oath of loyalty to the king and never to conclude any alliance to which he might object. The Flemings were to assist the king to punish anyone who broke the treaty, even if it were the count of Flanders himself. They were to supply the king for one year with 500 men at arms, and Ghent, Bruges, Lille, Ypres and Douai were to have their fortifications demolished.

count was to pay the king within four years the sum of £400,000 and to make him an annual tribute of £20,000. Every Fleming aged 14 and over had to swear to observe the treaty scrupulously and to give various sureties as to its fulfillment. The Flemish people strongly opposed the treaty, and during the next 20 years Philip IV and his successors had to engage in several military expeditions against Flanders in an effort to enforce it.

See F. Funck-Brentano, *Les Origines de la Guerre de Cent Ans: Philippe le Bel en Flandre* (1897); H. Pirenne, *Histoire de Belgique*, vol. i and ii (1900–32). (M. Pac.)

ATHLETE'S FOOT: *see* Skin, Diseases of.

ATHLETICS (ARTICLES ON): *see* Sports (Articles on).

ATHLETICS, a term commonly used in England for what are known in the United States as track and field sports (*q.v.*), which embrace events in running, jumping and throwing.

An athlete (from the Greek *athlon*, a contest) is one who takes part in any sort of contest involving physical activity, and in the United States athletics comprise not only track and field sports but the entire range of team and individual games and competitive activities, such as football, baseball, basketball, ice hockey, polo, swimming, tennis, fencing and golf.

The development of athletics in the 20th century progressed until it attained an important position in the national life of many countries, involving the expenditure of billions of dollars by millions of people from teen age on.

Most athletic sports are played on an amateur basis in schools, colleges and clubs, and in public park and recreation programs; but sports by professional athletes gained increasing popularity after World War I, particularly football (both U.S. and Canadian, and association football, or soccer), basketball, boxing, wrestling, ice hockey and golf.

HISTORY

Beginnings.—The earliest historical records of athletics are of the Grecian Olympic games (*c.* 800 B.C.). However, references in classical verse, such as the Homeric epics, and in the sagas of pagan heroes and gods indicate that contests of strength, speed and skill predate the historical era.

As early as the 5th century B.C., there was a division of athletes into amateurs, who competed for the love of the sport and for personal glory with no thought of material gain, and professionals, who used their athletic prowess as a means of earning a living. The latter were often recruited from the lower classes of society, including the slaves. The most famous class of professional athletes in ancient times were the gladiators who fought in Roman arenas. These were chiefly slaves captured in frontier wars. Their popularity ebbed in the Augustan era with the introduction of professional Greek athletes, skilled in the Olympic contests.

The ancient Olympic games were terminated by order of the emperor Theodosius in A.D. 394. (*See* Olympic Games. For Pythian and other Greek and Roman games *see* Games, Classical.)

Decline.—The history of athletics between the fall of Rome in the 5th century and the 19th century is quite sketchy. Religious festivals in the middle ages were often accompanied by rude ball games between rival towns and guilds. These were forerunners of the great spectator sports of the 20th century: soccer, baseball, tennis, football, etc. Contests of strength and skill were also common at harvest fairs. Other sports such as archery, shooting, riding and hunting were encouraged by rulers for their value in wartime.

Revival.—The coming of the Industrial Revolution in the mid-18th century and the later introduction of sports as a regular extracurricular activity in English public schools by Thomas Arnold (*c.* 1830) provided a spur which led to the great development of sports during the Victorian age in England.

Capping this athletic revival of the 19th century was the restoration of the Olympic games at Athens in 1896. As the 20th century dawned, interest in all competitive sports reached a peak and, despite two world wars and numerous minor hostilities, this interest continued to grow.

With the growth of popular interest in sports and with the gradual breakdown of class distinctions at all levels of society, the ancient wall between the amateur and professional athlete began to be broken down. The professional was still, at the start of the 20th century, one to be tolerated rather than accepted in polite society. His services were sought as a teacher in such sports as golf and tennis, but the concept of the "amateur gentleman" of sport, one who did not work for his living, was still popular until World War I.

The so-called "golden age" of athletics which followed that war wiped out the last vestige of this class distinction. Both professional and amateur athletic competitors such as George Herman ("Babe") Ruth in baseball; William Tilden in tennis; Walter Hagen in golf; Harold ("Red") Grange in football; Thomas Hitchcock, Jr., in polo; Paavo Nurmi in track; Don (later Sir Donald) Bradman in cricket; and Jack Dempsey in boxing captured the imagination of all classes of society and became national heroes.

The athlete after mid-20th century was likely to start his career as an amateur either in school, university or club competition. He would then move to professional status if his skills were strong enough. Only the most talented athletes in strictly amateur sports such as track, field, swimming, gymnastics, etc., remain in competition past the age of 25. Professional careers last, in some instances, past 40.

TRAINING

Ancient.—The training of an athlete in ancient Greece involved both physical and spiritual preparation. Candidates for the Olympic games and for other, lesser festivals were accustomed to live a celibate life in outdoor camps, devoting weeks and even months to arduous preparation. (*See* Olympia: *History*.)

Every precaution was taken to ensure that they were in prime physical condition for the games. Diet was strictly supervised and consisted chiefly of fresh cheese, dried figs, wheat bread and meats which are still the staples of training menus in the 20th century. Wine was allowed the Greek athletes in small quantities.

Competition consisted of running, leaping, hurling the discus and javelin, boxing and wrestling. In training, the athletes practised these events and also used other methods to strengthen their muscles, such as carrying heavy loads, lifting weights, bending iron rods and taming bulls. Few athletes were specialists in any one sport as the most important Olympic contests involved a combination of two or more events, such as the pentathlon (*q.v.*).

As religious preparation for the games, athletes sacrificed to the gods. Women were barred from the games at first, even as spectators. While competing, the athletes were naked, having their bodies salved with oil. Boxers wore a strap of leather, the *caestus*, bound tightly around the wrist and forearm.

It was considered a great honour to compete in the Olympic games and champions were treated as national heroes. All athletes swore an oath, calling upon the gods to witness that they would compete honourably, win or lose.

Modern.—While open religious practices are rare in modern athletics (they are retained in some forms of Japanese wrestling), the training-camp system has been preserved. The emphasis, however, in many modern sports is on the specialist. Such sports as golf, bowling, baseball and cricket lay greater emphasis on an athlete's technical skill than on his physical prowess. The long seasons of such sports as baseball, soccer, football and basketball also tend to minimize the importance of the training season, which becomes little more than an opportunity to retone muscles which have lost their co-ordination during the off season.

The purpose of training, whatever the sport, is to prepare the athlete, physically and psychologically, for competition. Physically, the concentration is on creating endurance, speed or strength, depending on the event. Psychologically, the athlete's mental attitude should be keyed so that he looks forward eagerly to the contest. The intensity of his eagerness should depend on the sport; a prize fighter normally will be more highly keyed than a tennis player.

Training procedures which fit almost all sports are walking, running, light calisthenics and light weight-lifting. The first

two exercises develop breath control and muscular endurance; the last two tone individual muscles and prepare the athlete for certain types of resistance he will meet in competition.

Once past the preliminary stages of conditioning his body, the athlete will concentrate on his individual specialty. In such sports as running and swimming, he will test himself at distances over and under those at which he usually competes to build up both endurance and speed. In team sports, he will first practise individual skills, such as batting, throwing and catching a ball in baseball. Then he will join with the other athletes in practising teamwork.

Medical examinations are required of most athletes before the training season begins; after that, large clubs and almost all schools and colleges employ a trainer who watches the condition of the athletes under his care. He checks their weight, examines and treats minor injuries, rubs them down with liniments to keep muscles loose after workouts and tapes sore or weak muscles.

The sport which requires the most intense training and highest degree of conditioning is running (*q.v.*), particularly over the longer distances. Methods of training vary, but a popular one introduced by Scandinavian runners after World War II is interval training, or *fartlek* (speed play), which consists of fast sprints alternating with long trots. It gives the distance runner more speed than the steady pacing of earlier methods and trains him to put on several bursts of speed during a race without tiring.

Attempts to train great masses of athletes were carried on in the U.S.S.R. and other eastern European nations after World War II with some remarkable results in sports such as gymnastics and distance running. These nations also carried physical culture for women far beyond anything attempted by other nations. There being, technically, no professional athletes under Soviet governments, amateur careers in these nations lasted far longer than in non-Communist countries.

ATHLETIC ASSOCIATIONS

Each amateur sport conducted on an international basis has its own federation, to which the various national federations belong. In addition, the international federations of the Olympic sports are affiliated with the Comité International Olympique (International Olympic committee [I.O.C.]), while the national federations are affiliated with the various national Olympic committees (*see* OLYMPIC GAMES). This complex organization grew from the 1896 Olympic revival, when it was decided to base the events on the program of the Amateur Athletic union of the U.S. For information on federations governing specific sports *see* articles on those sports, as FENCING; HOCKEY; SWIMMING; etc.

International.—Athletics (track and field) governing bodies sprung up in the latter half of the 19th century. Following upon the founding of the English Amateur Athletic association (A.A.A.) in April 1880 in an Oxford hotel there came the formation of the New Zealand A.A.A. (1887); the Amateur Athletic Union (A.A.U.) of the U.S.A. (1888); the A.A.U. of Canada (1888); Ligue Royale Belge d'Athletisme (Belgium, 1889); the South African Amateur Athletic and Cycling association (1895); Svenska Fri-Idrottsforbundet (Sweden, 1895); A.A.U. of Australia (1897); Ceskoslovenska Obec Sckolska-ustredi Lehke Atletiky (Czechoslovakia, 1897); Hellenic A.A.A. (Greece, 1897); Magyar Athlétikai Szövetség (Hungary, 1897); Federazione Italiana di Atletica Leggera (Italy, 1898); and Deutscher Leichtathletik-Verband (Germany, 1898).

In the 20th century national associations from more than 70 countries were formed. In 1913 in Stockholm, Swed., a world governing body, the International Amateur Athletic federation (I.A.A.F.), was set up and it is to this body that all national associations except that of Communist China, which withdrew in August 1958, became affiliated. The I.A.A.F., together with the world governing bodies of the other Olympic sports, is in turn affiliated, as stated, to the I.O.C. These associations sponsor annual national championship matches in their sports, and, except for track and field, most of them also promote world championship competition in non-Olympic years.

United States.—*The A.A.U.*—The Amateur Athletic Union of the U.S.A. was born in 1888 out of the arguments then being waged over professionalism. It took into its own hands the responsibility of certifying athletes as amateurs in a variety of sports. In 1889, it divided the U.S. into districts and claimed jurisdiction over 17 sports.

Collegiate Associations.—The development of sports in the United States during the 20th century brought into great prominence the associations which directly govern intercollegiate and interscholastic athletics. Chief among these are the National Collegiate Athletic association, the Eastern College Athletic conference and the National Federation of State High School Athletic associations.

The National Collegiate Athletic association (N.C.A.A.) was founded in 1905, at the urging of Pres. Theodore Roosevelt, as an advisory body for collegiate sports when there was a move to abolish football because players were being injured and killed. At first the group merely wrote rules for eligibility and competition, but in 1921 it conducted a track-and-field championship, thereafter branching out to do the same in other sports. The N.C.A.A. is organized into a number of geographical districts, each with a vice-president who serves on the council, the association's principal policy-making body. In 1948, it adopted a "sanity code" to regulate excesses in college recruiting policies. Thereafter, it penalized many schools for violations of this code, usually involving excessive financial aid to athletes or undue activities in inducing outstanding high school athletes to attend the offending institution.

Many college conferences are affiliated with the N.C.A.A., the largest being the Eastern College Athletic conference (E.C.A.C.), formed in 1938 with more than 20 subsidiary leagues and over 100 members. The E.C.A.C. grew from the Intercollegiate Association of Amateur Athletics of America (I.C.4-A.), a track-and-field organization founded in 1875. The I.C.4-A. is the oldest athletic organization in the United States; it conducts three annual meetings—an indoor and an outdoor track-and-field championship and a cross-country championship.

Some of the more important college conferences in the United States are the Western (Big Ten), Southern, Atlantic Coast and Ivy League. Each of these conducts its own championship matches and sets its own eligibility rules, always within the pattern established by the N.C.A.A. An independent association is the National Association of Intercollegiate Athletics, composed of smaller colleges and universities, some of them N.C.A.A. members.

High School Associations.—The National Federation of State High School Athletic associations was organized in 1920 at a meeting to discuss problems which had resulted from high school contests promoted by outside organizations and individuals. It conducts no championships and, in fact, frowns upon national meets and tournaments. It promulgates rules of competition and issues handbooks for various high school sports. It had more than 50 member associations in the latter half of the 20th century, representing more than 20,000 schools with a total enrollment of over 5,000,000.

Europe.—England and other European nations have no such highly organized intercollegiate competition as the United States. Athletics in these countries are conducted chiefly on a club basis, though universities such as Oxford and Cambridge engage in both intercollegiate and international competition. However, athletic events are strictly supervised and controlled. In England, a number of athletic clubs were formed as early as the 1860s, such as the West London Rowing club, which developed the first definition of eligibility for amateur competition. In all major sports, the European nations annually sponsor squads which take part in dual competitions as well as in world and regional championships. Club competition in the United States, on the other hand, deteriorated greatly during the first half of the 20th century as intercollegiate competition grew, and U.S. Olympic teams in track-and-field, basketball and other of the more popular sports were largely collegians.

See also GAMES, CLASSICAL; OLYMPIC GAMES; TRACK AND FIELD SPORTS; and, for a summary of titles of separate articles on sports and games, SPORTS (ARTICLES ON). (E. J. G.)

ATHLONE, GODARD VAN REEDE, Heer van Ginkel and 1st Earl of (1644–1703), Dutch soldier, who distinguished himself in the service of England, was born in June 1644 at Amerongen in Utrecht. He followed William of Orange to England in 1688 and took part in the suppression of a mutiny in a Scottish regiment. In 1691 he was made commander of the forces in Ireland. On June 30 that year he carried Athlone by storm, and on July 12 near Aughrim he decisively defeated and dispersed the Irish army, already disorganized by the death of its French commander, Saint-Ruth. Galway next capitulated, and Ginkel followed up this victory by a series of bold and successful manœuvres by which he captured Limerick, the Irish cavalry camp and the fort on Thomond bridge. The signing (Oct. 3, 1691) of a capitulation at Limerick completed his conquest of Ireland. For his services Ginkel received the earldom of Athlone and the barony of Aghrim in the peerage of Ireland. He died at Utrecht on Feb. 11, 1703. His British titles became extinct on the death of the 9th earl without issue in 1844. (J. P. K.)

ATHLONE (Áth Luain), an urban district in County Westmeath, Ire., on the river Shannon, 78 mi. W. of Dublin by road. Pop. (1961) 9,624. Area 1.9 sq.mi. A castle and a bridge were built by John de Grey, bishop of Norwich and justiciar of Ireland, in 1210. The first walls were erected in 1257. It became the seat of the presidency of Connaught under Elizabeth I and withstood a siege in 1641.

In the war of 1689 the town sustained two sieges, the first by William III, which failed, and the second by Gen. Godard van Ginkel in 1691. In 1797 the town was strongly fortified on the Roscommon side, but the works are now dismantled. Athlone was incorporated by James I and returned two members to the Irish parliament and afterward one member to the imperial parliament till 1885.

T. P. O'Connor, the politician and journalist, and John McCormack, the singer, were both natives of Athlone.

The river Shannon divides the town into two portions, the Leinster side (east) and the Connaught side (west). These are connected by a bridge, opened in 1844, the central portion of which is a swivel bridge. A lock communication with a basin renders the navigation of the river practicable above and below the town and permits pleasure cruises on the Shannon.

Athlone is an important agricultural centre and has a large cotton factory. The famous woolen mills, burned in 1940, are in production again. There are three Roman Catholic chapels, a courthouse and the Father Matthew hall, donated in 1952 and now housing the municipal offices and the library. About 1 mi. N. the Shannon broadens out into Lough Ree, which is famous for coarse fishing and is visited each year by thousands of anglers from all over Europe. The main transmitting station for Radio Éireann is at Athlone.

ATHOLL, EARLS AND DUKES OF. The territory of Atholl, together with Gowrie, originally formed one of the seven mormaorships of Scotland (*see* Mormaor), and its rulers became earls during the 12th century. In the 14th century the title was held by various members of the royal family. The Stewart line of the earls of Atholl originated with Sir John Stewart of Balveny (d. 1512), who was created earl of Atholl about 1457 (new charter, 1482).

John Stewart (d. 1579), 4th earl of Atholl in the Stewart line, succeeded his father, John, the 3rd earl, in 1542. As one of the principal Catholic nobles of Scotland, he was particularly trusted by Mary Stuart, but after the murder of Lord Darnley in 1567 he joined the Protestant lords against her and on her abdication was included in the regent's council for her son James VI. But he was again advocating her cause by 1569. He failed to prevent the earl of Morton's appointment to the regency in 1572, but succeeded, with the earl of Argyll, in driving him from office in March 1578, when James dissolved the regency and Atholl was appointed lord chancellor. Morton however regained his guardianship of James two months later. Atholl and Argyll, who were seeking assistance from Spain, then advanced to Stirling with a force of about 7,000 men, whereupon a compromise was arranged, the three earls being all included in the government. After a banquet held on April 20, 1579, to celebrate the reconciliation, Atholl became suddenly ill and his death on April 24 or 25 may have been caused by poison.

On the death in 1595 of his son John, 5th earl of Atholl, the earldom in default of male heirs reverted to the crown. Dorothea, daughter of the 5th earl, married (1604) William Murray, 2nd earl of Tullibardine, who in 1626 resigned that earldom in favour of his younger brother Sir Patrick Murray, on condition of the revival of the earldom of Atholl in his wife and her descendants.

John Murray (d. 1642), their only son, was accordingly created 1st earl of Atholl in the Murray line (1629). On the outbreak of the Bishops' War he called out the men of Atholl for Charles I and was imprisoned by the earl of Argyll in Stirling castle in 1640. He died in June 1642.

John Murray (1631–1703), 2nd earl and 1st marquess of Atholl (created 1676), son of the 1st earl, was born on May 2, 1631, and became a leading royalist. He was the chief supporter of the earl of Glencairn's rising in 1653, but was obliged to surrender a year later to George Monck, the Commonwealth commander in chief in Scotland. At the Restoration, Atholl received many high offices in Scotland and at first supported the tyrannical policy of the earl of Lauderdale, the high commissioner. But after the campaign of 1678, called the "Highland Host," in which he was among the leaders, he joined in a remonstrance to the king against the severities inflicted on the Covenanters and, although he was made vice-admiral of Scotland in 1680 and president of parliament in 1681, he was passed over for the chancellorship which became vacant in that year. Appointed lord lieutenant of Argyll in 1684, he had by 1685 become master of that region and at Inchinnan in June captured the earl of Argyll, who was leading an invasion in favour of the duke of Monmouth. In the revolution of 1688–89 he acted indecisively, although he took part in the proclamation of William and Mary as king and queen at Edinburgh. During Dundee's rebellion he retired to Bath to "take the waters," but became implicated in the Jacobite plot of Sir James Montgomery (1690) and subsequently in further similar intrigues. He received a pardon in June 1691 and acted later for the government in the pacification of the Highlands. He died on May 6, 1703. He married Amelia, daughter of James Stanley, 7th earl of Derby, through whom the later dukes of Atholl acquired the sovereignty of the Isle of Man (1736).

John Murray (1660–1724), 2nd marquess and 1st duke of Atholl (created 1703), was born at Knowsley, Lancaster, on Feb. 24, 1660. He favoured the accession of William and Mary in 1689, but was unable, during his father's absence, to prevent the majority of his clan under the command of his brother, Lord James Murray, from joining Dundee's rising. An attempt was made in 1703–04 by Simon, Lord Lovat, who used the duke of Queensberry as a tool, to implicate him in a plot against Queen Anne; but the intrigue was disclosed by Robert Ferguson and Atholl sent an explanation to the queen which resulted in Queensberry's downfall. Between 1705 and 1707 he vehemently opposed the union of England and Scotland, but on the score of illness, real or feigned, he took no part in the Jacobite invasion of 1708 and was kept under close watch in his castle at Blair (Perthshire). When the Tories came to power in 1710 Atholl returned to office and was high commissioner for Scotland from 1712 to 1714. He was dismissed on the accession of George I (1714), but at the rebellion of 1715, while three of his sons joined the Jacobites, he supported and assisted the government. He captured, on June 4, 1717, Rob Roy (Robert Macgregor), who succeeded, however, in escaping. Atholl died at Huntingtower, Perth, on Nov. 14, 1724.

John George Stewart-Murray (1871–1942), the 8th duke, married Katharine Marjory (1874–1960), daughter of Sir James Ramsay of Bamff, the historian. She was an M.P. from 1923 to 1938, and was parliamentary secretary to the board of education from 1924 to 1929. She published several books on international affairs. The present holder of the title, George Iain Murray (1931–), succeeded as 10th duke in 1957.

See *The Manuscripts of the Duke of Athole* (Historical Manuscripts Commission, 1891); S. Cowan, *Three Celtic Earldoms* (1909).

(G. S. P.)

ATHOLL or ATHOLE, a mountainous district in north Perthshire, Scot., area about 450 sq.mi., bounded on the north by Badenoch, on the northeast by Braemar, on the east by Angus (Forfarshire), on the south by Breadalbane, on the west and northwest by Lochaber.

It is watered by Tay, Tummel, Garry, Tilt, Bruar and other streams. Glen Garry and Glen Tilt are the chief glens, and Loch Rannoch and Loch Tummel the principal lakes. The population is mainly in Pitlochry and Blair Atholl (*q.v.*). Mountains with peaks reaching over 3,000 ft. (Ben-y-Gloe 3,671, Ben Dearg 3,304) enclose the Atholl basin whose floor level lies at about 1,500 ft. It can be entered by the pass of Killiecrankie (*q.v.*) on the south and of Drumochter on the north.

Pasture and a little cultivable land are found in the lower valleys. Red deer come down from the mountains to winter in the plains. Hydroelectric power stations have been constructed along the Tummel.

ATHOS, MOUNT, the most easterly of the three promontories of the peninsula of Chalcidice, Greece, which runs down from Macedonia into the Aegean sea. It is 30 mi. long and 6½ mi. wide at its broadest point, and has a mountainous spine thickly wooded at its northern end, culminating in the marble peak of Mt. Athos (6,667 ft.), which rises abruptly from the sea. The ancient name of the promontory was Acte. In 483–481 B.C. Xerxes cut a canal, traces of which are still visible, through its narrow neck to avoid taking his fleet round the treacherous cape. Under the name of the Holy Mountain (Ayion Oros), it is now a theocratic republic of Orthodox monks, inhabiting 20 monasteries and their dependencies, whose only town is its capital, Kariai (Karyes) (pop. [1961] 429). Of the total population (2,687 in 1961), which is exclusively male, less than 2,000 are monks, the remainder being lay officials and labourers.

Hermits first settled on Athos before 850 A.D., and by the 10th century had associated in small communities (Gr. *Lavrai*) under the general direction of a *protos*, with his seat at Kariai. In 963, however, the monk Athanasius of Trebizond, with the help of his friend and imperial patron, Nicephorus II Phocas, founded the first regular monastery, the Great Lavra, adhering to the rule of St. Basil as observed in the monastery of Studios in Constantinople. Athanasius was denounced as an innovator by the hermits; but in 971–972 the emperor John I Tzimisces settled the dispute by granting Athos its first charter or typikon. Two more monasteries, Vatopedi and Iviron, were built in the 10th century and several more in the 11th; and in 1046 Constantine IX ratified a second charter regulating the life of the greatly increased monastic population. In the 12th century the Russian monastery of St. Panteleimon or Rossikon was founded; and in 1198 Stephen Nemanya of Serbia and his son Rastko (St. Sava) built the monastery of Chilandari. Athos was plundered after the 4th crusade (1204), and again by the Catalans in 1307–09. But it revived in the 14th century, when many of the monks, notably St. Gregory Palamas, strongly upheld the doctrine of Hesychasm (*q.v.*). Andronicus II placed it under the jurisdiction of the patriarch of Constantinople; and by 1400 nineteen of the monasteries had been founded. The last built was that of Stavronikita (1542).

In the 15th century some of them abandoned the traditional communistic regime of a cenobitic community (Gr. *koinobion*), under the rule of an abbot, in favour of the more liberal idiorrhythmic system, in which the monks could possess personal property and be governed by two annually elected trustees (Gr. *epitropoi*). After the Turkish conquest of Salonika in 1430 the monks prudently submitted; but the tribute which they had to pay to the sultan led, despite the patronage of the rulers of Walachia, Moldavia and Russia, to the rapid impoverishment and decadence of their monasteries, and the increasing adoption of the idiorrhythmic system. It was in reaction against this development that there were founded (from the 16th century) the first sketes or ascetic settlements grouped round a common church as offshoots of the monasteries. In 1749 a vain attempt was made to revive intellectual life by the foundation of an Athonite academy. The patriarch Gabriel IV introduced successful reforms in a new charter in 1783; but, at the outbreak of the Greek War of Independence in 1821, a Turkish garrison of 3,000 troops did great damage to the monasteries and their libraries. In the 19th century Athos became an object of czarist imperialism, and the Russian monastery and its properties grew to enormous proportions. In Nov. 1912 it was liberated from the Turks by the Greek army; and the London conference of 1913, followed by the treaties of Sèvres (1920) and Lausanne (1923), declared it an independent republic under the protection of Greece.

Its present constitution was drawn up by the abbots and elders in 1924, and forms part of the Greek constitution of 1927. The Greek government is represented by a prefect; but the actual administration is in the hands of the Holy Community, composed of 20 annually appointed representatives, one from each of the "ruling" monasteries, and an executive committee of 4 monks, the Holy Epistasia, which dates from 1783. Eleven of the monasteries are at present cenobitic and nine idiorrhythmic, discipline and fasting being much stricter in the former. Dependent upon them are 12 sketes, some 200 *kellia* or smaller eremitical communities and several *kalyvai* or hermitages (Gr. *hesychasteria*), where anchorites and solitaries live in the greatest austerity and isolation. Most of the monasteries are built near the coast and consist of a quadrangle of buildings enclosing the main church; each has its tower or keep, which often houses the library. The churches contain some of the most important examples of Byzantine art and many miracle-working icons, relics and treasures; and the libraries, despite successive depredations, still possess a vast quantity of classical and medieval manuscripts, most of which have been catalogued. Since the 11th century no women have been allowed on Athos, which is dedicated to the Virgin Mary. The life of the monks is almost wholly devoted to prayer and fasting, although a small trade is done in icons and wood carvings.

The thousandth anniversary of the founding of the Great Lavra was celebrated in 1963, with festivities organized through the joint initiative of the ecumenical patriarchate and Greece.

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ATITLÁN is an elevated mountain lake of spectacular beauty famous as a tourist attraction of Guatemala. It occupies a roughly kidney-shaped natural crater of tremendous depth, approximately 11 mi. long and 5 mi. wide, formed between a precipitous, curving mountain wall and three volcanoes, San Pedro, Tolimán and Atitlán, which at that point form the escarpment of the highlands on the Pacific side.

In addition to its scenic grandeur, the lake is noted for the Indian villages that dot its shores, the inhabitants of which wear hand-woven costumes identifiably similar but detectably distinct. Among the best-known villages are Santiago Atitlán, San Pedro la Laguna and San Lucas Tolimán on the south shore, and San Antonio Palopó on the east. The lake is important in the domestic economy of the villagers, and it forms a significant transportation link in local commerce between highlands and lowlands. There is an abrupt fall in elevation toward the Pacific. The lake has no known outlet. (W. J. G.)

ATJEH (ACHIN), a province in northern Sumatra, Indon., forms the northern extremity of the island. The boundary extends from Salahadji on the east coast just north of Aru bay to a point on the west coast about midway between Singkil and Barus. Pop. (1961) 1,628,983; area 21,387 sq.mi. Atjeh is divided into four districts. It is very mountainous, with long ranges running parallel with the axis of the island, but, except in the extreme north, there is a fairly wide coastal plain, narrower in the east than in the west. The rivers are short, run down sharply to the coast and have little value for shipping, except small native boats.

The ports of Atjeh are Uleelheue and Sigli on the north and Lhokseumawe and Idi on the east coast, but large vessels go to

the free port of Sabang (*q.v.*) on We Island, 50 mi. N. of Uleelheue. Uleelheue is the gateway to Kutaradja (Kota Raja), the capital of the province, which is situated on the Atjeh river, about 3 mi. up from the sea. Kutaradja (pop. [1956 est.] 26,473) still possesses remains of its former glory when Atjeh was the wealthiest and most powerful sultanate in northern Sumatra, but the modern town consists largely of wooden and atap-roofed houses, a large mosque, some modern residences, offices and business premises.

History.—The cradle of Atjeh is at the very north end of Sumatra, known to the Arabs in the middle ages as Alrami or Lamari. In the 13th century it became the first Muslim stronghold in the archipelago. By 1525 Achin, as it was then known, had gained control over the coastal lands that now are part of the province of Atjeh. Its power reached its height in the time of Sultan Iskandar Muda (1607–36); extending in Sumatra southward to Palembang on the east coast and Bengkulu (Benkulen) on the west coast, and including on the mainland the states of Johore, Pahang, Kedah and Perak. In this period there were frequent wars with the Portuguese, who had established themselves at Malacca.

At their first arrival the Dutch (1599) and the English (1602) tried to establish factories in Atjeh, but these and later attempts were unsuccessful. After a short-lived alliance of the Dutch and the Achinese (Atjehnese), when the latter helped the Dutch in capturing Malacca, 1641, the sultanate of Atjeh declined in influence under Dutch pressure.

When, after the Napoleonic Wars, the East Indies were restored to the Netherlands, the British government sought to keep Dutch influence out of Atjeh. The treaty of 1824 with the Netherlands stipulated that, although all of Sumatra was recognized as within the Dutch sphere of control, no proceedings hostile to Atjeh should be undertaken by the Netherlands. Piracy, which had been common in these waters, became worse, with the Atjehnese immune to any measures by the Dutch navy. After many Dutch requests, the reservation regarding Atjeh was formally abandoned by the British in 1871, and in 1873 the Dutch declared war on Atjeh. It became a drawn-out struggle in which periods of Dutch control alternated with fresh rebellions, ending only in the early years of the 20th century under the direction of Gen. J. B. van Heutsz (later Governor-General). Until the very end of Dutch colonial rule Atjeh remained a not fully pacified region.

Following Japanese occupation and surrender in World War II there was political upheaval, in which the petty nobles who had served the Dutch and the Japanese were liquidated, and the Muslim religious teachers (Ulama) came to power under the leadership of Daud Beureuh. These men soon found themselves in disagreement with the central government. They objected to Javanese domination of the republic, desired an Islamic rather than a secular state, feared Communist influence and felt neglected in the economic sphere. In 1953 there was open rebellion, which was not fully suppressed by central government forces nor solved by the creation of a separate province of Atjeh in 1956.

The People and Economy.—The Achinese (*q.v.*), a Malayan people and devout Muslims, occupy the lowlands and adjoining hills. In the interior highlands live the Gayos, also Muslim, but in speech and culture more closely related to the Batak (*q.v.*). Rice is the food staple; it is grown more under *sawah* (wet) culture than *ladang* (dry), and there are irrigation works for the crop. Pepper, copra, areca nuts and rubber are the chief exports. Cattle raising, fishing and coastal trade are of some importance. There are some petroleum fields along the east coast.

A narrow-gauge railway links Kutaradja with Uleelheue and across country with Sigli on the northeast coast and from there to Medan. *See* also SUMATRA. (J. O. M. B.)

ATKIN, JAMES RICHARD ATKIN, BARON OF ABERDOVEY (1867–1944), British judge whose career included much work on the relationship between crime and insanity, was born in Queensland, Austr., on Nov. 28, 1867.

Educated at Christ college, Brecon, and at Magdalen college, Oxford, he was called to the bar at Gray's Inn in 1891, was elected a bencher and took silk in 1906. He became a judge of the high court (King's bench division) in 1913, was promoted to the court of appeal in 1919, and became a lord of appeal in ordinary in 1928, when he was created a life peer.

Atkin was a judge of liberal views as well as of great learning. In the course of his career he pressed for a legal redefinition of insanity, and, in the famous case of *Liversidge* v. *Anderson* (1942 A.C. 206), he delivered a dissenting judgment seeking to restrict the freedom of the executive from judicial control in relation to wartime powers of internment. He took part in many government inquiries, being chairman of the committee on crime and insanity in 1924.

Atkin died at Aberdovey, Wales, on June 25, 1944.

(W. T. Ws.)

ATKINSON, SIR HARRY ALBERT (1831–1892), New Zealand statesman who was an outstanding figure in the various Conservative governments of 1879–90 known as the "continuous ministry," was born in England at Broxton, Cheshire, on Nov. 1, 1831. His family emigrated to New Zealand in 1853 and settled at New Plymouth. Atkinson, appointed captain in the Taranaki Volunteer Rifles in 1860, was known as a good bush soldier and competent leader. He entered parliament in 1861. As minister of defense in the government of Sir F. A. Weld (1864–65) he urged that it would be cheaper and more effective to use only colonial troops against the Maoris and remained an advocate of this policy of "self-reliance." After visiting England he re-entered the New Zealand parliament (1872), joined Sir Julius Vogel's cabinet (1874) and was prime minister himself from 1876 to 1877, when he was foremost in abolishing the nine provincial governments and rearranging the administration. In 1877 the Liberals defeated his Conservative party, but in 1879 he returned as colonial treasurer to face a depression which lasted 14 years. Atkinson applied the unpopular remedy of cutting all government salaries by 10%, replacing John Ballance's land tax with a heavier property tax and increasing other taxation. He was prime minister from Sept. 1883 to Aug. 1884 and again after the interlude of the Stout-Vogel ministry (1884–87), bringing more retrenchment, cutting salaries of the governor, ministers and members of parliament, raising duties to protection level and saving everywhere to balance his budgets. He continued in office until Dec. 1890.

Self-taught, rough-hewn, resourceful and confident of mastering anything by sheer application, Atkinson could overpower more eloquent colleagues by his command of financial detail. The depression compelled rigorous economy, but he was not unsympathetic to hardship and in 1882 he, unsuccessfully, proposed a state insurance scheme for the aged, sick, widowed and orphaned. Knighted in 1888, he died at Wellington on June 28, 1892.

(N. M. TA.)

ATKINSON, SIR WILLIAM NICHOLAS (1850–1930), British inspector of mines, who first established the part played by coal dust in mine explosions, was born at Loughor, Glamorgan, on Nov. 19, 1850. Entering the civil service in 1873, he served, in turn, as assistant inspector of mines for the Newcastle upon Tyne and Durham area, inspector for the Staffordshire district, superintendent-inspector for the south Wales area and divisional inspector at the home office. With his brother, J. B. Atkinson, he published a book on explosions in coal mines in which he astonished his contemporaries by proving that, in the absence of firedamp, explosions are propagated by coal dust alone. He contributed many valuable reports on explosions and mine ventilation in the districts he inspected and, with J. S. Haldane, described the composition and origin of blackdamp and its health hazards. Atkinson was president of the Institution of Mining Engineers, 1894–95, and was knighted in 1918. He died at Wolverhampton on Feb. 15, 1930. (C. W. D.)

ATLANTA, the capital of Georgia, U.S., and its largest city, in the north-central part of the state, 8 mi. S. of the Chattahoochee river; lying mostly in Fulton county, of which it is the county seat, but partly also in De Kalb county. It is the financial and commercial capital of the southeast, the transportation and communication centre of the region and also an important distribution, manufacturing, educational and medical centre. Besides being the regional headquarters for most business and industrial concerns of national scope, it serves as the seat of most of the

activity of the federal government in the southeast. Atlanta is the most populous city between Washington, D.C., and New Orleans, La., and it is the centre of a large standard metropolitan statistical area, comprising Clayton, Cobb, De Kalb, Fulton and Gwinnett counties and including Marietta (*q.v.*), Decatur (*q.v.*), College Park and Hapeville. Pop. (1960) city 487,455; standard metropolitan statistical area 1,017,188. For comparative population figures *see* table in GEORGIA: *Population; see* also *Population*, below.

The city is located on the Allegheny watershed in the foothills of the Blue Ridge mountains. It is on the northern edge of the Piedmont and, although within sight of mountain ranges, is only 300 mi. from the Atlantic and Gulf coasts. At 1,050 ft. above sea level Atlanta is one of the highest large cities in the U.S. Rainfall is evenly distributed throughout the year, and the average mean monthly temperature ranges between 43.2° F. in January and 78.1° F. in July. The climate is invigorating, and, because of the elevation, nights are cool even in summer months.

One of the important influences in the development of Atlanta's distinctive character is the fact that it is an inland city located on no major body of water or navigable stream. It owes its existence and development to the railroads, the location of which were determined by geography. Situated at the southern extremity of the Appalachian range, it has become "the Gate City of the South" through which most overland traffic must pass between the eastern seaboard and the region to the west. It is a relatively new city having been largely rebuilt after it was burned by Union troops in 1864. Although not laid out according to a plan, the business district is impressive. There are numerous residential areas within the city and its environs. Dogwood abounds and in the spring, when its blossom is intermingled with redbud, crab apple and azalea, the city attracts many visitors.

Atlanta is often described as the symbol of the new south, having risen like the phoenix from the ashes of the Civil War. It is also famed as the home of Coca-Cola, whose developer, Asa G. Candler (1851–1929), was an Atlanta builder. Of particular interest to the visitor are Peachtree Street, the Cyclorama, a gigantic painting of the battle of Atlanta; the Wren's Nest, home of Joel Chandler Harris (1848–1908), the creator of Uncle Remus; and Stone mountain, an outcrop of naked granite, 15 mi. S.E. of the city. Atlanta, peopled primarily by southerners of rural background until World War II, has since felt the impact of the immigration of many non-southerners who serve the regional business and government offices. The spirit of the city tends to be liberal within the framework of southern conservatism. The attractions tend to be traditional rather than exotic. Customs have been influenced by the predominantly Protestant church tradition in the Bible belt.

History.—The founding of Atlanta came late in the history of Georgia. Title to the territory was not acquired from the Creek Indians until 1821. In 1837 a spot near the present site of the Union station was selected for the southern terminus of a railroad to be built by the state northward toward Chattanooga, Tenn., on the Tennessee river. The village was appropriately called Terminus, but in 1843 when a charter was granted the name was changed to Marthasville, in honour of the daughter of Gov. Wilson Lumpkin; and in 1845, when the city was incorporated, the name was changed to Atlanta, which was suggested by the name of the railroad (the Western and Atlantic). By 1860 the Georgia railroad, the Central railroad of Georgia, and the Atlanta and West Point railroad had been completed to Atlanta to connect with the Western and Atlantic. The basis had been laid for Atlanta to become the principal inland transportation centre for Georgia and the southeast. Atlanta's population, however, had not reached 10,000.

During the Civil War Atlanta became a depot of supplies and the location of Confederate war industries. It was also the keystone of Confederate transportation east of the Mississippi. Its importance made it the military objective of Gen. W. T. Sherman's invasion of Georgia from Chattanooga, in 1864 (*see* ATLANTA, BATTLES AROUND). Confederate Gen. Joseph E. Johnston brought his smaller army intact across the Chattahoochee river by mid-July; but he was replaced July 17 by Gen. John B. Hood, who was expected to fight rather than to continue to retreat. The battles of Peachtree Creek, Atlanta, Ezra Church and Jonesboro sealed the fate of Atlanta. Confederate forces were defeated and forced to evacuate the city. Union troops entered on Sept. 2. Civilians were ordered to leave and Atlanta was converted into a military camp. On Nov. 15 Sherman departed on his famous "march to the sea" but not before the city had been fired and a large part of it burned.

During the Reconstruction period Atlanta was the centre of federal government activities. In 1867 it became headquarters for the 3rd military district under Gen. John Pope. Later in the same year it was the meeting place for the constitutional convention which drew up the Georgia constitution of 1868. It became the capital of Georgia under the Republican state administration elected in 1868.

Under the leadership of Gov. Joseph E. Brown, Sen. Benjamin H. Hill, *Constitution* editor Henry W. Grady and others, Atlanta came to epitomize the spirit of the new south, advocating reconciliation with the north in order to restore business. This spirit was dramatized by three expositions held in Atlanta: the International Cotton exposition in 1881, the Piedmont exposition in 1887 and the Cotton States and International exposition in 1895. At the latter Booker T. Washington made his historic declaration, known as the Atlanta compromise, urging the Negro to seek economic security before expecting political or social equality.

Atlanta political leaders were a dominant force in Georgia politics in the 1880s. The constitutional convention of 1877 was held in Atlanta when the final effort to return the capital to Milledgeville was defeated. The present state capitol building was completed in 1889. The Populist revolt of the 1890s (*see* POPULIST PARTY) dethroned Atlanta as the dominant power in Georgia politics. Although Atlanta men occupied the governor's office during most of the period 1906–1921, they were heavily dependent upon the rural voters. Thereafter their influence in state politics declined.

The method of apportioning representation in the state legislature, with its attendant county unit system required by law for nomination of state officials in the Democratic primary, gives Atlanta and other urban centres small voice in the affairs of Georgia although they provide most of the state's revenue. The tensions between Atlanta and the rest of Georgia are traditional but became intensified after World War II.

Population.—Since 1870 when the population reached 21,789 Atlanta has been the most populous city in Georgia. Following World War II, however, the rate of growth increased both in the city and the metropolitan area. The population of Atlanta was 89,872 in 1900; in 1930, after several annexations of territory it was 270,366. Since 1950, 90 sq.mi. have been added by annexation, bringing the total area to 126 sq.mi. After 1950 the rate of increase of population in the standard metropolitan statistical area was twice as great as that in the city.

About two-thirds of the total population of the city is white, about one-third Negro. The percentage of white population in the metropolitan area is higher. The majority of Atlanta's white population is of Anglo-Saxon origin. The most significant change in the nature of the population after World War II was the great influx of non-Southern whites. They give a flavour to Atlanta's intellectual and cultural climate that distinguishes it from the rest of the state.

Government.—From its beginning the government of Atlanta has been of the unicameral type with a mayor and aldermen. Two aldermen are selected from each of the eight wards. Since 1938 the powers of the mayor over appointments and finance have increased considerably. In 1950 a study commission reported an eight-point plan of improvement which was approved in a referendum in Fulton county on June 28, 1950. In 1951 the general assembly passed a series of acts embodying the principal features of the plan which laid the basis for co-ordination of city and county activities.

Transportation, Commerce and Industry.—The key to much of Atlanta's importance is its strategic location at the focal

point of a wide network of excellent transportation and communication facilities. It is the largest railroad centre in the south, being served by 15 lines of 8 railways. Airlines serve Atlanta through the Municipal airport, Atlanta naval air station, Dobbins air force base, Fulton county airport and Parkaire field. The city is also an important bus terminal and the city and immediate environs are served by a local system of buses and trackless trolleys.

A natural transportation and trading centre, Atlanta, headquarters of the sixth federal reserve district, also is the region's financial centre and an important telephone and telegraph communications centre. One of Atlanta's principal businesses is wearing apparel. More than 15,000 retailers purchase goods worth approximately $45,000,000 annually. Trade shows are also held each year in housewares, china and art and giftwares.

Although Atlanta ranks first in the south as a distribution centre, it has become increasingly important in industry. The more important manufactures include textiles, chemicals, furniture, food, iron and steel products, aircraft and automobiles. Nearly every industry of national scope has a branch in Atlanta either for production or for storage and distribution of goods.

U.S. governmental offices in Atlanta include those maintained by the department of health, education and welfare; Ft. McPherson; Third army headquarters; a naval air station; the department of agriculture; the Atlanta general depot; the communicable disease centre; and the treasury department.

Education.—The Atlanta public school system was established in 1870 and is an independent city system. Among the best known private preparatory schools are Georgia Military academy, Marist college, Westminster and the Lovett school.

Atlanta has numerous institutions of higher education. The Georgia Institute of Technology (opened 1888) is the engineering unit of the university system of Georgia. Oglethorpe university (originally operated at Midway, but reopened at Atlanta in 1916) is a small private college. Emory university (founded by the Methodist Episcopal Church South in 1915) incorporated Emory college, which was operated 1837–1919 at Oxford, Ga. Endowed primarily by the Candler and Woodruff families and their associates, it is well known regionally and highly regarded, particularly for its school of medicine. Agnes Scott college (founded in 1889) is a small college for women located in suburban Decatur. The Georgia State College is the municipal unit of the university system of Georgia and offers a wide variety of evening and day courses. Other important institutions include: High Museum School of Art, Columbia Theological seminary (Presbyterian), Southern College of Pharmacy, Southern Technical institute, Atlanta School for Speech Correction and Cerebral Palsy school. In addition to those mentioned there are three independent law schools and four business colleges.

Atlanta is a centre for Negro higher education. The most prominent institutions are: Atlanta university (founded 1865 by the American Missionary association), now a graduate school and leader in the co-operative effort to strengthen all Negro colleges in Atlanta; Morehouse college (men), established in Augusta in 1867 by the American Baptist Home Missionary society; Clark college, a coeducational institution founded in 1869 by the Freedmen's Aid society of the Methodist Episcopal Church; Spelman college (women), originally endowed by the Women's American Baptist Home Mission society in 1881; Morris Brown college, a coeducational institution founded in 1881 by the African Methodist Episcopal Church; and Gammon Theological seminary (Methodist), established and endowed in 1883 by Elijah Gammon. All these institutions, except Gammon, are located on adjacent campuses.

Hospitals.—Atlanta is the medical centre of the southeast. It has 18 general hospitals and 9 related institutions with a total of more than 4,000 beds. The Emory university school of medicine provides leadership, especially in research. It also provides professional services at Grady hospital, a municipal charity hospital. Adjacent to the Emory campus is the laboratory and administrative headquarters building for the communicable disease centre, a division of the U.S. public health service.

Culture and Recreation.—The Atlanta Public library, organized in 1899, contains more than 500,000 volumes. These are housed in the main library and 16 branch libraries.

Atlanta has more than 300 white churches with a membership totaling more than 300,000 representing 30 different denominations. Many of these congregations are large; more than 40 have memberships in excess of 1,000 each and are housed in magnificent structures. Approximately one third of the churches co-operate in the Atlanta Christian council. There are also more than 270 Negro churches with a membership of more than 80,000. The Southern Regional council, organized in 1944 to promote improved race relations, has its headquarters in Atlanta.

Atlanta has its own 80-piece symphony orchestra with resident conductor. The High Museum of Art has a collection of considerable distinction.

Two daily newspapers are published: the *Constitution*, established in 1868 and developed by Henry W. Grady and Clark Howell; and the *Journal*, established in 1883 and developed by Hoke Smith and James R. Gray. Bitter rivals, politically and professionally, they were merged in 1950 under the ownership of Atlanta Newspapers Incorporated. Each has continued to operate an independent daily issue, but the Sunday edition was combined. There are 12 commercial radio and 3 television stations.

Atlanta maintains 150 parks and other areas for public use, including a zoo, in an area of about 3,000 ac. All Atlanta golf courses, seven of which are municipally owned, have grass greens playable the entire year. Within 50 mi. are Lakes Allatoona and Lanier for boating. (J. C. WA.)

ATLANTA, BATTLES AROUND, major engagements of the American Civil War (*see* AMERICAN CIVIL WAR). By the end of 1863, with Chattanooga and Vicksburg firmly in Union control, Atlanta became the logical point of attack in the western war. Distant from earlier fighting, Atlanta had become an important Confederate railroad, supply and manufacturing centre and gateway to the lower south. Hardly less important than strategic conquest would be the effect on morale and politics. New southern areas would learn the harsh realities of war, while the north would be encouraged by a solid victory won in time to influence the presidential election of 1864.

The fighting around Atlanta (July 20–Sept. 2, 1864), the last phase of the Atlanta campaign (May–Sept.), ended with Gen. W. T. Sherman forcing Confederate evacuation and presenting Lincoln with the key to political victory. Having pushed the Confederate defenders under Gen. *J. E. Johnston* back to the northern approaches to Atlanta, Sherman's double objective was to capture the city and destroy the defending army if the latter could be struck in the open field. To prevent possible reinforcement from Virginia, Sherman opened his maneuvers by moving against the Augusta railroad east of Decatur. He sent one of his three armies to cut the line beyond Decatur and two against Decatur, after which the three would unite and advance west on Atlanta.

Johnston, after months of delaying actions and retreats, was ready to defend Atlanta. His army, when reinforced by the Georgia militia, would be almost as large as that of Sherman, who had to leave troops behind to guard his supply line. *Johnston* had fortified a defense line on Peachtree creek north of Atlanta, from which he planned to take the Federals in the flank. On July 17, however, he was removed from command on orders of Pres. *Jefferson Davis*, and replaced by Gen. *John B. Hood*, whose forte was vigorous attack. Georgia politicians put pressure on officials in Richmond to remove *Johnston*, whose views on the situation appeared defeatist. *Hood* decided to attack at once. Sherman's forces were strung out for ten miles, with a dangerous gap between two of his three armies. *Hood* sent Gen. *William J. Hardee* with two of his three corps to assault Gen. George H. Thomas's army of the Cumberland as it crossed Peachtree creek. Thomas beat off all attacks (July 20). *Hood* then mounted a heavier attack, to begin against the exposed flank and rear of Sherman's left wing, Gen. James B. McPherson's army of the Tennessee. *Hardee's* corps was sent on a night march (July 21) around the Federal left. After *Hardee* had surprised and driven McPherson, *Hood* planned to rush out with his remaining two corps and roll up the Union line from south to north.

Hardee's flank march gave the defenders their best opportunity of the campaign. McPherson's cavalry was off tearing up the Augusta railroad, and *Hardee* achieved surprise as the Federals moved into abandoned Confederate trenches east of Atlanta. Attacking from thick woods, *Hardee* partially broke through to the Tennessee rear while *Cheatham's* corps assaulted the front. McPherson was killed as he rode into the unexpected fray. Logan assumed command and stabilized the Federal position after the hottest fighting of the campaign. The army of the Tennessee fought this, the battle of Atlanta (July 22), practically unaided.

The battle taught Sherman that his objective was too strongly held to be taken by storm and that *Hood's* army defied destruction. He determined, therefore, to deal with *Hood* by cutting off his supplies. Sherman moved the army of the Tennessee from the left wing to the right, appointed Howard its regular commander, and sent it around west of Atlanta against two railroads reaching the city from the south. *Hood* concentrated on holding the line from Macon. He delivered his third assault (July 28) against Howard at Ezra Church, southwest of Atlanta, accomplishing nothing except adding to his losses. Sherman continued to push south until his lines were stretched too thin for safety. He again changed his tactics, deciding to abandon his base and throw nearly his whole force against the railroads below Atlanta. This movement gave *Hood* a chance of saving Atlanta, if he could strike the Federals as they changed position. Instead, he was completely baffled, thinking Sherman was retreating north. Not until the Federals were across one railroad and on the other did *Hood* learn where they were. A final attack on Howard at Jonesboro failed (Aug. 31), and *Hood* hastily evacuated the next day.

(WI. E. B.)

ATLANTES, in architecture, male figures used as supports for an entablature, a balcony or other architectural projection, especially when such figures are posed as though they were actually upholding great weights, like Atlas carrying the world. The singular form is atlas. Male figures resembling the female caryatides (*see* CARYATID) are more properly known as canephoroe (*q.v.*) or telamones; half figures are known as terms. The earliest example of true atlantes occurs on a colossal scale in the temple of Zeus at Agrigentum (*c.* 500 B.C.). They were favourite motifs in the later Renaissance, particularly in Italy, Germany and France.

THAMES AND HUDSON, LONDON

ATLAS ON THE CATHEDRAL OF STA. MARIA ASSUNTA, ITALIAN ROMANESQUE, SPOLETO, ITALY

ATLANTIC, COMMAND OF THE. The voyages of exploration, dating from the later 15th century, shifted the maritime centre of gravity from the Mediterranean sea to the Atlantic ocean. Portuguese navigators crept southward along the African coast, rounded the Cape of Good Hope and blazed an all-sea route to India. Columbus, sailing westward for the same destination, stumbled instead into the Americas. Succeeding explorers gradually filled in the map of the new world. After the explorers came traders, colonists and buccaneers—Portuguese, Spaniards, Frenchmen, Englishmen and others—who fought the elements, the natives and each other, in a struggle for empire in America and for control of the sea routes connecting the new world with the old.

Dominance of British Sea Power.—Transformation of the Atlantic from a deserted waste into a vast arena of commercial and military activity profoundly altered political relationships in the old world. Lands fronting only on the Mediterranean lost in relation to those facing the Atlantic. In a long succession of wars (analyzed in the historical works of Capt. Alfred Thayer Mahan), Britain successfully contested the sea power of Spain, Holland and France. As a result of this epic struggle Great Britain became the dominant Atlantic power. By 1815, after the victorious close of the Napoleonic wars, British sea power had come literally to envelop the vast land mass of Eurasia-Africa from the North cape to the coast of China.

This far-flung *Pax Britannica,* as it was sometimes called, rested upon a remarkable combination of political, military and technological factors. For reasons beyond the scope of this article England experienced the Industrial Revolution earlier than its continental rivals. British imports of foodstuffs and raw materials and exports of manufactures flowed in ever-increasing volume along the ship lanes to and from the British Isles. The profits from this traffic were divided between further industrial development and support of the Royal Navy, which guarded the life lines of Britain's global empire.

Geography facilitated this task of the Royal Navy. The British Isles interposed a great barrier between northern Europe and the Atlantic ocean. To reach the ocean all sea-borne commerce to or from that region had to pass through the English channel or round the stormy northern tip of Scotland. The Rock of Gibraltar, taken by British arms in 1704, guarded the narrow strait which afforded the only marine exit from the Mediterranean down to the opening of the Suez canal. In Gibraltar, moreover, Britain possessed a formidable military stronghold separating the Atlantic and Mediterranean coasts both of France and of Spain. The island of Malta, which passed into British hands during the Napoleonic wars, somewhat similarly divided the eastern and western basins of the Mediterranean. Portugal was the only European country which suffered no strategical handicap that rendered it inherently vulnerable to the pressure of British sea power; but Portugal possessed neither the manpower nor the material resources necessary to remain a serious contender for the Atlantic trident after the onset of the industrial revolution.

Geography thus compelled most of the transatlantic, and much of the coastal, traffic of Europe to pass through narrow seas under the guns of the Royal Navy. British squadrons, patrolling the channel and the North sea within easy reach of their protected anchorages, afforded a constant reminder that British sea power had repeatedly in the past, and presumably could again, cut off northern Europe from sea-borne supplies. British squadrons in the Mediterranean afforded an equally impressive reminder of Britain's presumptive ability to halt the flow of traffic to and from the ports of southern Europe. British fleets could usually engage their continental foes without uncovering either the British Isles or a safe line of retreat to their own defended bases. British forces in the channel and North sea were favourably situated to interrupt communications between any hostile coalition of northern and western continental powers. By blockading the Strait of Gibraltar, Britain could divide the naval strength of Spain and especially of France, the country generally regarded during the 19th century as Britain's most dangerous maritime rival.

Primitive overland communications prevailing in Europe well down through the 19th century enhanced the strategical advantage which Britain derived from geographical position and a strong navy. There were no motor vehicles, almost no all-weather highways and only the rude beginnings of a railway system upon the European mainland. Large-scale movements of people or freight were next to impossible except by sea—and Great Britain commanded the sea right up to the coast of Europe. There was no escape from the paralyzing effects of sea blockade, and no way of countering the superior mobility which gave British sea power such a leverage on the continent.

Defensively, Britain's position was likewise secure. The fleets which stood ready to block the ocean portals of Europe simultaneously barred hostile approach to the British Isles. The automotive torpedo did not appear until 1860 and did not pass into general use for several decades thereafter. There were no submarines to steal through the blockade and raid British merchant shipping on the high sea. There were no bombing planes to rain destruction upon the ships, docks and factories of Great Britain.

British sea power dominated not only the ocean portals of Europe but all navigable passages leading from the Atlantic to the Indian and Pacific oceans as well. Acquisition of the Cape of Good Hope (1805) and of the Falkland Islands (1832) clinched the Royal Navy's hold on the only two sea routes to India and the far east down to the opening of the Suez canal. Occupation of a strategical site in the Gulf of Aden at the foot of the Red sea

(1839), together with naval stations at Gibraltar and Malta, assured Britain a secure hold on that marine short cut which connected the Mediterranean sea with the Indian ocean in 1869.

British sea power likewise dominated the western Atlantic down to the end of the 19th century. During the American Revolution, it is true, the French fleet of Admiral François J. P. de Grasse had wrested control of North American waters long enough to compel the surrender of Cornwallis at Yorktown in 1781. The resulting establishment of the United States raised a potential threat to Britain's permanent dominance in that region by laying the foundations for an independent, well-located and ultimately formidable power centre in North America. But it was more than a century before the new republic developed into a serious contender for command of the American seas. Meanwhile, from its bases in Nova Scotia, Bermuda and the West Indies, the Royal Navy continued to exert strong influence on sea communications throughout the western Atlantic. Squadrons operating from these bases blockaded United States ports in the War of 1812; and repeatedly thereafter the pressure of British sea power made itself felt at critical stages in Anglo-U.S. diplomacy.

This was especially the case during the long struggle for control of the Central American isthmus and of the Atlantic approaches thereto. Britain already possessed Jamaica, Trinidad and other strategical positions in this region. In addition, British leaders coveted the Spanish island of Cuba which screened the gulf coast of the United States in much the same manner as the British Isles covered the coast line of northern Europe. Another British objective was to control the various routes for a ship canal to the Pacific. Success in those aims would have strengthened British influence throughout the western hemisphere, and in particular would have given Britain a leverage on the United States comparable to that which it already held over Europe.

Anglo-American Relations.—American statesmen were awake to this danger. In framing the Monroe Doctrine (1823), in which the United States warned the monarchies of continental Europe to keep their hands off the newly liberated Spanish colonies in the western hemisphere, Secretary of State John Quincy Adams rejected overtures for a joint Anglo-U.S. declaration, lest such a move estop the United States later from turning the Monroe Doctrine against Great Britain itself. That contingency actually arose in the 1840s when Britain and the United States began a seesaw struggle for key positions in the Caribbean and in Central America, on the outcome of which depended the future command of the western Atlantic.

An uneasy truce was reached in the Clayton-Bulwer treaty of 1850. British pressure in this region was further eased from time to time by the diversionary effects of the Crimean War and subsequent European developments involving British interests. The phenomenal rise of United States industrial and military potential during and after the Civil War (1861–65), culminating in rapid naval expansion toward the close of the century, confronted Britain with the choice either of steadily strengthening its naval establishments in the American seas or of gradually losing command of those waters and therewith any possibility of controlling the future isthmian canal.

European complications again resolved this dilemma in favour of the United States. At the close of the Napoleonic wars, the Royal Navy was safely superior to all continental rivals. The long struggle had produced no radical changes in naval design. Technical stability meant slow obsolescence, a decided advantage to the leading naval power. By mid-century, however, a technical revolution was in full swing. The transition from sails to steam, from solid shot to explosive shells, from smooth bores to rifles, from wooden walls to armour—all these and other technical advances speeded obsolescence, and gave Britain's continental rivals a chance to compete on more nearly even terms. These technical developments also produced unsettling effects on political relations and behaviour, which in turn stimulated naval expansion. The resulting sense of insecurity was further aggravated by the growth of German political potential after the Franco-Prussian War (1870), and by the world-wide struggle for colonies, raw materials, protected markets and other imperialistic phenomena which accompanied the later stages of the industrial revolution.

In the late 1870s France, Russia, Italy and then Germany all began modernizing and expanding their navies. For a time the British government tended to regard France and Russia as the most dangerous rivals. With that combination in view, the British admiralty in 1889 publicly announced a "two-power standard" as the irreducible minimum to insure Britain's control of European waters and of the long sea routes to India and the far east. Gradually, however, British anxiety was transferred to Germany. The British watched German industrial and military growth with misgivings, heightened after 1890 by the aggressive overtones of German foreign policy. When Germany in 1900 launched a naval building program designed to break Britain's exclusive grip on the European seas, the effect was to bring about a fundamental reorientation of British policy.

To meet the rising German threat required the utmost concentration of British naval strength in European waters. Simultaneously to contest in the American seas the rapidly growing naval power of the United States was out of the question. Britain had no choice but to recognize U.S. primacy in the western Atlantic; and British statecraft proceeded with considerable finesse to derive from this necessity as much benefit as possible. A continuing and generally successful effort was made to settle outstanding disputes with the United States and to cultivate its good will in order that that country might safely be stricken from Britain's list of potential enemies. In the Hay-Pauncefote treaty of 1901, British statesmen even relinquished their long cherished ambition to share in the control of the future isthmian canal. And by 1904 the British admiralty had begun reducing its squadrons in American waters.

The first fruits of this reorientation were soon apparent. When European sympathies ranged almost solidly against Britain during the Boer War (1899–1902), U.S. statesmen countered with quiet but unwavering diplomatic support. Thereafter, as crisis followed crisis in Europe, and as the German empire made increasingly menacing gestures toward the western hemisphere, the weight of the United States was ranged consistently on the side of Great Britain in a manner that strongly suggested the possibility of an Anglo-U.S. naval coalition if such were necessary to hold the Atlantic against the steadily encroaching menace from the European continent.

The German menace had the further effect of suppressing at least temporarily the ancient rivalry between Great Britain and France. The Anglo-French entente of 1904 left Britain free to develop a fleet base at Alexandria near the Mediterranean terminus of the Suez canal and recognized a French protectorate over Morocco except for a coastal strip facing Gibraltar. This understanding was accompanied by marked improvement in Anglo-French naval relations, permitting withdrawal of British fleet units from the Mediterranean. The entente thus brought about a further strengthening of the northern sea frontier; but, like the parallel if less formal understanding with the U.S., this step too represented a dissipation of that exclusive command of the Atlantic which had once been the cornerstone of British naval policy.

While bargaining for allies and simplifying their strategic commitments, British statesmen steadily enlarged and strengthened the Royal Navy. Despite Germany's utmost efforts, the Royal Navy held its lead. In first-class capital ships, then regarded as the true index of naval power, the British fleet outranked Germany's in 1914 by a ratio of three to two. And the Anglo-French coalition, to which were added the naval resources of Russia, Japan, later Italy and eventually the United States, held an overwhelming preponderance of naval force measured in tons and guns.

World War I.—Following the outbreak of World War I in 1914, the Allies, under the leadership of Great Britain, skilfully translated this mathematical primacy into an effective command of the Atlantic and adjoining narrow seas. Within a few days their naval forces drove the German merchant flag from the high seas. Within a few weeks the German oversea cruiser squadrons were run down and destroyed or driven to cover. The main British fleet screened the transport of the British army to France, while the German fleet lay at anchor or cruised near its home bases in the

North sea, unwilling to risk a decisive battle and powerless to break up the blockade which the Allies drew tighter during the winter of 1914–15.

In Feb. 1915 the German command countered the Allied blockade with a submarine offensive against merchant shipping in a "war zone" surrounding the British Isles. Shortage of submarines, threats of U.S. intervention and other factors presently led to partial relaxation of this initial assault on Allied communications, but not until it had revealed the frightful commerce-destroying ability of the submarine, previously regarded with scepticism as a more or less useful auxiliary of the fighting fleets.

The temporary slackening of the submarine offensive was followed by increased activity on the part of the German high sea fleet. Late in May 1916 the German and British fleets met in the battle of Jutland. In this, the only major fleet action of the whole war, the fate of the Allies hung momentarily in the balance. A decisive defeat, shattering British sea power and transferring command of the Atlantic to Germany, would have constituted irretrievable disaster. No such catastrophe occurred. The German fleet, with skilful handling and exceptional luck, managed to inflict serious injury and then escape, though not without substantial casualties, from the annihilation that would certainly have been the outcome of a finish fight with Britain's grand fleet.

The battle of Jutland apparently convinced the German command of its inability in this way to smash the Anglo-French command of the Atlantic and thereby to raise the blockade. Only the submarine remained. U-boat construction was stepped up. The scope and area of submarine operations were gradually enlarged. Finally in Feb. 1917 the German command ordered a general submarine offensive against all merchant shipping, neutral as well as belligerent, in a desperate gambling attempt to starve Britain into surrender before an effective antisubmarine defense could be developed, and before the eventually certain intervention of the United States could turn the tide for the Allies.

This plan almost succeeded. When the United States entered World War I in April 1917, the U-boats were sinking merchant ships at an appalling rate. Existing defense measures—chiefly arming merchantmen and patrolling the ship lanes—were proving totally inadequate. The logical recourse was to convoy cargo ships in groups under armed escort, a device already tried and proved in the case of troopships. Now with American bases and naval reinforcements, a general convoy system became feasible and was successfully put into operation. In the intensified war against the U-boats, raids were carried out against the German submarine bases, mine fields were laid across the two Atlantic exits from the North sea, and acoustical devices were developed for detecting the presence of submerged U-boats. With the aid of these and other defensive measures, foodstuffs, raw materials and munitions continued to flow along the Atlantic sea lanes to the British Isles, across the channel to France and through the Mediterranean to Italy and the near east. A U.S. army, eventually 2,000,000 strong, was ferried safely across the Atlantic to the battlefields of Europe; and simultaneously the Allies drew steadily tighter the blockade of the Central Powers, which, starving their peoples and their war industries, prepared the way for their political and military collapse in 1918.

Post-World War I Developments.—The victory of 1918 completely altered the balance of naval forces in the Atlantic. The destruction of German sea power removed the threat which had chained the Royal Navy to European waters; which had suppressed the ancient antagonism of France and Britain; which had driven Great Britain and the U.S. into something approaching an alliance; and which had compelled the Royal Navy to relinquish without a struggle its primacy in the American seas. Temporarily at least, British sea power held exclusive and undisputed sway over the eastern Atlantic and adjoining narrow seas. And following the victory over Germany there were accumulating indications that British statesmen and their naval advisers looked forward to early restoration of their former global command of the seas.

This trend had disturbing repercussions on Anglo-U.S. relations. The war had caused an upsurge of navalism within the United States. Congress in 1916 had voted a construction program designed to give the United States a "navy second to none." Late in 1918 the administration had thrown its weight behind a supplementary building program which, if and when carried out, would have given the United States incomparably the strongest navy in the world. These mutually conflicting aims caused the close wartime association of Britain and the U.S. to cool rapidly after the Armistice. Anglo-U.S. relations began to show an alarming tendency to revert to their 19th-century pattern of mutual distrust and animosity.

One especially aggravating factor from the U.S. point of view was the continued existence of the Anglo-Japanese alliance. The reason for that pact had disappeared with the defeat of Germany, but neither party seemed willing to terminate it while the United States went on expanding its navy. U.S. statesmen, in turn, were just as unwilling to modify their naval plans as long as the Anglo-Japanese alliance remained in force, since its mere existence was felt to involve at least a theoretical possibility of simultaneous attack in two oceans.

The Washington conference for the limitation of armaments (1921–22) broke this deadlock. The Anglo-Japanese alliance was abrogated; naval building programs were drastically curtailed; a large number of older capital ships were scrapped; and the British, U.S. and Japanese battleship fleets were stabilized in the ratio of 5–5–3. The United States, in effect, recognized Britain's paramount strategic interest throughout the eastern Atlantic and European narrow seas. Britain, in turn, tacitly disavowed any intention of contesting United States control of the American seas.

The consequent improvement of Anglo-U.S. relations opened the way for a mutually advantageous redisposition of naval forces. The United States gradually shifted almost all its major fleet units to the Pacific. Britain postponed indefinitely the planned re-establishment of a battleship fleet in that ocean and concentrated British naval strength in European waters. Whether or not these dispositions reflected some definite understanding between the two governments, it is certain that the United States fleet came widely to be regarded as a symbol of Anglo-U.S. solidarity in the Pacific, and British sea power in European waters as the U.S. first line of defense in the Atlantic.

The Washington conference achieved no such happy solution of European naval problems. Irreconcilable differences between France and Britain on the one hand, and France and Italy on the other, appeared early in the negotiations. These differences grew out of the general failure to establish a stable power equilibrium in Europe after the war. At the outset it was largely an Anglo-French controversy. The British did not wholly share French fears of future aggression from a resurgent vengeful Germany. They believed rigorous repression of that country would seriously retard economic recovery. The prospect of French military hegemony over the continent aroused deep-seated opposition. The British ideal was still avoidance of military guarantees, a balance of power on the continent and a two-power naval standard for European waters.

No continental power was able, or even seriously disposed at that time, to contest Britain's two-power standard in the capital-ship category. But capital ships were no longer the only index of naval power. World War I had hastened the development of two new weapons which were to play an increasing role in the control of the seas, especially narrow seas such as the Mediterranean, the channel, and the North sea.

One of these new weapons, the submarine, had forced Britain to the brink of disaster, despite the Royal Navy's command of the ocean's surface. The other new weapon, the airplane, promised to develop into an even greater threat not only to shipping but also to the ports and industrial installations of the British Isles. The terms of peace prohibited Germany from possessing these newer weapons. But France suffered no such restriction and was geographically situated to use both submarines and planes against Britain with maximum effect. These weapons were consequently valuable diplomatic levers to be relinquished only in return for British guarantees to France. Moreover, if France were left to depend solely on its own defensive resources, a larger force of cruisers and destroyers would be required to ensure safe passage

across the Mediterranean for French colonial troops from Africa.

Another source of French intransigence was Italy's emergence as a serious contender for control of the Mediterranean. The Italian navy was decidedly inferior to that of France, but the Italian government insisted on the right to match France in every category of naval craft. Since Italy was exclusively a Mediterranean country, whereas France fronted on the Atlantic as well, to accept naval parity with Italy was equivalent, in French eyes, to surrendering control of the Mediterranean, and with it the assured flow of supply and reinforcements from Africa.

The French finally yielded with respect to capital ships and aircraft carriers, and in these two categories accepted parity with Italy and tonnage quotas low enough to preserve Britain's two-power standard for European waters. But every proposal to limit submarines and aircraft broke against the unsatisfied French demand for guarantees. Neither France nor Great Britain could agree on cruiser quotas acceptable to each other or to the other naval powers. The most that could be achieved was a qualitative restriction limiting individual cruisers to 10,000 tons displacement and 8-in. guns. Thus the way was left open for renewal of competitive warship construction.

The fascist revolution of 1922 provided just the stimulus needed to produce this result. To the fascists the Mediterranean was Italy's "mare nostrum." Mussolini boasted his determination to carve from its borderlands a modern counterpart of the classical Roman empire. Since control of the Mediterranean was an essential feature of his imperial pipe dream, Mussolini had no interest in naval limitation save as a means of cheaply improving Italy's naval position at the expense of France and Great Britain.

In 1927 the United States sponsored a second naval conference, called to deal specifically with the cruiser problem. Neither France nor Italy took any part in this conference which was thus foredoomed to failure. Its sessions, held at Geneva, quickly deteriorated into an Anglo-U.S. wrangle in which technical arguments and considerations were allowed to revive the ancient feud over freedom of the seas, and to recast the two great Atlantic powers in their abandoned roles of naval rivals and potential enemies.

A change of government in both countries inspired a fresh start. A third conference was held at London in 1930. Here some of the damage to Anglo-U.S. relations was repaired, and a provisional solution of the cruiser controversy was achieved. But the continued intransigence of France and Italy still prevented any stable adjustment of naval relations among the Atlantic and Mediterranean powers.

Likewise inimical to this end was the naval resurgence of Germany. Under the treaty of Versailles Germany was forbidden to acquire any modern armoured ship displacing over 10,000 tons. To circumvent this restriction, German naval architects created the so-called pocket-battleships, "Deutschland," "Admiral Scheer," and "Admiral Graf Spee." These ships, designed as commerce raiders, technically conformed to the Versailles limitation, but their 11-in. guns definitely outclassed the 8-in. weapons allowed on cruisers built by signatories of the Washington Naval treaty. These ships upset existing arrangements for the protection of commerce, compelled every Atlantic power to reconsider its naval program and in conjunction with other developments started a fresh cycle of competitive building.

One of these contributing causes was the Nazi revolution of 1933, followed by Hitler's denunciation of the Versailles treaty. Naval rearmament accelerated rapidly under the Nazis. Profiting from past experience, they concentrated mainly on commerce-raiding weapons. Their battle cruisers, "Scharnhorst" and "Gneisenau" (laid down in 1934), and even their great battleships, "Bismarck" and "Tirpitz" (1937), were conceived less as components of a massed fleet than as superraiders for attacking convoys on the high sea. The same objective was implicit in Germany's resumption of submarine building on a large scale. Yet in the face of these preparations manifestly directed primarily against Great Britain, Hitler won London's consent in 1935 to further German naval expansion up to 35% of British strength, with the possibility of eventual parity in submarines.

The Ethiopian crisis, later in 1935, focused attention on the deterioration which was taking place in the strategical position of France and Britain in the Mediterranean. Both London and Paris showed the greatest reluctance to take any steps which might force hostilities with Italy, and doubts were expressed in many quarters regarding the Royal Navy's continued ability to hold the Mediterranean against the air and sea power of Italy.

Formation of the Rome-Berlin axis in 1936 formally linked the growing danger in northern and in southern waters, and inclined the naval balance still more strongly against the Atlantic powers. But this event, followed by rapid deterioration of world conditions, provided the necessary stimulus for strenuous if tardy counter measures which were well under way when World War II intervened in Sept. 1939.

World War II.—The first phase of the ensuing battle for the Atlantic lasted until the fall of France in June 1940. During this period the Anglo-French coalition drove German merchant shipping from the Atlantic, and maintained a fairly effective long-range blockade on the general model of the previous war. The German-controlled zone in the North sea was somewhat broader than in 1914–18, mainly because of the maritime role now played by shore-based aviation. It was consequently more difficult to intercept German blockade-runners entering or leaving the North sea. The blockade in the Mediterranean also fell somewhat short, thanks to Italy's "nonbelligerent" help in forwarding sea-borne supplies to Germany. But these handicaps were offset by the close co-operation of the United States and other oversea countries in the use of various devices—pre-emptive buying, "navicerts," etc. —designed to cut at the source all traffic with the axis.

On the defensive side, the initial nonbelligerency of Italy postponed a showdown in the Mediterranean with resulting advantage to the Allies. Also the exclusion of axis men-of-war from a western hemisphere "safety zone," guarded by a "neutrality patrol" under United States leadership, afforded considerable protection to Allied shipping entering and leaving North and South American ports. On the other hand, the modern submarine proved to be a far more difficult weapon to combat than the primitive U-boats of 1918, and the Allies were dangerously short of antisubmarine equipment during the early months of the struggle. Early raids by the pocket-battleships, and threatened raids by the more formidable German battle cruisers, compelled the Allies to deplete their main fleets in order to provide battleship escort for their troop and cargo convoys. And the lengthening range of German air power, especially after the occupation of Norway, gradually curtailed British use of the North sea.

The battle for the Atlantic took a radically different turn following conquest of the Low Countries, the fall of France and Italy's entry into the war. Britain lost French naval support at the very moment when its own sea power was seriously crippled by losses incurred in the retreat from Narvik and evacuation from Dunkirk. The sea and air power of Italy, reinforced by German units, imperiled and eventually barred the direct route to Suez, forcing British shipping to use the long alternative route around the Cape of Good Hope. This cut the total cargo-carrying capacity of the British merchant marine almost in half at the very moment when German acquisition of naval and air bases on the channel and on the west coast of France foreshadowed more destructive attacks on shipping in northern waters.

At this critical juncture, the United States, though still technically a nonbelligerent, assumed a more positive role in the battle for the Atlantic. Fifty U.S. destroyers were turned over to Great Britain to make good previous naval losses. In return, the United States received long-term leases for ship and plane bases in Newfoundland, Bermuda and numerous points in the Caribbean. Congress voted a 70% increase in the navy, and early in 1941 a separate Atlantic fleet was established. U.S. units were sent to relieve the British garrison in Iceland, which had become a vital convoy depot and focus of antisubmarine activity. Greenland was occupied to provide additional facilities for the Anglo-U.S. sea and air patrol rapidly spreading over the north Atlantic. Transatlantic air-ferry service was developed for the delivery of planes and for the rapid transportation of important freight and personnel.

Early in 1942, after the United States had become a full belligerent, the axis opened a large-scale submarine offensive against coastal shipping in American waters. German U-boats also operated in considerable force along the south Atlantic ship lanes to India and the middle east. The Allied campaign (1942–43) to reopen the Mediterranean depended almost entirely upon sea-borne supply shipped through submarine-infested waters. Allied convoys approaching the British Isles, and those bound for the Russian ports of Murmansk and Archangel, had to battle their way against savage air and undersea attacks. It was publicly estimated at the close of 1942 that Allied shipping losses, chiefly from planes and U-boats, exceeded those suffered during the worst period of 1917. And a considerable weight of Allied naval power had to be kept constantly available in northern waters in case Germany's formidable surface raiders, especially the superbattleship "Tirpitz," should break into the Atlantic shipping lanes as the "Bismarck" did briefly in 1941.

On the other side of the ledger was the ever tightening Allied blockade of axis Europe and perceptible, if slow, progress in combating the axis war on shipping. With more and better equipment, the convoy system was strengthened and extended. Unprecedented ship building, especially in U.S. yards, caught up and began to forge ahead of losses, though the latter still remained dangerously high. Bombing raids on axis ports and industrial centres progressively impaired Germany's capacity to build and service submarines and aircraft. Transoceanic cargo planes provided for the United Nations an increasingly important alternative means of transport beyond the reach of enemy raiders. Brazil's entry into the war strengthened the Allied position in the south Atlantic. The occupation of virtually all west African ports, including the French naval bases at Casablanca and Dakar, denied to axis raiders their last possible havens in southern waters. By these and other means the Atlantic allies thwarted axis efforts to halt the passage of American armies and material to Europe and North Africa, to starve Britain into submission, to prevent supplies reaching the U.S.S.R. and to break up the blockade of axis Europe.

Victory in the Atlantic represented the collective effort of the United Nations, but chiefly of Britain, Canada and the United States. The strength of this coalition was derived in no small degree from the successful reintegration of the fundamental components of sea power: (1) a secure primary base, (2) superior resources and (3) favourable strategic position. Britain formerly possessed all three vis-à-vis both Europe and America. The rise of United States power coinciding with changing conditions in Europe had compelled Great Britain to recognize U.S. primacy in the western Atlantic. The tremendous industrial growth of Germany, coinciding with the development of submarines and later aircraft, undermined the security of England's island base off the coast of Europe, endangered the far-flung network of sea communications which supplied British industry, and thereby weakened the whole structure of British sea power. The United States lacked England's favourable strategical positions for offensive action vis-à-vis continental Europe. But the United States enjoyed a secure base thousands of miles from Europe and Asia. The United States also possessed resources and industrial potential surpassing those of any other country. Britain could no longer command the Atlantic singlehanded against a determined war on commerce backed up by the industrial resources of continental Europe. The United States, however, could not play Great Britain's historic role singlehanded. Together Britain and the U.S. combined, at least temporarily, the fundamental requisites for continued command of the Atlantic and adjoining narrow seas. Still it was by no means conclusive that even an Anglo-U.S. coalition could hold these waters indefinitely. The atomic bomb was not developed in time to play any role in the European-Atlantic phase of World War II. Nor did its use against Japanese cities demonstrate conclusively how nuclear weapons might affect the concepts of sea power in general, and command of the Atlantic in particular.

Post-World War II Developments.—Political realignments and technological advances following World War II posed unresolved issues regarding future control of the Atlantic. The U.S.S.R. stepped into the role previously played by Germany as challenger of Anglo-American primacy in the Atlantic. The Soviet government expanded its submarine force rapidly. New Russian submarines were believed to embody the latest design and to be more formidable craft than any operated in World War II. This development, together with the Soviet Union's rapid postwar industrial recovery, its unexpected upsurge in science and technology and the aggressive policies which characterized Stalin's last years, all combined to evoke countermeasures in the west. One of these was the North Atlantic alliance formed in 1949. NATO rested upon the premise, among others, that the nations fronting on the North Atlantic and connecting seas form a natural and viable defense community (*see* NORTH ATLANTIC TREATY ORGANIZATION).

This concept has an interesting background. One of the first to elaborate it in the context of sea power in the Atlantic was Sir Halford J. Mackinder (*q.v.*). This famous British geographer is better remembered for his earlier geopolitical hypothesis (formulated in 1904 and refined in 1919) that the layout of lands and seas favours the eventual rise of a dominant world power in the "heartland" of Eastern Europe and Inner Asia. In 1924, however, Mackinder propounded a counterhypothesis that strangely attracted very little attention. The essence of this counterhypothesis is that the potentialities of the Eurasian heartland could be balanced in the future by "Western Europe and North America," which (as Mackinder read the lessons of World War I) "constitute for many purposes a single community of nations." This geopolitical region, extending from the Volga river to the Rocky mountains of North America, he characterized (in 1931) as the "main geographical habitat of Western civilization." Within it he found all the ingredients of a great power constellation: over half a billion people, abundant natural resources, advanced technology, the most productive industrial regions, etc. "Notwithstanding the oceanic break it may be regarded as a single area," Mackinder argued, linked together as it is by the heavily traveled sea lanes of the North Atlantic which he significantly called the "Midland Ocean."

Mackinder's concept of the Atlantic community became a political reality in NATO. The concept's tenability has depended all along on ability of the NATO allies to maintain essential transatlantic traffic in the event of another world war. This issue poses two separable questions: Could Soviet submarines or other military forces fatally disrupt the flow of transatlantic traffic, as German submarines came close to doing in the two preceding wars? Would the initial blows and counterblows of an intercontinental war, fought with long-range nuclear weapons, leave any cargoes to ship, any usable ports through which to transport them or any surviving social organization to carry on at all? The technical aspects of Atlantic control in war are becoming ever more complex and uncertain. One reason is the development of nuclear-powered submarines capable of cruising submerged for weeks at a stretch. Another factor is the certainty that such craft can be armed with underwater-firing nuclear missiles capable of destroying distant ports and inland cities as well as shipping. The capacity of any nation to carry on effective armed conflict, or even survive as a nation, if its population and industrial centres were to suffer devastation from such missiles or other multimegaton nuclear weapons is even more uncertain and the subject of wide debate in the 1960s.

Meanwhile the Atlantic countries continue to depend heavily on sea-borne traffic. This traffic, because of its bulk and tonnage must be carried mainly in surface vessels, highly vulnerable to aerial bombs and submarine torpedoes. Half of Britain's food and most of its essential raw materials come from overseas. Western Europe as a whole is only slightly less dependent on transatlantic traffic. With progressive depletion of high-grade iron ore and other minerals within the United States, the American economy, too, grows yearly more dependent on raw materials shipped in by sea. As long as the nuclear stalemate continues (and it may continue indefinitely), traffic flows as usual along the Atlantic sea lanes to everyone's mutual advantage, the Communist countries included. What the situation might become in case of intercontinental nuclear war one can only speculate. But one can be reasonably confident that a future military battle

for the Atlantic, should it ever occur, would present difficulties far exceeding those that the western allies surmounted in the earlier world wars of the twentieth century. *See* also SEA POWER; WORLD WAR I; WORLD WAR II.

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ATLANTIC CHARTER is the name given to a joint declaration, drawn up at a series of meetings on board warships in the North Atlantic in Aug. 1941, by Franklin D. Roosevelt, then president of the United States, and Winston Churchill, then prime minister of the United Kingdom. Conceived after the model of Woodrow Wilson's fourteen points, it was issued officially on Aug. 14 and stated in eight points certain common principles of United States and British policy on which the two leaders based their hopes for a better future for mankind after World War II.

The Atlantic Charter started with a solemn declaration that the two countries did not seek any aggrandizement. The next two points defined the right of all peoples to self-determination and self-government. The two leaders declared that "they desire to see no territorial changes that do not accord with the freely expressed wishes of the peoples concerned. They respect the right of all peoples to choose the form of government under which they will live; and they wish to see sovereign rights and self-government restored to those who have been forcibly deprived of them."

The fourth and fifth points concerned equality of access to the trade and raw materials of the world, and fullest collaboration between all nations in the economic field with the object of securing for all improved labour standards, economic adjustment and social security.

In the last three points, the two leaders recorded their hope "to see established a peace which will afford to all nations the means of dwelling in safety within their own boundaries, and which will afford assurance that all the men in all the lands may live out their lives in freedom from fear and want. . . Such a peace should enable all men to traverse the high seas and oceans without hindrance." The two leaders proclaimed that "all of the nations of the world . . . must come to the abandonment of the use of force."

Though it was incorporated by reference in the declaration by the United Nations of Jan. 1, 1942, the Atlantic Charter, like many other wartime declarations, was characterized more by vague generosity than by any precise commitment. Its significance lies less in its message than in the fact that the leaders of the two great North Atlantic democracies, which shared a common tradition of liberty and law, proclaimed common goals in conformity with these traditions and gained their acceptance as the aim of all the United Nations in prosecuting the war. (H. Ko.)

ATLANTIC CITY, a city of Atlantic county, N.J., U.S.; a famous seaside resort on the Atlantic ocean, 55 mi. S.E. of Philadelphia, Pa., and 110 mi. S. by W. of New York City. Pop. (1960) 59,544; standard metropolitan statistical area (Atlantic county), 160,880. The Atlantic City standard metropolitan statistical area covers 575 sq.mi. and includes Hammonton, Pleasantville and Ventnor City. (For comparative population figures *see* table in NEW JERSEY: *Population.*)

The city lies on a low, sandy island (Absecon Island), 8.1 mi. long with varying widths of from one-tenth of a mile to 1.9 mi., separated from the mainland by a narrow strait and four or five miles of meadows which are partly covered with water at high tide.

Atlantic County.—Atlantic county was originally settled by whalers and oystermen. By the middle of the 18th century the bog iron industry flourished in its interior and shipyards lined the banks of its streams and bays, while the more secluded areas were haunts of pirates and, in time of war, privateers. Early in the following century the glass and textile industries were established there. The county has been crisscrossed by highways leading from Philadelphia to the shore towns and by the Garden State parkway which extends from New Jersey's northern boundary to Cape May at its southern tip. Vast farms raise blueberries, strawberries, apples, peaches, sweet potatoes, numerous varieties of vegetables, and poultry products.

The Boardwalk.—The possibilities of Absecon Island as a summer resort were first recognized by Jonathan Pitney, who settled there in 1820 to practice medicine. Three decades later he was the leader of a group which planned Atlantic City and induced the Camden and Atlantic railroad, later part of the Pennsylvania and Reading Seashore lines, to make the village its eastern terminus. The city was incorporated in 1854.

The first boardwalk was constructed in 1870 because of complaints of railroads and hotels about visitors' tracking sand onto their premises. The present boardwalk, built of steel and concrete with a wooden flooring, fifth to be built and completed in 1939, is 60 ft. wide and 4 mi. long. It is the centre of Atlantic City attractions. The first Easter parade took place there in 1876. A few years later the first of the amusement piers extending from it was constructed, the most famous and longest being Steel pier (2,000 ft. long), in operation since 1898.

Hotels not only line the boardwalk, but extend inland for several blocks. They range in size from small structures with only a few rooms to the large brick Chalfonte-Haddon hall with 1,000 rooms. Motels have become increasingly popular. Indoor-outdoor swimming pools, solariums and facilities for conferences and conventions at hotels and at Convention hall help Atlantic City to retain its position as a year-round tourist attraction. Each year it accounts for nearly half of all of the persons who visit New Jersey resorts.

The single event for which Atlantic City is most noted is the annual Miss America pageant. Established in 1921, it was discontinued in 1928 and revived in 1935 with a shift in emphasis from beauty to talent. College scholarships are included among awards given to "Miss America" and other prize winners. (E. R. D.)

ATLANTIC INTRACOASTAL WATERWAY, a protected route paralleling the Atlantic coast, from Massachusetts bay to Key West, Fla., comprises a number of natural and artificial waterways. Portions are used by deep-draft vessels. The route, which utilizes sounds, bays, lagoons, rivers and canals, was planned eventually to connect, by canals across Florida, with an extension of the Gulf Intracoastal waterway, forming a continuous 3,000-mi. protected waterway. The entire route is toll free.

Between Massachusetts bay and Buzzards bay, Massachusetts, the Atlantic Intracoastal waterway is through the Cape Cod canal, a sea-level canal 17.5 mi. long, with a project depth of 32 ft. at mean low water and width of 450 ft. It was purchased from a private company by the federal government in 1927 for $11,500,000, and subsequently deepened and enlarged. The canal is heavily used by ocean-going vessels between coastal ports. During the 1960s, annual traffic was between 10,000,000 and 12,000,000 tons, including 4,000,000 tons of foreign traffic and 3,500,000 tons of coal eastbound to New England.

From Buzzards bay at the southwestern end of the canal, the route proceeds through Block Island and Long Island sounds, the East river and New York harbour to Sandy Hook, New Jersey. South of Sandy Hook vessels must move in the open ocean to Delaware bay at Cape May, although small pleasure and fishing craft may use the 113 mi. of waterways behind the coastal barrier beach south of Manasquan inlet, 20 mi. south of Sandy Hook.

From Cape May, the route crosses Delaware bay to the Chesapeake and Delaware canal; originally privately owned with locks, the canal was purchased by the federal government in 1919 and converted to sea level. Although the project called for deepening to 35 ft., maximum vessel draft that could traverse the canal was 25 ft. in the 1960s.

The canal shortens the distance for ocean-going ships between Baltimore and ports to the north. Traffic amounts to about 10,-

000,000 tons annually, about half of which is foreign. Southward from the Chesapeake and Delaware canal, the route follows Chesapeake bay for about 170 mi. to Norfolk, Va.

The Atlantic Intracoastal waterway proper extends 1,134 mi. from Norfolk, Va., to Key West, Fla. For most of that distance, it follows coastal rivers and lagoons, behind barrier beaches which protect it from the sea. Unlike sections to the north, the waterway south of Norfolk carries relatively little commercial traffic—from 50,000 to 100,000 tons of barge traffic annually. Principally for pleasure craft, it is completely protected from the sea and connects populous northern metropolitan areas with resort areas of Florida. During World War II the route became important as a means of avoiding the submarine menace along the coast.

The limiting depth for the entire route is in the Dismal Swamp canal, which extends 22 mi. between Deep Creek, Va., and South Mills, N.C. This canal has a controlling depth of 6.1 ft., and at each end has a lock with a lift of 12 ft.

The Dismal Swamp canal was originally planned in 1763 when George Washington conducted surveys and was opened in 1828. Surveys were authorized by congress in 1837 to determine feasibility of a protected route from the Dismal Swamp canal to Charleston, S.C. Another survey was made in 1875, but actual work on the waterway proper, south of the Dismal Swamp canal, was begun in 1911. The final link between Norfolk and Key West was opened in April 1936, between Little river and Winyah bay, South Carolina.

After World War II, the vertical clearance of the many bridges across the route became a major issue. Frequent openings of the drawbridges caused serious delays in heavier motor traffic to and from shore line communities on the barrier beaches, resulting in a movement for fixed bridges. Commercial and yachting interests favoured bridges with relatively high clearances to permit passage by masted vessels; highway interests favoured lower fixed bridges to avoid costly construction of high-level approaches.

See also WATER TRANSPORT, INLAND. (H. M. M.)

ATLÁNTICO, a department of the republic of Colombia, bounded on the north by the Caribbean sea, on the east by the Magdalena river (*q.v.*) and on the south and west by the Dique canal, a navigable distributary of the Magdalena. The bifurcation of the Magdalena in effect makes of Atlántico an island surrounded by river flood plains except that a small part of the department of Bolívar is included within the "island." Although it is the smallest of the departments of Colombia (1,333 sq.mi.), Atlántico's strategic geographic position at the mouth of one of the continent's major rivers has given it an importance greater than its area suggests. Three-fourths of the population of the department (1961 est., 612,170) live in the capital city of Barranquilla (*q.v.*), one of Colombia's most active ports, 15 mi. upriver from the mouth of the Magdalena. Despite a long dry season, rural population density is high; cotton and sesame are the principal commercial crops. (Js. J. P.)

ATLANTIC OCEAN, the name given to the vast stretch of sea dividing the continents of Europe and Africa from the new world. The term is supposedly derived from Atlantis, presumed to be a submerged continent below the present ocean. For the relation of the Atlantic to other oceans and detailed explanation of phenomena common to all oceans, *see* OCEAN AND OCEANOGRAPHY.

Extent.—The Arctic basin which stretches from Bering strait across the north pole to Spitsbergen and Greenland belongs essentially to the Atlantic ocean, as in the south does the Weddell sea, south of South Georgia. The utilization of the Arctic and Antarctic circles as boundaries has neither geographical nor physical justification. The Atlantic ocean has, therefore, a share in both the seas of ice. From a consideration of winds, currents and temperature it is best to count the equatorial boundary of the North Atlantic at about latitude 5° N. In contrast to the South Atlantic it is rich in islands, in variety of coast line and in tributary seas. The latter include the Caribbean sea, the Gulf of Mexico, the Gulf of St. Lawrence, Hudson bay, Baffin bay on the west, and the Mediterranean sea, Black sea, North sea and Baltic sea on the east. Between Spitsbergen and Novaya Zemlya on the one hand and the Murmansk coast on the other lies the Barents sea; between Spitsbergen, Iceland, the Faeroes, Shetlands and Norway lies the Norwegian sea. The southern outlets from the Arctic basin are relatively narrow. Hudson strait is 64 mi. broad, Davis strait 200 mi., Denmark strait between east Greenland and Iceland 159 mi. and the passage between Iceland and north Scotland 518 mi. In the South Atlantic on the other hand, between Cape Horn and South Africa, the South Atlantic approaches Antarctica on a 3,965 mi. front, and is much colder and rawer than the North Atlantic. The Atlantic is, broadly, S-shaped and narrow in relation to its length, with the result that writers have spoken of an Atlantic valley. From the Bering strait in the north to Coats Land in the south the distance is 12,810 mi. The breadth from Newfoundland to Ireland is 2,059 mi. and from Capo Saõ Roque, Braz., to Cape Palmas, Africa, only 1,769 mi. Southward from these latter it becomes broader and is bordered by simple coasts almost without islands. Drake passage, between Cape Horn and the South Shetlands, is a strait 541 mi. wide into the South Pacific. E. Kossinna reckoned the area of the Atlantic without its dependent seas at 31,814,640 sq.mi. and with its dependent seas at 41,081,040 sq.mi. By comparison, the North sea has an area of 220,000 sq.mi. Although not the most extensive of the great oceans the Atlantic has by far the largest drainage area. The "long slopes" of the continents on both sides are directed toward the Atlantic, which accordingly receives the waters of a large proportion of the great rivers of the world, including the St. Lawrence, the Mississippi, the Orinoco, the Amazon, the rivers of La Plata, the Congo, the Niger, the Loire, the Rhine, the Elbe and the great rivers of the Mediterranean and the Baltic. Sir J. Murray estimated the total area of land draining to the Atlantic to be 13,432,000 sq.mi., or, with the arctic area, nearly 16,691,000 sq.mi., nearly four times the area draining to the Pacific ocean, and almost precisely four times the area draining to the Indian ocean.

Islands.—Among purely oceanic islands without a foundation of continental rock, usually the result of volcanic action, there are Jan Mayen Land Iceland, Fernando de Noronha (near Capo Saõ Roque), Ascension, St. Helena, Tristan da Cunha and Bouvet Islands (54° 10′ S. lat.). Mainly volcanic, but with a continental type foundation are the Azores, Canaries, Madeira and Cape Verde islands Purely continental are Spitsbergen and the Bear Islands, the British Isles, Newfoundland, the Great Antilles, the Falkland Islands, South Georgia and the South Orkneys. The Bermudas (30° N. lat.) are the most northerly coral-reef islands of the world. All Atlantic islands of purely oceanic origin together have an area of 43,000 sq mi. In this connection it seems best to consider Greenland as a part of the North American continent

(G. Sc.; C. A. Bs.)

Relief of the Ocean Floor.—The foundations of knowledge of the Atlantic floor were laid during the latter half of the 19th century. Numerous scientific expeditions, such as those of the H.M.S. "Challenger" (1872–76), the German ship S M.S. "Gazelle" (1874–76) and the surveying vessel the U.S.S. "Blake" (1877 and later), contributed to these early studies. In the 20th century the scientific upsurge beginning with World War II, and further stimulated during the International Geophysical year (IGY) of 1957–58 vastly expanded knowledge of the oceans. The greatest impetus to the early investigations was the need of information on the character of the sea bottom for the laying of transatlantic cables. Surveys made prior to and during the laying and repair of these submarine cables led to a fairly good understanding of the large-scale features of the bottom topography. Explorations in the arctic and antarctic at about the beginning of the 20th century provided information from high latitudes. The next stimulus to the study of the deep-sea topography arose from the invention of sonic depth finders (echo sounders) which came into general use about 1925. The generalized features of the sea bottom, based on relatively few soundings, taken by sounding weight and wire were found to be much oversimplified in light of the millions of echo soundings which were made after 1925. Despite the ease and rapidity with which echo soundings can be taken there are still vast areas in the Arctic and South Atlantic oceans that are but poorly surveyed. The installation of echo sounders as standard

equipment on all vessels introduced an additional aid to navigation where accurate bathymetric charts are available; consequently accurate surveys of coastal waters are made out to depths of about 13,000 ft. This program in the Atlantic aroused great interest in the character and origin of the continental shelves and slopes and provided information on the history and formation of these features. Beyond the slopes numerous sea mounts were discovered.

The floor of the Atlantic is divided into the eastern and western troughs by the Atlantic ridge, a tremendous elevation extending from the vicinity of Iceland to Bouvet Island. In the troughs depths exceed 16,000 ft., but the ridge is continuous at depths less than 10,000 ft. for the greater part of its length and in several places extends above sea level. The islands of the Azores, St. Paul, Ascension, Tristan da Cunha and Bouvet rise from the ridge. There is one small but oceanographically important break in the ridge in the Romanche furrow just north of the equator where the saddle depth is about 15,000 ft. The transverse Walfisch ridge, which extends northeast from the vicinity of Tristan da Cunha (37° S. lat.) to the coast of Africa in latitude 20° S., is continuous at depths of slightly more than 10,000 ft. and divides the eastern trough. An analogous feature, the Rio Grande ridge,

FIG. 1.—MAJOR ATLANTIC OCEAN BASINS WITH DEPTHS EXCEEDING 13,123 FT. (T. A-8)

Features of Great Depths (1-4). (Based on Vaughan *et al.*, 1940)

Western Atlantic	Eastern Atlantic
A. Labrador basin	J. North Polar basin
B. Newfoundland basin	K. West Europe basin
C. North America basin	L. Iberia basin
D. Western Caribbean basin	M. Canaries basin
1. Cayman trough (Bartlett deep) S-21 depth: 23,748 ft.	N. Cape Verde basin
E. Eastern Caribbean basin	O. Sierra Leone basin
F. Guiana basin	3. Romanche trench
2. Puerto Rico trough Milwaukee depth: 30,246 ft.	P. Guinea basin
G. Brazil basin	Q. Angola basin
H. Argentina basin	R. Cape basin
I. South Antilles basin	S. Agulhas basin
	T. Atlantic-Indian Antarctic basin
	4. South Sandwich trench (27,108 ft.)

ADAPTED FROM SVERDRUP, JOHNSON, AND FLEMING, "THE OCEANS" (COPYRIGHT, 1942, PRENTICE-HALL) BASED ON GOODE "BASE MAP" NO. 201 HO. BY PERMISSION OF THE UNIVERSITY OF CHICAGO PRESS

extends from the Atlantic ridge to South America in latitudes 30°–35° S. but is deeper and continues only at depths greater than 13,000 ft. These major structures have a pronounced effect on the deep-water circulation and, hence, on the temperature and other conditions at great depths.

Within the eastern and the western troughs are a number of more or less discrete basins in which depths exceed 13,000 ft. and usually 16,000 ft. In the Puerto Rico trough in the Guiana basin, the U.S.S. "Milwaukee" obtained a sounding of 30,246 ft., the greatest depth thus far found in the Atlantic. A maximum depth of 27,108 ft. has been obtained in the South Sandwich trench, an arcuate structure bordering the eastern side of the South Sandwich Islands. The basins bear geographic names.

The north polar basin and the intervening Norwegian basin are separated from the open Atlantic by a ridge extending from Greenland to Scotland upon which Iceland and the Faeroe Islands rise above sea level. The maximum depths in Denmark strait, between Greenland and Iceland, and over the Wyville-Thomson ridge, between the Faeroes and Scotland, are only about 1,600 ft. A lowering of sea level of about 1,600 ft. would impose a land bridge from North America to Europe and completely isolate the waters of the polar basin from both the Atlantic and the Pacific. In the north polar basin there were relatively few soundings until the Russian expedition (1937–38) which landed by plane on the ice within 60 mi. of the pole. After that time numerous soundings were made from the ice floes and ice islands throughout the basin. The basin, roughly elliptical, is divided into two parts by the Lomonosov ridge, having a sill depth of 5,000 ft., which runs from the continental shelf north of Ellesmere Island through a position of 89° N. 180° W. then south near the meridian of 140° E. toward the New Siberian Islands. The depression on the right looking north from Ellesmere Island is smaller but deeper, over 16,000 ft., whereas depths in the larger basin to the left (toward Alaska) approach 13,000 ft. There are two lobes in the larger basin and some evidence of a second ridge roughly parallel to the Lomonosov ridge. On the Greenland-Spitsbergen ridge the sill depth is about 5,000 ft. and in the Norwegian basin the greatest depth is about 12,000 ft.

Depths greater than 13,000 ft. occur in the Caribbean basin and in the Mediterranean sea. The former has numerous shallow and several deep connections with the open ocean, but the Mediterranean communicates with the Atlantic only through the Strait of Gibraltar, which is 12.2 mi. wide and where the maximum depth on the sill is only 1,000 ft. The partial isolation of the large adjacent seas has a profound effect on the conditions in the seas and also upon those in the open ocean. The topography in the Caribbean area is extremely rugged with deep trenches adjacent to steep-side ridges, many of which rise above sea level. The Milwaukee depth of 30,246 ft. is close to the northern side of Puerto Rico and in the Bartlett deep south of Cuba the U.S.S. "S-21" obtained a maximum sounding of 23,748 ft.

The mean depth of the Atlantic ocean, excluding adjacent seas, is, according to Kossinna (1921), 12,880 ft., or, including them, 11,000 ft. These values are somewhat less than corresponding values for the Pacific and the Indian oceans and are attributed to the extensive shelves with depths less than 650 ft. deep in the higher latitudes of the North Atlantic and in the Arctic oceans. Depths less than 650 ft. represent 13.3% of the Atlantic and adjacent seas, between two and three times their relative extent in the other oceans.

Bottom Deposits.—For the general characteristics of bottom deposits *see* OCEAN AND OCEANOGRAPHY: *Marine Sediments*. The greater part of the bottom of the Atlantic between the Arctic and the Antarctic circles is covered with globigerina ooze. At depths greater than 16,500 ft. the calcium carbonate content decreases and the calcareous deposits give way to red clay. On the submarine ridges the finer material is lacking and the shells of pteropod mollusks are sometimes sufficiently abundant to characterize the deposits as pteropod ooze. Diatom ooze is the most widespread deposit in the high southern latitudes but, contrary to conditions in the Pacific, is not found in northern latitudes. There is 73% of the main basin of the Atlantic (*i.e.*, including adjacent seas)

covered by pelagic sediments, globigerina and pteropod oozes covering 16,062,000 sq.mi. (50%); red clay, 6,139,000 sq.mi. (19%); and diatom ooze 1,583,000 sq.mi. (5%). The remaining 26% of the Atlantic and all adjacent seas are covered with terrigenous sediments characterized by relatively coarse mineral fragments of terrestrial origin. Air-borne material is abundant off the west coast of Africa where dry offshore winds carry material from the desert regions. In high latitudes ice-borne debris is a characteristic component of the deposits. Pebbles and rock fragments, sometimes showing the effects of glacial abrasion, are common in the tracks of the icebergs. The calcium carbonate content of the sediments of the Atlantic is notably higher than that in comparable depths and latitudes in the North Pacific. This situation is apparently related to the different conditions in the overlying water.

The German "Meteor" expedition (1925–27) collected numerous core samples in the tropical and South Atlantic. Samples up to 10 ft. long were obtained in 1936 by the cable ship "Lord Kelvin" on a line between Newfoundland and Ireland, and since World War II thousands of cores, some exceeding 50 ft. in length, have been collected, mostly from the North Atlantic. The sediments are more or less stratified, implying varying rates of accumulation of the various components. In some areas in the North Atlantic this is indicated by concentrations of volcanic ash or ice-borne terrigenous material. In lower latitudes there are changes in the relative abundance of different types of pelagic foraminiferal remains. This is interpreted as the result of changed water temperatures. Using the topmost layers characterized by cold-water fossils or abundant glacial debris as indicators of the most recent glacial period, it has been possible to estimate the rates of deposition of deep-sea sediments. In the second half of the 20th century increasing use was being made of radioactive dating. Estimates indicate that the pelagic sediments in the Atlantic are accumulating at a rate of about 1 or 2 cm. per 1,000 years.

Meteorology.—The large-scale wind system over the North Atlantic is directly related to the average distribution of atmospheric pressure of which the two major features are the Azores "high" and the Iceland "low." In the northern hemisphere the winds blow clockwise around a high-pressure area and counterclockwise around a low-pressure area. The prevailing winds on the equatorial side of the Azores high are therefore northeasterly to easterly. Since the pressure distribution remains nearly unaltered during long periods these winds, the trade winds, blow with a great constancy, particularly in winter when their regime extends farthest north. Between the Azores high and the Iceland low, westerly winds prevail. They are weak in summer and strong in winter, and on approaching northwestern Europe they assume a more southeasterly direction and bring warm and moist air to that part of the European continent. On the northern side of the Iceland low, along the east coast of Greenland and in the Labrador sea, winds with a northerly component are the more frequent.

The Iceland low is well-developed in winter only, but it is not so permanent a feature as the Azores high. Over the middle latitudes of the North Atlantic traveling lows (cyclones) develop which advance from west to east with southerly winds on their eastern side, northerly on the western. Some of these continue toward the northeast and pass over northern Norway, whereas others cross the British Isles, the Low Countries and Germany.

Over the tropical part of the North Atlantic the air temperature is throughout the year slightly lower than the surface temperature of the water, but the average difference is only about 0.8°. In winter large differences between air and sea-surface temperature are found in middle and higher latitudes and are related to the direction of the wind. Polar continental air often spreads from the North American continent over the adjacent part of the North Atlantic. This air is very cold and although it is rapidly heated when it comes in contact with the warmer water, its temperature hundreds of miles off the coast may still be 5° to 10° C. below that of the water surface. Under these conditions excessive evaporation occurs because the cold air has a low moisture content and the vapour pressure in the air is much lower than that at the warm sea surface. Over the western North Atlantic even the average air temperature is in winter considerably lower than the water temperature, and by far the greater amount of evaporation takes place in this season and not in summer, as is commonly believed. On the other hand, where warm air blows over cold water the air is cooled and the moisture in the air condenses, forming fog. This process accounts for the high frequency of fog over the Grand Banks of Newfoundland in spring and early summer when southerly winds carry warm air over the cold waters covering the banks. From July to September the air temperature differs little from that of the water.

Over the South Atlantic a high-pressure area is found between latitudes 20°–30° S., corresponding to the Azores high. On the equatorial side of this high the southeast trade wind blows weakly during the southern summer and strongly during the northern winter. Between the southeast trade winds and the northeast trade winds of the northern hemisphere lies the equatorial calm belt, the doldrums, which generally is located in the northern hemisphere between 2° and 10° N. The calm belt, characterized by light winds and heavy downpours, is generally absent off the coast of South America where the two trade winds join and blow strongly against the north coast of Brazil. In the southern hemisphere there is no counterpart of the Iceland low but a belt of low pressure surrounds Antarctica, and between this low-pressure region and the high in lat. 20°–30° S. westerly winds prevail. These westerlies which often reach gale force are particularly strong in latitudes 35°–45° S., the roaring forties.

The Benguela coast of southwest Africa is noted for its fog which forms when an onshore wind blows over the cold coastal water. The low sea-surface temperature is caused by upwelling (*see* OCEAN AND OCEANOGRAPHY: *Movement of Sea Water*).

Surface Currents.—The surface currents of the Atlantic ocean primarily correspond to the system of prevailing winds with such modifications as are imposed upon the movement of the water by land boundaries. Other factors which influence the currents are regional excess of evaporation or precipitation, regional differences in cooling or heating, friction and the effect of the earth's rotation. In the North Atlantic the trade winds maintain a fairly steady current from east to west, partly by the direct action of the wind and partly by maintaining an accumulation of warm water on the northern side of the current. A great bulk of water carried by this current continues into the Caribbean sea and through the Strait of Yucatan into the Gulf of Mexico from which it flows out as a warm and swift current through the Straits of Florida. This current is re-enforced by water which has flowed on the eastern side of the Antilles and forms the Gulf stream off the American east coast. The Gulf stream follows the coast closely as far as Cape Hatteras, continues at some distance from the coast and turns more and more toward the east, flowing due east to the south of the Grand Banks of Newfoundland in latitude 40° N. In its further course the Gulf stream loses its identity as a well-defined current. The warm surface waters turn to the right and form part of the big eddy circulating around the Sargasso sea. Somewhat colder water continues toward the European coast as the North Atlantic current. One diffuse branch turns south and another branch turns north and splits up still more. One part, the Irminger current, turns northwest, washes the southeast coast of Iceland and continues past the southern cape of Greenland. The waters of this current become gradually mixed with cold low-salinity water from the Polar sea but the last traces of Gulf stream water are still found in latitude 65° N. off western Greenland. Another branch of the Gulf stream system enters the Norwegian sea to the north of Scotland. One small portion turns south into the North sea but the major part follows the coast of Norway to North cape and continues to Spitsbergen, sending minor branches into the Barents sea. North of Spitsbergen the current submerges below the less saline waters of the Arctic and continues as a subsurface current clear across the Polar sea where traces of Gulf stream water of temperature slightly above 0° C. are found to the north of the New Siberian Islands.

The surface layer of the Polar sea is throughout the year at a temperature close to freezing point (−1.6° C.) but is of relatively low density because the salinity has been reduced by runoff from the great Siberian rivers. This cold and low-salinity water flows

out from the Polar sea along the east coast of Greenland where it is gradually mixed with Atlantic water. It continues around the south cape of Greenland, Cape Farvel, flows north along the west coast of Greenland, turns around again and after addition of cold water from Baffin bay it flows south as the cold Labrador current. To the south of the Grand Banks of Newfoundland where this cold water meets the warm waters of the Gulf stream it is deflected toward the east and mixes with the Atlantic water. In winter this mixed water, which has a salinity of about 34.95 per mille (parts per thousand), is cooled to a temperature of nearly 3° C. whereby it attains a density high enough to make it sink to the bottom and spread to the south. On an average for the whole year, 5,230,000 cu.yd. of water sink every second (about 86 cu. mi. per day). Similarly, bottom water is formed in winter to the north of Iceland, but this has a considerably lower temperature, about −1° C. It fills the deep basin of the Norwegian sea but is prevented from flowing into the Atlantic ocean by the submarine ridge which extends from Scotland to Iceland and from Iceland to Greenland.

In the southeast part of the North Atlantic surface water flows in through the Strait of Gibraltar and high-salinity Mediterranean deep water flows out along the bottom of the strait and spreads over wide areas. Along the west coast of northwest Africa the Canary current flows to the southwest and continues across the southern part of the North Atlantic as part of the north equatorial current. Low temperatures prevail on the African coast, partly because the waters come from the north and partly because of upwelling.

The currents of the South Atlantic correspond in many respects to those of the North Atlantic. The southeast trade winds maintain the south equatorial current which flows toward the west where it divides into two branches, one that continues to the northern hemisphere and enters the Caribbean together with water from the north equatorial current, and one which turns south as a weak counterpart of the Gulf stream, the Brazil current. Between the equatorial currents the equatorial counter current flows toward the east and is particularly well developed off Ghana where it is known as the Guinea current. To the south of the high-pressure area of the South Atlantic the current flows to the east and turns toward the equator when reaching the African coast. There the Benguela current is more pronounced than its northern counterpart, the Canary current, and is characterized by lower temperatures near the coast, caused by more intense upwelling. Further south the Antarctic circumpolar current enters the Atlantic ocean through Drake passage, sending one branch, the Falkland current, a counterpart of the Labrador current, along the east coast of Argentina. The major branch of the Antarctic circumpolar current continues to the east into the Indian ocean, sending another branch to the south and feeding a large clockwise eddy in the Weddell sea.

The Deep-Sea Circulation of the Atlantic.—The deep and bottom water of the North Atlantic is, as already stated, formed by sinking of surface water between Iceland and Greenland and in the Labrador sea, from where it spreads to the south. At depths between 3,000 ft. and 6,500 ft. the water which flows out from the Mediterranean spreads and can be recognized by an intermediate salinity maximum. With increasing distance from the Mediterranean the salinity decreases because of mixing with other water masses, but traces of Mediterranean water are found as far south as latitude 40° S.

In the Antarctic, bottom water of temperature −0.6° C. and salinity 34.65 per mille is formed by sinking of water from the continental shelf. The temperature of this water is so low that its density is higher than that of the North Atlantic deep water. This water flows toward the north and can be traced as bottom water to 40° N. Surface water sinks at the Antarctic convergence in about latitude 50° S. and spreads to the north as low-salinity water. This Antarctic intermediate water also crosses the equator and can be traced to about 20° N. Large amounts of the Antarctic bottom water and intermediate water mix with the North Atlantic deep water, return to the south, and rise toward the surface between 50° and 60° S. lat. In rising the deep water brings quantities of

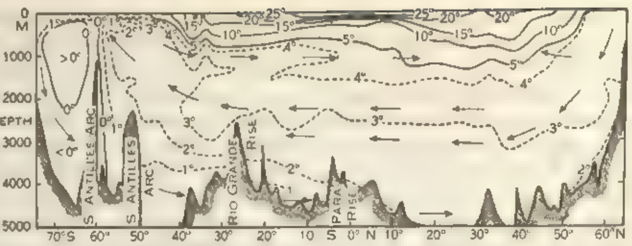

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FIG. 2.—VERTICAL SECTION SHOWING DISTRIBUTION OF TEMPERATURE IN THE WESTERN ATLANTIC OCEAN (AFTER WÜST)

plant nutrients, phosphates and nitrates to the surface layers, and the oceanic circulation therefore accounts for the high productivity of the Antarctic waters.

The deep and bottom waters of the Atlantic are characterized by a high oxygen content because there exists a fairly rapid circulation. The waters have sunk from the surface where they became saturated with oxygen by contact with the air.

Temperatures.—The distribution of the sea-surface temperature is closely related to the character of the currents. The waters of the north equatorial currents spread to the north and to the south when reaching the east coasts of North and South America and, correspondingly, the region of high-surface temperature is wide off the American east coasts but is narrow off the African coast where the Canary current and the Benguela current carry cold water toward the equator. Therefore, in latitudes about 10° S. to 30° S. and 10° N. to 30° N. the sea surface is warmer off the eastern coast than off the western, but poleward of 30° this feature is reversed. This reversal is barely evident in the South Atlantic where the Falkland current carries cold water up to about latitude 30° S. (in August to 25° S.) but is conspicuous in the North Atlantic. There the Labrador current brings cold water to latitude 40° N., whereas the extreme branches of the Gulf stream system carry warm water along the coast of Norway where ports remain ice-free even in latitude 71° N. The contrast between the South and the North Atlantic is related to the surface currents which in turn reflect the action of the prevailing winds and the effect of the shape of the coasts. Where the Falkland current meets the Brazil current and where the Labrador current meets the Gulf stream the surface temperature changes rapidly on a very short distance. The change is particularly striking when passing from the Gulf stream to the Labrador current ("the cold wall").

In the tropics the surface temperature is controlled by climatological factors to such an extent that it is nearly uniform, and differences related to currents do not appear. Such differences are very marked, however, at a depth of about 650 ft., where in latitude 6°–7° N. the temperature is 10° C. whereas it is 20° C. in latitude 20° N. The existence of the cold water at shallow depths to the north of the equator should not be interpreted as showing that deep water rises to the surface. The temperature distribution is directly related to the existence of equatorial currents which flow toward the west and within which the warm water must be to the right in the northern hemisphere and to the left in the southern.

The distribution of temperature at greater depths has already been touched upon when discussing the deep-water circulation. In the North Atlantic the temperature decreases slowly toward the bottom from a value of about 5° C. at 3,000 ft. to about 2.5° at the bottom. In the South Atlantic up to latitude 40° S. the temperature first decreases to a minimum between 3,000 ft. and 4,000 ft., increases again and reaches a maximum of 2°–4° C. at about 6,500 ft., indicating the flow of North Atlantic deep water, and then it decreases to less than 1° C. at the bottom where Antarctic bottom water is encountered. To the south of 40° S. low temperatures, 30° C. or less, prevail throughout, and near Antarctica a large body of water has a temperature below 0° C.

Salinity.—The surface waters of the North Atlantic ocean have a higher salinity than those of any other ocean, reaching values exceeding 37 per mille in latitudes 20°–30° N. The salinity

distribution is also related to the currents but is greatly influenced by evaporation and precipitation. Georg Wüst has shown that for each ocean the average surface salinity can be taken as equal to a constant basic value plus a correction which is directly proportional to the difference between evaporation and precipitation. The basic salinity value differs from one ocean to another and is highest for the North Atlantic. It is 35.5 per mille for the North Atlantic and 34.5 for the South Atlantic. This difference can be explained as the effect of the intense evaporation in the Mediterranean and the outflow from that sea of high-salinity water which maintains the salinity of the North Atlantic at a higher level than that characteristic of any other ocean. On an average for every latitude range, say 0° to 5° N., and so on, the deviations from the basic value are proportional to the difference between evaporation and precipitation. Near the equator precipitation dominates and surface salinities of about 35 per mille are encountered, but in latitudes 20° to 25° N. and about 20° S. evaporation greatly exceeds precipitation and over large areas the surface salinity is above 37 per mille. Proceeding poleward precipitation again becomes greater than evaporation and, correspondingly, the surface salinity decreases, in large areas to values below 34 per mille. Superimposed upon these general features are the effects of currents which again are more striking in the North Atlantic where Atlantic water of salinity exceeding 35 per mille is carried as far north as Spitsbergen in latitude 78° N. and Arctic water of salinity below 34 per mille is carried south to nearly 45° N. off Newfoundland. North of 40° N. the sea-surface isohalines run nearly in a north-south direction, whereas south of 45° S. they run east-west. In adjacent seas the salinity depends also upon the runoff from rivers. In the Mediterranean and the Red sea, where the runoff is small and evaporation is great, high salinities prevail; in the Black sea and in the Baltic where large rivers empty, the salinity is low. In the inner part of the Gulf of Bothnia between Sweden and Finland the water is nearly fresh. The surface water of the Polar sea has a salinity of 30–33 per mille because of admixture of fresh water from the great Siberian rivers.

Ice.—In winter the Polar sea is almost completely covered by sea ice which under the action of the wind has been broken and piled up in pressure ridges and hummocks. In summer, on the other hand, when the air temperature remains at about 0° C. from the end of June to the end of August, there are numerous patches of open water.

As much as 3 ft. of the ice melts during summer, but during the following winter new ice forms at the under side of the ice floes which by the end of the winter attain a thickness of about 10 ft. by freezing only. Where pressed together hummocks and pressure ridges rise to heights of 16 ft. or more above the general level and below these ridges the ice has a thickness of up to 65 ft.

It is probable that a great part of the pack ice of the Polar sea drifts with the winds in a clockwise eddy with its centre near the middle of the Polar sea. From this eddy a branch turns south along the east coast of Greenland and carries with it large masses of pack ice. The existence of the drift was first demonstrated by Fridtjof Nansen in 1893–96, and later by the drift of Russian vessels and of the Russian party which was landed by airplanes near the north pole in May 1937, and picked up off the east coast of Greenland in Feb. 1938. The icebergs of the North Atlantic come from the Greenland glaciers. In the Polar sea icebergs are encountered near Franz Josef Land (Fridtjof Nansen Land) and

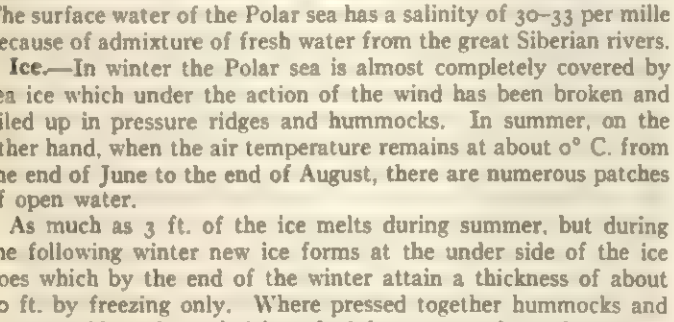

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FIG. 3.—VERTICAL SECTION SHOWING DISTRIBUTION OF SALINITY IN THE WESTERN ATLANTIC OCEAN (AFTER WÜST)

Spitsbergen, where small glaciers terminate in the sea. The ice islands, up to 18 mi. long and 200 ft. thick, apparently originate along northern Ellesmere Island and many have been sighted in the waters of the Canadian arctic archipelago. The icebergs from the glaciers on east Greenland are carried south by the east Greenland current, then north along the coast of west Greenland where many more are added, and finally south along the coast of Labrador. Off the Grand Banks of Newfoundland icebergs reach, in May and June, as far south as 42° to 43° N. where they seriously menace shipping. After the "Titanic" disaster in 1912 the international ice patrol was established by joint action of all nations with shipping interests in the North Atlantic. The ice patrol is conducted by the U.S. coast guard, which locates icebergs, predicts their drift and issues warnings. In winter the Labrador current also carries pack ice south.

Antarctica is surrounded by a belt of pack ice which in the Atlantic extends to about 55° S. at the end of the southern winter (October). At the end of the southern summer (March), the eastern and western coasts of the Weddell sea are often ice-free but the Weddell sea itself is covered by pack ice which drifts in a large clockwise gyral. Enormous icebergs break off from the Antarctic ice sheet and drift east and north. Flat-topped icebergs have been reported which have been up to 60 mi. long, 10 to 20 mi. wide and 300 ft. high. The average northern boundary of icebergs is in about 42° S., but on one occasion a small piece of floating ice was sighted in latitude 26° 30′ S., longitude 25° 40′ W.

See also Index references under "Atlantic Ocean" in the Index volume.

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(H. U. S.; R. H. Fo.; C. A. Bs.)

ATLÁNTIDA, a small department, facing the Caribbean sea in northern Honduras. Area 1,641 sq mi.; pop. (1961) 92,832 Except for the southern portion, the department consists chiefly of fertile coastal and alluvial plains, where most of the population resides. Banana districts, located in the Atlántida plains and served by railways, produce 15% of Honduras' commercial bananas, which are mostly exported. The department ranks second in national production of yucca and sweet potatoes, third in bananas, fifth in rice, and is important in production of corn, beans, cattle and swine. La Ceiba, the departmental capital (pop. [1961] 24,868) and Tela are respectively fourth and third ports of Honduras and also the two chief cities of the department.

(C. F. J.)

ATLANTIS (ATALANTIS or ATLANTICA), a legendary island in the Atlantic ocean. Plato in the *Timaeus* describes how Egyptian priests, in conversation with Solon, represented the island as a country larger than Asia Minor with Libya, situated just beyond the Pillars of Hercules. Beyond it lay an archipelago of lesser islands. Atlantis had been a powerful kingdom 9,000 years before the birth of Solon, and its armies had overrun the Mediterranean lands, when Athens alone had resisted. Finally the sea overwhelmed Atlantis, and shoals marked the spot. In the *Critias* Plato adds a history of the ideal commonwealth of Atlantis. It is impossible to decide how far this legend is due to Plato's invention, and how far it is based on facts of which no record remains. Medieval writers, receiving the tale from Arabian geographers

believed it true, and had other traditions of islands in the western sea, the Greek Isles of the Blest, or Fortunate Islands; the Welsh Avalon (*q.v.*), the Portuguese Antilia (*q.v.*) or Isle of Seven Cities, and St. Brendan's Island, the subject of many sagas in many languages. All except Avalon were marked in maps of the 14th and 15th centuries and formed the object of voyages of discovery; conjecture as to the existence of St. Brendan's Island persisted until the 18th century. Somewhat similar legends are those of the island of the Phaeacians (Homer, *Odyssey*), the island of Brazil, of Lyonnesse (*q.v.*), the sunken land off the Cornish coast, of the lost Breton city of Is, and of Mayda or Asmaide, the French Isle Verte and Portuguese Ilha Verde or "Green Island." The last appears in many folk tales from Gibraltar to the Hebrides, and until 1853 was marked on English charts as a rock in 44° 48′ N. and 26° 10′ W. After the Renaissance attempts were made to rationalize the myth of Atlantis. It was identified with America, Scandinavia, the Canaries or Palestine. Ethnologists saw in its inhabitants ancestors of the Guanches, the Basques or the ancient Italians. Even in the 17th and 18th centuries the credibility of the legend was seriously debated, and sometimes admitted, even by Montaigne, Buffon and Voltaire.

ATLAS, in Greek mythology, son of the Titan Iapetus and Clymene (or Asia), brother of Prometheus. Homer, in the *Odyssey*, speaks of him as "one who knows the depths of the whole sea, and keeps the tall pillars which hold heaven and earth asunder." In the first instance he seems to have been a marine creation. The pillars that he supported were thought to rest in the sea, immediately beyond the most western horizon. But as the Greeks' knowledge of the west increased, the name of Atlas was transferred to a range in the northwest of Africa. Later, Atlas was represented as a king of that district, turned into a rocky mountain by Perseus, who, to punish him for his inhospitality, showed him the Gorgon's head (Ovid, *Metamorphoses*).

According to Hesiod (in the *Theogony*), Atlas was one of the Titans who took part in their war against Zeus, for which as a punishment he was condemned to hold aloft the heavens. In works of art he is represented as carrying the heavens or the celestial globe.

The plural form atlantes (*q.v.*) is the classical term in architecture for the male sculptured figures supporting a superstructure, as in the baths at Pompeii and in the temples at Agrigeno in Sicily. In 18th-century architecture half figures of men with strong muscular development were used to support balconies.

(T. V. B.)

ATLAS is a term commonly applied to a collection of maps or charts, usually bound together. Folio-form handbooks on technical subjects, such as groups of anatomical drawings or ethnographical plates and related tabular data, are sometimes called atlases, but the name is most widely used in connection with cartographic works. A figure of the Titan Atlas, holding a globe on his shoulders, was first used by Gerardus Mercator in the late 16th century and frequently by other map makers of the following centuries as a frontispiece for their collections of maps and charts. Gradually the name came to be applied to volumes of maps or charts and sometimes to nongeographical publications of similar format.

There is a great range in the quality, content and utility of atlases, but in addition to maps and charts they often contain pictures, tabular data, facts about areas and an index of place names keyed to co-ordinates of latitude and longitude, or to a locational grid with numbers and letters along adjacent sides of the maps.

Atlases may be classified fundamentally into world and regional works, with each of these categories subdivided into general reference atlases designed to aid in the location or identification of geographical features or political entities, and special subject atlases providing detailed information about the boundaries, climate, economy, geology, history, languages, population, religions, resources, telecommunications, vegetation and other characteristics of an area.

Although the rediscovery of Ptolemy's *Geographia* in the 15th century, with the addition of *Tabulae Modernae* listing new place names and spellings, aroused interest in map making, collections of maps bound together in atlas form appear to have originated with the *Theatrum orbis terrarum* of A. Ortelius in 1570. Another monument of 16th-century cartography is the *Lafréri Atlas* containing maps compiled by gifted Italian cartographers between 1556 and 1575. In the following century fine atlases were prepared by V. Coronelli and other Italian cartographers, but in the production of high-grade maps the Dutch were supreme, as is illustrated by the classic atlases of Mercator, W. J. and J. Blaeu, H. Hondius, J. Jansson and N. Visscher. French atlases by N. Sanson and N. de Fer in the 17th century and by G. Delisle, C. H. Jaillot and G. L. LeRouge in the 18th were less ornate but equal in accuracy and richness of content to the Dutch and Italian maps. Contemporary German atlases such as those by the House of Homann, were burdened with enormous detail, numerous insets, notes and pictures. English atlases of the period resembled the Dutch in style but appeared more crowded. Among the more famous are works by C. Saxton in the 16th century, J. Seller, J. Speed and J. Ogilvie in the 17th century and J. Senex, William Faden, T. Jefferys and T. Kitchin in the 18th.

Among the most widely used great world atlases of modern times, indexing 250,000 to 500,000 place names, are Andree's *Allgemeiner Handatlas* (1881–1930); Stieler's *Handatlas* (1816–1937); the *Atlante Internazionale* of the Italian Touring club (first published 1929); the Soviet atlas *Mira* (first published 1954); and the London Times *Atlas of the World* in five volumes (1955–59). Detailed national atlases have been published in the 20th century by more than 35 countries. That of Canada approaches the ideal in organization, content and cartographic presentation. Regional and local atlases can show greater detail, and plans such as those of the Sanborn atlases of cities in the United States show even the structure and use of buildings.

The *Encyclopædia Britannica World Atlas* presents a world coverage of maps, statistical tables and an index of locations by name. The atlas, divided into five parts—political-physical maps, "The World Scene," "Geographical Summaries," "Geographical Comparisons" and an index—illustrates, for example, world distribution of crops, population, industry, political geography and physical features. The statistical section, "Geographical Summaries," includes data for over 200 countries on political subdivisions, population, productive enterprises, trade, finance, transportation, communications, education and health. "Geographical Comparisons" lists natural and man-made physical features of the world.

See also Map.

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ATLAS MOUNTAINS, the name for the mountain chains more or less parallel to the coast of northwest Africa. The name was given by Europeans who supposed them to be the home of the mythical Greek god, and is never used by the native races.

Geology.—The Atlas mountains form part of the Tertiary Alpine-Himalayan fold system. In them, rocks of all types and ranging from Pre-Cambrian to Miocene are intensely folded and often highly metamorphosed, the fold pattern being similar to that throughout the whole Alpine system. The movement commenced there at the end of the Jurassic, was renewed in the Upper Cretaceous and continued into the Miocene. There is also evidence of folding during earlier periods (Variscan in the Moroccan Meseta). The trend of the folds is approximately east-west, the folds having moved southward over the Saharan-African hinterland. The trend is continued eastward through Sicily into the Apennines, and westward into the Canary Islands. Intense glaciation occurred during the Ice Age as shown by moraines, etc., and some peaks are still snow-capped.

Sub-Divisions.—The Atlas mountains extend 1,500 mi. from southwest Morocco to northern Tunisia, traversing Morocco, Algeria and Tunisia. They form a topographic and climatic barrier between the Mediterranean sea to the north and the Sahara desert

to the south. They can be divided into two main chains: (1) the Maritime Atlas from Ceuta to Cape Bon; and (2) the inner and more elevated ranges, which, from Cape Guir, run south of the coastal ranges. The western inner ranges (the Moroccan ranges) are the most impressive of the whole system. The Maritime Atlas and the inner ranges in Algeria and Tunisia are treated under *The Eastern Ranges* below.

The Moroccan Ranges.—This section, whose Berber name is Idráren Dráren, consists of five ranges more or less parallel to one another and with a trend from southwest to northeast.

1. The main range, the High or Great Atlas, has a central position and is the longest and loftiest chain, with an average height of more than 11,000 ft. The slopes are precipitous toward the Atlantic but gradual toward the Dahra district (west of Algiers). Several summits are snow-clad during most of the year. The northern sides and tops of the lower peaks are often covered with forests of cork, oak, pine, cedar and other trees, with walnuts up to the limit of irrigation. Their lower slopes enclose well-watered valleys in which the Berber tribes cultivate tiny irrigated fields, their houses clinging to the hillsides. The southern flanks, being exposed to the hot dry winds of the Sahara, are generally destitute of vegetation.

The crest of the range has been deeply eroded, forming devious passes. The central section, culminating in Toubkal, 13,665 ft., maintains a mean altitude of 11,600 ft., and from this great mass a number of secondary ridges radiate. The best-known passes are: the Bíbáwan in the upper Sous basin (4,882 ft.); the Tizi n' Test, giving access from Marrákech to Tároudánt, rugged and difficult, but low; the Tizi n' Tichka (7,438 ft.) and the Talghemt (7,250 ft.), leading to Tafilált. There are two passes accessible to normal traffic which afford communication between the Tensift and Sous basins.

2. The lower portion of the Moroccan Atlas (the Middle or Moyen Atlas) north of the High Atlas, is crossed by the pass from Fès to Tafilált, both slopes being wooded. From the north this range presents a regular series of snowy crests.

3. The Anti-Atlas (Djebel Sarro or Lesser Atlas) runs parallel to and south of the central range and has a mean altitude of 5,000 ft., although some peaks and even passes exceed 6,000 ft.

4. The Djebel Bani, south of the Anti-Atlas, is a low, narrow rocky ridge with a height of 3,000 ft. in its central parts.

5. The foothills of Ghaiáta, north of the Middle Atlas are a series of broken mountain masses from 3,000 to 3,500 ft. high, to the south of Fès, Táza and Tlemcen. The last two are parallel ranges of less importance.

The Eastern Ranges.—The lesser range (Maritime Atlas also known as the Little Atlas, Tell Atlas or Atlas Tellien) nearer the sea, is not so impressive. From Ceuta to Melilla (150 mi.) the Rif mountains face the Mediterranean, and there, as along the whole coast eastward to Cape Bon, many rugged rocks rise boldly above the general level. In Algeria the Maritime Atlas has five chief ranges, several mountains exceeding 5,000 ft. The Djurdjura range, extending through Kabylia from Algiers to Bougie, contains Lella Khedidja (7,572 ft.) and Djebel Adrar (6,542 ft.). The Medjerda range, which extends into Tunisia, has no heights exceeding 3,947 ft. It was in these coastal mountains that the Romans quarried the celebrated Numidian marbles.

The southern or main range of the eastern division, the Saharan Atlas (Atlas Saharien), is linked by secondary ranges to the mountains of Morocco. The Saharan Atlas is essentially one chain, though known under different names: Ksour mountains (west), Djebel Amour, the Ouled-Naïl, and the Aurès (east).

The central part, the Zab mountains, is of lower elevation, the Saharan Atlas reaching its culminating point, Djebel Chélia (7,648 ft.), in the Aurès. This range sends a branch northward which joins the Medjerda range of the Maritime Atlas, and another branch runs south by Gafsa to the Gulf of Gabès. There Mt. Sidi Ali bu Musin reaches a height of 5,066 ft., the highest point in Tunisia. In the Saharan Atlas the passes leading to or from the desert are numerous, and in most instances easy.

Both in the east (at Batna) and the west (at Aïn-Sefra) the mountains are traversed by railways, which, starting from Mediterranean seaports, take the traveler into the northern [illegible] the Sahara.

History and Exploration.—The Atlas are the home of [illegible] races, and those in the least accessible regions have been [illegible] ent throughout their recorded history. In general the M[illegible] range was well known to the Romans, but some mountain [illegible] of Kabylia had never been visited by Europeans until the [illegible] military expedition of 1857. The Djebel Amour was travers[ed by] the column which seized Al Aghuat in 1852, and the survey [of the] mountains dates from that time.

The ancient caravan route from Mauritania to the western [illegible] crossed the lower Moroccan Atlas via the pass of Talghem[t] [illegible] through the oasis of Tafilált (*q.v.*), formerly known as [illegible] on the east side of the Anti-Atlas. The Moroccan system [was] visited and in some instances crossed, by various European [trav]elers carried into slavery by the Salli rovers, and was travers[ed] by René Auguste Caillié (*q.v.*) in 1828 on his journey [illegible] Tombouctou, but the first detailed exploration was made [by] Friedrich Gerhard Rohlfs in 1861–62.

In 1871 the first scientific expedition, consisting of [illegible] Hooker (afterward Sir), John Ball and G. Maw, explored [the] central part of the High Atlas. They ascended by the Ait M[illegible] valley to the Tagharat pass (11,484 ft.) and by the Amsmiz [illegible] to the summit of Djebel Tezah (11,972 ft.). Oskar Lenz in 18[illegible] 80 surveyed a part of the High Atlas north of Tároudánt det[er]mined a pass south of Iligh in the Anti-Atlas, and penetra[ted] thence across the Sahara to Tombouctou. He was followed [in] 1883–84 by Vicomte Charles de Foucauld, whose itinerar[ies in]cluded parts of the first and middle ranges; three routes over the High Atlas; and six journeys across the Anti-Atlas, with a gene[ral] survey of the foot of this range and several passages over [the] Djebel Bani. Then Joseph Thomson explored some of the [cen]tral parts in 1888; and Walter B. Harris explored some [of the] southern slopes and crossed the Atlas at two points during h[is ex]pedition to Tafilált in 1894. In 1901 and again in 1905 the m[arquis] de Segonzac, a Frenchman, made extensive journeys in the Mo[roc]can ranges. A member of his expeditions, De Flotte Rocquev[aire] made a triangulation of part of the western portion of the m[iddle] Atlas.

Since that time numerous travelers and scientists have [illegible] and explored the mountain (*see* also MOROCCO; ALGERIA, T[UNISIA] and SAHARA).

Minerals.—The mountains have considerable mineral potent[ial]. The development of better transport facilities will permit [the] exploitation of the reserves. Extensive exploration for na[tural] oil is going on throughout the Atlas region and also farther [illegible] in northern Sahara. Intensive work is now concentrated [in the] following four zones in the Maritime Atlas of northern Alger[ia]: (1) Oued Gueterini (Sidi-Aïssa); (2) South Tellian, (3) H[illegible] basin; and (4) Est-Constantinois basin. In the first region [illegible] quantities of oil are being produced and oil and or gas ha[ve been] proved in all the others. The oil is transported by pipeline [from] the oil fields to the Mediterranean ports of Algeria. Coal is m[ined] in Morocco and mineral phosphates abound in several [illegible] farther east. Other mineral resources are iron, manganese [illegible] zinc and antimony. (J. I. P.)

ATMOSPHERE. An atmosphere is the gaseous enve[lope] which covers a planet or large satellite (Gr. *atmos*, "vapour" [and] *sphaira*, "sphere").

The ocean of air in which we move and have our being [illegible] flows around us and sustains life on earth, owes its unique [illegible] benevolent character to a superb balance among the forces [of na]ture. Every planet in the solar system possesses an atmosphere, with the possible exception of the scorched little planet Mer[cury] circling closest to the sun. Several of the satellites of the [illegible] planets are also large enough to possess atmospheres. However, life as we know it is impossible on any of these other bodies.

To understand that balance of natural forces which determine[s] the atmosphere a body in space will have, the astronomer and [the] physicist must work together, the one probing the planets [with] his telescopes and radio antennas, the other examining the [illegible] of the planet Earth. From these efforts is gradually emerging [illegible]

understanding of how the planets came to be.

PLANETARY ATMOSPHERES

Before the planets were formed there existed a cloud of gas and dust, a mixture of all the elements contained in the solar system. In this mixture hydrogen and helium, the lightest gases, were by far the most plentiful and the heaviest elements were in general the least plentiful. As the gas condensed and the planets grew out of the gas and dust mixture the solid portion of each planet became the nucleus, or central part, and the gases and liquids clung to the surface. However, the gases were constantly in motion, due to the heat of the nucleus and of the sun, and some molecules gained enough velocity to escape from their parent body forever.

The amount of gas which a body in space can permanently retain around itself is determined by a long-term balance between its gravitational attraction, which holds the gas and prevents it from flying off into space, and the temperature of the gas at the top of the atmosphere, which is a measure of the energy available to the gas to escape. For example, the moon's mass is about one-eightieth that of the earth. Since it has a small gravitational attraction, and since the temperature is sufficiently high on the sunlit side, all but the very heavy gas molecules have gradually escaped. Earth, Venus and Mars are able to retain appreciable atmospheres, but lighter gases such as hydrogen and helium slowly escape even from these planets.

The large outer planets, Jupiter, Saturn, Uranus and Neptune are sufficiently cold due to their great distance from the sun, and sufficiently massive to retain large amounts of hydrogen and helium. In fact, these two elements are the most abundant ones in the atmospheres of these giant planets. Furthermore, their atmospheres are very thick, although just how thick is not known, since astronomers cannot probe beneath their swirling vapours of ammonia and methane.

The atmospheres of Venus, Earth and Mars are dissimilar in many respects. Nitrogen is probably the predominant gas in all three, and all contain carbon dioxide. Here the similarity ends. In the Venusian atmosphere methane and ammonia have been identified in amounts that are large in comparison to Earth. Free molecular oxygen is known to exist only in the earth's atmosphere.

Surface pressures of the three atmospheres differ also. The surface pressure is a measure of the total mass of the atmosphere from the surface of the planet to the top of the atmosphere (*see* below). On Earth the average surface pressure is about 1,015 millibars (mb.) (1 mb. = 1,000 dynes per square centimetres) or about 15 lb. per square inch. On Mars it is estimated to be between 50 and 100 mb. (corresponding to the pressure at 50,000 to 65,000 ft. in the terrestrial atmosphere). On Venus it is about 160 mb. at the top of the impenetrable clouds which cover the planet. The surface pressure on Venus is greater than this, but how much greater is not known.

Since an atmosphere forms a gaseous barrier between the surface of a planet and outer space, planetary atmospheres have important effects on surface conditions. They absorb the ultraviolet rays from the sun. They are sufficiently thick, except on Mercury and probably Pluto, to prevent all but the larger meteoroids from hitting the surface. They are constantly in motion, due to the application of solar heat and the planets' rotation. This motion erodes the solid surface and slowly levels mountains. Finally, in the case of Earth, the atmosphere supports animal and plant life.

THE TERRESTRIAL ATMOSPHERE

History.—The ever-changing sky has always inspired and intrigued mankind. Depending on the good graces of the weather for so many of his pursuits, man recognized early the necessity of studying the weather. The farmer watched the sunset and the motions of the clouds to determine if the next day would bring rain; the mariner watched the same signs, and as ships ranged around the world mariners prepared charts which showed the belts of the trade winds and the patterns of the monsoons (*see* also METEOROLOGY; WEATHER FORECASTING).

At the close of the 19th century, man began seriously to probe the upper atmosphere. However, with kites and manned balloons, he was able to reach heights of only a few thousand feet. In 1904, L. P. Teisserenc de Bort in France published the results of 581 free balloon ascents, in which recoverable, lightweight instruments measured the temperatures and pressures in the atmosphere to a height of about 14 km. (45,000 ft.).

The decades that followed these first balloon ascents saw rapid advances in knowledge of the upper atmosphere. Improved balloons, some transmitting their instrument records by radio, reached heights of over 40 km. (130,000 ft.). Higher regions were explored by a variety of means. Studies were made of the behaviour of sound waves from explosions, since these waves were observed to be refracted downward by the warmer strata aloft. The heights at which meteors appeared and disappeared gave indications of the density of the air between about 100 and 50 km. (330,000 to 160,000 ft.), and the occasional long-enduring luminous trail left by a meteor in the sky gave an indication of the winds in this region. The way in which the rays of the setting sun were scattered in the upper reaches of the atmosphere revealed information regarding the density of the air and the amount of suspended dust aloft.

In 1913, C. Fabry and M. Buisson reported the existence of ozone, a gas created by a photochemical reaction between sunlight and oxygen. Ozone provided an explanation for the warm region that, in the 1920s, was discovered to exist at about 50 km. (160,000 ft.). The behaviour of the ozone in the upper air, its distribution, the way in which it moves with the seasons, were subjects which in the second half of the 20th century constituted important facets in the study of the upper air.

A particularly powerful tool in early upper atmosphere research was the radio wave. The region above about 100 km. (330,000 ft.), known as the ionosphere, is electrically conducting and absorbs and reflects radio waves that have frequencies below about 10 mc. per second. This was understood as early as 1901, when A. E. Kennelly in the U.S. and O. Heaviside in England almost simultaneously predicted the effect of the ionosphere on radio waves. However, it was not until 1925, in both England and the U.S., that radio wave techniques were successfully used for the specific purpose of measuring ionospheric properties.

The electrical properties of the ionosphere, combined with the air motions in these regions, cause electrical currents to flow in a complex pattern. These high altitude electric currents cause changes in the earth's magnetic field (*see* also GEOMAGNETISM). In fact, the first suggestion of the existence of an electrically conducting layer in the atmosphere was made by Balfour Stewart in 1878, who based his conclusions on geomagnetic observations.

By 1946, when the first V-2 rocket devoted to exploring the upper atmosphere was fired from the White Sands proving ground, N.M., the major facts concerning the upper atmosphere had been fairly well established. The general features of temperature distribution, composition and density had been determined from the remarkable set of indirect observations and deductions just described. Further information had been provided by theoretical reasoning. However, the series of rocket observations which started in 1946 not only described the atmosphere itself more precisely than before, but they also provided invaluable information about the solar radiation which is absorbed in the upper atmosphere. Solar radiation in the ultraviolet and X-ray (very short wave) region of the spectrum has an important effect on the atmosphere, particularly the upper part. The scientific satellite program in connection with the International Geophysical year (1957–58), which was in a sense an extension of the sounding rocket program, is particularly useful in this respect, since satellites can observe the sun continuously.

Atmospheric Nomenclature.—The earth's atmosphere has a number of regions, one above the other, each with a unique set of characteristics. Though the boundaries between these regions are not always distinct, it is convenient to distinguish among them and to assign a name to each.

The part of the atmosphere in which we live, in which most clouds form and which is the theatre for weather as we know it, is called the troposphere. In the troposphere temperatures decrease with height, on the average, and there is a considerable amount of turbulent mixing. Most of the water vapour is trapped in this

TABLE I.—*Composition of the Lower Atmosphere*
(*Permanent Constituents*)

Constituent	Formula	Volume %
Nitrogen	N_2	78.084 ± .004
Oxygen	O_2	20.946 ± .002
Argon	Ar	0.934 ± .001
Carbon dioxide	CO_2	0.033 ± .001*
Neon	Ne	18.18 $\times 10^{-4}$
Helium	He	5.24 $\times 10^{-4}$
Krypton	Kr	1.14 $\times 10^{-4}$
Xenon	Xe	0.087 $\times 10^{-4}$
Hydrogen	H_2	0.5 $\times 10^{-4}$
Methane	CH_4	2.0 $\times 10^{-4}$
Nitrous oxide	N_2O	0.5 $\times 10^{-4}$

*Estimates of the rate of increase of carbon dioxide in the atmosphere due to the rapid burning of the earth's reserves of organic fossil fuels range from 2% to 3% of this value per decade, though the data are not entirely conclusive. There is considerable local variation of CO_2 due to localized sources and sinks. Ref.: E. Glueckauf.

region. The upper boundary of the troposphere is the tropopause, and it is often quite abrupt. The height of the tropopause varies from about 8 to 12 km. (25,000 to 40,000 ft.) at high and middle latitudes, and from about 16 to 18 km. (50,000 to 59,000 ft.) over the equator.

Immediately above the tropopause is a nearly isothermal (constant temperature) region followed by a region of temperature increase called the stratosphere (*q.v.*). For some time after the early observations of De Bort, whose balloons penetrated into the stratosphere, it was thought that the isothermal region might extend upward indefinitely, and so in much of the early literature the word stratosphere was used loosely to refer to everything between the troposphere and the ionosphere. This definition is still used by some, even though it is recognized that the isothermal region does not extend very far, and it is generally absent in the tropics.

The region between the stratosphere and the ionosphere is called the mesosphere, a term introduced by Sidney Chapman in 1950. In the mesosphere temperatures decrease with height to about 80 km. (250,000 ft.).

Above this is the ionosphere (*q.v.*), where the temperature increases with elevation, reaching very high values at the upper fringes of the atmosphere (*see* Table II). It is a region in which the short-wave radiation of the sun has a dominant effect. The bombardment by powerful short-wave radiation causes certain molecular constituents of the air to dissociate into their atomic form, and also to become ionized by the release of free electrons. The presence of large numbers of charged ions and free electrons above 100 km. (330,000 ft.) causes this part of the atmosphere to be a relatively good electrical conductor. At a sufficiently high level in the ionosphere an atom or molecule moving vertically upward would have a small but finite chance of escaping completely from the atmosphere without collision with an air particle. In other words, above this level some air particles will be able to travel in free orbits out of the atmosphere and back again. Lyman Spitzer, who studied this region theoretically (1949), used the word exosphere, a term which has gained general acceptance.

Atmospheric Composition.—The atmosphere in the troposphere is made up of a mixture of gases which, with the exception of a few constituents to be discussed, is quite constant. The percentages by volume of each of the permanent or relatively nonvariable gases in the lower atmosphere are summarized in Table I. In addition to these relatively permanent gases there are some constituents in the atmosphere which undergo changes of state or chemical reactions. In the troposphere water vapour, which enters the atmosphere by evaporation from the surface, leaves the atmosphere as rain, snow, hail, dew or frost (*see* HUMIDITY, ATMOSPHERIC). The amount of water vapour at sea level may vary from 20 g. or more per kilogram of air in the tropics to less than 0.5 g. per kilogram of air in cold, dry polar continental air masses. In addition, as G. M. B. Dobson, A. W. Brewer and R. J. Murgatroyd in England and C. J. Brasefield in the United States have shown by a number of ascents with aircraft and balloons, the distribution of water vapour is extremely variable in the vertical. It appears that vertical mixing proceeds at such a slow rate that layers of water vapour can persist for periods of several days to several weeks. These observations show that regardless of season there is a marked decrease in the water vapour above the tropopause, verifying the expectation that the upper atmosphere is much drier than the troposphere.

The other important variable in the atmospheric composition is ozone. Ozone is formed by photochemical processes in the mesosphere. Solar ultraviolet radiation causes the dissociation of molecular oxygen, and the atomic oxygen then combines with the remaining oxygen to form triatomic ozone. This results in a maximum concentration at about 20 to 30 km., but even here only a few parts of ozone are present per 1,000,000 parts of air.

If all the ozone present in a vertical column that extended through the entire atmosphere were collected at sea level in a container of the same cross section as the column, the thickness of the pure ozone sample would be between 0.2 and 0.4 cm. (This is the usual way of expressing the total ozone content of the air.) The total ozone content at middle latitudes is at a maximum in the spring and at a minimum in the fall. It may be nearly 0.4 cm. at high latitudes and less than 0.2 cm. near the equator. There is a build-up of ozone in polar regions in winter as the air in the mesosphere converges toward the poles, bringing ozone from lower latitudes. In the spring the flow is reversed, and there is an increase in total ozone at middle latitudes.

The heavier gases in the atmosphere have a tendency to settle down into the lower layers, while the lighter gases such as hydrogen and helium tend to gravitate to the top of the atmosphere. These tendencies are counteracted by the continual stirring of the atmosphere, which, over a long period of time, is apparently so effective that even up to altitudes of 70 km. (230,000 ft.), where rockets have obtained air samples, the separation of the heavier from the lighter elements is barely detectable. At higher altitudes in the ionosphere it is probably quite marked.

Temperature, Pressure and Density Distribution.—The atmospheric pressure at the surface of a planet is the result of gravity pulling down on the entire atmosphere. Surface pressure is a measure of the weight of an atmosphere above a surface, and as one moves upward the pressure decreases because there is less air above. The change of pressure, Δp, for a given change of height, Δh, is given by the hydrostatic equation:

$$\Delta p = -g\rho\Delta h$$

where g is the acceleration of gravity, and ρ is the average air density in the height interval. The density is a function of the pressure, and of the temperature and molecular weight of the air. This relationship is given by the equation of state:

$$\rho = \frac{pM}{RT}$$

where M is the molecular weight, T is absolute temperature (in degrees Kelvin), and R is a physical constant known as the universal gas constant (8.314×10^7 ergs per mole-degree). Substituting for ρ in the hydrostatic equation:

$$\frac{\Delta p}{p} = -\frac{Mg}{RT}\Delta h$$

This fundamental equation allows one to calculate pressure throughout an atmosphere if the temperature and molecular weight are known, or to calculate temperature if pressure and molecular weight can be measured.

TABLE II.—*Standard Atmosphere*

Altitude		Absolute temperature		Molecular weight	Pressure	
km.	ft.	°K. (Kelvin)	°R. (Rankine)		mb. (millibar)	lb.-force sq ft
0	0	288.16	518.69	28.966	1.01325 $\times 10^3$	2.11622 $\times 10^3$
11.02	36,152	216.66	389.99	↓	2.263 $\times 10^2$	4.727 $\times 10^2$
20.06*	65,824*	216.66	389.99		5.475 $\times 10$	1.155 $\times 10^2$
25.10	82,345	216.66	389.99		2.489 $\times 10$	3.197 $\times 10$
32.16	105,518	237.66	427.79		8.678	1.813 $\times 10$
47.35	155,348	282.66	508.79		1.204	2.516
53.44	175,346	282.66	508.79		5.832 $\times 10^{-1}$	1.218
75.90	240,001	196.86	354.35	↓	2.452 $\times 10^{-2}$	5.121 $\times 10^{-2}$
91.29	299,516	196.86	354.35	28.966	1.815 $\times 10^{-3}$	3.792 $\times 10^{-3}$
128.55	421,745	273.6	492.4	24.54	1.451 $\times 10^{-5}$	3.030 $\times 10^{-5}$
179.95	590,400	669.0	1,204.0	23.84	6.189 $\times 10^{-7}$	1.293 $\times 10^{-6}$
314.86†	1,033,003†	973.5	1,752.0	18.34	1.447 $\times 10^{-8}$	3.023 $\times 10^{-8}$

*Top of 1952 ICAO Standard Atmosphere.
†Top of 1956 United States Extension to the Standard Atmosphere.

Although there are complex variations in temperature and pressure with time and space, it has been found convenient to establish an average vertical distribution to use as a reference for aeronautical and other purposes. Table II is a condensation of the 1952 International Civil Aviation Organization (ICAO) Standard Atmosphere, which has been adopted as an international standard up to 20 km. (65,820 ft.), and above this of the 1956 U.S. Extension to the Standard Atmosphere. Values have generally been rounded off to four significant figures below 100 km. (330,000 ft.) and to three significant figures above this (except for molecular weight). Intermediate values of temperature in the Standard Atmosphere can be obtained approximately by interpolating linearly with altitude. Intermediate values of pressure or density must be obtained by integrating the hydrostatic equation, using the proper temperature-height distribution. Such an integration above 91.29 km. is further complicated by the changing molecular weight, and at great altitudes the change of gravity with height becomes significant also. However, for most purposes the pressure and density can be interpolated with satisfactory accuracy by plotting the logarithm of the values given against height, and connecting these points with straight lines.

Standard sea level values for the atmospheric properties in metric and British units are as follows:

Temperature:	288.16° K. = 518.688° R. = 15° C. = 59° F.
Pressure:	1,013.25 mb. = 760.00 mm. of mercury = 29.921 in. of mercury = 2,116.22 lb. per square foot = 14.696 lb. per square inch.
Density:	1.2250 kg. per cubic metre = 0.002378 slugs per cubic foot.

Note that the temperature in degrees centigrade and Fahrenheit, and the pressure expressed in millimetres of mercury (*see* METEOROLOGY) are exact by definition; all the other quantities are derived.

See also Index references under "Atmosphere" in the Index volume.

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ATMOSPHERIC ELECTRICITY: *see* ELECTRICITY, ATMOSPHERIC.

ATMOSPHERIC NITROGEN FIXATION: *see* NITROGEN, FIXATION OF.

ATOLL, a horseshoe or ring-shaped reef of coral enclosing a lagoon. Its form may be likened to that of a partly submerged dish with pieces broken from its edge. The dish is formed of hard coral and the shells of various reef-dwelling mollusks covered, especially at the seaward periphery, with a film of living coral polyps that continually extend the fringe and enlarge the diameter of the atoll. The lagoon entrance in the open part of the horseshoe is always to leeward of prevailing winds. Atolls are found only in waters shallow and warm enough to support coral life. The great area of atoll formation is the central, western and southwestern Pacific.

See CORAL REEF.

ATOM. The word atom, from the Greek *atomos* ("indivisible"), can be said to define the ultimate unit of something whose structure is granular or discontinuous. In particular, it is applied to the smallest amount of a chemical element ever found to take part in a chemical reaction. This definition of the atom in chemical terms does not imply that further subdivision, by processes other than chemical, may not take place. Indeed, the subdivision of atoms by a variety of physical means has become commonplace. Because, however, the subdivision of an atom destroys its original chemical identity, and because man's everyday experience of matter depends largely on its chemical composition and properties, the concept of the chemical atom as an ultimate building block is a useful and durable one.

This article traces the development of that concept, and then considers the structure and properties of individual atoms, in accordance with the following outline:

I. THE BEGINNINGS OF ATOMIC THEORY

The earliest well-authenticated expressions of the view that the ultimate structure of matter is discrete, rather than continuous, are ascribed to Democritus (*q.v.*), who lived about 420 B.C. It may well be that precedence should be given to Leucippus, who is said to have lived about 450 B.C. and who is quoted by Aristotle; however, Leucippus' existence was denied by Epicurus (341–270 B.C.). According to Democritus, "The only existing things are the atoms and empty space; all else is mere opinion." From this standpoint, qualities such as colour, taste, smell and texture were secondary, not basic; they could not be associated with the individual atoms, which were to be described solely in terms of geometry and motion. If, in fact, atoms had to be invested with all the properties of bulk matter, an atomic theory would not contribute in the slightest to man's understanding of nature. (If a person observes that a certain gas is green, and says that this is because its atoms are green, he has not offered an explanation of any consequence.) In this respect the approach taken by Democritus, though entirely speculative, contained a recognition of what a scientific explanation entails. He limited the properties of atoms to position, size, shape and motion, and believed that all the secondary properties of material things would thereby follow. His atoms were in ceaseless motion, infinitely numerous, and indestructible; his universe was strictly materialistic.

Much the same type of primitive atomic theory was espoused by Epicurus, whose views were eloquently transmitted to posterity by Lucretius in his poem *De rerum natura*. Here are found the assertions that nothing is ever annihilated, that matter is composed

of invisible atoms, that the atoms are always on the move, and that they are themselves devoid of colour, heat, sound, taste and smell. The properties of objects are due to varieties in the size and shape of atoms. The number of atomic shapes is large though finite, but the number of atoms of any one shape is infinite.

The atomism of the ancient Greeks was echoed many centuries later by such men as Giordano Bruno (1548–1600), Francis Bacon (1561–1626), Descartes (1596–1650) and Sir Isaac Newton (1642–1727). The main emphasis was still, however, more philosophical than scientific. Thus, for example, Newton: "It seems probable to me that God in the beginning formed matter in solid, massy, hard, impenetrable movable particles, of such sizes and figures, and in such proportion to space, as most conduced to the end for which He formed them. . . . And . . . that nature may be lasting, the changes of corporeal things are to be placed only in the various separations and new associations and motions of these permanent particles. . . ."

It was Daniel Bernoulli (1700–1782) who, in his book *Hydrodynamica* (1738), extracted for the first time a quantitative physical result from the picture of the chaotic motions of atoms. He showed that, if a gas is composed of swiftly moving atoms whose diameters are small compared to their separations, the pressure of a confined sample of the gas will be inversely proportional to its volume. This result was in accord with experiment (as expressed in Boyle's law) and marked the birth of a rational kinetic theory of gases (*see* KINETIC THEORY OF MATTER). It remained, however, for the growth of a quantitative science of chemistry (*q.v.*) to place the atomic theory on a solid experimental foundation.

II. DALTON'S THEORY

The rise of chemistry in the late 18th and early 19th centuries disclosed certain underlying features which the English chemist and physicist John Dalton was able to explain through a detailed atomic theory. First among these was the discovery of chemical elements, defined as those substances that cannot be further resolved into other substances by any means (*see* ELEMENTS, CHEMICAL). This concept of element had been clearly stated in 1661 by Robert Boyle in his book *The Sceptical Chemist*, and by 1800 about 25 or 30 substances conforming to the definition had been recognized. The second important discovery was expressed in the law of conservation of mass in chemical reactions. This result—carefully confirmed, though not originated, by A. L. Lavoisier (1743–1794)—lent powerful support to the original atomistic idea that all chemical changes are simply the reorganization of unchanging fundamental units. The third, and perhaps most crucial, discovery was expressed in the law of definite proportions (J. L. Proust, 1799), which states that every pure chemical compound contains fixed and constant proportions (by weight) of its constituent elements. Whenever a pure substance (composed, for example, of two elements) is broken down into those elements, they appear always in the same proportions. If the compound substance is synthesized by causing the two elements to react with each other, a surplus of one element or the other will be left over unless their amounts have been chosen to correspond to the proportions required.

1. Postulates.—Dalton was able to justify all these results with the postulates of his atomic theory, the main features of which were the following:

1. Matter consists of indivisible atoms.
2. All the atoms of a given element are identical in weight and in every other property.
3. Different elements have different kinds of atoms. In particular, the atoms of different elements are different in weight.
4. Atoms are indestructible, and chemical reactions are merely a rearrangement of atoms.
5. The formation of a compound from its elements takes place through the formation of "compound atoms" containing a definite (and small) number of atoms of each element.

These postulates were given final expression in Dalton's *A New System of Chemical Philosophy*, the first volume of which was published in 1808.

2. Rule of Greatest Simplicity.—The importance of Dalton's theory resided not so much in its novelty (much of it was indeed old) as in its concreteness. It made a clear and definite statement of the assumptions, and in particular laid great stress on the weights of atoms. The theory was thereby brought firmly to a point where it would stand or fall by the quantitative test of its predictions. In furtherance of this end, Dalton added another principle which, although later history showed it to be invalid contributed largely to the success of the theory. This was the "rule of greatest simplicity"; it asserted that if two elements formed only one known compound, that compound represented the union of one atom of each element. Its significance was that it permitted conclusions to be drawn about the relative weights of the atoms themselves. Thus, for example, in Dalton's day the only known compound of oxygen and hydrogen was water, formed by the reaction of about eight parts by weight of oxygen with one part by weight of hydrogen. (Dalton quoted a ratio of 7 to 1 instead of 8 to 1, but this was the result of inaccurate analysis.) The rule of greatest simplicity would specify the formula HO for water, and would lead to the conclusion that an atom of oxygen (O) weighs eight times as much as an atom of hydrogen (H). The fact that in this particular instance the numerical result is wrong (because the correct formula for water is H_2O) should not prevent a recognition of the perspicacity of Dalton's approach.

3. Law of Multiple Proportions.—Through a natural extension of the rule of greatest simplicity, Dalton supplied one of the most powerful arguments for his theory. The extension was merely this: if the atoms of two different elements are denoted by A and B, their combinations (assuming more than one to be possible) are likely to take such simple forms as A + B, A + 2B, 2A + B, A + 3B, etc. To make a compound corresponding to the combination A + 2B (or AB_2) will, for a fixed amount of element A, require exactly twice as much of element B as is needed to make the combination A + B (or AB). And although experimental data on the various compounds were already available in Dalton's time, the data had never before been analyzed from this point of view. It was known, for example, that carbon and oxygen formed two distinct compounds; one of them contained 28% by weight of carbon and 72% by weight of oxygen, the other contained 44% carbon and 56% oxygen. These figures take on a new significance if the ratio of oxygen to carbon is computed from them in each case:

	% Carbon	% Oxygen	% Oxygen / % Carbon
first compound	28	72	2.57
second compound	44	56	1.27

It is seen that the ratio of oxygen to carbon is almost exactly twice as great in the first compound as in the second, a relationship that was unsuspected until Dalton looked for it. This type of result, extended to include other simple ratios, has its general expression in Dalton's law of multiple proportions, which states that whenever two elements combine in more than one proportion by weight, the different proportions always bear simple ratios to one another. The improbability of such behaviour except on an atomistic basis is easy to recognize.

III. GASES AND THE MOLECULAR HYPOTHESIS

Dalton's theory, for all its success, left certain important questions unanswered. It did not lead to any conclusions whatsoever as to the absolute weights or sizes of atoms, and even in its determinations of the relative weights of different atoms it could not claim to be free of doubts and ambiguities. As an example of the latter, consider again the compounds of carbon with oxygen. There are two equally valid interpretations of the figures on the carbon oxides just quoted. If it is assumed that the first oxide has the formula CO, the second must have the formula C_2O because the measurements show that it contains only half as much oxygen relative to the same amount of carbon. On the other hand, if it is assumed that the second oxide is CO, the first must be CO_2 (which conforms to the true identification of these compounds as carbon monoxide and carbon dioxide respectively). It was the study of gases which resolved such questions as these and which also provided the first definite estimates of atomic size and weight.

1. Law of Combining Volumes.—In 1808 the chemist J. L. Gay-Lussac (1778–1850) discovered that when gases react chemically with each other, they do so in simple proportions by volume. For example, if a mixture of hydrogen and oxygen is detonated by an electric spark, the resulting reaction takes place in such a way that two volumes of hydrogen combine with one volume of oxygen to form two volumes of water vapour or steam. (For this result to be true, the volumes must all be measured at the same temperature and pressure.) The law of combining volumes, which summarized such behaviour, could be recognized as a counterpart of the law of definite proportions (whose concern was only with the weights of the reacting substances).

2. Avogadro's Hypothesis.—The extreme simplicity of these volumetric relationships led the Italian A. Avogadro (1776–1856) to propose in 1811 his hypothesis that equal volumes of different gases (at the same pressure and temperature) contain equal numbers of particles. But were these particles the same as Dalton's atoms? Avogadro took the position that in the gaseous elements well studied at the time (oxygen, hydrogen and nitrogen) the characteristic particle could not be a single atom, but must be two atoms of the element in close association. To illustrate this argument, consider the formation of water vapour from oxygen and hydrogen. If Avogadro's hypothesis is correct; the fact that two volumes of hydrogen react with one volume of oxygen means that two particles of hydrogen combine with one particle of oxygen. If the basic particle is a single atom in each case, the reaction may be written $2H + O \rightarrow H_2O$. But (applying Avogadro's hypothesis once again) this would imply that for each volume of oxygen consumed there would be only one volume of water vapour produced, which is contrary to observation. It would be possible to fit the facts by assuming that the smallest particle of hydrogen gas is a single atom but that the smallest particle of oxygen gas is a union of two atoms (O_2). The reaction could then be written $2H + O_2 \rightarrow 2(HO)$. On this evidence alone, there would be no need to assume that the smallest particle of hydrogen gas contains more than one atom. But, in another reaction known to Avogadro, three volumes of hydrogen combine with one volume of nitrogen to form two volumes of ammonia gas; this relationship cannot be achieved unless the hydrogen particle (and also the nitrogen particle) contains at least two atoms. This fact leads to the accepted statement of the oxygen-hydrogen reaction: $2(H_2) + O_2 \rightarrow 2(H_2O)$.

3. Molecules.—Out of such results arose not only a self-consistent account of chemical reactions, but also a recognition of the important and characteristic role played by what is normally the smallest particle of a gaseous substance—the molecule (*see* MOLECULE). The idea that the molecule of a pure element might consist of two or more atoms of that element was resisted by Dalton and others as being arbitrary and unreasonable. Why, for instance, if atoms of the same kind attract each other, should they stop short at aggregates of two or three instead of coalescing into one great cluster? But as the amount of chemical knowledge grew, it became increasingly clear that Dalton's scheme was inadequate, and finally (after 1858, when Avogadro's fellow-countryman S. Cannizzaro drew fresh attention to the logic of Avogadro's assumptions) the atomic-molecular theory as Avogadro conceived it became generally accepted.

IV. ATOMIC WEIGHTS

In 1860 an international conference on atomic weights officially adopted the Dalton-Avogadro scheme, and during the succeeding decades a highly accurate tabulation of the relative atomic weights of the elements was built up. It depended on the analysis of thousands of different compounds for which the molecular composition (*i.e.*, the numbers of different kinds of atoms per molecule) was assumed to be known. The risk of the sort of ambiguity that Dalton had suppressed (unreliably) through the rule of greatest simplicity was effectively eliminated by taking a sufficiently large variety of compounds.

1. Oxygen as Reference Standard.—For practical purposes, because only the ratios of the weights of different atoms were determined, the selection of one particular type of atom as a standard was necessary. Hydrogen, being the lightest atom, was first considered (by Dalton and others) as a standard. It had the disadvantage, however, that its compounds with other elements were limited in number and often difficult to handle chemically. Oxygen, on the other hand, formed stable and tractable compounds with most elements. Because the atomic weight of oxygen relative to hydrogen was known to be approximately 16, the decision was made (in 1902) to take the atomic weight of oxygen as precisely 16.000 . . . and to refer all other values to this figure. The list of atomic weights thus determined represented the culmination of the purely chemical approach to atomic theory, and was an important achievement.

2. Carbon as Reference Standard.—Early in the 20th century, it became known that the list did not express correctly the relative weights of individual atoms because one of Dalton's original assumptions is wrong. For most elements it is untrue to say that all the atoms are identical in weight; thus the chemical atomic weight is only an average taken over the different kinds of atoms of a given element (its isotopes) as they occur in nature (*see* ISOTOPE). That the composition of such mixtures should be almost the same for samples of a given element taken from different places on the earth is, of course, a noteworthy fact in itself. This loss of simplicity in the concept of a chemical element is offset to some extent by the fact that the weights of the different types of atoms of a given element cluster fairly closely around the average as expressed in the chemical atomic weight. However, the fact that the isotopic composition of oxygen itself is apparently not constant in nature led to the establishment in 1961 of a new set of values of atomic weights with an isotope of carbon as the reference standard. For a table of these values, and for more detailed information, *see* ATOMIC WEIGHT.

V. SIZE AND MASS OF ATOMS

If a molecule is regarded as a close association of atoms, the size of a molecule containing only a few atoms should not be very much greater than that of an individual atom. The determination of molecular sizes can thus be a useful step toward finding the sizes of individual atoms, and historically was the way of approaching this problem. The first quantitative estimates were obtained by Thomas Young (1773–1829) and presented by him in the *Encyclopædia Britannica Supplement* of 1816. Young based his conclusions on a study of surface tension and tensile strength of liquids. Although his conception of the relation between these two effects was substantially correct, his ignorance of the intimate structure of liquids and vapours led him to false conclusions, and (as mentioned earlier in this article) the first truly significant values of molecular size came from the study of gases.

1. Kinetic Theory; Avogadro's Constant.—One of the simplest and most direct deductions from the kinetic theory was that the molecules of gases must have very high speeds, of the order of 1,000 ft. per second. Seemingly opposing this deduction, however, was the fact that if a flask of, say, gaseous carbon dioxide is opened up to the air, no great amount of mixing of the two gases occurs over a period of hours. These results could be reconciled by ascribing to the molecules a diameter of such a size that any one molecule (at least in gas at normal atmospheric pressure) would travel only a minute distance before undergoing a collision with another molecule. In this way the movement or diffusion of the gas as a whole in a particular direction would be greatly discouraged. From the diffusive properties it is possible to estimate the average distance between successive molecular collisions. But this quantity, called the mean free path and denoted by the Greek letter λ, is determined from kinetic theory by the molecular diameter (d) and the number of molecules in a unit volume (n) according to the formula $\lambda = 1/\sqrt{2}\pi n d^2$. If, now, a volume V of gas or vapour, containing Vn molecules, condenses into liquid form so that the molecules are assumed to be densely packed, the volume (v) of condensed material cannot be less than $\pi V n d^3/6$, because $\pi d^3/6$ is the volume of a spherical molecule of diameter d. As a more realistic estimate take simply Vnd^3, because the packing of equal spheres does not fill space

completely. Multiplying v and λ together gives $v\lambda = Vd/\sqrt{2}\pi$, or $d = \sqrt{2}\pi\lambda(v/V)$. Experimental results show that for many gases $v = 0.005V$ approximately (*i.e.*, a given volume V of a gas at atmospheric pressure condenses to about $0.005V$ when converted to the liquid form of the substance) and that $\lambda = 2 \cdot 10^{-6}$ cm. approximately. This would mean that the diameter, d, of a molecule is equal to $5 \cdot 10^{-8}$ cm. very roughly, *i.e.*, about one fifty-millionth of an inch, or about $\frac{1}{1,000}$ of the wave length of green light. (No wonder, then, that individual atoms and molecules are invisible!)

As a further deduction from the same data, the number of molecules in a unit volume of a gas at atmospheric pressure can be obtained. With the figures just quoted, n turns out to be about $4.5 \cdot 10^{19}$ molecules per cubic centimetre. A determination of this number by the method just outlined was first made by J. Loschmidt in 1865. Of particular interest to chemists was the number of molecules in a gram-molecule (or mole) of substance; *i.e.*, the number in an amount of substance whose weight in grams is numerically equal to the molecular weight. It was known that a gram-molecule of a gaseous compound at standard temperature and pressure (0° C. and 1 atmosphere) occupies 22.4 l. or $2.24 \cdot 10^4$ c.c. According to the figures just derived, this volume would contain approximately 10^{24} molecules (*i.e.*, a trillion trillion in the U.S. system of numeration). It is implicit in the atomic-molecular theory that a mole of a chemical substance, under any conditions, has this number of molecules, and that a gram-atom of any element contains this same number of atoms, which is known as the Loschmidt number or Avogadro's constant. (The term Loschmidt number is also sometimes used to designate the number of molecules in just 1 cm.^{3} of a gas at standard temperature and pressure.) More accurate subsequent determinations by different methods (see *Proof of Existence of Atoms*, below) give its value as $6.0249 \cdot 10^{23}$ molecules per mole.

Knowledge of the Avogadro constant leads immediately to the absolute masses of atoms, or at least to the average isotopic mass for a given element. The masses are obtained by dividing the atomic weight by Avogadro's number. In this way it is found that, for the naturally occurring atoms, the masses range from $1.675 \cdot 10^{-24}$ g. (hydrogen) to $3.96 \cdot 10^{-22}$ g. (uranium).

2. Oil-Film Method.—Because of its extraordinary simplicity, a method of estimating molecular dimensions that was developed in 1890 by W. C. Röntgen and Lord Rayleigh deserves mention. It consists merely in depositing a tiny drop of oil on a water surface; the assumption is that the oil can spread until it forms a layer only one molecule thick. The limits of the oil patch can be seen by first sprinkling the water surface with a fine powder such as chalk dust or lycopodium powder. If the volume of the oil drop is V and the area of the resulting patch is A, the film thickness, and hence the molecular dimension, is V/A.

3. Atoms in Crystalline Solids.—For those chemical elements that exist in solid form, a good estimate of the atomic diameter can be made (given the value of Avogadro's constant) if it is assumed that the atoms are closely packed in a well-defined way—an assumption that the regular form of crystalline solids makes plausible. Thus, for example, a one-inch cube of the element copper has a mass of 146.4 g., and because the mass (isotopic average) of a single copper atom is $1.055 \cdot 10^{-22}$ g., it follows that the number of atoms in such a cube is $1.39 \cdot 10^{24}$. If the copper atoms are taken to be rigid spheres, packed as densely as the rules of geometry allow, these figures lead to the conclusion that the copper atom has a diameter of $2.56 \cdot 10^{-8}$ cm.

4. Variation of Size With Mass.—Similar, though less confident, estimates can be made for elements in liquid form, and the totality of results shows that atomic diameters all lie between about 1 and 5 angstrom units. (1 angstrom, designated by the symbol Å, is equal to 10^{-8} cm., and is a convenient unit of measurement on the atomic scale.) Thus there is far less variation in the sizes of the different atoms than in their masses. Moreover, contrary to what might be expected, there is no smooth increase of size with mass, although there are important regularities that can be understood in terms of the internal atomic structure (see *Atomic Structure and Periodic System*, below). One way of placing atomic size determinations on a common footing is to measure the volume occupied by a gram-atom of an element at its melting point. On this basis, which is admittedly somewhat arbitrary, the atoms of hydrogen and uranium appear to have almost the same effective size—a rather surprising conclusion. The largest atoms are those of the alkali metals (sodium, potassium, etc.) and the smallest are those of carbon and certain refractory metals (nickel, ruthenium, osmium, etc.).

VI. PROOF OF EXISTENCE OF ATOMS

It may seem strange to raise the question of the reality of atoms after discussing their actual properties in some detail yet for almost a century after Dalton laid its foundations the atomic theory remained just a theory, in the sense that the evidence for it was purely inferential. If, that is to say, chemists chose to assume the existence of atoms, the facts of chemistry could be nicely explained and they could even deduce (as indicated earlier in this article) the sizes and masses of the atoms; however, this did not constitute proof that an atomistic picture was correct. By the early 1900s all doubts had been swept away, and individual atoms were being counted and weighed. The two events that did most to bring about this advance were the discovery of the electron (*q.v.*) and the discovery of radioactivity (*see* RADIOACTIVITY).

1. The Electron.—The discovery of the electron, and the measurement of its charge and mass, were of immense relevance to atomic theory because of the intimate connection (first recognized by M. Faraday in 1833) between the transport of mass and the transport of electric charge in electrolysis. To deposit one gram-atom of an element by electrolytic methods requires the passage of an amount of electric charge which is equal to, or is a simple multiple of, a certain fixed quantity called the faraday (*see* ELECTROCHEMISTRY). For those who accepted an atomic theory of matter, this was clear evidence that electricity, also, must be atomistic, and that atoms carry one or more of the basic units of charge during electrolysis. With the identification of the electron the argument could be reversed, and so used to prove the reality of atoms. Moreover, the measured value of the electronic charge, divided into the faraday, furnished a new and corroborative value of Avogadro's constant.

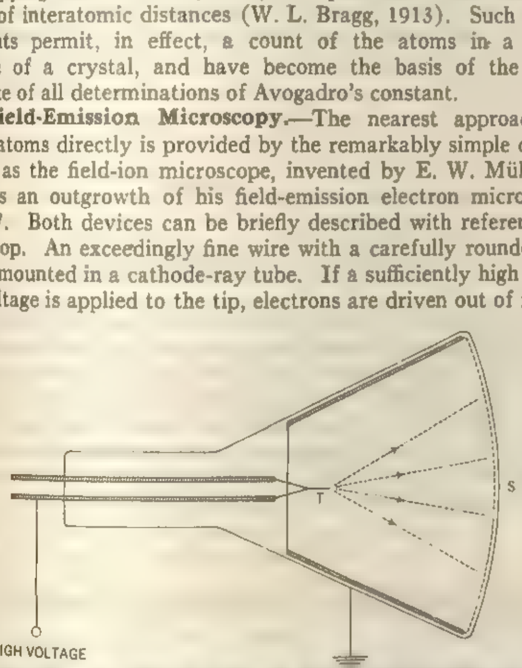
An electric charge equal to that of the electron was identified as the unit charge not only in electrolysis, but also in the conduction of electricity through gases. It was recognized that in both processes there are both positive and negative charge carriers. In gas discharges at low pressure it was possible, by use of magnetic and electric deflections, to measure the ratio of charge to mass for the carriers. It was in this way that J. J. Thomson in 1897 showed that the negative carriers were isolated electrons, but at about the same time studies on the "positive rays," notably by W. Wien, revealed that these positive carriers had charge-to-mass ratios similar to those found in electrolysis, dependent on the nature of the gas in the discharge tube. This was fairly strong evidence that the positive part of the current was carried by individual atoms or molecules, although the proof was not completed until 1907, when Thomson developed more accurate methods of positive-ray analysis and showed that the mass per charge was sharply defined. This was the starting point of mass spectroscopy (*q.v.*) and the analysis of isotopes.

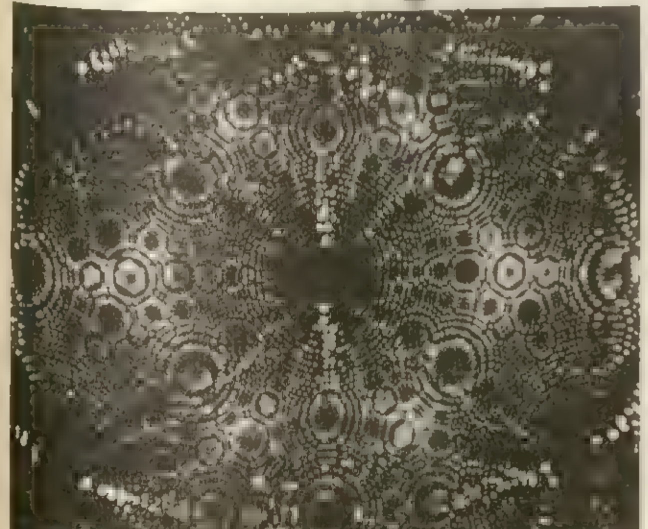
2. Radioactivity.—Even more direct and compelling, though at first less broad in its application, was the evidence from radioactivity. In 1903 J. Elster and H. Geitel (and also W. Crookes) observed that the so-called alpha radiation from a radioactive material caused separate and distinct flashes (scintillations) when it struck a screen of zinc sulfide. In the same year E. Rutherford, and independently T. des Coudres, observed the deflection of alpha rays in electric and magnetic fields, and showed that their ratio of charge to mass was similar to that of the positive rays formed in a hydrogen discharge tube. The next year (1904), in the first edition of his *Radioactivity*, Rutherford wrote: "In the scintillations of zinc sulfide, we are actually witnessing the effect produced by the impact . . . of single atoms of matter. . . ."

3. Brownian Movement.—It could well have been objected

that the phenomena of radioactivity and electricity did not supply any absolute proof that ordinary matter, in its normal state, has a granular structure; however, in 1908 (exactly 100 years after Dalton's theory was first propounded) the grounds for such objections were removed. In that year J. Perrin, testing a theory proposed in 1905 by Albert Einstein, made a detailed study of the ceaseless movement that microscopic objects undergo when immersed in a fluid. This motion, called "Brownian movement" (*q.v.*) after R. Brown, who first investigated it in 1827, could be interpreted as the direct and visible result of the buffeting of small objects by the still smaller (and invisible) molecules of the fluid. Such an explanation was put forward as early as 1877, but it was the work of Einstein and Perrin that showed how the motion, in all its quantitative details, could be explained through the kinetic theory of matter and could even be made the basis for yet another determination of Avogadro's number. After this demonstration the question of the reality of atoms became more a philosophic than a scientific one. It was, however, satisfying that within a few years the use of X-rays (*q.v.*) revealed the orderly arrangement of atoms in crystalline solids (W. Friedrich, P. Knipping and M. Laue, 1912) and provided direct measurements of interatomic distances (W. L. Bragg, 1913). Such measurements permit, in effect, a count of the atoms in a given volume of a crystal, and have become the basis of the most accurate of all determinations of Avogadro's constant.

4. **Field-Emission Microscopy.**—The nearest approach to seeing atoms directly is provided by the remarkably simple device known as the field-ion microscope, invented by E. W. Müller in 1951 as an outgrowth of his field-emission electron microscope of 1937. Both devices can be briefly described with reference to fig. 1, top. An exceedingly fine wire with a carefully rounded tip (T) is mounted in a cathode-ray tube. If a sufficiently high negative voltage is applied to the tip, electrons are driven out of it and go in straight lines to the screen S, where they cause bright fluorescent spots. The screen is not uniformly bright because the tip can never be made completely smooth on an atomic scale, and electrons are emitted most readily at corners or edges of the layers of atoms in the tip, where the electric field is greatest. If the radius of curvature of the tip is r, and the distance from tip to screen is R, the theoretical magnification of the microscope is R/r. For various reasons, including the wave properties of electrons (see *Wave Mechanics and Electron States*, below) superior performance can be achieved by making T positive instead of negative, and spraying the tip with atoms (especially helium) which settle on the tip for a short while and are then re-emitted as positive ions. With values for R and r in the region of 10 cm. and 1/100,000 cm. respectively, magnifications of a million or more can be obtained, and the array of spots on the screen is, in effect, a photograph at this enormous magnification of the positions of individual atoms in the emitting surface. Fig. 1, bottom, shows an example of the kind of picture obtainable.





PHOTOGRAPH BY COURTESY OF ERWIN W. MULLER, PENNSYLVANIA STATE UNIVERSITY

FIG. 1.—(TOP) SCHEMATIC DIAGRAM OF FIELD-EMISSION MICROSCOPE; (BOTTOM) FIELD-ION MICROSCOPE PHOTOGRAPH OF A TUNGSTEN NEEDLE TIP HAVING AN AVERAGE RADIUS OF 450 Å (PHOTOGRAPH HAS AN AVERAGE MAGNIFICATION OF ABOUT 950,000 ×)

VII. THE NUCLEAR ATOM

Thomson's researches on the mass and charge of electrons showed him that his results did not depend on the material from which the electrons are extracted. This fact led him to conclude that electrons were a universal constituent of all types of atoms. Actually, P. Zeeman and H. A. Lorentz had reached the same conclusion a year earlier (1896) through studies of the effect of magnetic fields on atomic spectra (*see* ZEEMAN EFFECT). It might have been tempting to contemplate the possibility that electric charges were the ultimate building blocks for all matter, but two facts stood out against this. First, no positive counterpart of the electron had been found; the lightest of the "positive rays" was about as massive as a hydrogen atom. Second, the electron was so light ($\frac{1}{1,837}$ the mass of a hydrogen atom) that very strained assumptions were needed to formulate a completely electrical theory of matter. Several attempts were made, however. Thomson himself came to favour the picture of a sphere of positive charge, occupying most of the volume of the atom, with electrons embedded in it. (He had concluded from the mass of the electron, assuming it to be pure electric charge, that its radius must be $2.8 \cdot 10^{-13}$ cm.; *i.e.*, only about $\frac{1}{50,000}$ of the radius of an atom.) P. Lenard in 1903 proposed a quite different model, according to which the atom was mostly empty space populated by small neutral doublets (close unions of positive and negative charges). His grounds for this view lay in some experiments he had made that showed atoms to be relatively transparent to fast electrons; he found, for example, that high-velocity electrons could pass through about 5,000 hydrogen molecules before being significantly deviated, or (to express a similar result in different terms) that the total impenetrable volume in a cubic yard of a very dense material, such as platinum, is smaller than a pin's head.

A picture almost identical with the one that was to gain final acceptance was put forward by H. Nagaoka in 1904. He proposed a "Saturnian atom" in which the electrons revolved in orbits around a central positive charge, like the particles of Saturn's rings around that planet. However, no strong evidence was offered in favour of this model at the time, and the credit for proving the existence of compact nuclei in atoms must unquestionably go to E. Rutherford.

1. **Alpha Particles.**—The evidence for the nuclear atom came from a series of experiments on the scattering of alpha particles by matter. The alpha radiation had been intensively studied; Rutherford and others had shown that the alpha particles were positively charged (with two units of the unit electronic charge) and in 1909 Rutherford and T. Royds proved, in a striking experiment, that alpha particles, upon coming to rest and being electrically neutralized, become identical with helium. With these projectiles, which had well-defined speeds of the order of one-tenth the velocity of light (which is about $3 \cdot 10^{10}$ cm./sec.) as a result of their ejection from radioactive atoms, Rutherford and his assistants bombarded thin foils of metallic elements. The crucial discovery, by H. Geiger and E. Marsden (1909), was the

occasional deflection of alpha particles through large angles (90° or more). Rutherford recognized that such a strong deflection of the alpha particle could only have been caused by collision of the particle with a small, massive center of electrical repulsion. (Note that a "collision," as defined in physics, can occur through the medium of long-range electric or other forces without involving any contact or interpenetration of the matter contained in the colliding particles.)

2. Rutherford Scattering Formula.—In 1911, Rutherford worked out the theory of the scattering on the assumption that the alpha particles were repelled by a concentrated positive charge according to the inverse square law of electrostatics (*see* ELECTRICITY: *Electrostatics: Coulomb's Law*). The Rutherford scattering formula is so important to the development of atomic theory that a derivation of it is given here. The calculation is in two parts. First, consider what would happen during a typical collision between an alpha particle and a nucleus. Suppose that the alpha particle, of mass m, speed v and charge $+2e$ (*i.e.*, twice the electron charge in size, but opposite in sign, the electron charge being designated by $-e$), is approaching a massive (and therefore almost immovable) nucleus of charge Ze, where Z is an integer specifying the magnitude of the charge. At large distances, before the electrical repulsion begins to take effect, the alpha particle moves in a straight line; this line is assumed to be offset a distance p from a straight line through the nucleus, as in fig. 2, top. As a result of the electrical repulsion the alpha particle is deviated as shown, so that when it is far removed from the nucleus it is again traveling in a straight line, but at an angle θ to its initial direction. Treating this as a problem in Newtonian mechanics reveals that the path taken by the alpha particle is a hyperbola, and that the distance p and the angle θ are related through the equation

$$\tan(\tfrac{1}{2}\theta) = \frac{2Ze^2}{mv^2p} \qquad (1)$$

It is convenient to introduce a certain distance b, representing the shortest distance between alpha particle and nucleus in a head-on collision. This "distance of closest approach" would be achieved by using up all the kinetic energy of the alpha particle to create electrostatic potential energy between the alpha particle and the nucleus; the condition is

$$\tfrac{1}{2}mv^2 = \frac{2Ze^2}{b} \qquad (2)$$

Making use of this condition, equation (1) simplifies to

$$\tan(\tfrac{1}{2}\theta) = \frac{b}{2p} \qquad (3)$$

This shows, of course, that the angle of deflection takes on larger values as p becomes smaller (and hence the repulsion stronger).

Now it is not in fact possible to prescribe the value of the distance p; any experiment on alpha-particle scattering consists simply of directing alpha radiation, in a well-defined direction, at a thin layer of scattering material. The alpha particles and the "target" nuclei cannot be individually localized, and the distribution of the various possible values of p is governed solely by the rules of chance. If, however, the frequency with which the alpha particles are scattered into the various directions θ as a result of these chance encounters is studied, an accurate analysis of the scattering mechanism becomes possible. For, referring to fig. 2, bottom, it is clear that all alpha particles passing through the shaded area (in the form of a circular ring of width dp and mean radius p) will have final directions between θ and $\theta + d\theta$. The area of this ring is $2\pi p\, dp$; thus equation (3) gives

$$p = \frac{b}{2}\cot(\tfrac{1}{2}\theta)$$

$$\therefore dp = -\frac{b}{4}\csc^2(\tfrac{1}{2}\theta)\, d\theta$$

$$\therefore 2\pi p\, dp = -\frac{\pi b^2}{4}\csc^2(\tfrac{1}{2}\theta)\cot(\tfrac{1}{2}\theta)\, d\theta \qquad (4)$$

Now the amount of solid angle contained between θ and $\theta + d\theta$ is $2\pi \sin\theta\, d\theta$, and a convenient measure of the effective area presented by a single nucleus for the purpose of deflecting an alpha particle through θ is obtained by dividing $2\pi p\, dp$ by this solid angle. This gives what is called the "differential cross section" $\sigma(\theta)$ for the scattering process, and the probability of a deflection through a particular angle is proportional to this cross section, which is given by the equation

$$\sigma(\theta) = \frac{b^2}{16}\csc^4(\tfrac{1}{2}\theta) \qquad (5)$$

Recalling the definition of b [equation (2)], equation (5) can also be written

$$\sigma(\theta) = \frac{Z^2e^4}{m^2v^4}\csc^4(\tfrac{1}{2}\theta) \qquad (6)$$

3. Nuclear Charge.—If the alpha-particle scattering is studied experimentally, it is possible in principle not only to test whether equation (6) correctly describes the dependence of $\sigma(\theta)$ on θ and v, but also to infer the value of the nuclear charge Ze. This is precisely what Rutherford, Geiger and Marsden proceeded to do during the years 1911–13. From one of the early measurements, in which a thin gold foil was the scatterer, Rutherford found the scattering as a function of angle to be well described by equation (6) with Z about 100. Knowing also the velocity of the alpha particles employed, he was able to conclude, with the help of equation (2), that the distance of closest approach, b, was about $3 \cdot 10^{-12}$ cm. The clear implication was that the nuclear radius must be less than this distance. A picture thus began to emerge of the atom as a structure in which nearly all the mass, together with a concentrated positive charge, is confined in an astonishingly tiny volume—certainly less than one hundred-billionth (10^{-11}) of the total volume of the atom. Outside this nucleus (*q.v.*) must lie a number of electrons at various distances from the nucleus, up to the established atomic radius; *i.e.*, 10^{-8} cm. or so.

Further measurements by Geiger and Marsden in 1913 confirmed Rutherford's scattering formula in a detailed manner for a number of different target elements, and indicated the nuclear

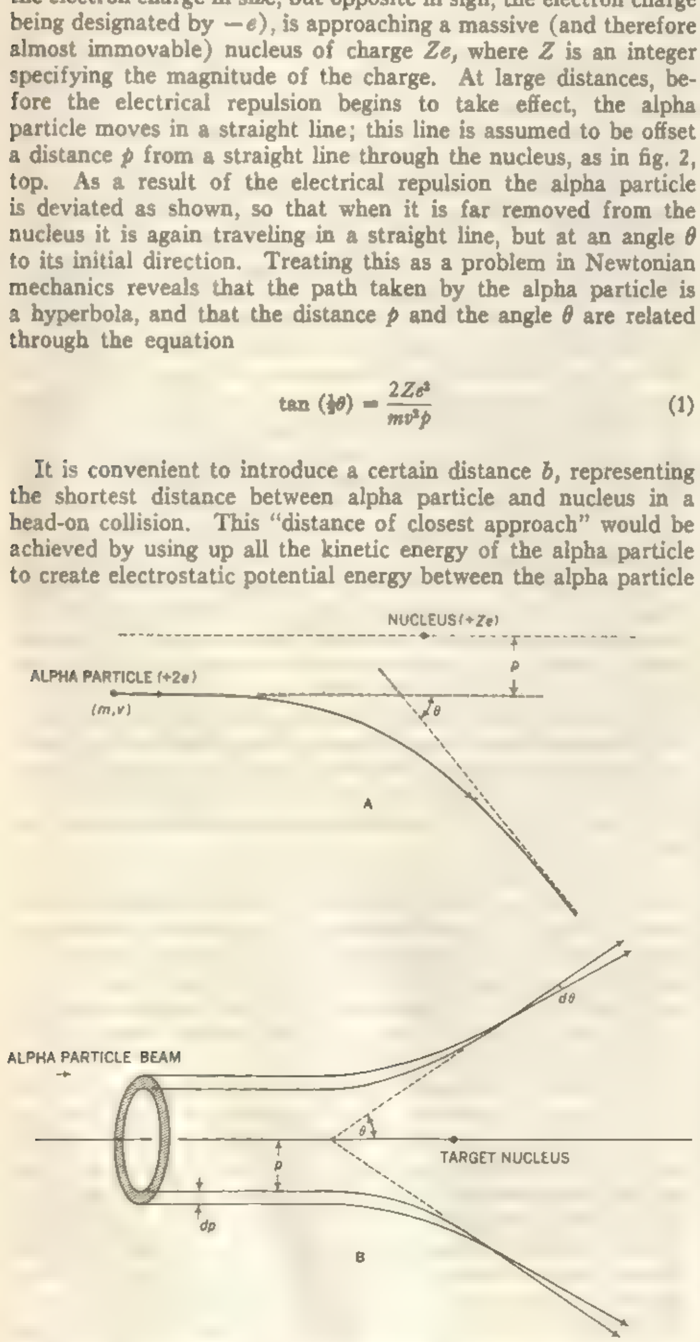


FIG. 2.—(A) DEFLECTION OF A SINGLE ALPHA PARTICLE BY A NUCLEUS; (B) EFFECTIVE CROSS SECTION (SHADED RING) FOR SCATTERING OF ALPHA PARTICLES BETWEEN θ AND θ + dθ

charge, Z, to be about half the chemical atomic weight. Because any atom is electrically neutral in its normal state, this discovery implied that the number of electrons in a given atom must be the same as the nuclear charge number, and, in fact, evidence to this effect was already extant. Lenard had found in 1895 that the attenuation of a fast electron beam is, to a good approximation, determined only by the mass of matter traversed and is independent of the chemical nature of the absorber. If it is assumed that electrons in the absorber are wholly responsible for the attenuation, then the number of electrons present is proportional simply to the mass of material, and thus, on an atomic scale, the number of electrons in any atom is proportional to its atomic weight. A similar conclusion was reached as a result of measurements made by C. G. Barkla between 1904 and 1911 on the scattering of X-rays by matter. (Thomson in 1906 devised theoretical interpretations and analyses of both the electron and the X-ray scattering experiments.) But all these measurements did little more than to indicate trends, and the clear-cut determination of nuclear charge was to come from quite another line of attack, which will be explained later.

VIII. BOHR'S ATOMIC THEORY

Rutherford's picture of atomic structure, though clearly necessitated by experimental evidence, left some crucial questions unanswered—and, indeed, raised some new ones. If the atom contained a concentrated positive charge at its centre, why were not the electrons drawn irresistibly into this centre? It did not answer the difficulty to suggest an analogy to the solar system, with electrons moving in orbits around the nucleus, because according to the laws of classical electrodynamics the electrons would, unlike the planets, be forced to radiate away their energy continuously and follow a shrinking spiral path that would bring them into the nucleus within a very short time. A related problem was to account in any reasonable way for the known sizes of atoms, which indicated that electrons persisted stably at distances of the order of 10^{-8} cm. (1 Å) from the nucleus.

1. Planck's Constant.—In 1913, Niels Bohr, recognizing (as indeed many did by that time) that classical physics was simply not adequate to describe systems of atomic size, made a radical and highly successful departure. In his own words: "Whatever the alteration in the laws of motion of the electrons may be, it seems necessary to introduce in the laws in question a quantity foreign to the classical electrodynamics." This quantity was Planck's constant, the "quantum of action." This famous constant, denoted by h, had first appeared in the theory of radiation from hot bodies; Max Planck in 1900 had shown that the spectrum of such radiation could be explained only if the radiation of frequency ν were "quantized" in packets of minimum energy $h\nu$, where $h = 6.625 \cdot 10^{-27}$ erg sec. (The physical dimensions of h are those of energy $\times$ time, or equivalently of momentum $\times$ distance; it was a quantity of the latter type that had been given the name "action" in classical mechanics.)

2. Atomic Spectra.—Bohr was guided mainly by some long-established regularities in the visible spectra of the elements, in particular the series of lines in the spectrum of atomic hydrogen (*see* SPECTROSCOPY). As viewed through a spectroscope, only four of the hydrogen lines are visible to the eye—a red, a green, a blue and a violet; many others, extending into the short-wavelength region of the ultraviolet, can be recorded photographically. J. J. Balmer in 1885 had shown that the measured wave lengths of these lines could be exceedingly accurately described (to about one part in ten thousand, in fact) by the formula

$$\frac{1}{\lambda_n} = R_H\left\{\frac{1}{4} - \frac{1}{n^2}\right\} \qquad (7)$$

where λ indicates wave length, R_H (Rydberg's constant for hydrogen), as evaluated by J. R. Rydberg in 1890, is approximately 109,677 cm.$^{-1}$, and n is a whole number whose successive values—3, 4, 5, etc.—characterize the lines of the spectrum in order of decreasing wave length or increasing frequency. It had been proposed by W. Ritz that equation (7) was merely a special case of the more general formula

$$\frac{1}{\lambda} = R\left\{\frac{1}{n_1^2} - \frac{1}{n_2^2}\right\} \qquad (8)$$

In seeking to explain such relationships with the help of the quantum hypothesis, Bohr first adopted a quite consciously naïve and even questionable approach, as follows:

Suppose that an electron, initially free and stationary, is drawn into a circular orbit of radius r around a nucleus of charge $+e$ (*i.e.*, a hydrogen nucleus). Let the mass of the electron be denoted by m and its orbital speed by v. To balance the electrical and centrifugal forces, the relation

$$\frac{e^2}{r^2} = \frac{mv^2}{r} \qquad (9)$$

is required. Now the total energy of the electron in its orbit is the algebraic sum of its kinetic energy E ($= \frac{1}{2}mv^2$) and its electrostatic potential energy $-e^2/r$. Use of equation (9) shows that this total energy is negative and equal to $-E$. Hence energy of amount E must be jettisoned, in the form of radiant energy, as the electron falls into its orbit. Furthermore, the frequency ν (revolutions per unit time) of the orbiting electron is given by $v/2\pi r$, and with the help of equation (9) ν can be found in terms of E:

$$\left.\begin{aligned} v &= \left(\frac{2E}{m}\right)^{\frac{1}{2}};\ r = \frac{e^2}{2E} \\ \therefore \nu &= \frac{1}{2\pi}\cdot\frac{(2E)^{\frac{3}{2}}}{m^{\frac{1}{2}}e^2} \end{aligned}\right\} \qquad (10)$$

Because the initial orbital frequency of the electron is zero, its average frequency during the transition is given by $\bar{\nu} = \frac{1}{2}\nu$. If this be identified with the frequency of the emitted radiation (which can be observed in a spectroscope if the frequency lies in the visible region), Planck's quantum hypothesis would demand that the amount of radiated energy be expressible as $nh\bar{\nu}$, where n is an integer. Now this amount of energy has already been given as E; therefore,

$$E = \frac{nh\nu}{2} = \frac{nh}{4\pi}\cdot\frac{(2E)^{\frac{3}{2}}}{m^{\frac{1}{2}}e^2}$$

whence

$$E = \frac{2\pi^2me^4}{h^2}\cdot\frac{1}{n^2} \qquad (11)$$

Consider now an electron jump between two circular orbits characterized by different values of n, and suppose that the change in electron energy is radiated away in a single quantum, of frequency ν and energy $h\nu$. Equation (11) then demands that

$$h\nu = \frac{2\pi^2me^4}{h^2}\left\{\frac{1}{n_1^2} - \frac{1}{n_2^2}\right\} \qquad (12)$$

Because the frequency and wave length of light (which is the type of radiant energy being discussed here) are related through the equation $\nu = c/\lambda$, where c is the velocity of light, equation (12) implies the result

$$\frac{1}{\lambda} = \frac{2\pi^2me^4}{ch^3}\left\{\frac{1}{n_1^2} - \frac{1}{n_2^2}\right\} \qquad (13)$$

Note that there is complete equivalence of form between this equation and the empirical equations (7) and (8). Moreover, Bohr's calculation was open to the most stringent of all tests, namely that the absolute value of the Rydberg constant R is specified in terms of known atomic and other constants. Using their numerical values as known at the time gives $2\pi^2me^4/ch^3 = 1.04 \cdot 10^5$ cm.$^{-1}$, with an experimental uncertainty of several per cent, as compared to the observed value of $1.10 \cdot 10^5$ cm.$^{-1}$ for R. The agreement was, in other words, as nearly perfect as the available data allowed, and the essential correctness of Bohr's theory as an explanation of the hydrogen spectrum could hardly be doubted.

3. Angular Momentum; Bohr's Postulates.—Having dem-

onstrated the numerical success of his theory, Bohr immediately reinterpreted its quantum aspects in a new and more fundamental fashion. Taking equation (11) for the kinetic energy of an electron in its orbit, and referring to the expressions for v and r in equations (10) gives

$$v = \frac{2\pi e^2}{nh}; \; r = \frac{n^2h^2}{4\pi^2me^2} \qquad (14)$$

Combining these results leads to the equation

$$mvr = \frac{nh}{2\pi} \qquad (15)$$

Now the quantity on the left side of this equation is the angular momentum of the electron in its orbit. Bohr therefore concluded that the quantity $h/2\pi$ represents a natural unit of angular momentum, and that only those motions for which this quantization holds are possible. In these terms the postulates of Bohr's theory can be stated as follows:

1. Electrons can move in circular (or, more generally, elliptic) orbits around the atomic nucleus.
2. The only orbits possible are those for which the orbital angular momentum is an integral multiple of $h/2\pi$.
3. These orbits are "stationary" in the sense that so long as an electron remains in a given orbit it radiates no energy.
4. An electron may jump from one orbit to a second orbit, of lower (more negative) energy, closer to the nucleus; in this process the energy liberated is emitted as a single quantum of light or other electromagnetic radiation.

The arbitrariness of these postulates was admitted, but their success was beyond dispute. Later the new atomic mechanics—called wave mechanics or quantum mechanics—led to the same results in a less forced manner (see *Wave Mechanics and Electron States*, below).

4. Size of Hydrogen Atom.—Besides accounting for the appearance and precise wave lengths of the sharp lines in atomic spectra, Bohr's theory set a definite size limitation on the hydrogen atom. The expression for the electron orbit radius in equation (14) shows that the possible radii are proportional to n^2; *i.e.*, to the squares of whole numbers. If the natural assumption is made that the normal state (ground state) of the atom has the electron in the orbit of lowest energy, then n would equal 1 and the corresponding radius would be $0.53 \cdot 10^{-8}$ cm. Thus the calculated diameter ($2r$) of a hydrogen atom is roughly 1 Å, in good agreement with the known order of magnitude of atomic dimensions.

IX. X-RAYS, ATOMIC NUMBER AND NUCLEAR CHARGE

Bohr's theory in its original application was confined to line spectra in the visible or near-visible region; *i.e.*, to radiations whose wave lengths are a few thousand angstroms. It was, however, known from the work of Barkla and others that the bombardment of substances by energetic electrons (accelerated through a potential difference of thousands or tens of thousands of volts) caused the production of so-called "characteristic X-rays." By 1913 it was well established that these X-rays are electromagnetic radiations similar to visible light but of much shorter wave length—of the order of a few angstroms only—and it seemed clear that these also should be considered within the framework of the Rutherford-Bohr atomic theory as quanta arising from electron jumps within the atoms of the bombarded material.

1. Moseley's Experiments.—In 1913 H. G.-J. Moseley (1887–1915) made a thorough study of these characteristic X-rays that could be excited in different elements by electron bombardment. His results demonstrated brilliantly that sharp spectral lines of various types could be traced in an absolutely regular fashion from the lightest to the heaviest elements (*see* SPECTROSCOPY; X-RAYS). When the square roots of the frequencies (or of the reciprocal wave lengths) for a given type of X-ray were plotted against the atomic weights of the elements, the points fell almost on a straight line. But a virtually perfect fit was obtained if, instead of atomic weight, the atomic number was used. The atomic number of a chemical element is the ordinal number of the element in the periodic system. (This arrangement places the elements, beginning with hydrogen, in an order that exhibits periodicities of chemical behaviour; it follows in the main the sequence of increasing atomic weights, but deviates from this order where necessary—*see* PERIODIC LAW.) As Moseley himself remarked, the X-ray spectra made it quite clear, without reference to any specific theory of atomic structure, that "these integers" (the atomic numbers) are truly characteristic of the elements. His measurements, however, did even more than this. For, taken in conjunction with Bohr's theory, they proved beyond any reasonable doubt that the chemical atomic number is to be identified with the number of units of positive charge carried by the nucleus—a possibility first suggested by A. van den Broek in 1913.

To show how compelling the argument is, consider a modification of the calculations just obtained for the hydrogen atom to cover the case where an electron moves around a central charge Qe instead of just e. The result, quite readily arrived at, is that equation (12) must be replaced by the equation

$$h\nu = \frac{2\pi^2me^4Q^2}{h^2}\left\{\frac{1}{n_1^2} - \frac{1}{n_2^2}\right\} \qquad (16)$$

Now it is extremely plausible that a given type of X-ray transition, occurring in a series of different elements, is characterized always by the same values of n_1 and n_2, so that only Q is changed in going from one element to another. If this is so, a graph of $\sqrt{\nu}$ against Q will be a straight line. Furthermore the slope of this line is determined solely by the values of n_1, n_2 and the atomic constants in equation (16), and Moseley's results showed that quantitative agreement was obtained for simple integral values of n_1 and n_2. (Actually the pair of values $n_1 = 1$, $n_2 = 2$ defined one set of lines; $n_1 = 2$, $n_2 = 3$ defined another.) The value of Q does not necessarily define the nuclear charge itself, because in a many-electron atom there may be some electrical screening of the nucleus by electrons lying very close to it. This possibility however, did not obscure the clear implications of the experimental results.

2. Origin of X-Ray Spectra.—It is noteworthy (and, from the point of view of Moseley's work, very fortunate) that the X-ray spectra are among the simplest of all atomic spectra, and show none of the apparently capricious variations that occur in the visible spectra of the elements. The reason is that the X-ray quanta come from transitions between a few of the innermost electron orbits, near to the nucleus and dominated by it, and the only important effect of increasing the nuclear charge is to make these orbits smaller. (Use of the simple Bohr theory shows that the orbit radius is inversely proportional to Q.) The transitions in the visible region of the spectrum, however, involve the valence electrons (the electrons on the outer fringe of the atom), which are strongly influenced by other electrons in the atom and whose number and disposition vary with the atomic number in a sensitive and far from continuous manner. It is easy to see, therefore, why Moseley's X-ray measurements made such a distinctive and important contribution to the understanding of atomic structure.

X. ISOTOPES AND THE NUCLEUS

Although the value of the atomic number (usually denoted by Z) serves to define a given chemical element, it does not necessarily define a unique kind of atom. This is because of the existence of isotopes (*see* ISOTOPE). The classification of the various kinds of atoms by element and atomic number is only a partial breakdown; there are 80 different stable elements on earth, but these comprise a total of 284 distinct atomic species. The classification by Z works quite well for the chemist, because chemical behaviour depends almost entirely on atomic number. Mass does play a part, because a heavy isotope moves more sluggishly than a light one at the same temperature, and this can influence (though only to a very small degree) chemical reactions and chemical equilibria—a fact that has been exploited in fascinating ways; *e.g.*, in paleoclimatology. But to the physicist, and particularly to the nuclear physicist, the different isotopes of an element may appear as radically different types of atoms, and the classification accord-

ing to atomic number may for this purpose be irrelevant and even undesirable. To pursue this particular matter would involve a study of the nucleus as such, which is the concern of a separate article (*see* NUCLEUS). A few statements about the basic properties of atomic nuclei are, however, relevant and necessary to present an adequate picture of the atom.

1. Protons and Neutrons.—The positively charged unit in nuclear structure is the proton (*q.v.*); it is the nucleus of the lightest atom found in nature, viz., the most abundant isotope of hydrogen. The observation had been made, even before the discovery of isotopes, that the atomic weights of many elements are close to integral multiples of the atomic weight of hydrogen, and the presumption that protons are building blocks of the heavier nuclei was a strong one. It was clear, however, that protons alone would not suffice, because the ratio of the atomic number to the atomic weight is less than one-half in all elements except hydrogen (for which it is almost exactly 1). Two possibilities presented themselves: either (1) the atomic weight is the true index of the number of protons in the nucleus, and the nuclear charge is reduced to the value Ze through the presence, within the nucleus itself, of a number of electrons (which would contribute exceedingly little to the mass); or (2) the atomic number Z is a correct measure of the number of protons in the nucleus, and the balance of the mass is provided by a number of electrically neutral particles of about the same mass as a proton. The discovery of the neutron (*q.v.*) in 1932 gave solid grounds for the conviction, which had been growing for about ten years prior to that date, that explanation (2) is the correct one.

2. Mass Number.—A particular atomic species, or "nuclide" (the term was coined by T. P. Kohman in 1947), is thus characterized by its number of protons, Z, and its number of neutrons, N. The sum of these two integers is the mass number, A. The actual mass of any atom is thus the result of combining Z protons, N neutrons, and Z orbital electrons; this total mass is somewhat less than the sum of the masses of the individual constituents, because energy E (and hence the mass equivalent of that energy, defined by $M = E/c^2$, where c is the velocity of light and M is the difference between the total mass of the constituent particles and the mass of the atom) is given up in forming this tightly bound system. Because the masses of both the proton and the neutron are quite close to 1 when referred to the atomic weight scale, and because the mass of all the electrons in any atom is less than $\frac{1}{1,000}$ of the whole, the total mass of an atom on the atomic weight scale is a number (though not an integral number) close to the integer A. Its precise numerical value depends on the arbitrary choice of a certain standard (see *Atomic Weights*, above.)

3. Nuclear Size.—Besides having specific values of Z, N and A, a nucleus has a quite well definable size. The extension of nuclear scattering experiments of the Rutherford type and a variety of other methods shows that nuclear radii lie between about $1.5 \cdot 10^{-13}$ cm. and 10^{-12} cm. Moreover, there is a systematic dependence of size on mass, according to the formula $R = r_0 A^{1/3}$, with $r_0 = 1.2 \cdot 10^{-13}$ cm. approximately. This means that the nuclear volume, unlike the volume of the atom as a whole, is rather closely proportional to the atomic mass, and hence that the densities of all nuclei are about the same. The value of this density is staggering—about 100,000 tons per cubic millimetre. It is not surprising, therefore, that nuclear matter has properties peculiar to itself, and that nuclear physics has acquired the status of a separate area of study, distinct from what is normally called "atomic physics." The magnitude of nuclear radii implies that the nucleus occupies an even smaller fraction of the total atomic volume than Rutherford's early experiments had indicated; the fraction varies from about 3 parts in 10^{13} for the lightest atoms to about 1 part in 10^{12} for the heaviest. Nevertheless the nucleus, with its relatively great mass and its centrally located positive charge, dominates the properties of the atom as a whole.

XI. ENERGY LEVELS OF ATOMS

The emission by atoms of sharp spectral lines, in both the visible and the X-ray regions of wave lengths, is clear evidence that an electron in an atom is not allowed to possess any arbitrary amount of energy, but is limited by the laws of quantization. In the simple Bohr theory of circular orbits, for example, the energy is specified by a single quantum number, n [*cf.* equation (11)].

1. Electron Ejection.—Confirmation of this situation comes from experiments in which electrons are knocked out of atoms in a carefully controlled way. This can be done by bombarding atoms with electrons of a well-defined velocity, or with electromagnetic radiation of a well-defined wave length. (The latter phenomenon is the external photoelectric effect; *see* PHOTOELECTRICITY.) The results show clearly that unless a certain minimum amount of energy is supplied, a given electron within the atom cannot be dislodged; the interaction between atom and bombarding agent is an elastic one, and the bombarding electron or quantum of electromagnetic radiation bounces off with no loss of energy. If, however, the minimum or threshold energy is just barely exceeded, a drastic interaction can take place; the atom absorbs all the energy of the bombarding agent, and in return ejects one of its electrons. (The process has a rough analogy to devices sometimes found at fairgrounds, on which a sufficiently vigorous sledgehammer blow will win a prize, but anything less is worth nothing.) If more than the minimum energy is supplied, the ejected electron will possess the surplus in the form of kinetic energy. Experiments with electromagnetic radiation are particularly amenable to accurate measurement, and show that the threshold conditions for removal of electrons are exceedingly sharp; the effect manifests itself as an abrupt increase in the absorption of radiation by the atom at certain wave lengths.

2. Absorption Edges.—If the absorption by atoms of a given type is measured for electromagnetic radiation of steadily increasing frequency (and therefore of increasing quantum energy), a whole succession of critical "absorption edges" can be observed. From the value of each critical frequency (or wave length) of the radiation, it is possible to deduce how much energy is required for the purpose, and hence how far down (on an energy scale) the various electrons are within the atom. A convenient unit of measurement for such energies is the electron volt (ev), defined as the amount of energy equal to that gained by an electron when accelerated through a potential difference of one volt. (1 ev $= 1.602 \cdot 10^{-12}$ erg.) The energy of a quantum of radiation of wave length λ (measured in angstroms) is approximately $12{,}400/\lambda$ ev; thus the energy for visible light of several thousand angstroms wave length is a few ev per quantum, and an X-ray quantum of a few angstroms wave length has an energy of some thousands of ev. Most atoms exhibit critical absorption phenomena at a number of energies over this range. In the case of barium ($Z = 56$), for example, critical conditions for removal of a single electron occur at quantum energies of 5.19 ev, 47.5 ev, 255 ev, 1,300 ev, 5,955 ev and 37,432 ev. This list is not exhaustive, but does bring out the main feature, namely that the electrons lie in a limited number of widely-spaced energy levels.

3. Electron Shells.—In the Bohr picture, these energy levels correspond to a succession of electron shells, with the most tightly bound electrons in a shell of small radius close to the nucleus (known as the K shell in spectroscopy) and other shells (L, M, N, etc.) of less tightly bound electrons at greater radial distances. This relatively simple geometrical model has been untenable since the advent of wave mechanics, but the reality of the well-defined energy levels survives. The great variation in binding energy for electrons in the K shells of different elements is noteworthy (though quite understandable with the help of equation [16]). In hydrogen ($Z = 1$) it is 13.6 ev; in uranium ($Z = 92$) it is 115,000 ev.

If an electron is driven completely out of an atom by the methods described, the atom proceeds to readjust itself by one or more quantum jumps until the stable state of lowest energy is regained. Because one electron has been lost from the atom at the beginning of the process, achievement of this final state cannot be completed until another electron has somehow been picked up. The general process of readjustment is accompanied by the emission of quanta of radiation; the preceding paragraphs, in other words, describe one way in which atoms can be excited so as to emit their characteristic spectral lines. In general, the radiation

thus produced is in the ultraviolet to X-ray region; the only significant exception is when one of the most weakly bound electrons, in the outermost shell, is ejected and is replaced by an electron which, in the process of falling into the vacated level, undergoes a succession of radiative transitions of low energy. Only those quanta having energy between about 1.5 ev and 3 ev lie in the visible region, which illustrates how little of the energy scale of atomic phenomena is accessible to our ordinary senses.

Despite the very small energy gap between an atom in its normal (neutral) state and an atom with one of its outermost electrons removed (*i.e.*, a positive ion), a very large number (in principle, an infinite number) of so-called excited states are available to the neutral atom within this gap; such excited states are for the most part quite short-lived (of the order of 10^{-8} sec.). The energy difference between the ground state and an excited state is called an excitation potential. A large part of spectroscopy has consisted of identifying all the observed spectral lines of an atom as transitions between a limited number of excited states, and so mapping out the energy level structure.

It is clear, from this picture of the energy levels in a typical atom having many electrons, that the electrons are not all free to drop down to the most strongly negative energy states; otherwise they would all be found in the K shell. In fact, the conclusion that each possible energy region can accommodate only a limited number of electrons seems to suggest itself. This, then, is a new principle, not contained or in any way implied in the Bohr theory, and its precise formulation is of the greatest importance to atomic theory. Before discussing this, however, it is appropriate to reconsider the general picture of electrons in atoms in the light of wave mechanics.

XII. WAVE MECHANICS AND ELECTRON STATES

The discovery in 1927 that the electron, theretofore regarded as a particle, has certain wave properties inseparably associated with it demanded a completely new description of situations and phenomena on the atomic scale. This description was provided by the mathematical system known as wave mechanics or quantum mechanics (*q.v.*). Its starting point was the experimental fact that an electron of mass m and speed v behaves as though it has a wave length λ equal to h/mv, where h is Planck's constant.

1. Standing Waves.—For free electrons (*i.e.*, those not bound in atoms), this wave character manifests itself in their ability to be diffracted like light or X-rays, but for electrons confined within an enclosure (and the interior of an atom is an enclosure of sorts) a new phenomenon appears—that of standing waves. The consequences of this can be visualized to some extent with the help of an analogy from the world of music. An organ pipe (or the body of any other wind instrument) is an enclosure for sound waves. Moreover, because this enclosure has a well-defined length, only certain wave lengths of sound can be accommodated within it, namely those that are simple submultiples of the length of the pipe. At these wave lengths, and at no others, it becomes possible for the air column within the pipe to undergo strong vibrations, with successive minima (nodes) and maxima (antinodes) of vibration at fixed positions along the length of the pipe, separated by quarter-wave-length intervals. The result of this is that the frequencies of the sounds obtainable from the pipe are limited to simple numerical multiples of a certain fundamental frequency. The equivalent problem in wave mechanics would be that of an electron confined between rigid walls a distance l apart. The permitted wave lengths would be those that allow a node at each end; these are given by $\lambda = 2l, l, 2l/3$, etc., or in general by $\lambda = 2l/n$, where n is an integer. However, because $\lambda = h/mv$, this result demands that $v = nh/2ml$ and, using the equation $E = \frac{1}{2}mv^2$ for the kinetic energy of the electron, it is seen that the only allowed values of E are defined by the equation

$$E = \frac{n^2h^2}{8ml^2} \tag{17}$$

The integer n thus appears in the role of a quantum number for the system. Moreover, the minimum possible energy of the system, defined by $n = 1$, is seen to be inversely proportional to l^2—the smaller the space into which the electron is compressed, the larger its kinetic energy must be.

2. Electron Energies.—Although the result just obtained is not applicable, as it stands, to the problem of electrons in atoms it does contain certain features—the existence of quantum numbers and the inverse relationship between kinetic energy and dimensions—that are basic both to an electron in an atom and an electron confined between two rigid walls. Note, however, that there are at least two important differences. First, the atomic problem is essentially a three-dimensional one. Second, the atom is not a hollow enclosure with rigid walls. A hollow and completely rigid enclosure is one in which a particle experiences no force at all until it encounters the wall, at which point the force becomes infinite. The atom, however, from the point of view of a single orbital electron, behaves as the centre of an attractive force which exists at all points, but whose magnitude gradually decreases to zero as the distance r from the centre becomes large. Such a force derives from a negative potential energy, $V(r)$, whose value for a single electron in the field of a positive point charge Ze is given by $V(r) = -Ze^2/r$. This potential is illustrated in fig. 3, top. The effective wave length λ for an electron of fixed energy E in this potential region is not constant, but is given by the equation

$$\lambda = \frac{h}{mv} = \frac{h}{\{2m[E - V(r)]\}^{\frac{1}{2}}} \tag{18}$$

The wave length becomes larger as $E - V(r)$ decreases; *i.e.*, as r increases.

This "electron wave" is described by a wave equation, called Schrödinger's equation, whose classical analogue is that of a wave passing through a medium of continuously varying refractive index. And although the possibility of having standing waves with well-defined wave lengths is now ruled out, the existence of stationary vibrations with well-defined energies is not. It turns out, in fact, that the total energy E, if negative, is limited to values given by the equation

$$E_n = -\frac{2\pi^2Z^2me^4}{h^2}\cdot\frac{1}{n^2} \tag{19}$$

This result is identical with the negative total energy of an electron as given by Bohr's theory, and note that once again $n = 1$ defines the lowest (most negative) energy state. The energy level structure is indicated in fig. 3, bottom; for positive E there are no restrictions on the precise value the energy may have.

3. Wave Function; Effective Charge Distribution.—It is striking that the same results as Bohr obtained should also come from the wave-mechanical approach. There are, however, some

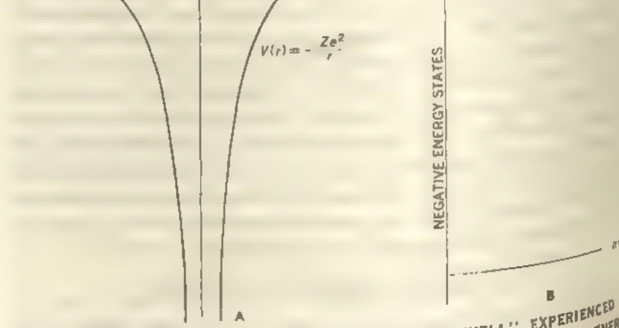


FIG. 3.—(A) SECTION ACROSS THE "POTENTIAL WELL" EXPERIENCED BY AN ELECTRON IN THE FIELD OF A NUCLEUS OF CHARGE Ze; (B) ENERGY LEVELS FOR A SINGLE ELECTRON IN THE POTENTIAL (A)

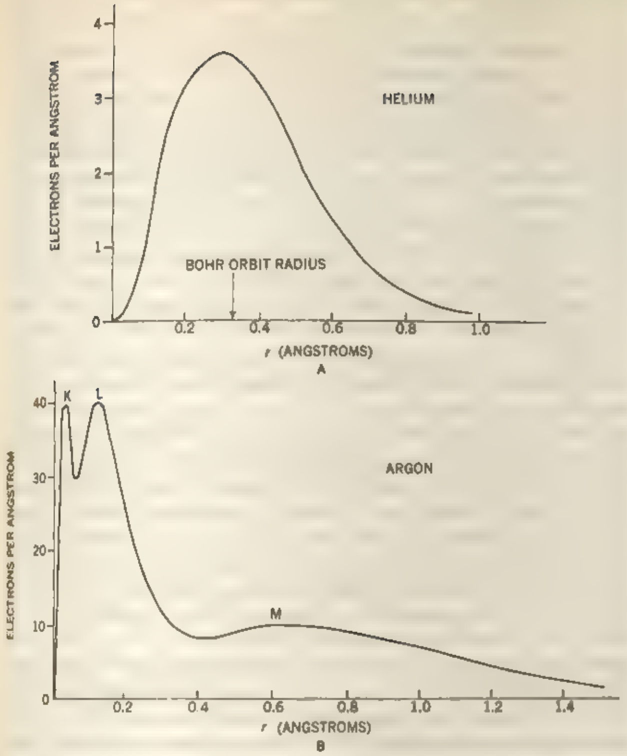


FIG. 4.—RADIAL CHARGE DISTRIBUTION OF THE ELECTRON CLOUD IN ATOMS. ORDINATE IS $4\pi r^2\rho(r)$, WHERE $\rho(r)$ IS THE CHARGE PER UNIT VOLUME AT RADIUS r. TOTAL AREA UNDER EACH CURVE REPRESENTS TOTAL NUMBER OF ELECTRONS IN THE ATOM. (A) HELIUM, STUDIED BY X-RAY DIFFRACTION (AFTER E. O. WOLLAN); (B) ARGON, STUDIED BY ELECTRON SCATTERING (AFTER L. S. BARTELL AND L. O. BROCKWAY)

very important differences. First among these is the disappearance of the concept of a well-defined orbit radius. Instead, the electron is described by a "wave function" which defines the probability of finding the electron at any particular location. This probability is usually high at distances corresponding to the Bohr radii, and falls away rapidly toward zero for large r. As a result of this lack of definiteness in its position, the electron behaves as though it were a smeared-out distribution of electric charge, instead of a point charge. By studying the scattering of X-rays or electrons from isolated atoms, this effective charge distribution can be mapped out, and fig. 4 shows experimental results for helium ($Z = 2$) and for argon ($Z = 18$). In the former case there is a single maximum at a radius close to that computed for $n = 1$, $Z = 2$ in Bohr's theory. In the latter case there is evidence for three maxima, which can plausibly be associated with the existence of three electron shells in argon (K, L and M) corresponding to $n = 1$, $n = 2$, and $n = 3$ respectively. But the many-electron system is a complex one, and before going further some other aspects of the one-electron problem must be mentioned.

4. **Quantum Numbers.**—No reference has yet been made to the orbital angular momentum, which was the main basis of Bohr's method of quantization. This quantity appears, however, when the circulation of the electron around the nucleus, as described by the electron's wave function, is considered. Crudely speaking, the charge cloud representing a single electron has some of the properties of a top; to describe its rotation necessitates a measure of how vigorously it is rotating, and also of how it is tilted in space. This introduces two new quantum numbers, l and m_l, in addition to the "principal quantum number," n. The magnitude of the rotation, as specified by the angular momentum L, is given by

$$L = \sqrt{l(l+1)}\frac{h}{2\pi} \tag{20}$$

This, then, is the analogue of equation (15) in Bohr's theory. The orientation of the charge cloud with respect to some physically defined direction (*e.g.*, that of a magnetic field) is defined by the component of L along that direction, and can be described by angles θ_m, which may have values such that $\cos\theta_m = m_l/\sqrt{l(l+1)}$. For any particular value of l, m_l may take on values $l, l-1, \ldots, 0, \ldots, -l$; *i.e.*, $2l+1$ different possibilities. Also, for any particular value of n, l is limited to the values $0, 1, \ldots, n-1$; *i.e.*, n distinct values.

A set of particular numerical values for the three quantum numbers n, l and m_l would completely specify the state of an electron in wave mechanics except for one thing, namely that the electron behaves as though it has a spin that restricts it to being oriented "up" or "down" with respect to a magnetic field or other specified direction. This property is most simply described mathematically by introducing a spin quantum number m_s that is either $+\frac{1}{2}$ or $-\frac{1}{2}$. This gives, finally, a set of four quantum numbers (n, l, m_l, m_s) that completely specifies the state of an electron in an atom.

XIII. ATOMIC STRUCTURE AND PERIODIC SYSTEM

There is one additional condition that makes intelligible the arrangement of electrons in a many-electron atom. This condition, called the exclusion principle (W. Pauli, 1925), asserts that no two electrons in the same atom can have the same set of four quantum numbers. To see what this entails, suppose that there is a "bare" nucleus of charge Ze to which electrons can be added one by one. The first electron will drop down into the lowest available state, which is characterized by $n = 1$, $l = 0$, $m_l = 0$. The second electron can do the same, provided that one electron has $m_s = +\frac{1}{2}$ and the other has $m_s = -\frac{1}{2}$. But at this point the possibilities for $n = 1$ have been exhausted; there is a closed shell (the K shell) of just two electrons. The third electron to be added is compelled to enter one of the next higher levels, with $n = 2$. This electron is much less strongly bound [*cf.* equation (19)], and on the average is much further from the nucleus than are those in the K shell. Now the quantum state for which $n = 2$ allows $l = 0$ and $l = 1$; moreover, because of the doubling allowed by the spin, there are $2(2l+1)$ different sets of quantum numbers (and hence electron states) for a given value of l. This means that the $n = 2$ shell (which is the L shell) can accommodate $2 + 6 = 8$ electrons, at which point it is filled and a shell of even more weakly bound electrons, with $n = 3$, (the M shell) must begin to form. The process is complete, of course, when a total of Z electrons has been added.

The more obvious features of chemical behaviour follow readily from this picture. The closed electron shell represents a chemically stable structure, and is illustrated by the noble gases (helium, neon, argon, etc.). The addition of one or two electrons beyond a closed shell gives a looser structure. It is relatively easy to detach these extra electrons and thus leave a surplus of positive charge in the system as a whole; this is the basis of chemical reactivity and of the formation of positive ions. Electronic structures of this type represent typical metals. On the other hand, a structure that is short of a closed shell by one or two electrons will acquire further stability by completing the shell, thereby becoming a negative structure; here there is the possibility of forming negative ions from typical reactive nonmetals such as oxygen and chlorine. (*See* VALENCE.)

By considering the progressive change of Z from 1 up to about 100 the periodic system of the elements can be built up, and it can be understood, for example, why the atomic volumes of the elements show abrupt increases at the alkali metals, which have just one loosely bound electron outside a closed-shell structure. The lack of any great general change in atomic sizes from one end of the periodic table to the other is also easily understood by recognizing that the closed electron shells of an atom of large Z make it appear to its outermost electrons like an atom with a central charge considerably smaller than Z.

XIV. UNSTABLE ATOMS

The principal concern of this article is a consideration of the existence and structure of normal, stable atoms of the elements. It is important to point out, therefore, that the number of different atomic species represented by these is greatly exceeded by

a variety of unstable or metastable atomic types. Apart from the naturally radioactive elements, which include all isotopes of the elements with Z greater than 82, *i.e.*, beyond lead, most of the unstable atoms are artificially produced isotopes of elements whose stable isotopes are found in nature. About a thousand unstable atomic species, with lifetimes ranging from about 10^{-21} sec. to millions of years, had been established by 1960. Instability of this type is nuclear instability, and its most usual cause is an abnormal ratio of neutrons to protons in a nucleus of given mass number.

1. Mesonic "Atoms"; Positronium.—A completely different type of unstable "atom" can be made by replacing orbital electrons with some other sort of negatively charged particles. In particular, such atoms have been made with negative mesons (μ or π). These particles are several hundred times more massive than the electron, but carry the same electric charge (*see* PARTICLES, ELEMENTARY). The result is that they can form Bohr orbits which are several hundred times smaller in radius than the corresponding ones for electrons. [This can be seen by reference to equation (14).] These mesonic (or mesic) atoms normally consist of a nucleus plus one meson, and so are similar to a hydrogen atom except that the central charge may be that of any nucleus. (The electrical neutrality of the atom is preserved by the continuing presence of electron shells far outside the meson orbit.) These atoms live only a very short time, because the meson either decays (being itself an unstable particle) or else is captured by the nucleus. A related type of unstable "atom" is a unique species, called positronium, composed of one electron and one positron (positive electron). One could call positronium an atom of mass number equal to zero. It can exist in two forms, but each has a very short life (about 10^{-7} sec. and 10^{-10} sec. respectively) which is terminated by the mutual annihilation of electron and positron.

2. Antimatter.—The discovery of the antiproton in 1955 and of the antineutron in 1956 confirmed a long-standing belief that all three of the constituents of normal atoms (*i.e.*, proton, neutron and electron) have antiparticles (mirror images, in a sense) that differ from their counterparts by having electric charges (in the case of the proton and electron) and magnetic moments of the opposite sign. This suggests the intriguing possibility that there may exist, somewhere in the universe, whole worlds made up of atoms of antimatter. An atom of antimatter would have a negatively charged nucleus, composed of antiprotons and antineutrons, surrounded by a cloud of positrons. In all its properties, except those depending directly on the reversal of charge and magnetism, it would be identical with (and just as stable as) a normal atom of the same Z and N; its energy levels would be precisely the same, and hence all its spectral lines would be indistinguishable from those of the normal atom. But if antimatter exists in any continuing way, it must be in regions quite devoid of normal matter, because any encounter between the two would result in their mutual destruction, with the release of vast amounts of radiant energy.

XV. ATOMICITY IN GENERAL

It seems that atomicity is one of the fundamental features of the material world. In this article it has been exhibited how electric charge, as well as mass, exists in basic and apparently indivisible units. Frequent reference has also been made to the manner in which radiation is emitted as discrete quanta. There is another side to the picture, however. Whereas, historically, man's detailed knowledge of radiant energy (light, X-rays, etc.) began with its wave properties and only later uncovered its atomistic qualities, man's knowledge of particles (electrons, protons, neutrons, etc.) was at first dominated by evidence of their atomic nature. The discovery of electron diffraction and of wave mechanics led to the realization that wave properties and corpuscular properties are not in fact separable on the atomic scale; neutral atoms can be diffracted like X-rays, as was first demonstrated by I. Estermann and O. Stern in 1930. Nevertheless the concept of the atom as a well-defined unit of matter, although becoming incomparably more detailed, remains as real as it was to the first atomists. *See* also Index references under "Atom" in the Index volume.

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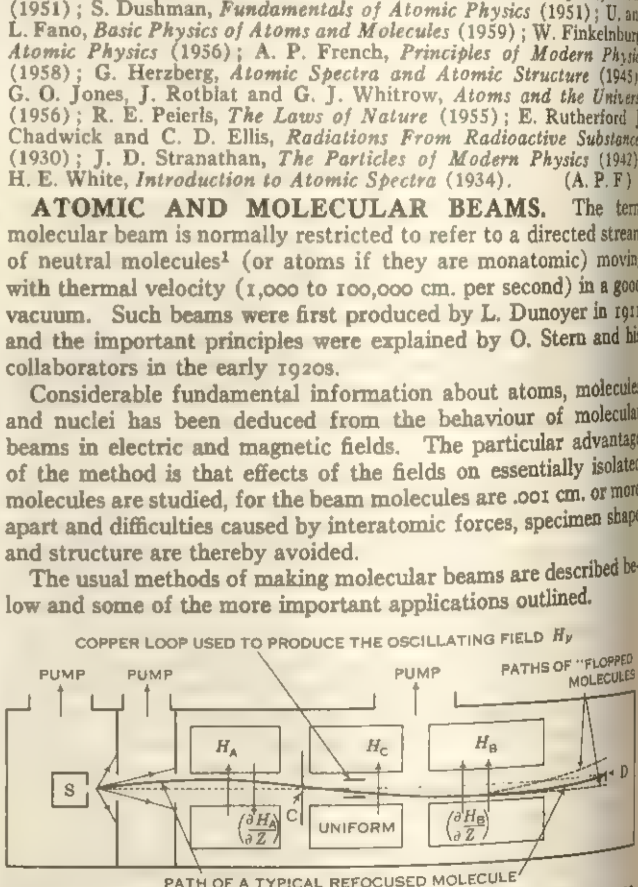
ATOMIC AND MOLECULAR BEAMS. The term molecular beam is normally restricted to refer to a directed stream of neutral molecules[1] (or atoms if they are monatomic) moving with thermal velocity (1,000 to 100,000 cm. per second) in a good vacuum. Such beams were first produced by L. Dunoyer in 1911 and the important principles were explained by O. Stern and his collaborators in the early 1920s.

Considerable fundamental information about atoms, molecules and nuclei has been deduced from the behaviour of molecular beams in electric and magnetic fields. The particular advantage of the method is that effects of the fields on essentially isolated molecules are studied, for the beam molecules are .001 cm. or more apart and difficulties caused by interatomic forces, specimen shape and structure are thereby avoided.

The usual methods of making molecular beams are described below and some of the more important applications outlined.



SCHEMATIC DIAGRAM OF A TYPICAL MOLECULAR BEAM MAGNETIC RESONANCE APPARATUS

Formation of a Molecular Beam.—The arrangement of a typical modern apparatus is shown in the figure. Molecules in the source S, where the pressure is p_s and the mean free path between collisions is λ_s, effuse through the source aperture, which is usually round (radius a) or rectangular (width a), into a well-evacuated space. If λ_s is much greater than a, the beam molecules suffer no further collisions until they hit a wall or a defining aperture, and the beam falling on the detector D consists of the molecules selected by the collimating slit C; the remainder of the molecules leaving the source (normally only about .001% of the molecules are used) are condensed on liquid-air-cooled surfaces or pumped away. Higher source pressures, such that λ_s is less than a, result in the formation of a turbulent cloud near the source aperture, the effective source width increases but θ, the beam intensity at the detector, does not increase proportionately unless the

[1]In this article, both atoms and molecules will be called molecules unless the distinction is important.

The pumps and traps must maintain a pressure in most of the apparatus (about 10^{-6} mm. mercury or less) such that λ, the mean path between collisions with residual molecules, is much less than L, the length of the beam, or attenuation of the beam intensity by a factor $e^{-L/\lambda}$ occurs.

Source.—The source cavity is made of a material which is chemically inactive at the source temperature and clogging of the aperture by condensation is avoided by running the aperture at a temperature slightly higher than the cavity. The beam material is placed as solid or liquid in the cavity where it produces vapour in equilibrium at the cavity temperature T or, in the case of many gases, it is fed to the cavity from a container outside. Local superheating or discharge tubes are sometimes used to obtain atomic beams by dissociating molecules, and beams containing molecules in excited (metastable) states have been produced by bombarding the molecules leaving the source with low-energy (approximately 10 ev) electrons.

Detectors.—Much of the early work was carried out by condensing the beam on a suitably prepared surface, cooled if necessary, and θ was found from, for example, the optical density of the trace. As a detector, it was insensitive (10 min. to detect 10^{12} molecules/cm.^{2}/sec.) and nonlinear, but it has come back into use with beams of radioactive molecules, for the deposit can then be estimated accurately by normal radioactive counting techniques. The alkali atoms and molecules containing alkali atoms, and most atoms with ionization energies less than 6 ev, can be detected efficiently by allowing them to fall on a hot oxidized tungsten strip. They evaporate as positive ions which are collected on a negatively charged plate connected to a D.C. amplifier. This surface ionization technique is most effective when the ions are accelerated into a sector magnet where ions of one particular mass are selected and then counted by a suitable ion counter. Elimination of unwanted background has allowed the use of alkali beam intensities as low as 10 molecules/cm.^{2}/sec. If the ions are produced by electron bombardment instead of surface ionization, the detector can be used with any beam material, but the efficiency is low (about .01%) unless large electron beams are used, and the mass spectrometer is essential for the elimination of ionized background molecules.

Considerable work has been done with the rare gases and hydrogen using Pirani gauges to measure the small pressure increases (about 10^{-8} mm. mercury) in a cavity when the beam enters through a long channel, but the electron bombardment detector reacts more quickly and yields a better signal-to-noise ratio in spite of its low efficiency.

Typical beam intensities used in practice are 10^{12} molecules/cm.^{2}/sec. or less at detectors 100 cm. from the source.

Gas Kinetics.—Many beam experiments have been carried out to test predictions of gas kinetic theory and study beam scattering by other molecules and surfaces; this gives information about interatomic forces and effective molecular dimensions. The wave nature of a molecular beam was first demonstrated by Stern in 1930 when he scattered helium atoms from the cleavage face of a crystal and observed diffracted beams in the directions predicted by Louis V. de Broglie's theory. Diffraction effects are unimportant in most beam experiments since apertures are never narrower than 10^{-3} cm. and the beam wave length is about 10^{-8} cm.

Light Source.—The spectral line emitted by a well-designed light source has a wave-length spread mainly due to Doppler shifts caused by random motion of the emitting atoms in the line of sight. A. Bogros (1926) showed that such line broadening can be eliminated almost entirely by observing the light emitted perpendicular to a beam of excited atoms, for the velocity spread in the line of sight is then reduced by a factor which is effectively the reciprocal of the beam divergence (in radians), and the line width is reduced in the same ratio. Unfortunately such light sources are weak and they are used only for the most accurate work.

Deflection Experiments.—Stern and W. Gerlach (1921) showed that a beam of atomic silver is split into two distinct beams on passing through an inhomogeneous magnetic field. This is in agreement with the quantum theory of spatial quantization and not with the classical assumption that any orientation of the atomic moment in the field is possible. Deflections proportional to $(\mu_a/v^2)(\partial H/\partial z)$ are produced by the field, μ_a being the atomic magnetic moment and v the velocity, and atoms with moments approximately equal to μ_0, the free electron moment,[1] are easily deflected 0.5 cm. In spite of this, the technique seldom yields an accuracy better than 5% because of the effect of the beam-velocity distribution and the difficulty of estimating large field gradients (10,000 gauss/cm. or more) produced by magnets with curved pole faces.

In weak fields (1,000 gauss or less) the relative arrangement of the nuclear magnetic moment μ_I and electronic moment μ_J are influenced by the field, and μ_a is in general a function of H. At certain critical fields, μ_a becomes zero, and such atoms remain undeflected in the apparatus. Measurement of the resultant peaks in beam intensity yields values for the nuclear spin I, magnetic dipole moment μ_I and electric quadrupole moment Q. This zero-moment technique has now been superseded by the more accurate resonance method.

Proton Moment.—Many atoms and simple molecules like hydrogen have magnetic moments[2] of the order $\mu_{NM} = \mu_0/1{,}836$ because the electron effects cancel leaving only nuclear and rotational moments. In spite of the small deflections which occur in this case, the deflection patterns produced by H_2 molecules were analyzed by O. R. Frisch and Stern in 1933 and the results showed that the proton is not a simple Dirac particle like the electron, because the moment was about $2.5\mu_{NM}$ instead of μ_{NM}.

Resonance Experiments.—According to quantum theory (*see* QUANTUM MECHANICS), the energy levels W_a of a molecule in a field H are discrete and each molecular state has a well-defined magnetic moment μ_a. The magnitudes of W_a and μ_a depend on H, on the electronic structure of the molecule and on the orientations and magnitudes of I, μ and Q for each nucleus in the molecule. Direct measurement of W_a is impossible, but the energy increments $(W_a - W_b)$ when the molecule changes from state a to state b can be deduced by applying a second weak field H_ν, oscillating at frequency ν. Since the transition probability is negligible unless the Bohr resonance condition $h\nu = (W_a - W_b)$ is satisfied, h being Planck's constant, measurement of the resonance condition gives $(W_a - W_b)$.

Molecular Resonances.—I. I. Rabi (1938) and his collaborators detected resonances of this type for the first time using diatomic molecules in the apparatus shown in the figure, and initiated the age of precision measurement of atomic, molecular and nuclear constants. The inhomogeneous deflecting fields A and B, the source slit, collimating slit and detector are adjusted so that beam molecules refocus on the detector when μ_a is the same in the A and B magnets. When H_ν is turned on in the homogeneous C field, transitions associated with nuclear reorientations occur and "flopped" molecules miss the detector because μ_a changes to μ_b (and the deflections due to the A and B magnets fail to cancel). The plot of detector reading against ν shows a typical resonance shape with a minimum at the nuclear Larmor frequency in the C field, $\mu_I H/Ih$ (about 1 kc./gauss). The accuracy with which μ_I can be deduced depends on the field measurement and the sharpness of the resonance. The apparatus contributes part of this line width, the rest being due to the effects of internal fields caused by molecular rotation, vibration and nuclear moments; analysis of the line structure in a high resolution apparatus gives accurate molecular data and nuclear moments. The quadrupole moment of the deuteron was discovered in this way, a result of great importance since it implies that the proton-neutron interaction includes a tensor force.

Atomic Resonances.—Resonances associated with atomic reorientations can also be detected in a similar apparatus at frequencies of about 1 mc./gauss when μ_a is approximately equal to μ_0. These frequencies depend on H_C, the electronic structure

[1]The magnetic moment expected for a Dirac particle with the electron mass and charge is μ_0 (9.3×10^{-21} EMU). It is used as the atomic unit of magnetic moment and is called the Bohr magneton.

[2]The nuclear magneton μ_{NM} is the moment expected for a Dirac particle with the electronic charge and the proton mass. It is used as the unit of nuclear magnetic moment.

of the atom, the electronic contribution μ_J to the atomic movement. and on I, μ_I and Q. Accurate values of these constants can be found by studying the field dependence of such resonances, and also others at frequencies of 100 to 10,000 mc. due to nuclear reorientations in the internal field due to the electrons.

Atomic Clock.—One particular atomic cesium resonance is almost independent of H_C if H_C is less than one gauss, and the frequency in terms of the mean solar year is 9,192.63183 mc. By deriving this frequency from a low frequency oscillator (5 mc.) which is itself controlled by the atomic-beam apparatus, primary frequency standards that are stable and reproduceable to a few parts in 10^{10} have been constructed.

Octupole Moments.—If atomic resonance frequencies are measured with an accuracy of one part in 10^6 or better, it is necessary in some cases to postulate nuclear magnetic octupole moments, as well as quadrupole and dipole moments, in order to account for the experimental results.

Anomalous Electron Moment.—P. Kusch and H. Foley (1948) showed that accurate measurement of μ_J for two states of the same atom allows the electron spin moment contribution to μ_J to be evaluated. They found a value about 0.115% greater than that predicted by Dirac theory, a result which stimulated significant development of the quantum theory of radiation before it was explained satisfactorily.

Lamb Shift.—The Lamb shift in the spectrum of atomic hydrogen is another result of importance in the quantum theory of radiation. W. E. Lamb and R. C. Retherford (1950) bombarded atomic hydrogen with electrons and produced a beam containing metastable $2S_{\frac{1}{2}}$ atoms which survived the passage through the apparatus (10^{-4} sec.) and finally ejected electrons when they fell on a tungsten plate. Other $2P_{\frac{1}{2}}$ atoms produced at the same time decayed immediately (10^{-9} sec.) and failed to eject electrons when they hit the target as ordinary $1S_{\frac{1}{2}}$ hydrogen atoms. According to Dirac theory, the $2P_{\frac{1}{2}}$ and $2S_{\frac{1}{2}}$ states should have the same energy, though optical results indicated a possible separation. This was confirmed by Lamb's experiment, since the $2S_{\frac{1}{2}}$ atoms would have decayed via the $2P_{\frac{1}{2}}$ state if the energy was the same and no electrons would be emitted. Furthermore, by applying a radio-frequency field at about 1,040 mc., $2S_{\frac{1}{2}} - 2P_{\frac{1}{2}}$ transitions were induced and the level separation was measured accurately, the resonance condition being indicated by a fall in electron current at the detector.

Electric Resonance.—Electric moments and other molecular constants have been measured accurately by electric deflection and resonance experiments using apparatus similar to that shown in the figure, but with electric fields instead of magnetic fields.

An important development of this technique is the maser (Microwave Amplification by Stimulated Emission of Radiation) developed by J. P. Gordon, H. J. Zeiger and C. H. Townes (1955). A four-pole electrostatic deflecting field is arranged to focus only ammonia molecules in the upper inversion level through a small aperture into a high Q cavity. If the beam intensity is high enough, stimulated emission exceeds absorption and self-sustained oscillations with frequency stability comparable with the cesium clock result. At lower beam intensities, the device can amplify without adding appreciable noise to the signal. *See* also ELECTRON DIFFRACTION; ELECTRON PARAMAGNETIC RESONANCE.

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(K. F. S.)

ATOMIC BOMB: *see* AIR POWER; ATOMIC ENERGY; NUCLEUS; ROCKETS AND GUIDED MISSILES; THERMONUCLEAR REACTIONS; WORLD WAR II.

ATOMIC ENERGY, a term denoting energy that is released in significant amounts from the atomic nucleus. It is more properly called nuclear energy. (The word "atomic" ordinarily refers only to phenomena involving the orbital electrons of an atom, and not to phenomena involving changes in the atom's nucleus. The term "atomic energy," however, has become so well established in actual usage that it is not likely to be changed.) One method of releasing atomic energy, known as nuclear fission, was first achieved in a controlled manner on Dec. 2, 1942. The same method was used July 16, 1945, in a test explosion of an atomic bomb.

Atomic energy first received public attention on Aug. 6, 1945 when an atomic bomb devastated Hiroshima, Jap. Since that time great improvements have been made not only in powerful atomic weapons but also in the continuous controlled release of atomic energy in devices known as "nuclear reactors." Such reactors are now in operation in many parts of the world.

Another method of releasing nuclear energy is known as nuclear fusion, or thermonuclear fusion. Public announcement was made in 1951 of U.S. atomic bomb tests "contributing to thermonuclear weapons research." By the early 1960s the United States, the United Kingdom and the U.S.S.R. had tested fusion bombs hundreds of times more powerful than fission bombs. Extensive work on controlled thermonuclear reactions was being carried on in these three countries, in the hope that useful power could someday be achieved by this method. (*See* THERMONUCLEAR REACTIONS.)

The energy released in chemical reactions, including TNT explosions, has its origin in the forces which hold atoms together in the form of molecules. It is associated with the outer or electronic structure of the atom. Atomic energy originates from the vastly stronger forces which hold together the particles of the core or nucleus of the atom. The nature of these nuclear forces is not completely understood. They are the subject of much research in an area of science called nuclear physics. Nuclear forces are quite different from electrical, gravitational and magnetic forces. A particle called the pi-meson plays an important role in connection with the forces between nuclear particles, much as the photon does with the electrical forces between charged particles. (*See* NUCLEUS: *Nuclear Structure and Nuclear Forces.*)

Of the two methods of releasing atomic energy, the first is a process which involves spontaneous splitting (fission) of a heavy nucleus into two or more less heavy nuclei. The second process involves the union (fusion) of two light nuclei to form a heavier nucleus. These methods yield comparable amounts of energy per pound of material, vastly more than can be obtained in a chemical reaction. The fission of one pound of uranium yields about 10,000,000 kw.hr. of heat energy. The combustion of 3,000,000 lb. of coal would be required to produce this same amount of energy.

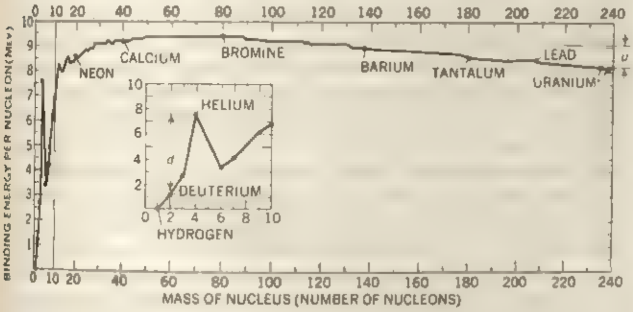
Atomic Structure.—Lord Rutherford (*see* RUTHERFORD, ERNEST RUTHERFORD) first established by theory and experiment that an atom consists of a loose structure of electrons surrounding a heavy central core, the nucleus. It was later discovered that the nucleus consists of positively charged particles called protons and other particles of about the same weight but without charge called neutrons (*see* ATOM; ELECTRON; NEUTRON; PROTON; *see* also PARTICLES, ELEMENTARY). The lightest nucleus, that of ordinary hydrogen, consists of a single proton. One proton and one neutron combined form the nucleus of deuterium, or heavy hydrogen. Heavier nuclei are stable only in certain proportions of neutrons to protons; the ratio is close to 1:1 for light nuclei and increases gradually to about $1\frac{1}{2}$:1 for heavy nuclei.

An atom of an element is identified by the number of protons in its nucleus (atomic number), which is equal to the number of orbital electrons which complete the neutral atom. The number of orbital electrons in turn determines the chemical and most of the physical properties characteristic of the element. Usually a given number of protons can form a stable nucleus with several proportions of neutrons close to the most stable ratio; for example, eight protons combine with 8, 9 or 10 neutrons to form oxygen nuclei of mass 16, 17 and 18, respectively. Such atoms of the same element but of different mass are called isotopes (*see* ISOTOPE). Oxygen nuclei having 6, 7 and 11 neutrons have been formed artificially, but they are unstable and decay by rad-

active disintegration to stable nuclei.

Sources of Nuclear Energy.—When atoms combine in a chemical reaction to form stable molecules, energy is released by a shift in the electron clouds of the original atoms which now must accommodate the added atomic nuclei. In a chemical reaction, the nuclei themselves do not change their composition. Similarly, if protons and neutrons were assembled to form a nucleus of a certain charge and mass, energy would be released in the process. It is known that this must happen, because stable nuclei have a measured mass less than that of the sum of their neutrons and protons. The difference is known as the "mass defect." By using the famous relation between mass and energy first given in 1905 by Albert Einstein (*q.v.*), this mass difference can also be given in terms of energy. Nuclear binding energies thus calculated are millions of times greater than chemical energies. Because nuclear forces are effective only when the particles are extremely close together, and enormous electrostatic repulsive forces must first be overcome, it is unlikely that significant amounts of nuclear energy can ever be released by synthesizing nuclei from protons and neutrons.

The nuclear energy potentially and presently available to mankind results from the fact that some nuclei are bound more tightly than others. The figure shows that the binding energy per nucleon



("nucleon" is a collective name for neutron or proton) is greatest for elements of medium mass, and falls off slightly for both lighter and heavier elements. If a heavy nucleus such as that of uranium of mass 235 is fissioned or split into two parts of comparable mass, both parts will lie in the medium mass range and the total binding energy for the two parts will be higher than it was for the uranium nucleus. The difference in average energy per nucleon ("*u*," in the figure), multiplied by the total number of nucleons in the two atoms, is released in the process.

The combination of two light nuclei to form a heavier one is called fusion. From the inset to the figure it can be seen that formation of the stable helium nucleus (mass 4) from deuterium (mass 2) will release energy ("*d*").

Much smaller amounts of nuclear energy are released by unstable or radioactive elements such as radium, whose nuclei spontaneously change one by one to a more stable form by internal rearrangement. The process is called radioactive decay (*see* RADIOACTIVITY). The first observation of such phenomena was made in 1896 by A. H. Becquerel (*q.v.*) when he observed radiations from certain heavy elements. Rutherford and others in the early years of the 20th century established that these radiations came from the atomic nucleus. As energy sources, these materials were unimportant except for such applications as the use of radium to produce luminous paint for watch dials.

Until 1919 no one had succeeded in producing a nuclear reaction artificially. It did not seem possible to overcome the repulsive force which always exists between two nuclei because of their positive charge. This repulsive force keeps nuclei so far apart that they do not react with one another. A simple mixture of atoms, even at the highest temperatures available on earth, could not be expected to react. Rutherford achieved success by using high-speed helium nuclei (alpha particles) spontaneously ejected from radium. These particles were able to reach the nuclei of nitrogen and knock out protons (nuclei of hydrogen). A nuclear reaction had been produced. It is expressed in a form similar to that used for a chemical reaction:

$$N^{14} + He^{4} \longrightarrow O^{17} + H^{1}$$

In this expression the superscript represents the mass number. Oxygen had been produced from nitrogen and an age-old dream of transmutation of the elements realized. It was the beginning of a new scientific pursuit called atom smashing (*see* ACCELERATORS, PARTICLE).

The Neutron.—Although suggested earlier on the basis of indirect evidence, the neutron was actually discovered in 1932 by Sir James Chadwick (*q.v.*). It was found as a product of the bombardment of beryllium with alpha particles. Its mass was established as nearly the same as that of the proton. This particle, having no electric charge to hinder its penetration into atomic nuclei, proved very effective in producing nuclear reactions, and many such reactions were rapidly discovered. In 1934 Enrico Fermi (*q.v.*) further improved the effectiveness of neutrons in producing reactions by passing them through water or through paraffin. Collisions with the light nuclei in these materials slowed the neutrons and thus gave them more time to react. One especially interesting reaction was produced by Fermi with this method. It was the absorption of slow neutrons by the heaviest element then known, uranium (*q.v.*) of atomic number 92. Radioactivity which suggested the formation of a new element with atomic number 93 was observed. There were also some unexplained results which did not become clear until the discovery of fission four years later.

Uranium Fission.—Prior to 1939 hundreds of nuclear reactions were produced and studied. In many individual cases more energy was received than given, yet there was no serious consideration of nuclear reactions as a practical source of energy. The reason was that large amounts of energy were required to accelerate nuclear projectiles, and even then only about 1 in 1,000,000 reached the target. Even if the product particles emerged with more energy, they had a similarly small chance of producing a second reaction. It appeared impossible to start a nuclear "fire" or to keep it burning. Nature seemed to forbid such a process except in the interiors of stars, where the temperature was sufficiently high and the energy produced did not escape (*see* STAR: *Stellar Structure* and *Stellar Evolution*). The discovery of fission in 1938 provided a new possibility of sustained fire, a chain reaction which would continue to "burn."

At the close of 1938 O. Hahn and F. Strassmann found that barium, a medium-weight element, was one of the products when uranium was bombarded by neutrons. The significance of this discovery was communicated by Lise Meitner and O. R. Frisch, refugees from Germany then working in Copenhagen, to Niels Bohr (*q.v.*), who was preparing to visit the U.S. Arriving in Jan. 1939, Bohr discussed the Hahn and Strassman discovery with Einstein, J. A. Wheeler and others. The presence of barium meant that uranium had been split into two nearly equal fragments, which represented a tremendous jump in energy produced over all previous transmutation reactions. Calculations showed that such a reaction should yield 10 to 100 times the energy of less violent nuclear disintegrations. This was quickly confirmed by experiment.

Bohr and Fermi discussed this reaction, called "fission," at a conference in Washington, D.C., on Jan. 26, 1939, and Fermi made the suggestion that neutrons might be released in the process. If this were the case, and if the number of neutrons was more than one, some losses could be tolerated and still leave a neutron to initiate another fission of uranium, thus producing a chain reaction which would continue to "burn" uranium. This suggestion produced considerable excitement, and physicists present at the conference initiated calls to their laboratories to start the search for fission neutrons. They were found, about $2\frac{1}{2}$ per fission on the average, though the number was kept secret during World War II.

Fission Reactions.—Theoretical studies by Bohr and Wheeler suggested that the fission observed with uranium did not come from the more abundant U^{238} variety but from U^{235}, an isotope which constituted only 1 part in 140 of natural uranium. By using minute quantities of uranium somewhat richer in U^{235} than normal, this prediction was confirmed. It was also found that neutron

is still an essentially limitless supply of fission reactor fuel available. H. Brown and L. T. Silver have shown that the granite rocks which make up most of the earth's crust contain about 15 g. per ton of uranium and thorium. Of this, about 3 g. per ton can be easily extracted by crushing the granite and leaching it with acids. Such fuels would cost more than those now obtained from high grade ores, but still the total energy expended in quarrying the rock and recovering the uranium and thorium would be only a negligible fraction of the yield in fission. A ton of granite can thus yield about nine times the energy of a ton of coal. The uranium and thorium would have to be converted to fissionable form in a special type of nuclear reactor known as a breeder reactor. Such reactors have been built and operated and proved technically feasible.

Thus the fears of the past over exhaustion of energy supplies can now be allayed, because both the rocks and the seas have energy content sufficient to last mankind for 10,000,000,000 years, which is about as long as the solar system is expected to last.

Nuclear Reactors.—A nuclear reactor, or atomic reactor, is a device containing fissionable or fusionable material in sufficient amount and so arranged that the device is capable of initiating and maintaining a controlled, self-sustaining nuclear chain reaction. Nuclear reactors were formerly called "piles," but the latter term is now virtually obsolete.

Fusion Reactors.—Nature has its own very successful version of a fusion reactor, namely, a star. Man's attempts to produce a controlled, continuous fusion reactor have so far served more to indicate the difficulties than to produce a solution. From the experiments that had been conducted by the early 1960s, it was generally believed that a fusion reactor would have to be a tremendous machine with heavy shielding, huge vacuum pumps, coils, and magnets to form a magnetic container for the hot gases. (The temperature necessary for fusion to occur is so high that the atoms are fully ionized, that is, all the electrons are separated from their orbits around the atomic nuclei, and the mixture of rapidly moving nuclei and electrons form an electrically neutral gas called a plasma. The only feasible container for a plasma appeared to be a strong magnetic field in a vacuum.)

Fission Reactors.—By the early 1960s the number of fission reactors operating in the world was well over a hundred. These reactors, constructed for a wide variety of applications, varied in core size from a few inches to dozens of feet, and in power from a few watts to hundreds of megawatts. A few of these applications will be discussed to indicate the importance of fission reactors. All reactors produce neutrons, gamma rays, fission products and heat. In most applications use is made of only one of these products.

1. Neutron sources. Compared to previous sources of neutrons for experimental purposes, reactors provide tremendously larger numbers of neutrons at moderate cost. Reactors have thus become important tools in physics research and in engineering development. Isotope production, including plutonium production, is another important use of a reactor as a neutron source. Hundreds of different radioactive species, having thousands of important applications, are produced. For example, radioactive cobalt has nearly displaced radium for gamma-ray therapy, radiography and other uses. (*See* RADIOACTIVITY.)

2. Gamma-ray sources. The action of the gamma radiation (high-frequency electromagnetic radiation) produced by reactors is generally destructive, a fact which requires heavy shields around the chain-reacting core. At least two beneficial uses of this radiation have been found, however—sterilization of foods and strengthening of plastics. Radiation sterilization allows plastic-wrapped meat, for example, to be kept for months without refrigeration. In the case of plastics, bombardment of polyethylene and other polymers produces cross-linking, or formation of additional chemical bonds which tie together laterally the end-to-end strands formed by the normal polymerization. Since the amount of cross-linking can be controlled by the radiation exposure, the properties of the plastic can be varied at will from those of a soft material which sags in warm water to those of a tough resilient solid.

3. Process heat. The principal release of energy in a reactor starts with the fission fragments, which fly apart with energies corresponding to temperatures of millions of degrees. The reactor is theoretically capable of operating at any temperature which the fuel and structure can withstand, subject to the practical limitation that it must be possible to extract the heat in a useful form. Some industrial or process heat applications for which reactors are potentially suitable are, in descending order of temperatures: fixation of atmospheric nitrogen to form nitrate fertilizer, conversion of coal to form petroleum products and gaseous fuel, distillation of sea water and heating of buildings.

4. Propulsion reactors. The chief advantage of a reactor for vehicle propulsion is the extended range given the vehicle. A few pounds of uranium (U^{235}) or plutonium form a fuel supply capable of driving the largest ship around the world. By the early 1960s the U.S. navy had over 20 nuclear submarines afloat, and was rapidly building a nuclear navy. The U.S.S.R. was operating a nuclear-powered icebreaker, the "Lenin," and the first nuclear-powered merchant ship, the NS "Savannah," had been launched.

Two types of nuclear aircraft were under development in the U.S. in the same period, a ramjet and a turbojet, but neither had undergone flight tests. Various types of nuclear-powered surface vehicles had been proposed, ranging from giant tractors to railroad locomotives.

The potential advantages of nuclear propulsion over propulsion by chemical fuels are most marked in the case of space rockets, and the advantage increases rapidly as larger payloads and longer ranges are sought.

5. Electric power. Power reactors, like process heat reactors or steam boilers, are primarily sources of heat. The heat is transferred to a working fluid such as steam or gas, and partially converted to mechanical energy by a turbine. The possibility of direct conversion without moving parts through the use of thermionic converters or thermoelectric devices was receiving increasing attention in 1960 (*see* ENERGY CONVERSION, DIRECT).

The first reactor to produce useful electric power was the Experimental Breeder Reactor No. 1, built by the Argonne National laboratory in 1951. The first experimental power station of the U.S.S.R. began operating in May 1954, and the first large-scale reactor power plant to operate (May 1956) was the United Kingdom's Calder Hall station. None of these plants produced power as cheaply as large coal-fired plants, but they were expected to lead the way to larger, improved reactor plants that could compete with coal. Most countries were anxious to gain experience with the new source of energy, even though a clear-cut cost advantage had not been attained. Experience with the largest stations showed that construction and operating costs were reasonable, and that the biggest remaining obstacle to achieving economic nuclear power was in fuel cycle cost.

The basic cost of the fuel itself in terms of energy content is in the same range as coal, but a reactor cannot consume all the fissionable material in its fuel at one loading. To operate at all, it must always have present at least a sufficient number of fissionable atoms to sustain the chain reaction. This amount of material is called the critical mass. It varies with the concentrations of fissionable atoms, the kinds of other atoms present, and the configuration of the system. After a certain fraction of the original fuel is consumed the fuel must be replaced. This may be due to depletion of the fissionable material or to accumulation of the fission-product atoms, which can absorb the neutrons needed for the chain reaction and can in some cases cause destructive structural changes in the fuel material. The discharged fuel is highly radioactive and must be handled by machinery inside enclosures shielded by heavy concrete walls or by thick layers (about 15 ft.) of water. The valuable fissionable portion of the fuel structure must be recovered and used to manufacture new fuel structures, called fuel elements, that can undergo another trip through the reactor. The operations of handling and recovering the discharged fuel and remanufacturing the new fuel are known as fuel reprocessing, and are quite costly. Extensive effort has been expended in searching for cheaper ways to produce fuel elements which would last longer in the reactor and be easier to reprocess.

By the early 1960s three general groups of reactors, all having certain advantages and disadvantages, had emerged:

1. Water-cooled reactors. In these the water serves as the neutron-slowing medium as well as the coolant. As an outgrowth of the submarine program, these reactors enjoy an advanced state of development. Compared to the other two groups, water reactors are characterized by high operating pressure and low operating temperature. If heavy water (D_2O) is used as the coolant, water-cooled reactors can be fueled with natural uranium metal, which contains only 0.7% of U^{235}. Usually, uranium oxide fuels are used when ordinary water is the coolant, necessitating fuel enrichment with extra U^{235} from diffusion plants. One form of water reactor uses a homogeneous solution of enriched fuel in heavy water. When the reactor core is surrounded by a so-called blanket containing mostly thorium, the neutrons leaking from the core are captured in the thorium, converting some of the thorium to fissionable U^{233}. Such a reactor can "breed" as much fuel in its blanket as it burns in the core.

2. Gas-cooled reactors. These reactors, exemplified by the large British nuclear power stations, can also be fueled with natural uranium. The neutrons are slowed down (moderated) by graphite. The more advanced types use enriched fuel and are being designed for higher and higher temperatures. The gas coolant has been used to produce steam in a separate unit, but in principle the gas could drive a gas turbine directly.

3. Sodium-cooled reactors. Although the art of handling molten sodium metal has not been highly developed, sodium is attractive as a reactor coolant because of its excellent heat transfer capability at high temperatures without the need of a pressure vessel. Although sodium reacts with air and water, when properly enclosed and purified it is less corrosive than water. The fast-neutron breeder reactor is potentially the most attractive of the sodium-cooled types. For this type no neutron-slowing medium is used, and fissions are produced by fast neutrons. If the fuel used is plutonium, and the core is surrounded by a blanket of ordinary uranium, such a reactor will breed as much as 50% more plutonium than it consumes.

For more detailed information on fission reactors, *see* NUCLEAR ENGINEERING.

See also references under "Atomic Energy" in the Index.

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(R. P. HA.)

ATOMIC NUMBER, the number of a chemical element in the periodic system. In this system, the elements are arranged according to the number of nuclear protons or extranuclear electrons in an atom. For experimental basis *see* ATOM; NUCLEUS; PERIODIC LAW; VALENCE.

ATOMIC WARFARE, a term that came into use after the first employment of atomic bombs against Japan at the end of World War II. Simply stated, it is warfare in which atomic weapons are used. Such weapons may take the form of atomic missiles or rockets (both large and small, short-range and long-range), atomic bombs dropped from aircraft, artillery shells carrying atomic warheads, or atomic land mines. All-out atomic war threatens sudden and catastrophic destruction followed by long-term danger from lingering radioactivity.

See AIR POWER; ARMY; ATOMIC ENERGY: *The Atomic Bomb*; ROCKETS AND GUIDED MISSILES; TACTICS: *World War II* and *Nuclear Age*.

ATOMIC WEIGHT, a number, different for each chemical element, that gives the weight or mass of an atom of the element relative to that of an atom of an element taken as a reference standard. From 1900 until 1961 oxygen was used as the reference element for the so-called "chemical scale" of atomic weights, with an assigned atomic weight of 16. This number was derived from the approximate atomic weight of oxygen on an earlier scale, for which hydrogen, with atomic weight 1, was the reference standard. Because of this circumstance, the atomic weights of nuclides coincide, to the nearest integer, with their mass numbers. A mass number represents the total number of nucleons (protons and neutrons) in the nucleus of an atom (*see* ATOM: *Atomic Structure and Periodic System*). In 1961 the principal isotope of carbon, carbon-12, replaced oxygen as the reference standard, changing the then-established atomic weights very slightly (about 0.004%).

In the following discussion the terms "atomic weight" and "atomic mass" are essentially synonymous. "Atomic mass" describes more accurately the property of matter that is of basic interest. However, the term "atomic weight" has the sanction of long usage and is valid when measurements are based upon weighing.

SCALES

In 1929, it was discovered that natural oxygen contains small amounts of two slightly heavier isotopes, in addition to the most abundant isotope mentioned above. Thus it became apparent that the number 16, as used in the chemical scale of atomic weights, represented the average weight of the atoms of the three isotopic species of oxygen as they occur in nature.

It is possible by several methods to determine the relative weights (or masses) of the atoms of individual isotopic species of the elements. This led to the adoption of a scale of atomic weights in which 16 is the numerical value assigned to the atoms of the predominant isotope of oxygen. This scale was known as the physical scale. Because natural oxygen contains only minute amounts of the other two isotopes, the two scales differed only slightly. They were numerically related to each other in the approximate ratio 1:1.000275.

Because this ratio could not be fixed exactly, owing to slight variations in the isotopic composition of natural oxygen from different sources, and because of the difference between the scales, chemists and physicists in 1961 established a new scale which replaced the two then in use. The most abundant isotope of carbon, with an assigned relative weight (mass) of 12, was chosen as the reference species for this new scale. This scale required only minimal changes in the values that had been used for chemical atomic weights, lowering them by 43 parts in 1,000,000. Values based on the physical scale were lowered by 318 parts in 1,000,000.

EXPERIMENTAL DETERMINATION

Although numerous discoveries concerning the structure and composition of atoms and the transformations that atoms can undergo have made necessary substantial modifications in atomic theory, the concepts of atoms and atomic weights are still fundamental and of great usefulness. The vast majority of changes that occur in the composition of matter are those in which the atoms themselves are not altered. This class of changes, termed chemical, can be readily distinguished from those changes, termed nuclear, in which atoms are altered, by a simple classification based upon the magnitude of the energy consumed or expended in the change. The least energetic nuclear reaction involves an exchange of energy more than 1,000 times greater than that involved in the most energetic chemical reaction. (*See* ATOMIC ENERGY; NUCLEUS: *Nuclear Reactions*.)

In chemical reactions all quantitative operations, whether aimed at the analysis or the synthesis of materials, pivot on atomic and molecular weight. (The molecular weight of a molecule is numerically equal to the sum of the atomic weights of all the atoms which make up the molecule; *see* MOLECULE.) The numbers representing these weights determine the accuracy of the operation of the most basic law of chemistry—that of definite combining proportions (*see* ATOM: *Dalton's Theory*). Ever since this law was discovered (Joseph Louis Proust, 1799; John Dalton, 1808), one of the most important tasks of the chemist has been to determine atomic weights. In the 19th century this activity marked the transition of chemistry from a purely descriptive to a quantitative science. In the 20th century the goal of both chemists and physicists has been to achieve ever-increasing accuracy in the measurement of these weights.

Chemical Methods.—Of the various methods available for the determination of atomic weights, the first to be used is based upon converting a precisely weighed quantity of the unknown element (or of a compound of the unknown element and another element of known atomic weight) into a resultant compound which

contains some other element whose atomic weight is known; the resultant compound is then weighed. Until about 1930 this was the most generally applicable method. If all substances are of the requisite purity, and no loss has occurred during the conversion, the unknown atomic weight is derived from the ratio of the two measured weights by a simple proportion. An illustration can be drawn from the determination of the atomic weight of iron by G. P. Baxter and C. R. Hoover. These investigators treated weighed quantities of ferric oxide (Fe_2O_3) with hydrogen at a high temperature and thus converted the meticulously prepared oxide to pure iron. The loss in weight represented the quantity of oxygen present in the oxide. In a typical experiment the two observed weights were 7.59712 g. and 5.31364 g. and the loss 2.28348 g. From the proportion $(2.28348):(5.31364) = O_3:Fe_2 = 3(16.000):2x$, the atomic weight of iron, x, was found to be 55.848. Numerous repetitions of the experiment minimized the effect of errors.

Another type of reaction that has been much used is one in which the chlorine or bromine combined with an element whose atomic weight is to be determined is caused to combine quantitatively with silver. For this purpose the combining weights of silver with chlorine and with bromine must be known and one or more of these three elements must be numerically related to oxygen. T. W. Richards, Baxter and their associates performed many experiments in which weighed amounts of the most carefully prepared metallic silver were converted, without significant loss or contamination, into silver nitrate ($AgNO_3$), silver chloride ($AgCl$) and silver bromide ($AgBr$). In the first of these conversions knowledge of the atomic weight of nitrogen derived from another chemical ratio permitted the establishment of a ratio relating silver to oxygen and thus yielded the atomic weight of silver. With this intermediate but carefully determined value, the ratios Ag:AgCl and Ag:AgBr yielded the atomic weights of chlorine and bromine. With the values for silver, chlorine and bromine thus fixed, use of the reaction mentioned above made it possible to determine the atomic weights of many elements that form chlorides and bromides.

Another, and closely related, procedure is illustrated by the work of Baxter and A. H. Hale, who determined the chemical equivalence (*see* EQUIVALENT) of sodium carbonate (Na_2CO_3) and iodine pentoxide (I_2O_5) by dissolving in water weighed amounts of these two compounds. Since sodium carbonate is a base and a solution of iodine pentoxide is a strong acid, observations of the relative weights of the two required to yield a precisely neutral solution provided the measure of their chemical equivalence. It is to be noted that three elements, sodium, carbon and iodine, are involved in addition to the former reference element, oxygen. If the atomic weights of any two of the three are known from other work, the value of the third can be determined. The work cited was aimed at the determination of the atomic weight of carbon, but the result obtained was not highly accurate because of errors in the assumed values for sodium and iodine. Later recalculation showed that the experimental work was of very high accuracy.

During the 19th century extensive investigations involving chemical ratios were made by J. Berzelius, J. C. G. de Marignac, J. B. A. Dumas, J. S. Stas and many others. To the later investigators that have been mentioned already, all of whom worked in the United States, should be added B. Braumer and O. Hönigschmid as leaders in this field in Europe.

Physical Methods.—The most important physical methods of determining atomic weights involve the use of gas density ratios, X-ray diffraction, mass spectroscopy, nuclear reaction calculations, and microwave spectroscopy.

Gas Density Ratios.—A general method of determining atomic weights, but one that is applicable only to gases, depends upon Avogadro's rule (the assumption that under identical physical conditions equal volumes of gases contain the same number of molecules) and consists essentially of weighing like volumes of different gases under like conditions of temperature and pressure. The ratio of the densities (mass per unit volume) of two gases, when suitably corrected for the slight deviations of each gas from the behaviour of a so-called "perfect" gas, is equal to the ratio of their molecular weights. If the molecular composition is known from other considerations, atomic weights are readily derived, and if one of the gases is oxygen, the atomic weight in question is related directly to oxygen. The method involves the same requirements as the chemical methods with respect to the purity of the substances under consideration, but involves greater difficulties with respect to weighing and the additional problems of accurate control of temperature and pressure. The method was at first the only one applicable to the six inert gases (helium, etc.), and it also contributed to the study of other elements. Noteworthy investigations involving the gas-density method were made by Lord Rayleigh, E. W. Morley, P. A. Guye, A. Leduc, E. Moles, R. Whytlaw-Gray and Baxter.

X-Ray Diffraction in Crystals.—A second method based upon purely physical measurements, but involving solids rather than gases, has been used to a limited extent. It is possible to determine from X-ray diffraction measurements the geometrical arrangement of atoms and the distances between atoms in a crystalline substance (*see* CRYSTALLOGRAPHY: *Diffraction by Crystals*). From these data can be computed the actual volume occupied by the small number of atoms or combinations of atoms that form the basic pattern of the crystal, the so-called unit cell, and thus, by a simple proportion, the volume occupied by any multiple of that number, for example one based upon Avogadro's number (6.023 $\times 10^{23}$); that is, the number of molecules contained in a gram-molecular weight of a substance (*see* AVOGADRO'S CONSTANT). The volume thus computed will be that occupied by a gram-molecular weight of the substance in question. By means of the relation between weight and volume of the substance, the weight of the gram molecule is derived from this volume. This weight is numerically identical to the molecular weight, from which the atomic weights of the constituent elements can be obtained. If the molecular weight of a crystalline substance is already known, the method offers a valuable means of determining Avogadro's number. The method places the same demands of purity on the substance used as do other methods, and, in addition, requires that the crystals be free of imperfections within the limits of the desired accuracy.

Mass Spectroscopy.—A purely physical method that came into increasingly general use after about 1920 (F. W. Aston, J. Mattauch, K. T. Bainbridge, A. O. C. Nier) is that which determines the mass (or rather the ratio of mass to electric charge) of rapidly moving charged atoms or molecules by means of their deflection by electric and magnetic fields. This technique is known as mass spectroscopy (*q.v.*). The positions of impact of beams of such charged particles on a photographic plate or sensitive electrical receiver determine the relative masses of the particles among a selected group. In its original form (J. J. Thomson, 1912) the method furnished the first experimental evidence not only that all atoms of some elements are alike in mass but also that all atoms of certain other elements are not of equal mass.

At most, 22 of the substances recognized as chemical elements are known to exist in nature in simple (nonisotopic) form. Some elements have numerous natural isotopes; for example, ten natural isotopes of tin and nine of xenon are known. When atomic weights are determined by mass spectroscopy, it is necessary to measure not only the relative masses of the several isotopes but also their relative abundances. Relative abundances of isotopes cannot be determined as accurately as individual masses, but continuing improvements in this type of measurement have resulted in the adoption of values for a number of atomic weights to replace demonstrably less accurate values derived from chemical methods and gas-density determinations.

Calculations from Nuclear Reactions.—In many instances masses of individual nuclear species (nuclides) can be calculated with high precision from the net energy change ΔE involved in a nuclear reaction in which one element is transformed into another. The change in mass, Δm, is computed by means of the Einstein equation $\Delta E = \Delta m \cdot c^2$ for the equivalence of mass and energy, c being the velocity of light. The accuracy of the mass determination by this method is equal to and possibly greater than that afforded by the most advanced mass-spectroscopic measurements. For an element having several isotopes, however, it is necessary to supplement the mass measurements with isotopic abundance

measurements in order to derive the atomic weight.

Microwave Spectroscopy.—Displacements between the rotational spectra of molecules are a function of the molecular masses and hence, for similar molecules, may yield information on the masses of specific atoms in the molecules. Because of the limitation imposed by the required similarity of the molecules, this technique is applicable principally to comparing the masses of isotopes. The accuracy of the method is considerably less than that of mass spectroscopy or nuclear reaction calculations. (*See* MOLECULAR SPECTRA.)

TABULATED VALUES

Although atomic weight was once regarded as a unique, unalterable property of an element, the processes of both natural and artificial nuclear transformations and of isotopic differentiation make it possible for almost every element to vary in its isotopic composition and thus to have a variable atomic weight. Thus, knowledge of the atomic weight of an element must be accompanied by a knowledge of its isotopic composition. However, the vast majority of chemical operations for which a knowledge of atomic weights is required involves elements in a state of essentially constant isotopic composition. It is only to such elements that the term "atomic weight" can be applied with its traditional meaning and usefulness. It is therefore recommended that the term, when used without qualification, be limited to elements as they exist in nature without artificial alteration of their isotopic composition and, further, to natural elements whose isotopic composition is essentially unaffected by the several phenomena of radioactivity. In keeping with this recommendation, the accompanying table of weights lists no values for the radioactive elements with the exceptions of thorium and uranium, whose isotopic compositions in nature are essentially constant. For certain stable elements, such as lead, whose isotopic compositions are affected by radioactivity, the value given is for the isotopic composition that has not been so affected. (*See* RADIOACTIVITY.)

Variations have been observed in the isotopic compositions of a number of the elements in their natural occurrences, and such variations must be considered possible for any element having isotopes. The atomic weights of six elements are known to be affected within the limits of their assigned values. The magnitudes of these effects are stated in a footnote to the table. A second footnote indicates the estimated experimental uncertainties of the atomic weights of five elements. (ED. WS.)

International Atomic Weights

(based upon 12 as the exact atomic weight of carbon-12)

Element	Symbol	Atomic number	Atomic weight	Element	Symbol	Atomic number	Atomic weight
Actinium	Ac	89	...	Mercury	Hg	80	200.59
Aluminum	Al	13	26.9815	Molybdenum	Mo	42	95.94
Americium	Am	95	...	Neodymium	Nd	60	144.24
Antimony	Sb	51	121.75	Neon	Ne	10	20.183
Argon	Ar	18	39.948	Neptunium	Np	93	...
Arsenic	As	33	74.9216	Nickel	Ni	28	58.71
Astatine	At	85	...	Niobium	Nb	41	92.906
Barium	Ba	56	137.34	Nitrogen	N	7	14.0067
Berkelium	Bk	97	...	Nobelium	No	102	...
Beryllium	Be	4	9.0122	Osmium	Os	76	190.2
Bismuth	Bi	83	208.980	Oxygen	O	8	15.9994*
Boron	B	5	10.811*	Palladium	Pd	46	106.4
Bromine	Br	35	79.909†	Phosphorus	P	15	30.9738
Cadmium	Cd	48	112.40	Platinum	Pt	78	195.09
Calcium	Ca	20	40.08	Plutonium	Pu	94	...
Californium	Cf	98	...	Polonium	Po	84	...
Carbon	C	6	12.01115†	Potassium	K	19	39.102
Cerium	Ce	58	140.12	Praseodymium	Pr	59	140.907
Cesium	Cs	55	132.905	Promethium	Pm	61	...
Chlorine	Cl	17	35.453†	Protactinium	Pa	91	...
Chromium	Cr	24	51.996†	Radium	Ra	88	...
Cobalt	Co	27	58.9332	Radon	Rn	86	...
Copper	Cu	29	63.54	Rhenium	Re	75	186.2
Curium	Cm	96	...	Rhodium	Rh	45	102.905
Dysprosium	Dy	66	162.50	Rubidium	Rb	37	85.47
Einsteinium	Es	99	...	Ruthenium	Ru	44	101.07
Erbium	Er	68	167.26	Samarium	Sm	62	150.35
Europium	Eu	63	151.96	Scandium	Sc	21	44.956
Fermium	Fm	100	...	Selenium	Se	34	78.96
Fluorine	F	9	18.9984	Silicon	Si	14	28.086*
Francium	Fr	87	...	Silver	Ag	47	107.870†
Gadolinium	Gd	64	157.25	Sodium	Na	11	22.9898
Gallium	Ga	31	69.72	Strontium	Sr	38	87.62
Germanium	Ge	32	72.59	Sulfur	S	16	32.064*
Gold	Au	79	196.967	Tantalum	Ta	73	180.948
Hafnium	Hf	72	178.49	Technetium	Tc	43	...
Helium	He	2	4.0026	Tellurium	Te	52	127.60
Holmium	Ho	67	164.930	Terbium	Tb	65	158.924
Hydrogen	H	1	1.00797*	Thallium	Tl	81	204.37
Indium	In	49	114.82	Thorium	Th	90	232.038
Iodine	I	53	126.9044	Thulium	Tm	69	168.934
Iridium	Ir	77	192.2	Tin	Sn	50	118.69
Iron	Fe	26	55.847†	Titanium	Ti	22	47.90
Krypton	Kr	36	83.80	Tungsten	W	74	183.85
Lanthanum	La	57	138.91	Uranium	U	92	238.03
Lawrencium	Lw	103	...	Vanadium	V	23	50.942
Lead	Pb	82	207.19	Xenon	Xe	54	131.30
Lithium	Li	3	6.939	Ytterbium	Yb	70	173.04
Lutetium	Lu	71	174.97	Yttrium	Y	39	88.905
Magnesium	Mg	12	24.312	Zinc	Zn	30	65.37
Manganese	Mn	25	54.9380	Zirconium	Zr	40	91.22
Mendelevium	Md	101	...				

*The atomic weight varies because of natural variations in the isotopic composition of the element. The observed ranges are boron, ±0.003; carbon, ±0.00005; hydrogen, ±0.00001; oxygen, ±0.0001; silicon, ±0.001; sulfur, ±0.002. †The atomic weight is believed to have an experimental uncertainty of the following magnitude: bromine, ±0.002; chlorine, ±0.001; chromium, ±0.001; iron, ±0.003; silver, ±0.003. For other elements the last digit given is believed to be reliable to ±0.5.

ATOMISM, in philosophy, is the doctrine that the material universe is composed of simple and unchangeable minute particles called atoms (Gr. *atoma*, "things that cannot be cut or divided"). It holds that all observable changes must be reduced to changes in the configuration of atoms and that the multiplicity of visible forms in nature is likewise based on differences of configuration.

In order to understand the historical development of atomism and, especially, its relation with modern atomic theory, it is necessary to distinguish between atomism in the strict sense and other forms of atomism. Atomism in the strict sense, as propounded by the Greek philosophers Leucippus and Democritus (*qq.v.*) in the 5th century B.C., should be regarded as an attempt to reconcile with the data of sense experience the thesis of Parmenides (*q.v.*) that matter is unchangeable. Parmenides rejected the possibility of change on rational grounds: change seemed to him to be unintelligible. Democritus agreed with Parmenides on the unintelligibility and impossibility of qualitative change, but did not agree with him on the impossibility of quantitative change. This type of change, he maintained, is subject to mathematical reasoning and therefore possible. By the same token, Democritus denied the qualitative multiplicity of visible forms, but accepted a multiplicity based on purely quantitative differences. Consequently, the only differences between atoms, according to Democritus, must consist in their size and figure. The infinite variety of observable things could be explained by the different shapes and sizes of the atoms which constituted them and by the different ways in which the atoms were combined. Observable changes were based on a change in combinations of the atoms. During such combinations or separations, however, the atoms themselves remained intrinsically unchanged.

Other forms of atomism differed from that conceived by Democritus mainly in two points. First, some atomists did not restrict the differences between the atoms to purely quantitative ones, but accepted also differences in quality. The system of Anaxagoras (*q.v.*) even assumed as many qualitatively different atoms as there are different observable primitive substances, but usually only a few kinds of atoms were assumed, based on

the doctrine of the four elements, earth, water, air and fire, as for instance in the system of Empedocles (*q.v.*). Secondly, some atomists regarded "atoms" as divisible, whereas Democritus had regarded them as indivisible. This conception that "atoms" can be divided occurs frequently, but is usually accompanied by the view that they then become "atoms" of another substance. Here again, however, an exception must be made in the case of Anaxagoras, who held that "atoms" can be divided, but remain of the same kind (hence they were described as "homoiomeric," that is, possessing similar parts).

From the historical viewpoint, the most important system admitting qualitatively different atoms is that developed by certain commentators of Aristotle, namely Alexander of Aphrodisias (2nd century A.D.), Themistius (4th century A.D.) and Philoponus (6th century A.D.). In their system the atoms are called *elachista* ("very small" or "smallest"), the Greek equivalent of the Latin *minima*, the word used in medieval Latin writings to indicate the smallest particles.

In Greek philosophy there were also transitions between qualitative and quantitative forms of atomism. Plato characterized the atoms of the four elements by different mathematical forms.

Examples of qualitative atomism, based upon the doctrine of the four elements, are also found in Indian philosophy. In some Indian systems the atoms are not absolutely indivisible, but only relatively so. In certain aspects Indian atomism is, therefore, more related to the *minima* doctrine than to the atomism of Democritus. On the other hand, in Indian atomism the atoms cannot be destroyed, and that is a more Democritean than Aristotelian characteristic.

In evaluating the importance of Greek atomism in the light of modern atomic theories, it should be borne in mind that in Greek thought philosophy and science still formed a unity. Greek atomism, then, was inspired as much by the desire to find a solution for the problems of mutability and plurality in nature as by the desire to provide scientific explanations for specific phenomena. While it is true that some of the Greek atomists' ideas can rightly be considered as precursors of later physics, the main importance of the old atomistic doctrine for modern science does not lie in these primitive scientific anticipations. Much more important is the attempt to reconcile with the variety and mutability discerned by sense experience the thesis of Parmenides about the unity and the immutability of matter. In its search for universal and unchangeable laws, modern science is to a great extent inspired by the same idea as Parmenides, since universal laws presuppose a certain unity in the material world, and unchangeable laws cannot be established without the presupposition that something unchangeable must be hidden behind all changes. The great achievement of the Greek atomists, therefore, was that they took a general view of nature as a whole, which made a scientific attitude possible. To this both the quantitative and the qualitative atomism contributed, the former by drawing attention to the mathematical aspects of the problem, the latter by drawing attention to the empirical.

A few words may be added concerning the later history of atomism. The influence of Aristotle precluded Democritus' atomism from gaining pre-eminence in ancient Greek thought, though there were a few adherents of Democritean atomism in later times, such as Epicurus and the Roman poet Lucretius (*qq.v.*). Even so, the general idea of atomism had a certain influence in the long period intervening between its exposition by Democritus and the revival of it by Pierre Gassendi (*q.v.*) in the 17th century. During this period the *minima* doctrine was elaborated from an abstract philosophical doctrine in such a way that it could be used in science. This is largely due to the influence of the Arabic philosophers in the middle ages, especially Averroës (*q.v.*) and his followers in the Christian west. Inspired by the writings of the Arabs, medieval Europe became interested not only in philosophy but also in science. Accordingly the emphasis in atomistic thinking came to be shifted from the philosophic to the scientific, and attention was focused no longer on the general problem of how to explain mutability in nature, but on trying to explain concrete changes. Thus, in the 16th and 17th centuries, "atomists" such as Julius Caesar Scaliger (1484–1558), Daniel Sennert (1572–1637), David van Goorle (1591–1612), Gassendi (1592–1655) and Robert Boyle (1627–91) were blending together the typical Democritean approach and the Aristotelian into a general corpuscular theory which prepared the way for the atomic theory of John Dalton.

See K. Lasswitz, *Geschichte der Atomistik vom Mittelalter bis Newton*, 2 vol., 2nd ed. (1926); A. G. M. van Melsen, *From Atomos to Atom*, 2nd ed. (1960). (A. G. v. M.)

ATONALITY, a term loosely used to describe a concept of harmony (*q.v.*). Introduced by Arnold Schoenberg (*q.v.*) as a result of the increasing chromaticism in traditional harmony, and illustrated in his own transitional works (1908–11), atonal harmony, which he preferred to call "pantonal," eliminated the tonal centre and with it the concept of key. The 12 semitones of the diatonic scale were thus melodically and harmonically unrelated to each other. Paul Hindemith, Anton Bauer, Herbert Eimert and Darius Milhaud also adopted this principle. Schoenberg soon abandoned atonality for the 12-note system, though atonal works continued to be written by other composers.

See H. Eimert, *Atonale Musiklehre* (1924).

ATONEMENT, one of the perennial themes in the history of religion and of theology. Rituals of expiation and satisfaction appear in most religions, whether primitive or developed, as means by which the religious person re-establishes or strengthens his relation to the Holy. Atonement is often attached to sacrifice (*q.v.*) and, like sacrifice, tends to connect ritual cleanness with moral purity and religious acceptability. In Christian theology the term "atonement," as an early translation of "reconciliation" in II Cor. v, 18–19, has been a favourite way of speaking about the saving significance attributed to the death of Jesus Christ on the cross. Various theories of the atonement have arisen: satisfaction for the sins of the world; redemption from the devil or from the wrath of God; a saving example of true suffering love; the prime illustration of divine mercy; a divine victory over the forces of evil. One or another of these images has tended to predominate in the system of a theologian, but most theologians and most eras in the history of the Christian church have usually spoken of the work of Christ in many different metaphors rather than in only one. Christian theories of atonement are discussed at greater length in the article JESUS CHRIST.

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ATONEMENT, DAY OF: *see* JEWISH HOLIDAYS.

ATRATO, a river of western Colombia, South America, rising on the slopes of the western cordilleras, in latitude 5° 36′ N. and flowing almost due north to the Gulf of Urabá, or Darién, where it forms a large delta. Its length is 416 mi., but because of the heavy rainfall of this region it discharges no less than 175,000 cu.ft. of water per second, together with a very large quantity of sediment, which is rapidly filling the gulf. The river is navigable to Quibdó (250 mi.). The Atrato at one time was considered as a feasible route for a transisthmian canal. (Js. J. P.)

ATREK (Persian RUD-E ATRAK), a river which rises in latitude 37° 10′ N., longitude 59° E. in the Kuran Dagh, a mountain range in the northeastern part of the Iranian province of Khurasan. It flows westward, forming for a part of its course the international boundary between Iran and the Turkmen Soviet Socialist Republic U.S.S.R. It is 311 mi. long. It empties into the southeastern corner of the Caspian sea, its mouth being on the Soviet side of the frontier near the Iranian port of Bandar Shah. It is used for irrigation and, like other rivers flowing into the Caspian, its lower course is a spawning ground for sturgeon, a source of caviar. (D. D. Cr.)

ATREUS, in Greek legend, son of Pelops and Hippodamia, elder brother of Thyestes and king of Mycenae. The story of this family—"the house of Atreus"—is virtually unrivaled in antiquity for complexity and corruption. After their father was cursed by Myrtilus (*see* PELOPS), the brothers began their bloody course with the murder of their stepbrother, Chrysippus. The favourite of his father (and born of a nymph, not of Hippodamia), Chrysippus apparently was to inherit the kingship. Atreus

Thyestes and Alcathous (*q.v.*), conspiring with their mother against him, threw him into a well where he drowned.

The brothers were compelled to flee their native city of Pisa, Alcathous to Megara, the others to Mycenae, where Atreus became king on the death of Eurystheus. But Thyestes either contested Atreus' right to rule (in some versions by stealing the golden sheep that was the symbol of kingship), or seduced Atreus' wife, Aërope; in consequence he was driven from Mycenae. To avenge himself, Thyestes sent Pleisthenes (Atreus' son, whom Thyestes had brought up as his own) to kill Atreus, but the boy was himself slain, unrecognized by his father.

Later, when Atreus had learned the truth, he recalled Thyestes to Mycenae, in apparent reconciliation, and feasted him on the flesh of his son (or sons), whom Atreus had slain in vengeance for the death of Pleisthenes. Thyestes fled in horror, coming to Sicyon, where he impregnated his own daughter, Pelopia, in the hope of raising one more son to avenge himself. Atreus subsequently married Pelopia, without knowing who she was or that she was pregnant; she bore Aegisthus, the son of Thyestes but believed by Atreus to be his own.

Still later, Thyestes was found by Agamemnon and Menelaus (sons of Atreus and Aërope) and imprisoned at Mycenae. Aegisthus being sent to murder Thyestes, mutual recognition took place via the sword that Pelopia had taken from her father and given to her son. Father and son slew Atreus, seized the throne and drove Agamemnon and Menelaus out of the country (for their further adventures *see* the respective articles).

The artificial complexity of the myth is clear from the thematic repetition of incidents in the two branches of the family: just as

HOUSE OF ATREUS

nymph = Pelops = Hippodamia

Chrysippus Aërope = ATREUS = Pelopia Thyestes Alcathous

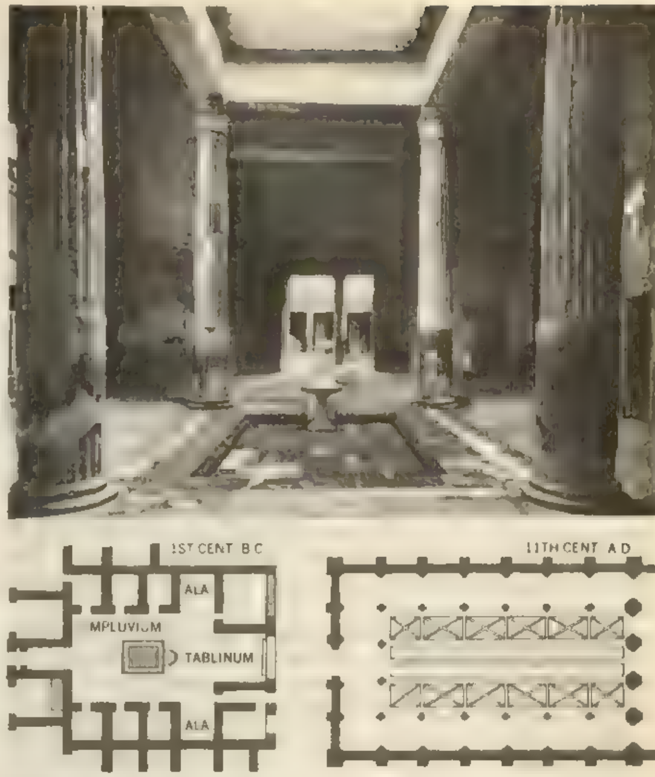
Pleisthenes Helen = Menelaus son(s) Pelopia Aegisthus
Clytemnestra = Agamemnon

Aegisthus was born of his father and sister, so Agamemnon was said to have been the son of Aërope and his own brother Pleisthenes. The attempted murder of Atreus by his son Pleisthenes, depending from the lack of recognition between the two, is mirrored in the attempt by Aegisthus unknowingly against his father Thyestes. Similarly, the same kind of incident repeats itself in time, the repeated corruption in the family being a feature that particularly attracted Aeschylus to the myth (*Oresteia*): as Thyestes seduced Aërope, so his son Aegisthus seduced Clytemnestra. As Atreus was slain for the possession of the throne of Mycenae by Thyestes, so Agamemnon was slain by Aegisthus (in Homer) for the same reason. (T. V. B.)

ATRI, a city of central Italy, region of Abruzzi e Molise, province of Teramo, stands on a hill, 1,450 ft. above sea level, overlooking the Adriatic (7.5 mi. [12 km.] away) on one side and the Gran Sasso on the other. Pop. (1961) 12,469 (commune). The 13th-century cathedral has a Romanesque façade, a series of frescoes by Andrea Delitio (15th century) and archives including illuminated manuscripts, three of which were printed in Mainz in 1495. The palace of the dukes of Acquaviva (15th century) stands on the main street. The main industries are agricultural and include wine, olive oil, grain, cattle, cheese and eggs, flour, macaroni and terra cotta.

Hatria, later Hadria, was a pre-Roman city. After becoming a Roman colony, it issued its own coins and became famous for its pottery. The family of the emperor Hadrian came from Hadria. In the middle ages it passed from the popes to the Swabians and then to the Angevins until, in 1393, it became the feudal estate of the Acquaviva family, whose descendants bear the title of dukes of Atri. In 1860 it became part of the kingdom of Italy and in World War II it was captured by the Allies in June 1944.

(M. T. A. N.)



(TOP) ALINARI (BOTTOM) BY COURTESY OF MAU, "POMPEII, ITS LIFE AND ART" (MACMILLAN); DARTEIN "ÉTUDE SUR L'ARCHITECTURE LOMBARDE" (DUNOD)

TOP: ATRIUM OF THE "HOUSE OF THE SILVER WEDDING," POMPEII. BOTTOM. FLOOR PLANS OF ATRIA. (LEFT) HOUSE OF PANSA, POMPEII; (RIGHT) CHURCH OF SAN AMBROGIO, MILAN

ATRIUM originally may have been the central room of a Roman house in which was placed the hearth. Since this room had a hole in the roof to let out the smoke, the atrium was in essence a small court. When with the developing complexity of the Roman house the kitchen and hearth were removed to other positions the atrium remained as a court serving as a formal reception room and as the official centre of family life. By the end of the republic the addition of one or more colonnaded courts in the larger houses removed from the atrium the last vestiges of family life, and in the empire it became practically the office of the owner of the house. The atrium might be either with or without columns; it had, universally, a marble basin which was known as the impluvium. This was situated in the centre under the opening in the roof called the compluvium.

The term atrium is used in a generic sense (like the English "hall") for both consecrated and unconsecrated buildings such as the Atrium Vestae, where the vestal virgins lived, and the Atrium Libertatis, the residence of the censor, where Asinius Pollio established the first public library at Rome. The word atrium, in Rome, had a second signification, being given to any open court with porticoes around, sometimes placed in front of a temple. A similar arrangement was adopted by the early Christians with relation to the basilica, in front of which there was an open court surrounded by colonnades or arcades.

The church of San Clemente at Rome, that of San Ambrogio at Milan and the cathedral of Parenzo in Istria still retain their atria.

In medical science the term atrium is applied to the two upper chambers of the heart and also to certain other "halls" or "chambers" in the body. (T. F. H.; X.)

ATROPATENE (MEDIA ATROPATENE), anciently the district now occupied by the Azerbaijan Soviet Socialist Republic, U.S.S.R., and the Iranian provinces of East and West Azerbaijan. It formed part of the ancient Persian empire and that of Alexander, but, in the confusion after his death, secured for some time the rank of an independent state. *See* PARTHIA; PERSIAN HISTORY.

ATROPHY, in medical terminology, implies a shrinkage of

a cell, tissue or organ, either localized or spread throughout the body. Causes and effects of atrophy vary according to the structures involved and the nature of the condition. For example, muscles may atrophy because of disuse, because of paralysis or immobilization as in rheumatoid arthritis or because of degeneration of motor neurons in the spinal cord or brain as in amyotrophic lateral sclerosis (*q.v.*). Other parts of the body that may atrophy for a variety of reasons include the bones (interstitial atrophy), nerves (atrophy of the optic nerve), the tissues supporting the teeth (periodontal atrophy), either side of the face (facial hemiatrophy), the liver (acute yellow atrophy of the liver) and the skin, in certain areas of which there may be chronic localized atrophy.

ATROPINE, a poisonous, crystalline alkaloid used in medicine.

Uses.—The therapeutic uses of atropine are based for the most part on its peripheral actions. Its chief use is in ophthalmology, where it is applied locally to the eye to dilate the pupil in the examination of the retina or to break up or prevent adhesions between the lens and the iris. It was formerly used in bronchial asthma to relax the bronchial spasms, but it was largely replaced by epinephrine and other measures. It gives symptomatic relief in hay fever and head colds only by drying up the nasal and lachrymal secretions.

Since atropine relaxes intestinal spasms due to parasympathetic stimulation it is prescribed in certain types of bowel distress and is included in a number of proprietary cathartics in order to decrease griping. It is used in the treatment of childhood bedwetting and is occasionally employed to relieve ureteral and biliary spasms.

Atropine is no longer used as a respiratory stimulant, though the belladonna alkaloids, because of their central actions, have been found to give relief in certain central nervous system diseases.

The ubiquitousness of the effects of atropine is a distinct disadvantage in its clinical use, and a number of synthetic substitutes with more specific effects were introduced. Thus, homatropine has a more transient action in the eye and has little or no effect on the central nervous system, while trasentine and syntropan have the antispasmodic action of atropine without producing dilation of the pupil, dryness of the mouth or an increase in heart rate.

Pharmacology.—Atropine has a central effect, at first stimulating and later depressing the central nervous system. Its characteristic pharmacological action, however, is a depressant effect on the parasympathetic nervous system. According to the chemical theory of the transmission of nerve impulses, acetylcholine is liberated at the nerve endings of the parasympathetic fibres by impulses traveling down the nerve and in some way stimulates the effector cell.

Atropine does not interfere with the formation of acetylcholine at the nerve ending but apparently prevents it from acting on the receptor cell. Atropine also inhibits the secretory nerves of the human sweat glands, which anatomically belong to the sympathetic nervous system but which liberate acetylcholine rather than sympathin at their terminals. Acetylcholine is also liberated at the ganglionic synapses of both sympathetic and parasympathetic nerves. However atropine, except possibly in very large doses, does not interfere with the transmission of impulses at these points.

Specific effects of atropine resulting from its peripheral action include the arrest of secretion of sweat, mucus and saliva; inhibition of the vagus leading to an increased heart rate; dilation of the pupil and paralysis of accommodation; relaxation of the bronchial, intestinal and other smooth muscles. Central effects include excitement and delirium followed by depression and medullary paralysis.

Toxicology.—The symptoms of atropine poisoning have been succinctly summarized as follows: "Hot as a hare, blind as a bat, dry as a bone, red as a beet and mad as a hen." The temperature rises because of inhibition of sweating and restlessness; the pupils are widely dilated and the vision blurred; the skin is hot, dry and flushed, and a rash may appear, suggesting scarlet fever; the patient is excited and confused, hallucinations are common and the behaviour is frequently suggestive of delirium tremens. Treatment consists of gastric lavage if the poison was taken by mouth. Morphine may be given cautiously to control convulsions, while the peripheral symptoms may be treated with pilocarpine. Depression should be combated with caffeine or other stimulants. Artificial respiration may be necessary.

Chemistry.—Atropine ($CH_3.N.C_6H_{10}.CH.O.CO.CH[C_6H_5]CH_2OH$) does not occur in appreciable amounts in nature, but is derived from levohyoscyamine (*see* HYOSCYAMINE), found in various solanaceous plants (*see* SOLANACEAE), as belladonna (*Atropa*), henbane (*Hyoscyamus*), thorn apple (*Datura*) and *Scopolia*. Pure atropine crystallizes from alcohol, on addition of water, in colourless prisms, which melt at 114°–116° C. It is readily soluble in alcohol or chloroform, less so in ether, and almost insoluble in water. When atropine was first prepared in 1833 the processes in use for the extraction of alkaloids were too crude to avoid racemization of levohyoscyamine, and so the racemic isomeride, atropine, was obtained, and partially racemic mixtures were later mistaken for new alkaloids, of which "daturine," "duboisine," etc., are examples.

Atropine is made by racemization, with small quantities of alkali, of crude *l*-hyoscyamine, the best source of which is Egyptian henbane (*Hyoscyamus muticus*). The alkaloid may be extracted by the process described in the article ALKALOIDS, and is generally purified after racemization by conversion into, and recrystallization of, the neutral oxalate. Atropine forms a series of well-crystallized salts, of which the sulfate is that principally used in medicine. This salt crystallizes in long, slender, colourless needles (which break up on exposure to air to a crystalline powder) and melts at 194° C.

Both atropine and hyoscyamine have been synthesized and are known to be, respectively, the racemic and levotropic esters of tropine, and many attempts have been made to improve on them. The most successful attempt of this kind is homatropine, which is a phenylglycollic ester of tropine. *See* HYOSCYAMINE; TROPINE; *see* also Index references under "Atropine" in the Index volume.

(F. O. K.)

ATROPOS, in Greek mythology, one of the three Fates, the others being Clotho and Lachesis. Atropos' name ("unalterable" or "inflexible") indicates her function, that of rendering the decisions of her sisters irreversible or immutable. Atropos is most frequently represented with scales, a sundial or a cutting instrument, the "abhorred shears" with which she "slits the thin-spun life." *See* FATE.

ATTACHMENT, in law, a writ issuing from a court of law to seize the person or property of a defendant. In several of the older states in the U.S., attachments against property readily issue at the commencement of suits to secure any judgment which may be entered for the plaintiff. In other states, attachments before judgment issue only against the property of nonresidents or upon specific statutory grounds relating to fraud or the like. The plaintiff is commonly required to post an indemnity bond. Attachment may also issue after judgment, the term being frequently used to designate a levy upon a bank account or other intangible right of the debtor against a third party. *See* DEBTOR AND CREDITOR LAW; PRACTICE AND PROCEDURE.

(J. A. MacL.)

ATTAIGNANT, PIERRE (*c.* 1480–*c.* 1550), early Parisian music printer and publisher who was among the first to use single-impression printing. He is first mentioned in 1515. Before 1527, he took over the movable music-type of Pierre Haultin, first using it in his *Chansons nouvelles* . . . (1528). There followed an ambitious series of publications. In 1538 he was music printer and bookseller to the king. After 1549 he disappeared from public life and died before July 1553. Attaignant's prints comprise more than 30 masses, more than 300 motets, *Magnificat*, psalms and Passions; more than 2,000 *chansons*; 5 dance collections; 1[illegible] volumes for organ and 2 for lute. More than 150 composers are represented, including Josquin des Prés, Pierre de la Rue, Jean Mouton, Nicolas Gombert, Clement Janequin, Claude de Sermisy, J. Arcadelt, A. Willaert, Clément and Claude Le Jeune. His surviving publications are a mine of information for early 16th-century music.

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ATTAINDER, in English common law, refers to the extinction of civil and political rights resulting from the imposition of a sentence of death or outlawry after conviction of treason or a felony. Among the important consequences of attainder were forfeiture and corruption of blood. For treason the offender's lands were forfeited to the king. For felony they were forfeited to the king for only a year and a day and then escheated to the lord from whom the offender held his tenure, a consequence traceable to the early concept of felony as a breach of the feudal bond. The contest between king and lords for these valuable rights produced the clause of Magna Carta in which the crown renounced any claim to forfeiture on the ground of felony and contributed to the definition of high treason by statute in the reign of Edward III. Forfeiture and escheat related back to the date of the crime and ignored intermediate sales and encumbrances made by the offender. Even harsher to innocent parties was the doctrine of corruption of blood, by which the person attainted was disqualified from inheriting or transmitting property and his descendants were forever barred from any inheritance of the title which had to be traced through him. Thus if A owned land and his son, B, committed treason and was attainted, and A thereafter died, the land would escheat to A's lord even though B left a son, C, who would otherwise have inherited it. The Inheritance act of 1833 (3, 4 Wm. IV, c. 106, s. 10) abolished this doctrine. Escheat and forfeiture for felony or treason were abolished in 1870, except that forfeiture as a consequence of outlawry upon an indictment for treason was preserved (33, 34 Vic., c. 23, s. 1). The constitution of the United States provides that "Congress shall have power to declare the Punishment of Treason, but no Attainder of Treason shall work Corruption of Blood, or Forfeiture except during the Life of the Person attainted" (art. iii, sec. 3). The punishment declared by congress is death, or a minimum of five years' imprisonment and $10,000 fine plus disability from holding any office under the United States. U.S. code, title 18, sec. 2381.

A legislative act for attainting a person without a judicial trial was known as a bill of attainder (or, where punishment less than death was inflicted, as a bill of pains and penalties). The power of parliament to declare guilt and impose punishment by such measures was well established by the 15th century. During the Wars of the Roses bills of attainder were used by the rival factions to rid themselves of each other's leaders and Henry VIII induced a subservient parliament to pass such bills against ministers whom he had ceased to trust. When impeachments (*q.v.*) were revived under James I and Charles I as a method for ousting ministers unpopular with parliament, bills of attainder sometimes proved a more expeditious means to the same end, as in the famous case of the earl of Strafford who was attainted and beheaded in 1641. Unlike impeachment, a judicial proceeding in the house of lords on charges made by the house of commons, a bill of attainder was a legislative act adopted by both houses with the formal assent of the king. The offenses charged in such bills were usually characterized as treason but did not have to satisfy established legal definitions of that or any other crime. Thus bills of attainder have generally been deplored not only because they deprived the accused of a fair trial but also because of their typically ex post facto quality, making new crimes of conduct which had proved politically offensive to the dominant faction of the legislature. In England the last bill of attainder in the strict sense was that against Lord Edward Fitzgerald, who was condemned to death by act of parliament for leading the 1798 rebellion in Ireland. The last bill of pains and penalties, introduced in 1820, led to a legislative trial of Queen Caroline, George IV's wife, on charges of adultery but was not passed. Acts of attainder or of pains and penalties were passed by some of the American colonial legislatures, a notable example being the New York act of 1779 which banished and forfeited the property of 59 named Loyalists for the offense of having "voluntarily been adherent" to King George III.

The constitution of the United States forbids both congress and the states to pass any bill of attainder or, by accepted interpretation, any bill of pains and penalties (art. i, sec. 9, 10). In applying these prohibitions the supreme court has expanded the historical conception of such bills. Thus it invoked these clauses to strike down test oaths passed after the Civil War to disqualify Confederate sympathizers from practising certain professions (*Cummings* v. *Missouri*, 4 Wall. 277 [1867]; *Ex parte Garland*, 4 Wall. 33 [1867]). Similarly, it invalidated as a bill of attainder a rider to an appropriation bill forbidding the payment of salaries to named government officials who had been accused of being subversive (*U.S.* v. *Lovett*, 328 U.S. 303 [1946]). Later decisions, however, have declined to treat requirements of loyalty oaths as bills of attainder, though sometimes invalidating such requirements on other grounds. (See *Garner* v. *Board of Public Works*, 341 U.S. 716, 730 [1951] [dissenting opinions]; *Shelton* v. *Tucker*, 364 U.S. 479 [1960]).

See also Confiscation and Expropriation; Escheat.

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ATTALID DYNASTY, a line of rulers in Pergamum during the 3rd and 2nd centuries B.C. whose devotion to Hellenism made Pergamum renowned as a leading centre of Greek civilization.

The dynasty was founded by Philetaerus (*c.* 343–263 B.C.), ruler of Pergamum after 282, who was born in the Greek city of Tios, on the Black sea, of a Greek (or Macedonian) father, Attalus, and a Paphlagonian mother, Boa. He served under Antigonus I (*q.v.*) in Phrygia until 302, when he deserted to Lysimachus (*q.v.*), who shortly afterward entrusted to his keeping the fortress of Pergamum with its treasure of 9,000 talents. In 282 he transferred his allegiance to Seleucus I (*see* Seleucid Dynasty) and in return he was able to acquire a larger measure of independence than before.

The territory Philetaerus controlled was as yet quite small—no more than Pergamum and its environs—and it was largely of necessity that he curried favour with the first Seleucid kings and the Greek cities near him; his gifts to the temples at Delphi and on the island of Delos helped his family to obtain some prestige farther afield. When, after the death of Seleucus I in 280, the Seleucid grip on Asia Minor slackened, he found a chance to increase the area under his control (probably so far as to embrace the whole of Mysia); and before his death in 263 he had abandoned the Seleucids and formed a tie with Egypt.

His successors, Eumenes I, Attalus I and Eumenes II (*see* Eumenes; Attalus), carried forward the work of expansion and consolidation, although Attalus I and Eumenes II lost ground to Antiochus III (*see* Antiochus). Finally, as a result of alliance with Rome and untiring diplomatic intrigue, the ambitions of the Attalid kings were realized to the full in the treaty of Apamea (188) between Rome and Antiochus III, under the terms of which the greater part of Seleucid Asia Minor was assigned to them. The last three kings, Eumenes II, Attalus II and Attalus III, were in consequence able to play a leading part in the political life of the Hellenistic world, even though their subservience to Rome made them unpopular and circumscribed their independence.

The history of the dynasty falls into two parts: before and after the assumption of the royal title by Attalus I. It is to the second half of the latter period that most of the available evidence relates. The first two rulers had been no more than local dynasts of a type then common in Asia Minor; the kingdom, by contrast,

had a much greater political significance. In its institutions it resembled the other Hellenistic monarchies: ruler worship was practised; royal officials were graded in order of importance. One difference from the Ptolemies and Seleucids was that the Attalids lived in a more modest style and were in spirit more Greek than Macedonian; nevertheless, the power of the king was absolute throughout the kingdom. The Greek cities within the kingdom were nominally autonomous bodies, but the king was ready to intervene in their affairs. Thus, at Pergamum the usual city institutions (council, assembly, etc.) were in being, but the administration lay with a board of five generals who were not elected by the citizens but nominated by the king. The king could exercise control even more directly by royal decrees, which were observed within the city as equivalent to laws. The degree of his control over other cities varied. The ancient city-state of Aegina in the Saronic gulf was ruled by a royal governor (*epistates*) and was entirely subject to royal decrees; and after the treaty of Apamea several places paid tribute as subjects to the Attalids (they included Byzantium, Lysimachia and Sestos around the Hellespont; Phocaea, Teos, Ephesus and Sardis in western Asia Minor). But many cities, recognized as autonomous by Rome, were merely attached to the kingdom as free allies, and to these the kings behaved with a benevolence and restraint in striking contrast with their attitude to the other class of city.

The provinces of the kingdom were governed by generals (though they were not, perhaps, officially called such) after the manner of the Seleucid empire. Few new Greek foundations can be attributed to the Attalids; preferably they took over existing settlements. In this and in other respects they benefited greatly from the achievements of the Seleucids. Nevertheless, in many departments they demonstrated a remarkable flair for government, not least in their creation of a strong army and navy.

Their financial system as it concerned subject cities was peculiar in that, while they imposed heavy taxes and tribute, they also gave subsidies in money and kind that enabled the cities to meet the charges that otherwise would have been beyond their means. In general, a strict financial control was exercised in all parts of the Attalid kingdom. All the kings took a keen interest in their territory's economic life; the high degree of organization achieved and the successful exploitation of the country's natural riches are comparable to the Ptolemies' work in Egypt.

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ATTALUS (PRISCUS ATTALUS) (fl. early 5th century A.D.), usurping Roman emperor, was raised to the purple in 409 by Alaric (*q.v.*), who was then besieging Rome. Hitherto a pagan, Attalus was baptized into the Arian Church by a Gothic bishop, but refused to be Alaric's puppet. After appointing Alaric to a high military office, he forbade the Goths to send forces to seize Africa. Attalus failed to depose the legitimate emperor Honorius, in whose interests the count Heraclian, who was holding Africa, stopped the transport of grain from Africa to Italy. Despite the resulting famine in Rome, Attalus again refused to allow Alaric to send an army to Africa. Alaric consequently deposed the emperor whom he had himself elevated (summer 410). Raised to the throne again in 414 by Ataulphus, Alaric's successor, who was then in Gaul, he was deserted by the Goths and fell into the hands of Honorius, who exiled him to Lipara. (E. A. T.)

ATTALUS, the name of three kings of the Attalid dynasty of Pergamum in the 3rd and 2nd centuries B.C.

ATTALUS I SOTER (269–197 B.C.), ruler of Pergamum from 241 to 197 and king from *c.* 230, succeeded his uncle Eumenes I. His mother was Antiochis, a Seleucid princess. Shortly before 230 he was attacked by the Galatians (Celts who had settled in central Asia Minor in the 3rd century B.C.), having refused to pay them the customary tribute. He completely defeated them outside the walls of Pergamum, whereupon, to mark the occasion, he took the title of king, the first of the Attalids to do so. Subsequently he defeated Antiochus Hierax (*see* ANTIOCHUS) in three battles, as a result of which he gained a brief control over all the Seleucid domains in Asia Minor apart from Cilicia (228–223). He built a fleet, bought the island of Aegina in the Saronic gulf from the Aetolians and fought alongside Rome and the Aetolians against Philip V of Macedonia (212–204). In 201 he took the side of the Rhodians in their war with Philip, and, with them, brought about by diplomatic approaches in Rome a new Roman intervention against Macedonia.

ATTALUS II PHILADELPHUS (220–138 B.C.), king of Pergamum from 160 or 159, was the second son of Attalus I and brother of Eumenes II, whom he succeeded. Before his accession he had played a prominent part in public life as the devoted aide of his brother; he commanded the Pergamene forces attached to the Romans in their campaigns in Galatia (189) and Greece (171); he visited Rome frequently as an ambassador and enjoyed great influence there. Even when Eumenes II lost the Romans' favour after 168, Attalus retained his reputation in Rome, and it was widely believed that the Romans wanted him to dispossess his brother. This he was unwilling to do.

As king Attalus maintained the former close link with Rome. with the connivance of the Romans he aided the pretender Alexander Balas (*q.v.*) against the Seleucid king Demetrius I; and with their help he held his own against Prusias II, the aggressive king of Bithynia.

ATTALUS III PHILOMETOR EUERGETES (d. 133 B.C.), king of Pergamum from 138 to 133 B.C., a son of Eumenes II and nephew of Attalus II. Little is known of his reign. He is said to have behaved tyrannically at first but later to have lived a quiet and studious life. When he died it was found that his will bequeathed the kingdom to Rome (*see* ASIA, ROMAN PROVINCE OF). His motives in making this bequest are obscure. *See* ATTALID DYNASTY. (R. H. SI.)

ATTAR: *see* FARID UD-DIN 'ATTAR.

ATTAR OF ROSES, otherwise known as "otto of rose," is an essential oil distilled mainly from the pink damask rose *Rosa damascena*. By far the major source is Bulgaria, where the growing of roses in the humid valleys and the subsequent distillation have become an important, highly modernized state enterprise. Some attar is also produced commercially in Turkish Anatolia. It takes about 250 lb. of roses to produce a single ounce of the expensive, richly perfumed attar. In the south of France and in Morocco, other types of rose oil are obtained, partly by distilling but principally by the solvent extraction of centifolia roses (*R. centifolia*). Rose water is a by-product of distillation. Rose oils are invaluable ingredients of fine perfumes and liqueurs. (F. V. Ws.)

ATTAWAPISKAT, a river of northern Ontario, Can., issuing from Attawapiskat lake (elevation 815 ft.) midway between Lake Superior and Hudson bay and flows in an easterly direction to James bay, having its mouth west of Akimiski Island. For most of its 465 mi. (including headwaters) the river is sluggish, alternating with short, swift and rapid stretches which do not make portages necessary. The lower 135 mi. is full of islands and leads through almost level, swampy country. Timber decreases down river. Lansdowne House on Attawapiskat lake and Attawapiskat at its mouth are trading posts. (AN. KR.

ATTENTION, as typically used in spoken or written communication, means the selective process by which certain events in the environment come to be consciously perceived. That of which a person is clearly aware at a given instant is said to be attended to. For example, while conversing with a friend, I pay attention to the words he is speaking and ignore the voices of others around me. I attend to the picture on the television screen and fail to notice persons that enter or leave the room. I listen attentively to the melody played by the violin and have only a vague awareness of the background provided by other instruments of the orchestra. The scientist interested in discovering systematic relationships between environmental events and sensory experience has found that he also has to take into account this selective process which is called attention.

In the early days of experimental psychology, investigators attempted to break down conscious experience into its elements. The method used was that of introspection under carefully controlled conditions. A number of attributes or discriminable di-

mensions of sensory experience were agreed upon by most investigators; these included intensity, quality, duration and spatiality. But it became evident that sensory experiences could not be completely described in terms of these characteristics; a fifth attribute, clearness or attensity, had to be added. A visual object, for example, not only could vary in such characteristics as its brightness, its colour, the length of time it was present and its size, but it also could occupy the centre of consciousness to a greater or lesser extent—it could be clearly perceived or be in the periphery of awareness. The process which had to do with controlling this aspect of sensory experience was called attention.

As the science of experimental psychology developed, psychologists ceased to be concerned with the introspective analysis of sensory experience. Instead, experiments dealing with sensation and perception usually fell into one of three classes: (1) psychophysical experiments in which a physical stimulus was systematically varied and the responses (verbal or nonverbal) of a living organism (man or lower animal) were observed and measured; (2) physiological experiments in which again a physical stimulus was varied but a physiological event such as discharge of nerve impulses or change in blood pressure was measured; or (3) a psychophysiological experiment in which physiological events were manipulated (*e.g.*, by administration of drugs or by damage to the central nervous system) and behaviour of the organism measured.

Psychophysical Studies.—Numerous psychophysical experiments (*see* PSYCHOPHYSICAL METHODS) have been done in which factors which influence or control attention have been examined. It has been shown, for example, that the direction of attention is determined by such characteristics of a stimulus object as its size, intensity, duration, novelty and relation to other stimulus objects in the environment. That object which is attended to is also determined by subjective factors; *i.e.*, characteristics of the person who is attending. His sensory capacities, interests, needs, past experiences and level of alertness or wakefulness are all factors which may be important in determining the direction of attention at any given time.

In other experiments, attempts have been made to answer such questions as: How long can attention be maintained on one particular stimulus object? What conditions influence fluctuation or shifting of attention? Can two or more objects be attended to at one time? Simple answers cannot be given to these questions because there are numerous conditions which affect the experimental results obtained. In several experiments, however, it has been found that attention to one object can be maintained for about five to ten seconds. Tests have been made with objects seen, heard and felt. Fluctuations of attention may be due to adaptation of the sense organs, to slight movements of the sense organs (particularly in the case of vision) or to slight changes in the stimulus conditions. Most experimental evidence indicates that two objects cannot be attended to at one time. Rapid shifting of attention makes it possible for a person to carry on two tasks simultaneously; *e.g.*, adding a column of numbers and listening to a story which later must be recalled.

Physiological Studies.—From studies of electroencephalograms, which record the electrical activity of the brain by means of electrodes placed on the skull or directly on the brain, it is known that a change in the pattern of recorded activity occurs if a light or sound is presented to a resting, relaxed subject. The brain wave pattern changes from one of slow waves of high amplitude to one of fast waves of relatively low amplitude. This change is referred to as activation of the EEG, or arousal response. It seems to be related closely to the degree of general alertness or attentiveness of the subject whose electroencephalogram is being recorded.

Experiments done on animals have shown that a similar arousal response or activation of the EEG may be produced by electrical stimulation of the brain stem reticular formation. This consists of a complex of nuclei extending along the core of the brain stem from the level of the medulla to the thalamus. Boundaries and subdivisions of individual nuclei within the total complex are not well known. Whereas stimulation of the brain stem reticular formation produces the EEG activation response, surgical removal of the anterior portion in an experimental animal produces somnolence or, if the damage is extensive, a comatose state. These and other kinds of evidence suggest that the brain stem reticular formation plays an important role in the maintenance and control of attention, alertness and consciousness.

Closely related functionally to the brain stem reticular formation is a group of thalamic nuclei referred to as the unspecific thalamocortical projection nuclei. While the anatomical connections between these thalamic nerve centres and the reticular formation are not known clearly, evidence from electrophysiological studies indicates that the unspecific thalamic nuclei as well as the brain stem reticular formation project diffusely to the cerebral cortex. Also, like the reticular formation, the unspecific projection nuclei of the thalamus appear to play an important role in the control of attention. Experimental evidence suggests that the reticular formation is important in the control of the general state of alertness or wakefulness and that the unspecific thalamic nuclei may be concerned in such processes as directing and shifting of attention.

While recognizing that the brain stem reticular formation and unspecific thalamocortical projection system play highly critical roles in the control of consciousness and of attention, the fundamental importance of the main pathways from sense organs such as the eye and ear to the cerebral cortex should not be overlooked. It is in the pathways and centres of the primary sensory systems that the information coming from the sense organs is processed for use in guiding or controlling behaviour. For an understanding of the neurophysiological processes underlying attention, knowledge of the patterns of interaction between the reticular formation and unspecific thalamocortical projection system on the one hand and the primary sensory systems on the other is essential. Furthermore, it is necessary to clarify the neuroanatomical and neurophysiological relationships of these systems with those parts of the brain which have to do especially with the processes of emotion and motivation.

Psychophysiological Studies.—In laboratory experiments, the behaviour of animals is often tested before and after removal of parts of the brain or transection of neural pathways. In the clinic, operations are made on human patients after damage to the central nervous system, the damage being done by accident, disease or neurosurgical procedures designed to alleviate conditions produced by accident or disease.

As noted above, damage to the brain stem reticular formation of an experimental animal can produce a somnolent or comatose state depending on the locus and extent of the damage. In some cases, the animal may sleep except when aroused by strong sensory stimulation and will quickly return to sleep when stimulation ceases. With more severe damage, arousal becomes impossible.

In both experimental studies of animals and clinical studies of man, cases have been described in which deficiencies in ability to attend have resulted from damage to the cerebral cortex. It has been shown, for example, that after surgical removal of the auditory projection areas of the cerebral cortex an experimental animal can still respond to very weak sounds and can discriminate small differences in the frequency or intensity of sounds; in discriminations which require that activity for a short period of time be guided by a sound cue or that a series of cues be utilized, however, the animal may behave in such fashion as to suggest that it is deficient in ability to maintain attention. Similarly a patient with damage to the cortical area which has to do with the sensation of touch in the left hand may be able to respond to light touch of that hand, but he may fail to recognize or even be aware of an object placed in the left hand if at the same time a second object is placed in the right hand, the latter being unaffected by the cortical damage. If, however, the object in the right hand is removed, that in the left hand may then be felt and recognized. This and similar phenomena which have been noted in the clinic may be described as deficits in ability to attend. *See* also PERCEPTION; PSYCHOLOGY, EXPERIMENTAL.

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ATTERBOM, PER DANIEL AMADEUS (1790–1855), the first in the line of Sweden's great romantic writers. The son of a clergyman in Östergötland, he was born on Jan. 19, 1790, at Åsbo. At 15 he went to Uppsala and there, with some friends, founded in 1807 the society Musis Amici, rechristened the following year Auroraförbundet. Its publication, *Phosphoros* (1810–13), together with the organ of the Stockholm romantics, *Polyfem* (1809–12), initiated the literary revolution in Sweden. Atterbom contributed to both, in the former as the leading poet and essayist of "the new school," in the latter as an acid polemical writer in the battle against the "old" pseudoclassical school. A distinctive feature of *Phosphoros*, as of Atterbom himself, is an adhesion to Schelling's nature philosophy and aesthetics. This led to the Uppsala romantics' early rejection of extreme German romanticism in favour of the classicism of Goethe and Schiller. Atterbom also contributed industriously to *Poetisk kalender* (1812–22), which was modeled on the German poetic calendars, and to *Svensk literaturtidning* (1823–24), which became a leading Swedish periodical of literary criticism.

Atterbom is famed as the poet of *Blommorna* ("The Flowers"; 1812–37). In his first poems about flowers he shows how nature's cycle, from budding vernal life to autumnal decay and death, teaches that the changes in human life and in civilization also point to an eternal existence beyond death and annihilation. In the unfinished fairy play *Fågel blå* ("The Blue Bird") similar thoughts are to be found. The writer's greatest poetic work, the fairy play *Lycksalighetens ö* ("The Isle of Bliss"; 1824–27), treats the story of King Astolf, who leaves his northern kingdom for the temptations of sensual beauty beyond duty and calling—a symbolical representation of the beguiling power of imagination in the history of poetry.

At his death Atterbom was working on his great *Svenska siare och skalder* ("Swedish Prophets and Poets"), in seven volumes, where he does justice to the writings which, with the recklessness of youth, he had earlier attacked. The style and erudition of this work give him the rank of Sweden's first great literary historian. He died at Stockholm on July 21, 1855.

Atterbom's complete works were published in 13 vol. (1854–70). A selection was published in 6 vol., *Valda Skrifter* (1927–29).

See C. Santesson, *Mot Lycksalighetens ö. Atterbomstudier* (1956); H. Frykenstedt, *Atterboms livs och värlolsåskådning* (1951). (H. E. U. F.)

ATTERBURY, FRANCIS (1663–1732), English bishop, was a zealous participant in many of the literary, political and ecclesiastical controversies of his time. He was born at Milton, Buckinghamshire, where his father was rector, on March 6, 1663, and was educated at Westminster school and at Christ Church, Oxford. He became a tutor of his college and a close associate of the dean, Henry Aldrich, a leader of Oxford Toryism after 1688. Through this connection Atterbury became involved in Charles Boyle's unmannerly attack upon Richard Bentley, himself writing (1698) much of Boyle's defense of the authenticity of the *Epistles of Phalaris*.

Atterbury took holy orders in 1687. After his appointment as lecturer at St. Bride's Fleet street in 1691, and as preacher at Bridewell hospital in 1693, an increasing number of engagements, including sermons at court, caused him to spend much of his time in London. A fanatical supporter of the high church party, he led the agitation for the revival of convocation, which had not assembled since 1664. As a result of his campaign, sessions were renewed in 1701, and the bishop of Exeter appointed Atterbury archdeacon of Totnes, thus enabling him to be a member. He was made dean of Carlisle in 1704. His primary object achieved, he now employed his taste for controversy in vindicating the constitutional powers of the lower house of convocation and in provoking many clashes with the Erastian bishops. When Henry Sacheverell's sermons castigating the Whig ministry for their neglect of the church led to his impeachment in 1710, Atterbury helped to frame his defense. Atterbury became prolocutor of the lower house of convocation in the same year. He had gained Queen Anne's favour and in 1711 she appointed him to succeed Aldrich as dean of Christ Church. But he did not prove a good college administrator and after being consecrated bishop of Rochester in 1713, he left Oxford.

Events now diverted Atterbury's energy to politics. He was among those who had hoped to set aside the Act of Settlement and establish James (the Old Pretender) as Queen Anne's successor. However, he took the oath of allegiance to George I in 1714, but his attempts to ingratiate himself with the new court were ill-received and he drifted steadily into the Jacobite camp. On the occasion of the 1715 rebellion he refused to sign an address of loyalty; and by 1717 he was in correspondence with James. He was arrested in Aug. 1722, charged with complicity in a Jacobite plot; after nearly ten months in the Tower of London he was sentenced to deprivation and exile. He went first to Brussels and thence to Paris, where by 1725 he had become James's principal agent; but quarrels and jealousies led to his resignation two years later. He lived in retirement at Montpelier from 1728 to 1730 but then returned to Paris where he was again in James's service until his death on March 4, 1732.

Atterbury was a member of the Scriblerus club (formed *c.* 1713), and Swift, Pope and Matthew Prior were among his friends. He wrote a little verse and made some translations from classical poets; but his contribution lay in his topical polemic writings and in his role as pacemaker for his more brilliant associates.

See F. Williams, *Memoirs and Correspondence of Francis Atterbury* (1869); H. C. Beeching, *Francis Atterbury* (1909).

ATTESTATION, the execution of certain solemn documents, such as deeds and wills, in the presence of statutorily required witnesses who themselves sign the document and who must, if available, be called to identify the document in subsequent proceedings involving it or questioning its validity. *See* OATH AND AFFIDAVIT. (R. E. DE.)

ATTHIS (an adjective meaning "Attic"), the name given to a monograph or special treatise on the religious and political history, antiquities and topography of Attica and Athens. The first of the atthidographers was Hellanicus of Lesbos, who committed to writing part of the tradition about early Athens which even in his time (late 5th century B.C.) was still mainly oral. About two generations later began a succession of Athenian writers on these topics (the approximate dates of whose writings are given in parentheses): Clidemus, called Clitodemus by Pausanias (*c.* 350 B.C.); Androtion (*c.* 340 B.C.); Phanodemus (*c.* 340–330 B.C.); Melanthius (date uncertain); Demon (*c.* 300 B.C.); and Philochorus (who lived *c.* 340–262 B.C.). The work of Ister "the Callimachaean" (*i.e.*, pupil of the poet and critic Callimachus) was not a true *Atthis*. Although no written records existed in Athens from earlier than 682 B.C., and very few for about two centuries thereafter, these writers were not deterred from beginning at the beginning, and did not draw the line at mythology. Indeed they turned mythology into history, sometimes with a wealth of corroborative detail, as in the story (preserved in Plutarch's *Life of Theseus*) of a great victory on Athenian soil over the Amazons.

Not one of the *Atthides* has survived even in part, but from references and short quotations in surviving literature it seems that they differed from each other in material probably very little but quite significantly sometimes in their interpretation. Of these writers only Androtion was a professional politician, but it is no accident that Athenians wrote histories of Athens only in the age when there had developed the threat (sometimes the reality) of foreign domination. They were a kind of reply to those (*e.g.*, Isocrates) who advocated collaboration. The past of Athens, in all its variety and its moments of glory, was told and retold by writers who saw it whether as radical democrats (Clidemus) or as conservatives like Androtion and Philochorus. The works of Clidemus, Androtion and Phanodemus, their views of the past all coloured by their own political complexions of the present, were available to Aristotle (or his pupil) in writing his *Constitution of the Athenians*, in which the occasional lapses from unity may arise partly from the diversity of these sources.

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ATTIC, in architecture, any portion of wall raised above the main cornice, utilized by the Romans principally for decorative purposes, inscriptions, etc., as in triumphal arches. It was developed in the Renaissance as an important part of a façade, frequently enclosing an additional story, the windows of which were treated as part of the decoration. In modern usage the word is also employed to designate a story immediately under the roof, especially when the roof is of steep pitch.

ATTICA (Gr. ATTIKE; modern ATTIKI) a district of 1,000 sq.mi. in ancient Greece comprising part of the modern department (*nomos*) of the same name (1,470 sq.mi.). With its administrative centre at Athens (*q.v.*), the modern department extends farther westward than ancient Attica to include Megara on the Isthmus of Corinth. The ancient district was bounded by Boeotia in the north (the frontier extending from Mt. Cithaeron to Mt. Parnes), by the Euboean channel in the east, by the Aegean sea in the southeast, by the Saronic gulf in the south and by Megarian territory in the west. The name was probably derived from the peninsular (*Aktike*) character of the district, which terminates in the headland of Sunium. The southern coast has the most sheltered waters and contains the sandy beach of Phalerum, where small craft can be drawn on shore, and the deep-water inlets of the Piraeus on the west and Zea on the east of the promontory of Munychia. Thus Attica is well qualified to attract the maritime trade that enters the Saronic gulf en route for the west via the Corinthian canal or that in antiquity was conveyed by land across the neck of the Isthmus of Corinth.

The climate of Attica is particularly fine. The cold of winter and the heat of summer are both tempered by the influence of the sea. The long summer and much sunshine favour the growth of the olive, vine and fig, and the annual rainfall of 16 in. is adequate for cereals. The air is exceptionally dry and clear. The light on a summer day is brilliant, and the colours of sea, sky and land are strong and pure.

The frontier between Boeotia and Attica is formed by the eastern outliers of Mt. Cithaeron (4,623 ft.) and the range of Mt. Parnes (4,636 ft.), and the main road from Thebes to Athens crosses the limestone watershed at a height of about 2,000 ft. above Kriekouki (near the ancient Erythrae). This strategic area was contested between Boeotia and Attica in ancient times, and it is picketed by the ruined fortresses of Eleutherae and Panactum. The pass that was called Dryoscephalae or Treis Cephalae (modern Drios Kefalae) had great importance in the campaign of Plataea in 479 B.C. (*see* GRECO-PERSIAN WARS). A more direct path from Thebes to Athens crosses the western flank of Mt. Parnes by the ruined fortress of Phyle (modern Kastro). Between the eastern spurs of Mt. Parnes and the sea there is easy, low-lying country by Aphidna and Decelea (the railway enters Attica there); the territory of Oropus on the north of the gap was annexed to Attica in the 5th century, lost in 412 to Boeotia and changed hands repeatedly. The frontier between Megaris (part of the Isthmus of Corinth) and Attica was formed by the limestone masses of Mt. Pateras (3,714 ft.) and Mt. Keratos (1,542 ft.). It is crossed at the northern end by an easy pass west of Villia (probably the ancient Oenoe), and at the southern end the main road and railway from Megara to Athens follow the gap between Mt. Keratos and the sea. Thus the land frontiers were relatively easy to defend. Moreover, Attica lay just off the main route in antiquity between central Greece and the Peloponnese, which ran through Megaris by way of Ayios Vasilios and Tripodiscus (7 mi. N.W. of Megara).

Within the frontiers the chief feature is the central plain, bounded on the east by Mt. Hymettus (3,366 ft.) and Mt. Pentelikon (3,638 ft.), on the north by Mt. Parnes and on the west by Mt. Aegaleos (1,535 ft.). The plain of light fertile soil, watered by the Cephissus river, was farmed in antiquity by Athenian families that claimed to be autochthonous. The dominant feature of the plain is the city of Athens, built on the slopes of the acropolis hill and crowned by the Parthenon, the temple of the virgin goddess Athena. The city has the further advantage of proximity to the beach of Phalerum and the ports of Piraeus and Zea, which were included in its walled defenses during the 5th century B.C. West of the central plain a pass between Mt. Aegaleos and Mt. Parnes was defended in the 4th century B.C. by a wall, known as the Dema, but the direct route to the fertile Thriasian plain passed over Mt. Aegaleos along the Sacred Way to Eleusis, where Demeter was worshiped as goddess of the earth. Another Cephissus waters the Thriasian plain; it rises in Mt. Cithaeron above Villia. Passage from the central plain to the northeastern hill country is easy, and the main road runs from Decelea to Oropus on the coast. The wide gap between Mt. Pentelikon and Mt. Hymettus, where the tyrant Pisistratus defeated the Athenians in 546 B.C., contains the roads that lead northeastward to Marathon and Rhamnus and southeastward to Porto Raphti (the ancient Prasiae), Thoricus and Sunium. The Persians landed in this remote part in 490 B.C. and were defeated at Marathon.

The natural resources of Attica are varied. Mt. Parnes affords summer pasture and carries some forests of fir; the western hills especially are thickly wooded with evergreen scrub and the dwarf oak from which charcoal is made; some of the coastal hills are clad with woods of Mediterranean pine and with maquis scrub. The rolling lowlands, especially on the western side of the central plain and in eastern Attica, are rich in olive groves and vineyards. The plains yield cereals—wheat round Eleusis and barley elsewhere—and a variety of vegetables and pulse. In Neolithic times, when Attica was sparsely settled, the country was heavily wooded and wild animals included the brown bear. The poems and coins of Solon (archon 594/593 B.C.) refer to the wolf and fox and to hunting; to pasturing of sheep, mules and horses, and to the making of butter, presumably from sheep's milk; to harvesting of wheat, grapes and olives; and to fishing and seafaring. Thereafter as Attica became deforested and eroded, the population exploited the mineral resources of Laurium in southeastern Attica—silver, zinc, lead and iron—the marbles of Mt. Pentelikon and Mt. Hymettus and the fine clays from which Attic pottery was made.

Athenian tradition and archaeological discovery show that there were a number of independent settlements in Attica in early times, with centres of organization at Eleusis, Athens and Marathon. The country was unified by Theseus, who established a central government at Athens. (His lifetime fell in the 13th century B.C. if the genealogical setting provided by Homer and Thucydides is accepted.) The unification was celebrated for centuries at the *Synoikia* ("festival of union") in honour of the goddess Athena. Thereafter the history of Attica became the history of Athens.

See also Index references under "Attica" in the Index volume.

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(N. G. L. H.)

ATTICUS, TITUS POMPONIUS (109–32 B.C.), Roman *eques* ("knight"), Epicurean and patron of letters, best remembered for his connection with Cicero, with whom he was educated, was born in Rome three years earlier than his friend. His name was Titus Pomponius, that of Atticus being given him later from his long residence in Athens (88–65 B.C.) and his intimate acquaintance with Greek literature and language; he assumed the name of Quintus Caecilius Pomponianus when his rich uncle, Q. Caecilius, died in 58.

When Pomponius was still a young man his father died, and he prudently transferred himself and his fortune to Athens in order to escape the civil war, in which he might have been involved through his connection with the murdered tribune, Sulpicius Rufus. He lived quietly, devoting himself to study and business interests, especially banking and moneylending; in 68 he bought an estate in Epirus.

On his return to Rome he kept aloof from political life, attaching himself to no particular group and continuing on intimate terms with men so opposed as Caesar and Pompey, Antony and Octavian. His most intimate friend, however, was Cicero, whose correspondence with him extended over many years.

Atticus' private life was happy. He did not marry until 56 B.C.,

and his only child became the wife of Agrippa, the minister of Augustus. In 32, being incurably ill, he starved himself to death.

Of his writings none is extant, although he wrote a history, in Greek, of Cicero's consulship, a Roman history down to 54 B.C. and genealogical works. His most important work was the edition of the letters addressed to him by Cicero. He formed a large library at Athens, and engaged a staff of slaves to make copies of valuable works.

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ATTILA (d. 453), king of the Huns from 434 to 453, one of the greatest of the barbarian rulers who assailed the Roman empire, known in western Europe as the "Scourge of God," at first ruled jointly with his elder brother Bleda. The empire which they inherited from their uncle Rua seems to have stretched from the Alps and the Baltic in the west to somewhere near the Caspian sea in the east (*see* HUNS). Their first known action on becoming joint rulers was the negotiation of a peace treaty with the East Romans at the city of Margus (Pozarevac), by which the Romans undertook to double the subsidies which they had been paying to the Huns and in future to pay 700 lb. of gold each year.

From 435 to 439 the activities of Attila are unknown, but he seems to have been engaged in subduing barbarian peoples to the north or east of his dominions. The East Romans do not appear to have paid the sums stipulated in the treaty of Margus, and so in 441, when their forces were occupied in the west and on the eastern frontier, Attila launched a heavy assault on the Danubian frontier of the Roman empire. He captured and razed the important cities of Viminacium (Kostolac), Margus, Singidunum (Belgrade), Sirmium (Mitrovica) and other places. The Romans managed to arrange a truce for the year 442 and recalled their forces from the west. But in 443 Attila resumed his attack. He began by taking and destroying Ratiaria (Archar) on the Danube and then drove into the interior of the empire toward Naissus (Nish) and Serdica (Sofia), both of which he also destroyed. He next turned toward Constantinople, took Philippopolis, defeated the main Roman forces under Aspar (*q.v.*) in a succession of battles and so reached the sea both north and south of Constantinople. It was hopeless for the Hun archers to attack the great walls of the capital, so Attila turned on the remnants of the Roman forces, which had withdrawn into the peninsula of Gallipoli, and destroyed them. In the peace treaty which followed he obliged the Romans to pay the arrears of tribute, which he calculated at 6,000 lb. of gold, and he trebled the annual tribute, henceforth extorting 2,100 lb. of gold from the Romans each year.

Attila's movements after the conclusion of peace in the autumn of 443 are unknown. He murdered his brother Bleda *c.* 445 and thenceforth ruled the Huns as an autocrat. In 447, for reasons which have not been recorded, he made his second great attack on the Eastern Roman empire, but little is known of the details of the campaign. It was planned on an even bigger scale than that of 441–443, and its main weight was directed toward the provinces of Lower Scythia and Moesia; *i.e.*, farther to the east than the earlier assault. He engaged the Roman forces on the Utus (Vid) river and defeated them, killing their commander Arnegisclus, but he himself suffered serious losses. He then captured Marcianopolis, devastated the Balkan provinces and drove southward into Greece, where he was only stopped at Thermopylae. Nothing is known of the further course of this invasion. The three years following it were filled with complicated negotiations between Attila and the diplomats of Theodosius II. Much information about these diplomatic encounters has been preserved in the fragments of the *History* of Priscus of Panium, who himself visited Attila's headquarters in Walachia in company with a Roman embassy in 449. The treaty by which the war was terminated was harsher than that of 443; the Romans had to evacuate a wide belt of territory south of the Danube, and the tribute payable by them was continued though the rate is not known.

Attila's next great campaign was the invasion of Gaul in 451. Hitherto, he appears to have been on friendly terms with the Roman general Aetius (*q.v.*), the real ruler of the west at this time; and his motives for marching into Gaul have not been recorded. He announced that his objective in the west was the Visigothic kingdom centred on Tolosa (Toulouse) and that he had no quarrel with the western emperor, Valentinian III. But in the spring of 450 Honoria, the emperor's sister, sent her ring to Attila asking him to rescue her from a marriage which had been arranged for her. Attila thereupon claimed Honoria as his wife and demanded half the western empire as her dowry. He also became involved in a dispute with Aetius about the succession to the chieftainship of the Ripuarian Franks. When Attila had already entered Gaul, Aetius reached an agreement with the Visigothic king, Theodoric I, to combine their forces in resisting the Huns. Many legends surround the campaign which followed. It is certain, however, that Attila almost succeeded in occupying Aurelianum (Orléans) before the allies arrived. Indeed, the Huns had already gained a footing inside the city when Aetius and Theodoric forced them to withdraw. The decisive engagement was the battle of the Catalaunian plains (*q.v.*), or, according to some authorities, of Maurica (both places are unidentified). After fierce fighting, in which the Visigothic king was killed, Attila withdrew and shortly afterward retired from Gaul. This was his first and only defeat.

In 452 the Huns invaded Italy and sacked several cities, including Aquileia, Patavium (Padua), Verona, Brixia (Brescia), Bergamum (Bergamo) and Mediolanum (Milan); Aetius could do nothing to halt them. But the famine and pestilence which were raging in Italy in that year compelled them to leave without crossing the Apennines.

In 453 Attila was intending to attack the eastern empire, where the new emperor Marcian had refused to pay the subsidies agreed upon by his predecessor Theodosius II. But during the night following his marriage to a girl named Ildico he died in his sleep. Those who buried him and his treasures were subsequently put to death by the Huns so that his grave might never be discovered. He was succeeded by his numerous sons, who divided his empire between them.

Priscus, who saw Attila when he visited his camp in 449, described him as a short, squat man with a large head, deep-set eyes, flat nose and a thin beard. He was of an irritable, blustering, truculent character and a very persistent negotiator, but by no means pitiless. When Priscus attended a banquet given by him, he noticed that Attila was served off wooden plates and ate only meat, whereas his chief lieutenants dined off silver platters loaded with dainties. No detailed description has survived of any of his battles, so that his qualities as a general cannot be precisely estimated; but his successes before the invasion of Gaul are very impressive.

See also Index references under "Attila" in the Index volume.

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ATTIS (ATYS), a deity worshiped in Phrygia, Asia Minor, and later throughout the Roman empire, in conjunction with the Great Mother of the Gods. Their worship included the celebration of mysteries annually on the return of the spring season. Attis was confused with Pan, Sabazius (*q.v.*), Men and Adonis, and there were resemblances between the orgiastic features of his worship and that of Dionysus. His resemblance to Adonis led to the theory that the names of the two are identical and that Attis is only the Semitic companion of Syrian Aphrodite grafted onto the Phrygian Great Mother worship. It is likely, however, that Attis, like the Great Mother, was indigenous to Asia Minor adopted by the invading Phrygians and blended by them with a deity of their own.

According to Pausanias, Attis was a beautiful youth born of the daughter of the river Sangarius; he was descended from the hermaphroditic Agdistis, a monster sprung from the earth by the seed of Zeus. Having become enamoured of Attis, Agdistis struck him with frenzy as he was about to be married with the result that Attis castrated himself and died. Agdistis in repentance pre-

vailed upon Zeus to grant that the body of the youth should never decay or waste.

According to Arnobius, Attis emasculates himself under a pine tree, at the foot of which violets sprang from his blood. The Great Mother and Agdistis carry the pine tree to her cave, where they wildly lament the death of the youth. Zeus grants the petition as in the version of Pausanias, but permits the hair of Attis to grow and his little finger (which has been interpreted as the phallus) to move. In the version of Diodorus, the Mother is the carnal lover of Attis (her son), and, when her father discovers her fault and kills her lover, roams the earth in wild grief.

In Ovid's *Fasti* she is inspired with chaste love for Attis, which he pledges himself to reciprocate. On his proving unfaithful, the Great Mother slays the nymph with whom he has sinned, whereupon in madness he mutilates himself as a penalty.

Another form of the legend (Pausanias), showing the influence of the Aphrodite-Adonis myth, relates that Attis, the impotent son of the Phrygian Calaus, went into Lydia to institute the worship of the Great Mother, and was there slain by a boar sent by Zeus. Attis was originally a god of vegetation, or tree spirit, as is indicated by his association with the pine tree, into which he was said to have been afterward changed. In his self-mutilation, death and resurrection he represents the fruits of the earth, which die in winter only to rise again in spring. *See* also GREAT MOTHER OF THE GODS.

See J. G. Frazer, *The Golden Bough: Adonis, Attis, Osiris*, 2 vol. (1955). (G. S.)

ATTITUDE is a word having no precise technical meaning when used to describe human beings psychologically. It refers, in a general way, to inclinations, presumed to be enduring, to react in a certain way in response to certain kinds of situations, to see and interpret events according to some predisposition and to organize opinions into coherent interrelated clusters. Thus, for example, if a person is presumed to have a "hostile attitude" toward some organization, this person is expected to show evidence of hostility in his overt behaviour in connection with this organization, to interpret facts about the organization's structure and activities in a negative manner and to hold a variety of opinions about issues and events which are consistent with his hostile attitude. There are no very clear distinctions between "attitudes" and phrases like "opinion clusters," "belief systems" and "value systems."

Since an attitude is thought to be something inside the person which possesses the characteristics of an inclination or a predisposition, the question of how an attitude may be measured or identified becomes important. In principle, such measurement can be made only through observation of what the person says or does. What a person says, however, is not always in accordance with what he does. For example, during an interview a person might express opinions, ideas and values from which it would be concluded that his political attitudes are very conservative. It might be found also, however, that he actually belonged to a political party which mostly espoused liberal views. Which of these, then, reflects the person's attitude? In general, behaviour is affected by many things, relevant attitudes being only one part of the totality of important factors. In the above hypothetical example, the person may belong to the liberal political organization mainly for business reasons. Thus, generally, behaviour would be expected to be influenced by attitude but would not be a good direct measure of attitude.

What a person says in answer to questions is a more direct measure of attitudes in the sense that what he says will be affected mainly by his attitudes, provided the interview is conducted properly. If the interview is not conducted properly, what the person says may be completely invalid as a measure of his attitude. Thus, the manner and appearance of the person doing the interviewing, the way the question is asked and what the respondent feels is the correct or socially acceptable answer may all serve to distort the obtained measure of the respondent's attitude. Nevertheless, it is possible to obtain valid measures of specific attitudes by asking questions. Typically, questionnaires designed to measure attitudes ask for expressions of opinions on specific matters related to the general attitude being measured, ask for expressions of preference among various alternatives or ask the respondent to state what he would do in a number of specified situations. Such attitude scales are pretested to ensure that the numerical score derived is a reliable and valid indicator of the attitude.

These problems of measurement have received considerable attention. One requirement of any series of questions designed to measure a specific attitude is that it be homogeneous or unidimensional. This means, specifically, that all the questions should reflect the same attitude. If the answers to some questions reflect more than one attitude, or if some questions reflect one attitude while other questions on the same scale reflect a wholly different attitude, then the score derived from the series of questions may be ambiguous and difficult to interpret. Thus, to put it simply, in a series of questions intended to measure attitudes toward labour unions, for example, it would be best if every question produced an answer affected solely by the respondent's attitude toward labour unions and by nothing else. This is not always possible to ensure. Frequently, questions which seem to be directed at one thing turn out to be affected by others.

Attitude questionnaires are evaluated for degree of homogeneity or unidimensionality by analyzing the internal consistency of the responses made to the questions. The exact nature of the internal consistency required of answers depends upon the nature of the questions. The simplest case is that in which each question reflects a cumulatively greater degree of the attitude in question. Under these circumstances, unidimensionality is reflected in the following way: if a person has answered "yes" to the question requiring the greatest degree of the attitude, he presumably also answers "yes" to every other question; if a person has answered "no" to the one reflecting the greatest degree but has answered "yes" to the question reflecting the next greatest degree of the attitude, he would presumably answer "yes" to all the remaining questions, and so on. An analogue here would be a test of some ability. If a person has passed a very difficult item on a test, and if all the items on the test measure the same ability, the person would be expected also to pass all the easier items.

Apart from the problems of attitude measurement, research has been concentrated on questions such as: How do attitudes develop and how do they change? What relationships exist between attitudes and behaviour? What relations are there between attitudes and personality characteristics?

Social factors are probably the major determinants of the content of attitudes (*see* PSYCHOLOGY, SOCIAL). What other people say and do, how they feel, what they value, their inclinations and preferences tend to become accepted as the correct and proper way to act and feel. On issues where there is near uniformity, attitudes will develop easily and strongly. What exists uniformly will generally be accepted as the way things are and the way they must be. Very few people will question generally accepted attitudes to the effect that, for example, home, mother, family are good and highly valued things while laziness, lack of ambition and sin are bad things. Such nearly uniform attitudes may be said to be part of the culture. They develop readily in children, become highly stable and are rarely challenged. Many of these widespread attitudes are taken so much for granted that people are hardly aware that they are attitudes and values rather than "human nature."

Many attitudes, of course, are not uniform in the culture; development of these depends more on the local social situation. Thus, a child who grows up in an atheistic family will develop attitudes toward religion different from those of a child who grows up in a very religious family; a child who grows up in the state of Georgia will most likely have attitudes toward Negroes different from those of one who grows up in Minnesota. Such attitudes are more likely to be challenged and subjected to influence and, consequently, more than the universally accepted attitudes, likely to change. If a person with a very conservative political attitude goes to a college where the prevailing intellectual climate happens to be liberal, his attitude will tend to change more and more in the liberal direction. In short, people are influenced by those with whom they associate.

The best evidence indicates that the mass communications

media, such as newspapers, radio and television, affect attitudes and opinions on occasions on which these media are all on one side of the issues and no dissenting voices are raised. On the other hand, when both sides of a matter are aired, these communications media seem to be very ineffective. There are several reasons for this. First, people tend to read newspapers and listen to speeches which agree with their own attitudes and opinions. Similarly, they tend to avoid exposing themselves to information and opinions which disagree with their own point of view. Second, when a person is exposed to information and opinions which disagree with his own, he has a strong tendency to talk about the matter with others who do agree with him. This process serves to obtain social support for his existing views, bolstering his attitudes and opinions. Third, when a person is exposed to disagreement via the mass communications media, it is usually possible for him to lessen the influence of this disagreement by regarding the source of the communication as less trustworthy than he had previously thought or as having some special hidden motive which has nothing to do with the truth of the matter. On controversial issues concerning strongly held attitudes, any influence the mass media may have is mediated through the face-to-face associations of the person.

The question of the relationship between attitudes and behaviour (*q.v.*) is complicated. It may be called reciprocal in that, on the one hand, attitudes affect and in part determine behaviour, and, on the other, behaviour will affect and partly determine attitudes. The ways in which attitudes affect behaviour are fairly clear. When the situation in which a person finds himself is relevant to a certain attitude which he holds, his behaviour will tend to be consistent with that attitude. Thus, for example, a person who has anti-intellectual attitudes is not likely to encourage his children to go to college. But the relationship would be very weak because other factors also enter into determining behaviour. The anti-intellectual parent might urge his children to go to college because this is a sign of status, because it is expected by others and because he recognizes that it will help his children get good jobs later in life. The attitude concerning intellectualism will be merely one among many factors which determine the specific behaviour.

Because attitude is only one of many determinants of behaviour, persons often engage in actions which are inconsistent with their attitudes. When such inconsistency exists, the person will make strong efforts to justify his actions to himself. In general, there are two major tendencies. First, the person may persuade himself that those factors which are consistent with his action are even more important than he had previously thought and find still more reasons, not previously thought of, which are consistent with the action. Second, he may change his attitude so that it corresponds more closely with his action, thus lessening the inconsistency. Thus, for example, a person who finds himself in a situation where, for one reason or another, he publicly espouses an opinion which is inconsistent with his privately held attitudes will, over time, change his attitudes somewhat to bring them more in line with the position he has taken publicly.

In general, however, by the time a person is adult many or most of his attitudes are well integrated and highly resistant to change. His associates tend to be persons who share his attitudes, and he tends to avoid situations which threaten them. In spite of the pressures on attitudes and the changes in them which do occur, the prevalent picture is one of stability.

This prevailing general stability permits questions to be raised concerning the relation between attitudes and other enduring personality characteristics. It is, however, difficult to distinguish between consistency among various attitudes and relations between attitudes and personality characteristics. The fact that there is consistency among attitudes is well documented. For example, people who are prejudiced against Negroes tend also to be prejudiced against other minority groups. But such people tend furthermore to have more "authoritarian personalities," and it is unclear whether the latter should be regarded as just another correlated attitude or as a correlated personality characteristic. Relations have been sought between attitudes and such personality characteristics as dominance, rigidity, dependency, tolerance of ambiguity and a host of others, but no clear and consistent relations have been discovered.

On the other hand, there are very clear relations between attitudes and such variables as intelligence, amount of education, socioeconomic level and age. More intelligence and more education usually go along with more liberal attitudes, while higher socioeconomic level and greater age are usually associated with more conservative attitudes. It is suspected, however, that these variables are not themselves directly causally related to the content of attitudes.

Variables such as level of education and socioeconomic status are probably indicative instead of the person's social milieu and pattern of activity, and these are probably the factors which directly influence attitudes.

See also CONCEPT FORMATION, PSYCHOLOGY OF; PERSONALITY; PSYCHOLOGICAL TESTS AND MEASUREMENTS.

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ATTLEBORO, a city of Bristol county in southeastern Massachusetts, U.S., 12 mi. N.E. of Providence, R.I.

The area was part of the Rehoboth North purchase when John Woodcock began real settlement in 1669. The town was incorporated in 1694 and named for the English market town. In 1887 it was divided by the creation of the township of North Attleborough, also a manufacturing centre. Attleboro was incorporated as a city in 1914.

Industrial life began early with the founding of a jewelry business in 1780, a tannery in 1787 and a textile plant in 1801. The manufacture of jewelry, including costume jewelry, is the leading industry, along with the manufactures of silverware and plated ware.

Other substantial industries include the manufacture of scientific and controlling instruments, fabricated metal products and machinery.

For comparative population figures *see* table in MASSACHUSETTS: *Population*. (CA. M. C.)

ATTLEE, CLEMENT RICHARD ATTLEE, 1ST EARL (1883–) British statesman, was leader of the Labour party from 1935 to 1955, and prime minister from July 1945 to Oct. 1951.

He was born at Putney, London, on Jan. 3, 1883, the fourth son of a prosperous City solicitor and was educated at Haileybury college and University college, Oxford. After he left the university neither the shortage of money nor the bent of his talents forced him quickly into a career. He was called to the bar in 1906, but he practised little and in 1909 he abandoned the law. In 1905 he had begun regular visits to Haileybury house, a settlement in the poorest part of east London. In 1907 he took up residence there and, apart from his war service, the East End was his home until Jan. 1922. When he first went there he was a Conservative (although his father had been a Liberal), but the harsh poverty which he saw undermined his faith in the existing order. He did not undergo a sudden political conversion but his views moved steadily to the left. In 1907 he joined the Fabian society and in 1908 the Independent Labour party. From then onward he was a committed, ethical socialist.


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LORD ATTLEE

He was not a pacifist, however; and within two months of the outbreak of World War I he was commissioned in an infantry regiment. He served in Gallipoli, Mesopotamia and France, was severely wounded and attained the rank of major. On demobilization he returned to the East End and to social and local political work. He was defeated for the London County council in 1919 but when

the Labour party won control of the Stepney Borough council that year he was called in from outside to be mayor. In 1922 he was elected member of parliament for Limehouse and sat for that constituency until 1950. From 1950 to 1955 his constituency was West Walthamstow.

In the house of commons Attlee's progress was steady but in no way meteoric. In the first Labour government he was under-secretary of state for war. In 1927 he was appointed to the Indian Statutory commission, which accounted for his receiving no office on the foundation of the second Labour government. In 1930, however, he joined that government as chancellor of the duchy of Lancaster, a sinecure post which left him free to give wide-ranging assistance to the prime minister and other senior ministers. In March 1931 he was made postmaster general. When the government broke up a few months later Attlee showed no disposition to follow Ramsay MacDonald. On the contrary he reacted to the crisis of 1931 by moving left and for a year or two took a more cataclysmic view of social progress than was habitual with him.

At the general election of Oct. 1931, Attlee was one of the very few Labour leaders whose seats held firm. As a result he became deputy leader of the party under George Lansbury. In 1935 Lansbury resigned and Attlee succeeded to the leadership. The general election of that year resulted in the return to the house of commons of several figures who, had they been members of the previous parliament, would probably have been preferred to Attlee. They did not, however, succeed in replacing him as leader. In a contested election he secured 58 votes, Herbert Morrison 44, and Arthur Greenwood 32. A second ballot gave Attlee 88 against Morrison's 44. His leadership was never again challenged to a vote.

During the late 1930s Attlee led his party toward a moderate home policy (symbolized by the adoption of the "immediate program" in 1937) and resistance to fascism and aggression abroad (tempered by a reluctance to accept rearmament). He gave his full support to the British declaration of war in 1939, but was unwilling to join a government under Neville Chamberlain. In May 1940, it became impossible for Chamberlain to carry on without bipartisan support and Attlee's attitude was decisive in forcing his replacement by Churchill. Attlee then entered the war cabinet as lord privy seal. In 1942 he became deputy prime minister and secretary of state for dominion affairs. In 1943 he became lord president of the council, though retaining the deputy premiership, and served in this capacity until the end of the war. Only he and Churchill served continuously in the war cabinet throughout the life of the coalition government.

In May 1945 Attlee led his party out of the coalition and achieved a great parliamentary majority at the general election which followed. He became prime minister on July 26 and held this office until Oct. 1951—a longer continuous period than any man since Asquith. The government over which Attlee presided was notable for its social legislation, including the establishment of the national health and national insurance schemes, for its extensive measures of nationalization and for the granting of independence to India. With this last decision Attlee himself was particularly closely associated.

Several of Attlee's principal colleagues—notably Ernest Bevin, Stafford Cripps and Herbert Morrison—were more dominant public personalities than he was, but he held the government together with great success and was reputed to exercise a firm control in cabinet. He gave unfailing support to Ernest Bevin's policy of building up the strength of the west and in 1950 he readily accepted the need both for armed intervention in Korea and for the launching of a big rearmament program. By this time his parliamentary majority had been reduced in the general election of Feb. 1950 to the tight margin of six. In April 1951 the government was further weakened by the resignation of Aneurin Bevan and Harold Wilson, and in the autumn of that year Attlee decided to ask for a dissolution of parliament. The subsequent general election resulted in a narrow Conservative victory and Attlee's resignation as prime minister.

He remained leader of the opposition until Nov. 1955, endeavouring to preserve the unity of his party throughout the difficult days of the "Bevanite" quarrel and leading it in the unsuccessful election campaign of May 1955. On his resignation from leadership of the Labour party he was created an earl; he had been made a knight of the order of the Garter in 1956. In 1954 he published a volume of memoirs, *As It Happened.* (R. J.)

ATTORNEY: *see* LEGAL PROFESSION.

ATTORNEY GENERAL. A governmental official found in nearly every country in which the legal system of England has taken root. Briefly defined, the attorney general is the chief law officer of the state or nation and the legal adviser to the chief executive.

UNITED STATES

The attorney general of the United States is the chief law officer of the government and head of the department of justice, one of the executive departments. He is appointed by the president and is a member of the cabinet. In case of death, resignation, removal or disability of both the president and the vice-president, he is in line of succession to the presidency, after the speaker of the house of representatives, president pro tempore of the senate, secretary of state, secretary of the treasury and secretary of defense.

The office of attorney general of the United States was created by the Judiciary act of 1789. This act divided the United States into 13 judicial districts, established courts therein, defined their jurisdiction and also the appellate jurisdiction of the supreme court. The act provided that in each district there should be an attorney for the United States who should have charge of civil and criminal actions in his district, and finally that there should be appointed an attorney general of the United States who was to be "a meet person learned in the law," whose duty it should be to represent the United States in the supreme court and who should be the legal adviser of the president and of the heads of the departments "touching any matters that may concern their departments." The attorney general, under this act, was not an executive officer of the government. His duties, as defined by the statute, made him merely an adviser of the executive branch and an advocate in the supreme court, and the measure of his compensation, $1,500 a year, was based upon the belief that his duties would take but little of his time, leaving him free to enjoy the professional emoluments which it was thought the prestige of his position would bring him. Until about the year 1814, the attorney general did not reside at the seat of government. In that year, Atty. Gen. William Pinkney, one of the great lawyers of his day, resigned because Pres. James Madison insisted that he take up his residence in Washington. From the beginning, however, the office was regarded as one of great dignity and importance, and with the growth of the United States and the development of its governmental functions statutes were enacted from time to time which increased its duties and responsibilities, and gradually brought it to a parity with the heads of the executive departments. In 1870 it was organized by law as the department of justice.

The department of justice is an executive department and the attorney general as its head has plenary control over the law business of the government, all its other law officers being subordinate to him, though most departments, bureaus and commissions of the federal government have lawyers on their staffs who are not officers or employees of the department of justice and who, in the performance of their duties within their respective departments, are not under the specific direction of the attorney general. In the language of the U.S. supreme court he "has charge of the institution and conduct of the pleas of the United States and of the litigation which is necessary to establish the rights of the Government."

The duties of the attorney general are primarily those of a lawyer, but as head of the department much of his time and energy must be devoted to administration. His chief assistant is the deputy attorney general, who by law exercises the powers of attorney general in the latter's absence and is the department's chief liaison officer with congress and other government agencies. The solicitor general has charge of the government's litigation in the

supreme court and decides, after consultation with the attorney general in cases of particular importance, whether review in the higher courts shall be sought in cases which the government has lost in courts below. This duty of passing upon questions of appeal and therein seeing to it that the government's interests are protected and all reasonable effort made to procure a correct construction of the law, at the same time avoiding imposing unwarranted burdens upon the appellate courts and unnecessary expense to litigants, is one of grave responsibility, calling for the exercise of sound, discriminating judgment.

There are also ten assistant attorneys general, among whom supervision of the other work of the department is principally apportioned. Each assistant attorney general has charge of one of the department's eight divisions—antitrust, civil, civil rights, criminal, internal security, lands, tax, administrative—or the office of legal counsel or the office of alien property. In addition a United States attorney is appointed by the executive for each of the federal district courts and, except for matters assigned to other department attorneys, represents the U.S. government in litigation arising in that district.

The number of federal district courts has increased from the original 13 to 91, including Alaska and Hawaii, each having one or more district judges. There is a court of appeals, composed of three to nine circuit judges, for each of the 11 circuits (including the District of Columbia as a circuit). In 1855 there was established a court of claims (*see* Petition of Right: *Proceedings Against the State in the United States*).

The Federal Bureau of Investigation is one of the bureaus of the department of justice. The FBI investigates all violations of federal criminal statutes with the exception of those assigned by law to the department of the treasury, including income and liquor taxes, smuggling, counterfeiting and narcotics violations and, in addition, the security of the president and vice-president, this duty being the task of the secret service, an agency of the treasury. Under an executive order of the president the FBI is given sole responsibility for the handling of matters pertaining to the general internal security of the nation. The order directs that all information relating thereto be reported to it.

Through the director of the bureau of prisons the attorney general controls all federal prisons and prisoners.

The administrative control and supervision of the offices of U.S. marshals are in the attorney general. All petitions to the president for pardon, commutation of sentence or other form of executive clemency are investigated by an official of the department called the pardon attorney, and the facts relating to each application are ascertained for the guidance of the attorney general in making his recommendation to the president. The attorney general also makes recommendations to the president respecting appointments to all federal judicial positions, including the U.S. supreme court.

As already pointed out, from the beginning the attorney general has been the legal adviser of the president and of the heads of the executive departments with respect to the questions arising in the administration of their departments. For many years pursuant to statute his formal opinions have been published from time to time in book form. They generally control the action of the executive officers of the government, are frequently cited by the courts and regarded as of high authority. Prepared under statutory sanction by the chief law officer of the government for the guidance of the heads of departments charged with the administration of the statutes enacted by congress, they have the status of important state papers entitled to the highest respect upon all questions of the powers and duties of the executive branch of the government. For the names and terms of service of U.S. attorneys general, *see* Cabinet.

There is also under each state government an officer, usually called the attorney general, whose relation to the government of his state is similar to that of the U.S. attorney general to the federal government. He is usually elected by the people at the same time and for the same term as the governor. For an accurate description of the duties of the attorney general of any particular state an examination of the constitution and laws of that state is necessary. *See* also Legal Profession.

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ENGLAND AND WALES

In England and Wales, the attorney general is the senior law officer of the crown. He is assisted by the solicitor general, who is subject to his authority but has otherwise the same rights and duties. The law officers have a small department, staffed by professional civil servants (who are also barristers). Functions in many respects similar to those of the English law officers are performed by the lord advocate and solicitor general for Scotland and by the attorney general for Northern Ireland.

The attorney general, who is the crown's representative in courts of law and the legal adviser of the sovereign and the sovereign's ministers, is a member of the government (but not, nowadays, of the cabinet). He is consulted on the drafting of all government bills, advises government departments on matters of law and has a wide range of duties in relation to the courts. The attorney general is invariably a member of the house of commons; he is answerable to the house for the exercise of his ministerial duties; he has a right to address all its standing committees; and he deals in the house with all matters, including law reform bills, which lie within the province of the lord chancellor.

The office of attorney general dates from the middle ages but did not begin to assume its modern form before the 16th century. The medieval attorney was not a barrister but merely the representative of his client in legal proceedings and, for the crown's business, "king's attorneys" were at first appointed only for particular business or for particular cases or courts. The issue of a patent in 1399 to William de Lodington as "King's Attorney in the Common Bench and all other places" may be regarded as the first appointment of an attorney general for the crown. In time he acquired the right to appoint deputies and became something like a permanent official with a staff of assistants. However, the right of audience before the medieval courts was the exclusive privilege of barristers and, when the office of attorney general became too important to be held by a mere attorney, it was from the barristers that he came to be appointed and whose leadership he eventually assumed. As the medieval system broke down and new courts and new political institutions were set up, there was a marked increase in the influence of the law officers, which has been characterized by one writer as a "phenomenon of the same kind as the rise in the political sphere of the King's Secretaries at the expense of many older medieval functionaries." At the beginning of the 17th century the office of attorney general was held by men of the calibre of Edward Coke and Francis Bacon; the position of the law officers as legal advisers to the crown had become established and they conducted state prosecutions and defended the royal interests in parliament. However, the link with parliament came first through the attorney general's attendance on the house of lords, to which the law officers were summoned with the judges as assistants in matters of law; and it was the solicitor general who first acquired a seat in the commons. The attorney general, for long being the traditional upholder of the king's prerogative, remained suspect with the commons as an instrument of the royal influence in parliament; not until after the Restoration did it become normal for him to be a member of the house of commons.

The attorney general still exercises many of his historic functions as legal adviser to the sovereign. He advises on petitions claiming peerages that are dormant or in abeyance, reports on applications for royal licences to hold land in mortmain, makes recommendations for the disposition under the sovereign's hand of certain property bequeathed for charitable purposes and examines the drafts of royal charters. It is because he is the representative of the sovereign as *parens patriae* (the liege lord and

protector of subjects) that legal proceedings to enforce public rights (such as public rights of way) and proceedings on behalf of the interests of charity are conducted in his name. It is also by virtue of his office as a law officer of the crown that the attorney general is recognized by the bar as the leader of the profession.

The greater part of the law officers' work today, however, is, apart from their parliamentary duties, that of counsel for the crown in a wider sense. The modern departments of state have their own legal staffs, but the law officers are responsible for the legal advice given to the government, and it is to the law officers that departments turn for advice on matters of particular difficulty or of political or national importance. The law officers continue to practise as barristers while they are in office, although the crown is their only client and their fees take the form of an annual salary, and they appear personally in court, where they take precedence over all other barristers, in cases particularly affecting the rights and interests of the crown. It is also the custom for a law officer to represent the United Kingdom before such tribunals as the International Court of Justice.

Although the attorney general is a minister of the crown, he exercises the majority of his functions in a quasi-judicial manner and without regard to political considerations of any kind. In modern times there has been a tendency to add functions of this kind to his duties; for example, at public inquiries into aircraft accidents he represents the interests of the general public as distinct from the interests of any government department which may be involved. But perhaps the most significant modern development in this field has been in relation to the criminal law. Before the 19th century it was the invariable rule in England and Wales that criminal prosecutions were instituted not in the name of the state but by private individuals, "public" prosecutions being instituted by officials in their private capacity. In practice, all prosecutions for such offenses against the state as treason and sedition were instituted on behalf of the crown in the name of the attorney general; and the harsh and oppressive manner in which this function was exercised exposed the law officers to such general opprobrium and suspicion that parliament would certainly have resisted any attempt to centralize the control of prosecutions in their hands. In the 19th century, however, the rigidity of the general rule about private prosecutions was undermined. First, the development of police forces resulted in a marked decrease in the number of prosecutions instituted by the ordinary citizen; second, parliament found it necessary to take steps (such as the enactment of the Vexatious Indictments act, 1859) to restrict some of the liberties of the private prosecutor; and third the law officers began to conduct themselves less as servants of the executive than as independent officers of state. When, therefore, in 1879 the Prosecution of Offences act created the office of director of public prosecutions with the primary duty of advising on and, where necessary, taking over the conduct of prosecutions, it was natural that he should be placed under the general superintendence of the attorney general; and there are in the second half of the 20th century over 50 offenses created by act of parliament for which prosecutions can be instituted only with the consent of either the attorney general or the director of public prosecutions.

The attorney general also has a right to stay criminal proceedings in the superior courts. This power, which is not subject in any way to review by the courts, is in modern times used almost (but not quite) exclusively to dispose of proceedings against persons who are, and are likely to remain, for medical reasons unable to stand their trial.

Although the attorney general is a minister and the director of public prosecutions is a civil servant, the administration of the criminal law is conducted without interference from the government of the day and independently of party political pressure; indeed, in 1924 the mere allegation that a prosecution (in the famous Campbell case) had been withdrawn on the instructions of the attorney general under pressure from the cabinet was the immediate occasion of a vote of censure which brought down the government. It is now established that, subject to the attorney general's right and duty to consult his ministerial colleagues on the likely consequences of a particular prosecution, he exercises his duties in the enforcement of the law free of governmental control or political pressure.

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ATTRIBUTES, in philosophy, insofar as they are not simply predicates, are either the qualities ascribed to a substance beyond the finite mind's powers of definition (as theologians speak of the attributes of God) or properties recognized as necessarily consequent from the essence of a substance. *See* Predicables; Qualities; Substance; also Spinoza, Benedictus de.

ATTWOOD, THOMAS (1783–1856), English political reformer and writer on economics, was born at Halesowen, Worcestershire, Oct. 6, 1783. A country banker by occupation, connected with the local iron industry, he was high bailiff of Birmingham in 1811. From that year on he was preoccupied with currency questions. When successive governments refused to accept the ideas which he advocated in his pamphlets and in 1819 the decision was taken to return to the gold standard, Attwood became increasingly radical in his political outlook. The prevalence of economic distress, particularly after 1826, encouraged him to set up a new political organization to bring pressure on the government. In Dec. 1829 he founded the Birmingham Political union to demand parliamentary reform as a means of securing currency reform. Its structure and methods were copied in many other parts of the country. After the passing of the Reform act in 1832 he was elected a member for the new borough of Birmingham, for which he sat until 1839. Inside and outside the house of commons he advocated that national currency based on a gold standard should be replaced by state-regulated paper money, the volume of which should be determined by the level of employment. Although at the time his views were considered heretical, they were influential in the midlands and have since been considered more plausible and interesting than the classical economists maintained. He died at Great Malvern, March 6, 1856. (A. Bri.)

AUBADE, music sung or played at dawn as opposed to serenade (evening music). The form originated in Provence where it was known as the *alba*, the earliest known manuscript being an anonymous *alba bilingua* in Latin and Provençal. In the 12th and 13th centuries the Provençal *alba* was the warning-song sung to lovers at dawn by a watchman (*see* Troubadours). Examples are the anonymous *Gaite de la tor* and *Reis glorios* by Guiraut de Bornelh. The later German form of the *alba* was the *Tagelied*. In the 19th and 20th centuries the term aubade was used in a more general sense to describe morning music as is shown by the aubade in Edouard Lalo's opera *Le Roi d'Ys* and by Sir Arthur Bliss's *Aubade for Coronation Morning*. In France the term is also used to describe music played at dawn in honour of distinguished people.

AUBE, a *département* of France, is situated southeast of Paris in the ancient province of Champagne (*q.v.*). Area 2,317 sq.mi. Pop. (1962) 255,099. It is bounded north by Marne, east by Haute-Marne, southeast by Cote d'Or, southwest by Yonne, and northwest by Seine-et-Marne. The *département* is traversed from southeast to northwest by the converging valleys of the Aube and Seine rivers, crossing the dry chalk platform of Champagne. Beyond a low escarpment that forms the southeastern edge of the chalk outcrop is a belt of damp, undulating clay country, with pastures and woods. The ground rises southeastward again toward the scarped limestone hills that are known as the Côte des Bars, with Bar-sur-Aube and Bar-sur-Seine in the river gaps. In the western part of the *département* a capping of sands and clays overlies the chalk and gives a damper surface and more

varied relief in the Forêt d'Othe.

The bare chalk platforms were long of little use except for sheep grazing, but have been improved for agriculture since the middle of the 19th century. They are sparsely inhabited and most of the population lives in the well-watered valleys. Champagne lay on important trade routes in the middle ages and was famous in the 12th and 13th centuries for its great fairs, especially at its capital, Troyes (*q.v.*), in the valley of the Seine. The woolen industry rose to importance, but suffered eclipse later. After stagnating during the 17th and 18th centuries Troyes was revived by the modern development of the hosiery and knitwear industry, using cotton and later rayon and man-made fibres. Hosiery factories are widespread in the *département*, but Troyes (pop. [1962] 67,074) is the chief centre of the industry, and has important associated engineering works. The woolen industry survives chiefly in the Pays d'Othe.

The *département*, which is centred upon Troyes, is divided into the *arrondissements* of Troyes, Bar-sur-Aube and Nogent-sur-Seine. The bishopric of Troyes lies in the archbishopric of Sens. In the southeastern corner of the *département*, in the Aube valley, is the historic abbey of Clairvaux (*q.v.*). For educational organization the *département* lies in the *académie* of Dijon, and its court of appeal is at Paris. (Ar. E. S.)

AUBE RIVER, in east-central France, is a tributary of the Seine river which it joins above Romilly. The Aube and its tributary the Aujon rise on the Langres plateau and flow northwestward for 154 mi. in trenchlike valleys across the dry oölitic limestone country. By Montigny-le-Roi and Châteauvillain respectively the valleys open as they traverse the clay depression in front of the broken corallian limestone escarpment known as the Côte des Bars. The Aujon joins the Aube at Clairvaux as the rivers enter the *département* to which the Aube gives its name, and the valley is again trenchlike about Bar-sur-Aube as it cuts across the limestone outcrop. It opens out again and the river receives many small tributaries in crossing the Lower Cretaceous clay country toward Brienne. From Brienne to its confluence with the Seine the valley of the Aube, curving west past Arcis-sur-Aube, is a flat strip of alluvium set within the dry chalk platform of Champagne, and the river receives few surface tributaries. (Ar. E. S.)

AUBER, DANIEL FRANÇOIS ESPRIT (1782–1871), French opera composer who was one of the principal figures in the development of the *opéra-comique* in the first half of the 19th century. Born, Jan. 29, 1782, at Caen, he composed instinctively as a child, and later became a pupil of Luigi Cherubini. His first publicly performed dramatic work was the one-act *Le Séjour militaire* (1813). This was followed by *Le Testament et les billets-doux* (1819). Neither was remarkable. Auber's contribution to *opéra-comique* derived partly from his association with Eugène Scribe who, with A. H. J. Mélesville, wrote the libretto, based on Walter Scott's *Kenilworth*, of *Leicester, ou le Château de Kenilworth* (1823), and partly from the impact made on French music by Rossini. Scribe's librettos, constructed with an infallible sense of the theatre, offered an ideal framework for the romantic type of *opéra-comique* to be cultivated by Auber, while the vivacious works of Rossini provided him with a musical style readily adaptable to French operatic taste. Between 1823 and 1864, 38 dramatic works of Auber on librettos of Scribe were produced in Paris. Most were *opéras-comiques*, of which the most successful were *Le Maçon* (1825), *La Fiancée* (1829), *Fra Diavolo* (1830), *Le Domino noir* (1837) and *Les Diamants de la couronne* (1841). Rossini's tribute to their lively style, "*petite musique mais d'un grand musicien*," is still valid.

The romantic vein explored by Auber and Scribe was also suited to grand opera and several of their works, including *La Muette de Portici* (1828, also known as *Masaniello*), *Le Philtre* (1831), *Le Serment* (1832) and *Gustave III* (1833), anticipated the operas of Meyerbeer. Further evidence of this link with romantic opera is seen in the fact that the librettos of *Le Philtre* and *Gustave III* were adapted for Donizetti's *L'elisir d'amore* and Verdi's *Ballo in Maschera*.

Auber's life, almost entirely devoted to opera, was uneventful. His religious music, consisting of motets and cantatas written between 1852 and 1855, is little known. He was elected a member of the Academie Française in 1829, and appointed director of the Paris Conservatoire in 1842 and chapel master to Napoleon III in 1857. He died in Paris, May 12, 1871. Though few of his works were revived, his influence, recognized by both Wagner and Richard Strauss, was wide, extending to the early works of Gounod and Massenet.

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AUBERGINE: *see* EGGPLANT.

AUBERVILLIERS, a town in northern France in the *département* of Seine, lies 4 mi. (6 km.) N.N.E. of Paris on the St. Denis canal. Pop. (1962) 70,592. Its church of Notre-Dame-des-Vertus (15th–16th centuries) recalls that it was an important place of pilgrimage from the 14th century. Its chief industry was the provision of vegetables for consumption in Paris but now, although market gardening continues, Aubervilliers has become an industrial complex. Chemical products predominate including tallow, artificial manure, paints, varnishes, matches and perfumes. (H. DE S.-R.)

AUBIGNAC, FRANÇOIS HÉDELIN, ABBÉ D' (1604–1676), French critic who played an important role in literary discussions of the 1640s and the 1660s, was born in Paris, Aug. 4, 1604. Attached to Richelieu, he furthered the cardinal's efforts to improve the status of drama. He wrote plays, three of which are extant, in prose (*Cyminde, La Pucelle d'Orléans*, both published 1642, *Zenobie*, 1647). The abbé's polemical writings fall into three groups: two essays against Ménage (1640, 1656); four essays in criticism of plays of Corneille, written in 1663–64; and a study of dramatic technique, *La Pratique du théâtre*, commissioned by the cardinal, but abandoned after his death, and published only in 1657. It is referred to by Corneille and Racine, but had no wide appeal. D'Aubignac also wrote allegorical pieces and a dissertation on Homer. He lived in Paris until after the Fronde. Recent research shows him associated with the coteries concerned in *Les Précieuses ridicules*. He died in Nemours, July 25, 1676.

La Pratique du théâtre, written in a period of lively critical polemic, is a systematic treatment of the elements of playmaking. Long thought to be a codification of French classical doctrine it does not actually define the unities, but insists on credibility (or *vraisemblance*) in the eyes of the audience as the guiding principle. It is therefore an excellent indirect testimony to the taste of the French theatre-going public. The abbé insists, presumably because the public did, on the dramatic illusion being as complete as possible. That illusion is broken if, for instance, actors call for silence or if the audience without changing their own position are asked to imagine a change of scene. The illusion is the greater if the subject be presented as near to its crisis as possible, if the number of actors be such that no confusion (a key word) be left in the minds of the audience as to what is happening, if the speeches in the play be dramatic rather than rhetorical. All this is presented with a mass of quotations from Aristotle and ancient Greek drama, on the assumption that reason and respect for the classics were almost one and the same. Despite the work's small sale it was probably a notable force in the formation of French classical taste. It makes many points which Corneille and Racine were to put into practice, and this in spite of the fact that d'Aubignac has no grasp of poetic tragedy nor of the comedy which Molière was creating under his nose. The *Pratique* indeed avoids major aesthetic questions and modestly keeps to the means and methods of dramatic workmanship. D'Aubignac, however, states repeatedly his admiration for Corneille. It is ironical that, soured by later polemic he scored out, in a copy still preserved, all favourable references to Corneille, but that this copy was unknown to the publisher of the second edition, in 1715.

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AUBIGNÉ, THEODORE AGRIPPA D' (1552–1630)

major French poet of the late 16th century and also renowned as a Huguenot captain and polemicist and historian of his own times, was born near Pons in Saintonge on Feb. 8, 1552. After a strenuously studious youth in Paris, Orléans, Geneva and Lyons, he escaped from his guardian's house at 16 to join the Huguenot forces, and served throughout the Wars of Religion on the battlefield and in the council chamber. He was *écuyer* ("master of horse") to Henry of Navarre. After Henry's accession to the French throne as Henry IV and his abjuration of Protestantism, Aubigné withdrew to his estates in Poitou. Under the regency of Marie de Médicis, his intransigence estranged him from his Huguenot brethren. Proscribed in 1620, he took refuge in Geneva, where he remained until his death on April 29, 1630. His closing years were clouded by the scandalous conduct of his son Constant—father of Françoise d'Aubigné, later Madame de Maintenon.

Among Aubigné's prose works, the *Confession catholique du sieur de Sancy*, first published in 1660, is a parody, ironically dedicated to Cardinal du Perron, of the tortuous explanations offered by Protestants who followed Henry IV's example of abjuration. His comment on life and manners ranges more widely in the *Aventures du baron de Faeneste* (1617) in which the Gascon Faeneste represents attachment to outward show (*le Paraître*), while honest squire Énay, embodying the opposite principle (*l'Être*), tries to clear Faeneste's mind of cant. The *Histoire universelle*, so called because it treats not only of France, but also, more schematically, of Europe at large, deals with the period from 1553 to 1602, with an appendix to cover the death of Henry IV (1610); an unfinished supplement was meant to bring the story down to 1622. Despite its author's conscientious documentation and sincere effort to achieve historical detachment, the interest of the *Histoire* lies chiefly in its many eyewitness accounts and in the liveliness of Aubigné's writing.

His major poem, in seven cantos, the *Tragiques*, begun in 1577 and published only in 1616, celebrates the justice of God, who in the Great Doom will gloriously avenge his slaughtered saints. The nature of the subject matter and the sectarian bias, besides serious faults of composition and expression, account for the almost complete neglect of the poem until C. A. Sainte-Beuve called attention to it in 1828. But there are many passages of great poetic power, realistic or satirical, elegiac or apocalyptic; while the scope of the design, extending from the hovel of the tortured peasant to the courts of Heaven, confers an extraordinary grandeur on the work. Modern research on the baroque in literature has awakened interest also in Aubigné's youthful love poetry, collected in the *Printemps*, written for Diane Salviati, a niece of Pierre de Ronsard's Cassandre. It remained in manuscript until 1874. In this, the traditional figures of the pseudo-Petrarchan manner then current are transmuted into a highly personal style, full of tragic resonances, by Aubigné's characteristic vehemence of passion and force of imagination.

Aubigné's works have been published as follows: *Oeuvres complètes* (excluding the *Histoire universelle*), edited by E. Réaume and F. de Caussade (1873–92); another edition, including the *Histoire universelle*, by A. de Ruble (1886–1909); the *Supplément*, edited by J. Plattard (1925); the *Printemps*, edited by B. Gagnebin (first part, 1948) and F. Desonay (second part, 1952); and the *Tragiques*, edited by A. Garnier and J. Plattard (1932).

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(A. J. St.)

AUBREY, JOHN (1626–1697), English antiquary, best known for the pen portraits of contemporaries which he wrote for Anthony à Wood's *Athenae Oxonienses* and which were later published as *Lives of Eminent Men*, was born on March 12, 1626, at Easton Pierse, Wiltshire. His father was a country gentleman with estates in Wiltshire, Herefordshire and south Wales which Aubrey inherited in 1652. Aubrey had spent some years in Oxford as an undergraduate at Trinity college, and in London as a student of the Middle Temple, and had already displayed his taste for antiquities by calling attention to the prehistoric stones at Avebury, Wiltshire. His literary and scientific interests won him a fellowship of the Royal society in 1663. Meanwhile he had been traveling in England and visiting the continent, distracted by a series of love-suits and lawsuits which he refers to in his diary with a naïveté made the more disarming by his ingenuous belief in the influence of his own horoscope. "I was never riotous or prodigall," he says, "but . . . sloath and carelessness are equivalent to all other vices." He spent much time in "delitescence," avoiding creditors and enjoying the hospitality of friends in the country. He was never free from lawsuits until in 1670 he sold what was then left of his estates. He never married.

In 1667 Aubrey met Anthony à Wood (*q.v.*), and his antiquarian zeal was thenceforward devoted largely to supplying material for Wood's *Athenae Oxonienses*. He also collected material for his own *The Natural History and Antiquities of . . . Surrey* (pub. 1719) and *The Natural History of Wiltshire* (pub. 1847), but his main legacy to posterity was *Lives of Eminent Men*, on which Wood drew extensively. Extracts were published in two volumes (1813), but the definitive presentation of Aubrey, as a man and as a biographer, is Andrew Clark's edition, *Brief Lives* (2 vol., 1898). The editor omits some coarse passages, but the text gives a series of vivid and intimate (and sometimes acid) portraits of his contemporaries and a delightful impression of the whimsical and easygoing author himself.

Aubrey's only work published in his lifetime was *Miscellanies* (1696), a collection of stories of apparitions and curiosities. He had an eye for the odd and the picturesque, particularly in human behaviour and characteristics, but no power of organizing his material or planning a major work. His easy and equable temper won him many friends, among whom were Elias Ashmole, Sir Christopher Wren, Robert Hooke, Thomas Hobbes, Sir William Petty and Bishop Seth Ward, besides Wood and Bishop Tanner, to whom he made over much of his manuscript collections. In his later years, Aubrey considered emigrating to North America or the West Indies to take up grants of land with which his patrons offered to relieve his financial straits. But he never left England, and died while passing through Oxford in June 1697.

BIBLIOGRAPHY.—A *Memoir* by J. Britton appeared in 1845. A more lively account is given by Anthony Powell, *John Aubrey and his Friends* (1948), and a comprehensive selection from his biographical manuscripts was edited by O. L. Dick (1949). (J. Sp.)

AUBRIETIA, a genus of about 12 species of small, perennial, ornamental herbs of the family Cruciferae (*q.v.*), found in the mountains from Italy to Iran. The chief cultivated species is the purple rock cress (*A. deltoidea*), found from Sicily to Asia Minor. It is a prostrate, mat-forming perennial with small leaves and showy, four-petaled, purple or violet flowers. Over 40 horticultural forms of it are grown as ornamentals, having variously coloured and sometimes double flowers. All are best grown in the rock garden, in full sunshine and in a gritty or sandy loam that is not acid. (N. Tr.)

AUBURN, a city of southwestern Maine, U.S., on the Androscoggin river opposite Lewiston, 32 mi. N.E. of Portland; seat of Androscoggin county. The manufacture of shoes is the city's chief industry. With Lewiston, it forms an important industrial centre favoured by abundant water power. Auburn's large area, 66 sq.mi., includes four bathing beaches and other recreational facilities; and Taylor pond, a resort area, and Lake Auburn, source of the water supply for both municipalities, are within the city limits.

Settled in 1786, Auburn was incorporated as a town in 1842, rechartered as a city in 1869, and in 1917 was the first Maine city to adopt council-manager government. Pop. (1960) city, 24,449; Lewiston-Auburn standard metropolitan statistical area (Lewiston, Auburn, Lisbon town), 70,295. For comparative population figures *see* table in MAINE: *Population*. (Ro. Be.)

AUBURN, seat of Cayuga county, N.Y., U.S., in the heart of the Finger Lakes district, 25 mi. S.W. of Syracuse, on an outlet of Owasco lake, which lies 2 mi. S.E. (For comparative population figures *see* table in NEW YORK: *Population*.)

The manufacture of stationary and marine diesel engines is one

of the city's chief industrial enterprises. Other industries include the manufactures of molded plastics, rope, women's shoes, carpets and electronic components. The city is a centre of truck transportation.

The Auburn Theological seminary, chartered in 1819, was located there until 1939 when it merged with Union Theological seminary at New York city. The Seymour (public) library is housed in the Case Memorial building. The Auburn Community college, administered jointly by the Auburn board of education and the State University of New York, was founded in 1953.

The Auburn state prison, when it was built in 1816, embodied advanced ideas of prison construction and the Auburn system (solitary confinement by night, work in association during the day) received much attention from the penologists of Europe and the United States (*see* PRISON: *Silent System*). The hiring of prison labourers at low rates, a practice which was not abolished until 1882, attracted a number of industries in the 19th century.

Auburn was founded in 1793 by Col. John L. Hardenbergh on the site of a Cayuga village called Wasco, near the place where the Genesee trail crossed the outlet of the lake, and was first called Hardenbergh Corners. In 1805 it became the county seat and was incorporated in 1815. It was chartered as a city in 1848, and in 1920 adopted the commission-manager form of government.

On the summit of Fort Hill—once a stronghold of the Cayuga Indians—in the southwestern part of the city is a grass-grown earthwork on which stands a monument to the Cayuga leader Logan (b. 1725), an unswerving friend of the early settlers of the region. Auburn was the home of William H. Seward, Abraham Lincoln's secretary of state, and Enos Thompson Throop (1784–1874) who was the 12th governor of New York (1829–33). (V. C. C.)

AUBUSSON, PIERRE D' (1423–1503), grand master of the order of St. John of Jerusalem, famous for his defense of Rhodes against the Turks, was born of a noble French family. Very early in life he served the Austrians as a soldier of fortune against the Turks in Hungary. On his return to France, he became the friend of Charles VII's son, the dauphin Louis, whom he succeeded in making more obedient to his father. About the time of the fall of Constantinople to the Turks (1453) Aubusson joined the order of St. John of Jerusalem and in 1476 became grand master. The defense of Rhodes against the fleet of the sultan Mohammed II in 1480 made him famous throughout Europe. Later, however, when Jem, brother of Mohammed's successor Bayazid II (*q.v.*), took refuge in Rhodes, the grand master, though he had given Jem a safe conduct, nevertheless accepted a bribe from Bayazid and imprisoned Jem for six years and then handed him over to Pope Innocent VIII. Aubusson's reward was a cardinal's hat (1489) and the power to confer all benefices connected with the order without the sanction of the papacy. Subsequently he did much to restore discipline and zeal in his order and to strengthen its authority in Rhodes. He extirpated Judaism in the island by expelling all adult Jews and forcibly baptizing their children. He also tried to organize a large international crusade against the Turks, but in 1501, when he led an expedition against Mytilene, dissensions among his motley host rendered it abortive. His last years were embittered by chagrin. He died on July 3, 1503.

See D. Bouhours, *Histoire de Pierre d'Aubusson* (1676, 4th ed. 1806; extracts several times reprinted in the 19th century); G. E. Streck, *Pierre d'Aubusson . . .* (1872); and general histories of the order of St. John of Jerusalem. (MI. M.)

AUBUSSON, a market town in central France, lies on the Creuse river in the *département* of that name, 59 mi. N.W. of Clermont-Ferrand by road. Situated at 1,430 ft. it is near the northern edge of the plateau of Millevaches, the highest part of the Monts du Limousin. Pop. (1962) 5,343. Aubusson is famous for its manufacture of tapestries and carpets which employs more than 2,000 people. The industry dates back at least to the 16th century, and artistic standards are maintained by a national school of decorative arts, founded in 1869. Beauvais and Gobelins tapestries are still made there on handlooms. In the middle ages Aubusson was the centre of a viscounty; from the family of the viscounts was descended Pierre d'Aubusson (*q.v.*). (AR. E. S.)

AUCASSIN AND NICOLETTE, an early 13th-century *chantefable,* a story told in alternating sections of verse and prose, the former sung, the latter recited. It is considered by some to have Moorish and Byzantine sources.

Aucassin, son of Count Garin of Beaucaire, is in love with Nicolette, a converted Saracen slave who later proves to be the daughter of the king of Carthage(na). To keep them apart both are imprisoned, but Nicolette escapes and Aucassin, when released, joins her in the forest. They flee to Torelore (Aiguesmortes) and remain there for three years until captured by Saracens and carried off in two ships which are separated by a storm. Aucassin's ship is conveniently wrecked off Beaucaire (then a port) and, his parents being dead, he becomes count. Nicolette is taken to Carthagena and is recognized by her father. When, however, he wishes her to marry, she disguises herself as a minstrel, takes ship, returns to Beaucaire and marries Aucassin.

This work is known in a late 13th-century manuscript (Bibliothèque Nationale, fonds fr. 2168) with marked northeastern characteristics. Its northern French author excels in the depiction of youthful love, but reveals little taste for pure narration. He shows strong artistic and musical talent, a tendency to playful mockery and much human sympathy. While Nicolette is full of resourcefulness, Aucassin, "endowed with all good qualities," is merely a lovesick swain, lacking initiative, unfilial in his attitude to his parents, needing to be bribed to do his duty as a knight and defending his heritage absent-mindedly until faced with death; nor is he a very good Christian when he prefers hell with Nicolette and a gay company of sinners to heaven with ill-clad priests and the halt and the lame. These latter characteristics may explain the work's apparent lack of popularity in the middle ages, but it was sufficiently esteemed to be plagiarized in *Clarisse et Florent,* a continuation of the 13th-century *chanson de geste, Huon of Bordeaux.*

Floire et Blanchefleur, a romance of supposed Byzantine or Arab origin, known in two versions of the 12th and 13th centuries and in renderings in other European languages, including English, treats the same theme and is thought by some critics to have a common source with *Aucassin et Nicolette.* Here the roles and nationality (or religion) of the main characters are reversed. The 15-year-old Floire, son of a Saracen "king" of Spain, is in love with his childhood companion, Blanchefleur, daughter of a Christian slave of noble birth. Floire is sent away and his parents sell Blanchefleur to foreign slave dealers. Floire traces her to a tower where maidens destined for the emir of Babylon's harem are kept, induces the keeper to smuggle him inside in a basket of flowers and is discovered with Blanchefleur. Their judges, however, touched by their constancy, allow them to be married, and Floire takes his bride back to his kingdom, where he and all his subjects become Christians.

For both works consult R. Bossuat, *Manuel bibliographique de la littérature française au moyen âge* (1951) and *Supplément* (1955) under their titles. For *Aucassin et Nicolette* see editions by F. W. Bourdillon (1919) and Mario Roques (1925 and 1936). For *Floire et Blanchefleur* see editions by Margaret M. Pelan (1937) Bibliothèque Nationale, fonds fr. 375; Wilhelmina Wirtz (1937) Bibliothèque Nationale, fonds fr. 1447 and Felicitas Krüger (1938), both versions, all five manuscripts. There is an Eng. trans. by A. Lang (1887) and a modern French trans. by G. Michaut (1947). (F. J. WE.)

AUCH, a city of southwestern France, capital of the *département* of Gers, lies on and around a hill on the west bank of the Gers in the heart of Gascony, 45 mi. S. of Agen. Pop. (1962) 16,109. The town is divided into an upper and lower quarter joined by several flights of steps. Three bridges over the Gers link Auch with the suburb of Patte d'Oie. The old part of the town, which has some very narrow streets called *pousterles,* is centred on the Place Salinis from which the Escalier Monumental leads down to the river. On the north side is the cathedral of Sainte-Marie (1489 to 1662), one of the finest Gothic buildings of southern France. The chief features are the 113 Renaissance choir stalls of carved oak and the Renaissance stained-glass windows. The Greco-Roman façade dates from the 16th and 17th centuries, and the great organ (17th century) is one of the best in the world for the music of the time of Louis XIV. The 18th-century arch-

bishop's palace, with a 14th-century tower, adjoins the cathedral. Nearby are the museum of art and archaeology, the Gascon museum and the museum containing the archives of the *département* of Gers, a large library and collection of manuscripts. The prefecture, adjoining the cathedral, was once the palace of the archbishops of Auch. Tiles and tobacco are manufactured, while the chief trade is in Armagnac brandy, wine, cereals, poultry and *foie gras*.

Known in classical times as Elimberris, the city was the capital of the Celtiberian tribe of Ausci, and it became an important city of Roman Gaul. In the 4th century its bishopric was founded and after the destruction of Eauze it became the metropolis of Novempopulana. In 732 Saracen ravages forced the inhabitants to move their city from the right to the left bank of the Gers. The Benedictine abbey of St. Orens (of which little remains) was founded by Count Bernard of Armagnac in the 10th century, and the city was the capital of Armagnac in the middle ages. During the religious wars of the 16th century Auch remained in Catholic hands, except for a short occupation in 1569 by Huguenots under Gabriel, count of Montgomery. In the 18th century it was the capital of Gascony and the seat of a generality. Antoine Mégret d'Étigny, *intendant* from 1751 to 1767, did much to improve Auch and its commerce. The district was occupied for a short time in 1814 by British and Spanish troops. In World War II Auch was occupied by the Germans from Nov. 1942 to Aug. 1944.
(H. Po.)

AUCKLAND, GEORGE EDEN, Earl of (1784–1849), was governor general of India from 1835 to 1842. He was born at Beckenham, Kent, on Aug. 25, 1784, the son of William Eden, 1st Baron Auckland, to whose title he succeeded in 1814. In politics he was a consistent Whig and was president of the board of trade in Lord Grey's reform ministry (1830–34), and first lord of the admiralty under Lord Melbourne in 1834.

As governor general, Auckland was an excellent administrator; he extended irrigation, inaugurated effective famine relief, and adjusted the balance between oriental and European studies in India. He shared Lord William Bentinck's aim of expanding British trade and influence toward central Asia, and wanted a commercial treaty with the Afghan ruler, Dost Mohammed.

Forced to intervene in Afghanistan by Persian and Russian interference, Auckland chose to replace Dost Mohammed at Kabul by his rival, Shah Shuja (a move which would also prevent Afghan conflict with the British ally, Ranjit Singh). Auckland secured his communications with ruthless vigour—bullying, extorting money, and disregarding treaties as seemed expedient—and by 1839 Shuja was master of Kandahar and Kabul. For this victory, warmly welcomed in Britain, Auckland was created an earl (1839). But Shuja, lacking revenues, disciplined troops and personal popularity, depended on the British. They, with reforming or military zeal, interfered in Afghan administration. Their public reforms and private immoralities led to tribal revolts. Cuts in tribal allowances, which followed Auckland's orders to reduce the burden upon India's finances, transformed local risings into an attack upon the British forces in Afghanistan, and gross political and military blunders led to their destruction in 1841, during a winter retreat from Kabul. Auckland was recalled, when affairs were at their worst, in Feb. 1842.

He became first lord of the admiralty again in 1846, and died on Jan. 1, 1849.

See Janet Dunbar, *Golden Interlude: the Edens in India, 1836–1842*, with bibliography (1955). (J. B. Ha.)

AUCKLAND, WILLIAM EDEN, 1st Baron (1744–1814), English statesman, who, in 1786, negotiated with France the commercial treaty which usually bears his name, was born on April 3, 1744, the third son of Sir Robert Eden. He was educated at Eton and Christ Church, Oxford, and was called to the bar in 1769. Elected to the house of commons for Woodstock in 1772, he became undersecretary of state that same year, and successively commissioner of the board of trade (1776), commissioner of North America in connection with the dispute with the American colonies (1778), and chief secretary for Ireland (1780). He resigned this latter office in 1782, but he was for a short time joint vice-treasurer of Ireland in 1783. He strongly opposed the younger Pitt's proposals to establish free trade with Ireland in 1785, but agreed to go to France on a special mission relating to commerce (1785–87). Subsequently he was ambassador to Spain (1787–89) and to the Netherlands (1789–93). He was raised to the Irish peerage as Baron Auckland in 1789, and to the British peerage (with the same title) in 1793. In 1798 he joined Pitt's government as joint postmaster general. He attempted to dissuade Pitt from resignation in 1801 and himself retained office under Addington (afterward 1st Viscount Sidmouth) from 1801 to 1804. This terminated his friendship with Pitt and unlike some of his colleagues he was left out of Pitt's last ministry in 1804. In 1806 he was appointed president of the board of trade in Lord Grenville's ministry of All the Talents (the name given to the coalition government which came into office after the death of Pitt). He was never again in office after the dismissal of this ministry in 1807. He died at Beckenham, Kent, on May 28, 1814.

He had married in 1776 Eleanor Elliot, sister of the first Lord Minto. Of his large family, the most notable members were George, 2nd baron and earl of Auckland (*q.v.*), and Emily Eden (1797–1869), the novelist. The barony eventually passed to a younger son, Robert John (1799–1870), bishop of Bath and Wells who published his father's *Journal and Correspondence*, 4 vol. (1861–62), a useful source for the political history of the time.
(A. Al.)

AUCKLAND, the largest city and seaport of New Zealand, is situated on a narrow isthmus between the Waitemata harbour on the east and the Manukau harbour on the west coast of the North Island. Metropolitan Auckland consists of the city proper and more than 20 local authorities. Total pop. (1956) 381,063; (1959 est.) 413,100, 17.7% of the population of New Zealand. Total area about 95 sq.mi. Auckland has a temperate climate with a mean daily maximum temperature of 64.9° F., a mean daily minimum of 53.2° F. and an average annual rainfall of 48.9 in. The city is the administrative centre of the province of Auckland, which covers almost half the North Island and is rich in sheep, dairy pastures, forests and natural resources.

The land on both sides of the Waitemata harbour is undulating, broken intermittently with low hills, which are extinct volcanoes. Mt. Eden (643 ft.), once fortified by the Maoris (*q.v.*), and One Tree hill, the site of the grave of Sir John Logan Campbell, the "father of Auckland," are the best known.

The nucleus of the city, and the heart of the commercial and shopping area, is in and around Queen street, much of it on reclaimed land. Auckland has many fine public gardens, parks and reserves: Albert park (14 ac.), in the heart of the city, once the site of Albert barracks (the military post of the young colony during the Maori wars); Cornwall park (230 ac.), where Acacia cottage, Auckland's first wooden building (1842), is preserved; the zoological park (29 ac.); Ellerslie racecourse (30 ac.); and the Domain (194 ac.), containing winter gardens, sports fields, native bush and the Auckland War Memorial museum (1929, enlarged 1960). This museum has some of the finest Maori anthropological and ethnological exhibits in the world. The City Art gallery (1888), with its Frances Hodgkins collection, New Zealand paintings, 20th-century European sculpture and old masters, is the best in New Zealand. The public library (1887) is famous for its collection of manuscripts, incunabula and rarities given by Sir George Grey, its New Zealand and Maori collections and the comprehensive Reed Dumas collection. Each year the Auckland festival attracts artists from all parts of the world. Auckland university (1926), part of the University of New Zealand, includes the schools of architecture, engineering, fine arts and postgraduate obstetrics and gynecology. There are also two teachers' training colleges and more than 150 schools and colleges.

In 1957 nearly one-third of the overseas liners visiting New Zealand (from Great Britain, Canada, the United States, the far east, Australia) arrived in Auckland. The Waitemata, an arm of the Hauraki gulf, is a broad, deep, natural harbour, completely sheltered by an outlying chain of islands and dominated by the symmetrical volcanic island of Rangitoto (854 ft.). There are 27,301 ft. of good berthage, 14,789 ft. being available for overseas shipping. On the northern side of the Waitemata are Calliope

graving dock, which can take ships up to 595 ft. in length, and the chief New Zealand naval base and dockyard. Although the Manukau harbour, on which is situated the port of Onehunga, is larger and nearer to Australia, it is suitable only for small coastal vessels because of the bar at its entrance. One-third of New Zealand's total exports (dairy products, frozen meat, scrap iron, wool, hides, tallow, wood pulp) and nearly half of the total imports (petroleum, manures, iron and steel, wheat, sugar, motor vehicles, fresh fruit) passed through the seaport of Auckland in 1957. Whenuapai airport, 22 mi. N.W. of the city, provides services to Australia, Fiji, Great Britain, the United States and many other countries. Road, rail, air and sea transport link Auckland with the rest of New Zealand, while diesel and trolley buses ply between the city and the suburbs. A landmark on the skyline is the four-lane, 3,348-ft.-long toll bridge, opened in 1959, which spans the Waitemata harbour and links the rapidly growing north shore suburbs with the city.

Modern business establishments and large department stores provided employment for about one-third of the working population of Auckland in 1958. There was great industrial development during the 1950s and by 1959 Auckland, the major manufacturing centre of New Zealand, was employing 30% of all industrial workers and producing 29% of the total manufacturing output. The chief industries are engineering, motor assembly, timber and allied products, chemical products, freezing and fertilizing works, food manufacture, breweries, sugar refining, footwear, clothing and textiles, tanneries, plastics, and brick and cement works.

Founded in 1840, and the capital of New Zealand until 1865, Auckland has developed from a government store, a few traders' tents and a "sea of fern" to the largest and most vigorous city of the country.

See A. W. Reed, *Auckland, City of the Seas* (1955). (R. D.)

North Auckland Land District embraces the Auckland-Northland peninsula north of the southern fringe of the Franklin county and the lower reaches of the Waikato river. Dairy farming, fruit growing (at Henderson and Keri Keri) and market gardening (at Pukekohe) are the principal rural industries, but this district has a large urban population centred on the Auckland metropolitan area (448,218) and Whangarei (21,773). The concentration of industrial activity on the Tamaki isthmus is the greatest in New Zealand. The Bay of Islands was the centre of early European contacts before 1840 and Russell was the first capital of the infant colony. Kauri timber and kauri gum were for many years the economic mainstays of the district.

South Auckland Land District embraces regions popularly known as the Waikato, Coromandel, the Hauraki plains, the King Country, the Bay of Plenty and the Volcanic plateau. Hamilton (pop. [1961] 50,433) is the largest urban centre and the commercial and transport focus of one of the world's most intensive and productive dairying areas. Rotorua (25,074) and Tauranga, with Mt. Maunganui (24,759), a new and fast growing port, serve the Bay of Plenty and the new timber industries on the Volcanic plateau. Thames (5,314) was in the middle of the 19th century the centre of gold mining and heavy engineering industries and one of the five largest towns in the country. Huntly is the centre of an important coal mining district. (K. B. C.)

AUCKLAND ISLANDS, a group of uninhabited islands in the southern Pacific ocean about 200 mi. S. of New Zealand in 50° 32′ S., 166° 13′ E. They cover about 234 sq.mi. and were discovered in 1806 by Captain Bristow. The islands are of volcanic origin. They were granted to a private company by the British government as a whaling station, but the establishment was abandoned in 1852. The islands belong politically to New Zealand, which maintains there a depot of food and clothing for shipwrecked sailors.

AUCTION. The auction has long been an effective marketing institution for the purchase and sale of real and personal property at a reasonably fair price. An auction usually involves open public bidding, preceded by an inspection by prospective purchasers of the items to be auctioned. The inspection period enables buyers to evaluate various lots, determine comparative grades or qualities, and arrive at a reasonable price to offer at auction time. Normally, the auctioneer is the agent of the seller. Auction sales are subject to a great variety of regulations stemming from custom, common law and statutes.

The traditional auction process involves a succession of increasing bids or offers by potential purchasers. Competitive bidding ceases when the highest bid is accepted by the auctioneer and the property to be sold is, by the fall of the auctioneer's hammer, "knocked down" to the successful bidder. Unless the auction is advertised to be "without reserve" the auctioneer may withdraw goods without accepting the highest bid or offer. On the other hand, a bid may be withdrawn at any time before it is accepted by the auctioneer. A Dutch auction is conducted somewhat differently. The seller, through the auctioneer, offers property at successively lower prices until one of his offers is accepted or until the price drops so low as to force the withdrawal of the offered property.

Types of Auctions.—The F.O.B. auction is usually a telegraphic auction where bids are received by wire on carloads of fruits and vegetables. Such bids are received by the auctioneers simultaneously over leased wires from individual or assembled buyers in various parts of the country. There have been fruit auctions in the United States since the middle of the 19th century, and their continued existence helps maintain the flow of fresh fruits and vegetables into major metropolitan areas.

In the United States the loose leaf tobacco auction has been a fairly constant method of purchase and sale of tobacco. At such an auction each grower's lot, usually piled separately from the lots of other growers, is placed in flat baskets. This method of display permits the buyer to identify and to evaluate each lot. Loose leaf tobacco auctions have been especially helpful to the small growers of tobacco, who may sometimes be in a weak bargaining position, because they tend to equalize prices between markets and between similar lots of loose leaf tobacco shipped into the same auction market.

Items other than tobacco that are frequently sold at auction include secondhand household goods, used farm equipment, collections of art objects (*see* Art Selling) or curiosities, antiques, stamps, rare books and unclaimed baggage. In a sense, the great exchanges where commodity futures and securities are bought and sold resemble auctions. On the New York stock exchange, for example, floor traders make bids to buy securities and offer securities for sale. Whenever a bid and an offer coincide, a transaction takes place.

History.—In Europe in earlier centuries trade auctions were regularly held to dispose of products, especially those imported from the colonies. This was particularly true of imports such as wine and leather. The history of European auctions clearly indicates the extent of such transactions, especially in London, Amsterdam and Hamburg. It was not until the Industrial Revolution that processed raw materials, such as cotton goods, found their way into the various auction markets of Europe. Such products became major trade items between countries and played a very important role in the development of the mercantile system.

Auctions provided an exceptionally rapid and effective means of disposing of goods, especially perishable products. In the European markets it is recorded that fruit was shipped from countries such as Italy, Cuba, Spain, the Netherlands and the West Indies into the wholesale auction markets in major cities. This practice was ultimately adopted in the American colonies following the establishment of cities such as Boston, New York and Philadelphia.

The earliest record of an auction in the American colonies is an application filed to hold a sale in New Amsterdam in 1662. Details of other 17th-century auctions are meagre but become fuller after 1700. Most information comes from newspaper announcements of sales, printed broadsides and catalogues of sales. Two comprehensive lists of all known American auction catalogues were published by the New York Public library, George Leslie McKay's *American Book Auction Catalogues, 1713–1934* and Harold Lancour's *American Art Auction Catalogues, 1785–1942*. Together they account for nearly 20,000 sales. But a great many sales such as the "country auctions" of today did not have printed catalogues.

The earliest auction catalogue extant was for a sale of the books of Ebenezer Pemberton at the Brown coffee house in Boston on July 2, 1717. For most of that century Boston remained the important auction centre. Auctioneers themselves were specialists who would conduct a sale for a set fee or for a stated percentage of the receipts. Gradually individual auctioneers in Boston, Philadelphia and New York gained sufficient prestige and business success to establish firms with their own auction rooms.

Over the years it became clear that for a product to be successfully auctioned it should possess certain characteristics:

1. A reasonably constant supply of the given product (such as fruits and vegetables) in season.
2. Relatively easy grading according to established standards of quality.
3. Uniform packaging or uniform size lots. (Whether they be small lots or carload quantities makes little difference.)
4. Consistent with the above, auction products would normally have to arrive at the auction point in a sufficiently large quantity to permit easy handling at relatively low cost.

Auction points, both in the United States and abroad, were normally located near transit terminals. Following the development of the railroad in the 19th century and of the long-haul truck in the 20th century, the auctioneer would obtain car manifests, or otherwise prepare lists, and would advertise them for the information and guidance of the buying public. This enabled the auctioneer, assuming a relatively constant flow of goods, to schedule regular auctions, provide for inspection and conduct his auction at stated times and places.

Aside from commodities and real estate, the auction also served as a means for transferring ownership of slaves. There are evidences of slave auctions in Greek history on a fully established basis during the Homeric period. The practice persisted through the early period of Christianity into the period of the modern slave trade, which developed about the time of the decline of serfdom. The Spaniards engaged in the slave trade, selling slaves in the markets at Seville through transactions similar to that of the auction. English slave traders brought slaves into the American colonies where they were frequently sold at auction to the tobacco planters. American colonial ship owners also engaged in the slave trade.

Auction procedures and customs have varied over the years. It was once common practice to bid until a candle burned an inch or went out, until a sandglass ran out, or until a running boy reached his goal. The last bidder became the successful purchaser. More recently the fall of the auctioneer's hammer, when the auctioneer believes he has reached the peak bid, has become the customary way of signifying a sale. Following a sale, but usually for only a limited time, the auctioneer binds the purchaser by signing on his behalf the memorandum of agreement.

Auctions have usually been conducted by individuals who are licensed auctioneers or by auctioneering companies and their agents. Property to be auctioned is often described in writing. Chattels may be described in a catalogue, or through posting a list, such as a car manifest, and real estate may be described in a document known as the particulars of sale. Such descriptions state the terms of sale and set forth the relative rights and liabilities of the parties to the sale.

Laws and Regulations.—Originally, auctions were regulated by custom, but as the common and statutory laws of sales and contracts developed, auction transactions were made subject to them. In Europe, especially in England, legislation developed to control fraud and abuse. The English Auctioneers act of 1845 required the annual licensing of auctioneers and required them to exhibit at the auction, a board showing the name and address of the auctioneer. The Sale of Land by Auction act of 1867 contained certain provisions about reserve prices and biddings in the sale of land (including buildings). Similar provisions about auction sales of chattels and livestock were contained in the Sale of Goods act of 1893. The Auctions (Bidding Agreements) act of 1927 rendered it a criminal offense for dealers in goods to take part in what is popularly known as a "ring" or an agreement for a "knock-out." The latter is an agreement between dealers not to bid against each other, in order that one of them may obtain the articles at a low price; the resulting profit is then divided among those taking part. A copy of the 1927 act must be exhibited at auction sales.

Professional Organization.—Systematic arrangements are made in England for the training and professional welfare of auctioneers and estate agents. The beginnings of professional organization can be traced to the end of the 18th century when the Select Society of Auctioneers, which still exists as a dining club, was formed at the Piazza coffee house on May 20, 1799. At mid-20th century the senior professional institution representing auctioneers and estate agents was the Chartered Auctioneers' and Estate Agents' institute. Another body representing auctioneers was the Incorporated Society of Auctioneers and Landed Property Agents.

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(J. M. WT.; J. W. CZ.)

AUCTION BRIDGE: *see* BRIDGE.

AUCUBA, a small genus of the dogwood family (Cornaceae) containing the familiar Japanese laurel (*Aucuba japonica*), grown in frost-free places or in cool greenhouses. It bears male and female flowers on distinct plants; the red berries often last until the next season's flowers appear. A variegated form is the gold-dust tree.

AUDE, a *département* of southern France, formed in 1790 from part of the ancient province of Languedoc (*q.v.*), is separated from Spain by Rousillon (*département* of Pyrénées-Orientales) and lies southwest of Hérault in the plain of Languedoc. Area 2,406 sq.mi. Pop. (1962) 269,782. From the coast of the Gulf of Lions it extends inland into the Gate of Carcassonne, between the Montagne Noire portion of the Massif Central and the outer ranges of the eastern Pyrenees, including the Corbières massif. Both these flanking highlands rise to about 4,000 ft. Most of the *département* lies within the drainage basin of the Aude river, but it extends westward beyond the watershed (col de Naurouze) into the basin of the Garonne river. Since 1685 the Canal du Midi has connected the Mediterranean with the Atlantic through this gap. The railway from Toulouse to Narbonne bifurcates northward to Béziers and the Rhône valley and southward to Perpignan and Spain. The regular, sand-dune coast is backed by extensive lagoons, notably those of Sijean and Leucate. La Nouvelle is an artificial port, formed by cutting a passage through the sandspit for the Canal de la Robine, a branch of the Canal du Midi, which serves Narbonne. (*See* MIDI, CANAL DU.)

The lowlands of Aude have a typical Mediterranean climate, with notably mild winters and hot, sunny, dry summers, and the olive is grown as far west as Castelnaudary. The lowlands are very largely devoted to growing vines, which are now virtually the only crop, producing vast quantities of cheap wine. Minervois, the limestone foreland of the Montagne Noire, is part of the vineyard country. Mineral resources are comparatively unimportant, the chief being the sulfur of Le Malvezy, near Narbonne, and the iron ore of Leucate on the coast. Quillan, a Pyrenean foothill town in the Aude valley in the southwest, has become an important centre for the manufacture of plastics. Carcassonne (the capital), Narbonne (*qq.v.*) and Limoux give their names to the three constituent *arrondissements*. They are rich in historical and architectural interest, especially Carcassonne, where the Cité, encased in its ancient fortifications on a defensive hill site, overlooks the later, planned town of the 13th century across the Aude river. The *département* forms the diocese of Carcassonne, and comes under the court of appeal and the *académie* of Montpellier. (AR. E. S.)

AUDEN, WYSTAN HUGH (1907–), English-born poet, one of the most consistently interesting and variously gifted poets of the mid-20th century, was born on Feb. 21, 1907, at York. He was educated at Gresham's school, Holt, and Christ Church, Oxford. For a time a schoolmaster, he soon began to earn his

living as a writer. In 1935 he married Erika Mann. Throughout the 1930s he was deeply involved in social and political considerations; his central concern has always been man in society. For him, and for those others who are sometimes called "the Auden group," T. S. Eliot's philosophical attitudes were often unattractive; but his—and Gerard Manley Hopkins'—poetic examples were respected. In this decade—see especially *Look Stranger* (1936) and *Another Time* (1940)—Auden's best verse mirrors with epigrammatic pungency the current social and psychological unease. Only one of the three plays he wrote in collaboration with Christopher Isherwood, *The Ascent of F. 6* (1936), is worth much attention; but then, as later, he wrote some excellent lyrics. In 1937 he received the king's medal for poetry.

The religious foundation of all Auden's thinking was plain by 1940, by which time he had settled in the United States (he subsequently adopted U.S. citizenship). Four long and uneven poems first showed this basis directly, the last, *The Age of Anxiety* (1947), being the most ambitious. In 1956 Auden was made professor of poetry at Oxford though his home remained the United States. His most striking later development was in symbolic landscape poetry, sometimes with a syllabically counted line (*see* "In Praise of Limestone" in *Nones*, 1951).

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AUDE RIVER, of southwest France, is 138 mi. long, with a basin of 2,062 sq.mi., rises in the eastern Pyrenees near the Pic de Carlitte and flows into the Gulf of Lions. The upper course is through deep gorges (except near Axat) and is harnessed for hydroelectric power. Below Carcassonne its course, from north, turns due east, skirting the Corbières, to enter the Mediterranean about 12 mi. E.N.E. of Narbonne. The Aude gap, between the Pyrenees and the Montagne Noire, was one of the great historic thoroughfares of western Europe.

AUDIENCE, usually an assembly of hearers (Lat. *audire*, "to hear") or spectators, often designates the formal interview which a spiritual or temporal ruler grants to an inferior and, more particularly, the ceremonial presentation of credentials by ambassadors or others to a sovereign.

The pope holds audiences with all grades of ecclesiastical and lay dignitaries, besides giving private, semiprivate and public audiences to ordinary persons.

In Great Britain, audience is the right of access to the sovereign of peers individually and of the house of commons collectively. The audience court, now merged in the court of arches, was an ecclesiastical court of the archbishops of Canterbury and York.

In France, *audience* is the sitting of a law court for hearing actions. In Spain, the *audiencia territorial* is a regional high court and the *audiencia provincial* is a court of first instance for criminal offenses. The Spanish American court called *audiencia pretorial* allowed appeals only to the council of the Indies in Spain.

AUDIFFRET-PASQUIER, EDME ARMAND GASTON, DUC D' (1823–1905), French statesman, prominent in the early years of the third republic, was the nephew and adoptive son of the baron Étienne Denis Pasquier (created Duc Pasquier in 1844). Born in Paris on Oct. 23, 1823, he served as commissioner (*auditeur*) at the *conseil d'état* from 1845 to the revolution of 1848. Under the second republic, as an Orleanist, he lived in retirement. During the second empire he was elected a member of the *conseil général* of the Orne *département*, but failed at the general elections of 1863 and 1869. Elected to the national assembly as member for Orne in Feb. 1871, he attracted attention as a forceful critic both of the fallen imperial regime and of the Government of National Defense. He became chairman of the right centre group in 1873 and was elected vice-president of the national assembly in 1874. After the fall of Thiers in May 1873, Audiffret-Pasquier conducted the negotiations between the two royalist groups, the Legitimists and the Orleanists, with a view to reestablishing the monarchy in France and so was partly responsible for the failure of the project when the comte de Chambord (*q.v.*) tried to insist on the white flag of the old regime instead of the tricolour. Yet he retained the confidence of the assembly and was its president when, in 1875, the new constitution was adopted. From 1876 to 1879 he was president of the senate. In 1878 he was elected to the French Academy. He died in Paris on June 4, 1905. (JE. V.)

AUDIO FREQUENCY, a frequency in the band corresponding to normally audible sound waves. The upper limit ordinarily lies between 10,000 and 20,000 cycles. The lower limit is about 16 cycles. *See* also HEARING: *Phenomena of Hearing*.

AUDIO-VISUAL EDUCATION commonly denotes methods used in formal teaching, but the principles are applied also in business and industry, the armed services and to some extent in the field of mass communications.

Materials commonly considered audio-visual include objects and models; diagrams, charts, graphs, cartoons and posters; maps and globes; pictures, slides and other projected transparencies; filmstrips (slide and slide-sound films), recordings, transcriptions and tapes; motion pictures (silent and sound); radio and television. Facilities include the blackboard; bulletin (tack) board; display cases, tables and areas; museums; flannel boards and electric boards. Audio-visual equipment includes picture projectors of many kinds, record players, tape recorders, equipment and facilities for recording and broadcasting, and the various types of equipment used by teachers and pupils in the preparation of instructional materials, such as photographic equipment, dry mounting presses and stenciling and lettering devices. Such activities as field trips and the use of resource people are usually considered part of audio-visual programs, and even demonstrations, dramatizations, experiments and creative activities are sometimes included.

The purpose of audio-visual education is to improve learning. Educators have come to recognize that traditional methods of teaching by lecture and textbook frequently result in students memorizing meaningless facts without actually learning. It has been determined that the most effective learning takes place when the individual has direct experience with the subject under study, "learning" being defined as "changed behaviour." In other words, a student learns best by doing. Not all subject matter, however can be taught through direct experience. Hence, there is need for instructional methods and materials that provide an effective substitute for direct experience.

A number of investigators have found that the use of audio-visual materials, together with textbooks and other devices, makes an improvement in students' performance that is statistically measurable by testing procedures. Educational theorists point out that perception is largely visual experience, reinforced by the auditory and other senses. This phenomenon suggests that experiences rich in visual stimuli should evoke the strongest responses in a classroom or other learning situation, as well as in other kinds of human activity. Thus, the audio-visual mediums can contribute to the creation of more meaningful learning experiences. In particular, in the study of any real life phenomenon or situation where vision is important, the motion picture comes closest to simulating actual experience.

Audio-visual education as a systematic method of teaching is a development of the 20th century, but throughout history man has shown a natural inclination to learn and to teach with pictures, specimens, demonstrations and the like. Johann Amos Comenius (*q.v.*), a Czech educator, was one of the first to record a stated philosophy of audio-visual education. His *Orbis sensualium pictus*, published in 1658, was profusely illustrated with drawings, each playing an important role in teaching the lesson at hand. Comenius was followed by other great educators, including Rousseau, John Locke and J. H. Pestalozzi, who advocated the use of sensory materials to supplement words in teaching.

The problem of perception by visual, auditory or other sensory experiences has been a subject of investigation since the beginnings of experimental psychology. Research in the use of audio-visual materials had its beginnings before 1920 and developed rapidly after 1929. Among the earliest experimental studies of the influence of motion pictures upon learning were those of D. R. Sumstine (1918) and J. V. Lacy (1919). J. J. Weber (1922) investigated the comparative effectiveness of several visual aids.

and V. C. Arnspiger (1933) was one of the first to measure the effectiveness of sound motion pictures. By and large, however, the research of unsubsidized individuals proved less effective than that of co-ordinated and subsidized teams of specialists, such as those that carried on the Eastman studies (B. D. Wood and F. N. Freeman, 1929), Yale University studies (D. C. Knowlton and J. W. Tilton, 1929), Harvard studies (P. J. Rulon, 1933), the Payne fund studies (W. W. Charters, 1933) and the American Council on Education studies (1936–42).

During and after World War II the wide use of audio-visual materials by the armed services provided opportunity for extensive investigation of audio-visual materials, methods and administrative practices. The study reported by C. I. Hovland *et al.* in *Experiments on Mass Communication* (1949), in which the effects of the *Why We Fight* films were investigated, clarified some areas in which the previous evidence was conflicting, and provided data on the problem of changes in opinion. A study reported by J. J. Gibson, *Motion Picture Testing and Research* (1947), proved of general value to film users and producers, and a series of research studies reported by C. F. Hoban, Jr., emphasized the need for trained personnel and an organized program to promote the use of audio-visual materials. By the second half of the 20th century, close to 200 research studies had explored the teaching effectiveness of audio-visual materials. Much of this study was made possible by the continuing interest and support of the armed services. It was further stimulated, however, by the growth of interest in teaching by television, which received support from the Ford foundation and other organizations.

Edgar Dale and Hoban stated that research supported the following claims for the effectiveness of audio-visual materials properly used in teaching (W. S. Monroe [ed.], *Encyclopedia of Educational Research*, p. 1323, Macmillan, New York, 1941).

(1) They supply a concrete basis for conceptual thinking and hence reduce verbalistic response of students; (2) they have a high degree of interest for students; (3) they supply the necessary basis for developmental learning and hence make learning more permanent; (4) they offer a reality of experience which stimulates self-activity on the part of pupils; (5) they develop a continuity of thought; this is especially true of motion pictures; (6) they contribute to growth of meaning and hence to vocabulary development; (7) they provide experiences not easily secured in other materials, and hence they contribute to the depth and variety of learning.

Evidence indicates significant gains in informational learning, retention, recall, thinking, reasoning, interest and imagination, and better assimilation and personal growth when audio-visual materials are properly used. Best results are achieved when a variety of audio-visual materials, printed materials and follow-up experiences are used together. Experiments have shown that good films can teach a body of subject matter efficiently, but that films cannot replace the teacher. Thus, where thoroughly qualified teachers are unavailable, specially designed films, properly administered, can do an effective job of teaching. It is recognized, however, that the best teaching is accomplished by highly qualified teachers using educational films and other modern audio-visual tools of instruction.

Audio-visual materials have proved effective in all areas of learning, in all subject-matter fields and at all ages. Where effectiveness is tested in terms of verbal responses to information tests, films seem to be relatively more effective for mediocre pupils; but where effectiveness is tested in terms of ability to make verbal generalizations, films are more effective for bright pupils.

United States.—Pictures, book illustrations, maps, globes, charts, specimens and models were recognized adjuncts to teaching long before the term audio-visual was conceived. However, it was not until the turn of the 20th century that organized programs of visual instruction began to emerge. An early development was the co-operative arrangement between city school systems and local museums. In 1905 the first school museum was started in St. Louis, Mo., followed during the next few years by school museums in Cleveland, O., Chicago, Ill., and Reading, Pa. By 1923 many larger school systems had departments of visual instruction.

The visual material provided in early school museums consisted of drawings, paintings, photographs, stereographs, lantern slides, models and displays of various kinds. School libraries of visual materials still provide most of these types of visual aids. Although the early $3\frac{1}{4} \times 4\frac{1}{4}$ in. slide gave way in later years to the smaller, more convenient 2×2 in. slide, transparencies are still used in cases where teachers, and even students, desire to produce their own hand-made slide materials, especially for use with the overhead projector.

By far the most widely used of still picture materials is the filmstrip (a series of still pictures on 35-mm. film, usually with captions, projected one at a time), introduced during the early 1920s. Teachers have found the filmstrip an effective teaching tool—inexpensive and easy to use.

The phonograph record was early recognized as an important teaching device, particularly in music education. In later years the recording of drama, poetry and stories became common. Disk and tape recorders are also used, primarily by teachers of music, speech and foreign languages.

The potentialities of education by radio were recognized within a year after the first commercial radio broadcast in 1920, but effective educational radio did not begin until a decade later. A number of universities licensed their own stations; local stations and networks developed educational programs; and radio receivers appeared in classrooms. Increasing numbers of school systems operated low-power FM radio stations that broadcast programs directly to classrooms; and educational television stations developed programs for classroom audiences.

Probably the motion picture is the most dynamic of all the audio-visual mediums. While the potential value of films for use in education was early recognized, schools were slow to make wide use of them. Much impetus for organized visual education in the early 1920s resulted from World War I experience with motion pictures. J. R. Bray's techniques in using animation, which he applied to teaching films, were successfully used in the armed services and in classrooms. Progress in the use of films was retarded in part by technical problems, but the audio-visual idea received added stimulus in 1923 with the introduction of the relatively lightweight and portable 16-mm. projector and 16-mm. safety film. Pioneer efforts in the production of classroom films were the Yale Chronicles of America photoplays and the Eastman silent films. In 1929 the Western Electric company organized a company to produce sound classroom films for the few 35-mm. sound projectors then used in U.S. schools. This company, Erpi Classroom Films, Inc., developed a program of classroom film production and later produced films independently as Encyclopædia Britannica Films Inc. In the early 1930s the 16-mm. sound projector and film were introduced and became the standard for the educational field.

By the mid-1930s the findings of research and the waning of the great depression stimulated a decided growth of the audio-visual field. By 1940 an estimated 10,000 schools had acquired 16-mm. sound motion-picture projectors; hundreds of school systems and universities had established libraries of audio-visual materials. *Educational Screen* (established in 1922) weathered the depression, and other publications were launched. Audio-visual conferences and workshops rapidly became a potent force in the movement.

Entrance of the United States into World War II demanded the immediate training of a very large number of men and women who had to learn new skills, to gain new knowledge and to be imbued with new attitudes. Every resource of mass communication was assembled. The army and navy each established extensive facilities for the production and utilization of motion pictures, filmstrips and other audio-visual materials, and brought together specialists in education with specialists in motion-picture production and other communications methods.

The navy alone made or supervised the making of 3,300 motion pictures and filmstrips in a period of $3\frac{1}{2}$ years during the war, and more than 10,000 different film titles were used in its training program. Twenty-five hundred motion pictures were made for the army film program.

Most of the materials produced and distributed by the armed services were designed to teach mechanical skills, ranging from

how to assemble a rifle to how to navigate a ship, but extensive experiments also were made with the use of films and other materials to shape attitudes.

After World War II there was a steady increase in the use of audio-visual materials in the schools of the United States, as well as in industrial training programs. The success of the armed services with audio-visual methods of teaching provided an important incentive. However, the chief stimulus in the second half of the 20th century was the fundamental change in educational philosophy and teaching methods. Increasing numbers of teachers embraced the philosophy that learning is improved if the written and spoken word is supplemented by related experiences. The education departments of most universities and colleges offered courses in the use of audio-visual materials, some of them at the graduate level. A number of the state universities and teacher training institutions assembled libraries of motion pictures and other materials to serve schools on a state-wide and regional basis. Some went into the production of films and other materials, including kinescopes for educational television.

In the second half of the 20th century, most schools and school systems of any size owned motion-picture or filmstrip projectors, tape machines, record players and other equipment, though few were adequately equipped according to generally recognized standards. A survey of audio-visual education in urban school systems made by the U.S. department of education reported a ratio of approximately 24 motion-picture projectors for each 10,000 students. The number of film libraries providing materials to schools was approaching 4,000 and was increasing steadily. There were about 20,000 available motion pictures and filmstrips on subjects taught in the school curriculum, and new materials were being added at the rate of several hundred new titles each year.

In most schools the audio-visual program is directed by a member of the teaching staff especially trained in the use of these materials or by the librarian. In larger city and county school systems the program is supervised by an audio-visual director from a centre equipped and staffed to serve the entire system. School budgets include appropriations for the audio-visual program, and most state departments of education have appointed audio-visual staff specialists. By the 1950s a number of states had adopted a policy of allocating funds specifically to the audio-visual program, and in the National Defense act that became law in 1958, the federal government appropriated funds for research and experimentation in more effective utilization of television, radio, motion pictures and other mediums for educational purposes. Activities in this field of education were co-ordinated nationally through the Department of Audio-Visual Instruction of the National Education association, the National Audio-Visual association, the National Association of Educational Radio and Television Broadcasters and the National Association of Educational Broadcasters.

Great Britain and the Commonwealth.—Audio-visual programs were well established in many British schools by the second half of the 20th century, and most colleges that trained teachers offered courses in this field. As early as 1923 the Imperial Education conference had established a committee to investigate the evidence that the film could be a valuable teaching aid. Its report led to establishment of a film commission in 1929 whose findings in turn led to the creation of the British Film institute (with its Scottish counterpart, the Scottish Film council). Survey and guidance assistance by these organizations was a major factor in the growth of the use of films in British schools.

During World War II the British government's information films for civilian and military use generated new interest in films and other audio-visual materials. After the war the field developed rapidly. After 1946 national guidance was provided by the National Committee for Visual Aids in Education, which co-ordinated the needs of teachers with available production facilities. After 1948 a second national organization, the Educational Foundation for Visual Aids, arranged for production of films requested by the national committee, distributed them, sold and rented non-sponsored educational films and filmstrips and all makes of projectors.

Many British educators tended to classify films as either background or lesson films. Background films are directed toward extending the student's experience beyond the confines of the classroom. Documentary films (especially on contemporary life) are considered suited for use as background films, and the documentary film movement in Great Britain had an important influence on the use of films in education. Lesson films are designed to correlate directly with the curriculum. For many years British educators were inclined to favour silent films and filmstrips on the ground that these allow the teacher to provide his own commentary based on specific lesson objectives and the understanding of his students. In later years the increasing availability of sound films led to their greater use. A notable development was experimentation with the "visual unit," a package of audio-visual materials dealing with a particular subject. This might include charts, records, still pictures, films and other materials combined to provide the teacher with a complete teaching program. A widely used program of radio broadcasting to classrooms was developed by the British Broadcasting corporation.

In Canada the use of films received special stimulus through the work of the National Film board of the federal government, but the audio-visual program was independent of that agency. Each Canadian province appointed an audio-visual director who worked through the provincial department of education; each province operated a film library for use in its school system and made use of other aids, such as pictures, wall charts, dioramas, stereographs and radio and television broadcasts. Many school districts set up and maintained visual aids libraries supplementary to those supplied by the departments of education.

The history of audio-visual education in Australia and New Zealand is somewhat similar to that of Canada. After 1945 the Australian National Film board followed the Canadian pattern. Most of the dominions and colonies of the British Commonwealth had established visual aid departments and educational film libraries by the 1950s, and the production, distribution and use of classroom films, filmstrips and other audio-visual aids became an integrated and accepted part of the educational system.

Other Countries.—The centrally regulated educational systems in continental Europe are not conducive to the growth of the use of audio-visual teaching materials. While efficient in broad curriculum planning, national ministries of education are at a disadvantage when dealing with needs and opportunities in individual schools. Maps, bulletins, charts and blackboards have been traditionally used by European teachers in all grades, but filmstrips and films have been slow to follow because of lack of funds, conservative teaching policies and lack of electrification. Some small countries, such as Denmark and Hungary, used silent films in the first quarter of the 20th century, and Germany and France sponsored ambitious experiments with films in science and geography. Switzerland, capable of utilizing films from the large countries surrounding it, organized a program, but it took root slowly because of conservative teaching practices. Sweden and Norway became the two European countries with the largest number of sound films in proportion to their student populations. Denmark used silent films predominantly through the 1950s. After World War II France began rebuilding its program of sound films, especially for the lower grades; Italy also set up an audio-visual educational program, and film libraries were established in Belgium and the Netherlands. In all these countries the use of silent filmstrips was expanded faster than the use of motion pictures, with France, Germany and the Scandinavian countries leading with the largest numbers of filmstrips in their school catalogues. Among other countries, India established an exceptional program. Audio-visual materials of many types were used extensively in the Fundamental Education program with the help of teams from the United Nations Educational, Scientific and Cultural organization. The program, as developed by UNESCO, was planned to make available in educationally underdeveloped areas of the world functional knowledge for the improvement of agricultural production, health and sanitation, community organization and local industries and crafts, and for the reduction of illiteracy. As an outcome of two UNESCO conferences on international film exchanges, held in

Tangier and Paris, the International Centre of Films for Children was established with headquarters in Brussels, Belg.

See also MOTION PICTURES: *Educational Films;* TELEVISION: *Closed-Circuit Television.*

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AUDIT, an investigation of an activity by someone not connected with it to determine whether it is being carried on in conformance with its objectives. Professional auditing involves the examination of the activities, records and reports of the enterprise by accounting specialists who are not the same accountants responsible for their preparation. An auditor is one who plans or participates in such investigations.

Perhaps the most familiar type of auditing is the administrative or pre-audit, which consists of investigating individual vouchers, invoices or other documents for accuracy and proper authorization before they are paid or entered in the books. Internal auditing is a relatively new type of auditing and is designed primarily to meet the needs of management. Internal auditors try to determine whether the requirements of the accounting system are being met effectively and also whether the system itself is adequate for management needs. Thus internal auditing, according to the Institute of Internal Auditors, is a means of managerial control that operates by appraising the effectiveness of other controls.

Public auditing by independent accountants has acquired professional status and has become increasingly popular with the rise of large business units and the separation of ownership from control. The public accountant performs sufficient tests and examinations to determine whether the management's statements fairly present the firm's financial position and operating results. Unbiased, independent evaluations of management reports are of interest to actual and prospective shareholders, bankers, suppliers, employees, lessors and governmental agencies. In all English-speaking countries public auditors are usually certified, and high standards are encouraged by professional societies. (*See* CERTIFIED PUBLIC ACCOUNTANT.) The American Institute of Certified Public Accountants, the Institute of Chartered Accountants in England and Wales, and similar groups in Australia, New Zealand and Canada have developed standards for independence and competence, for appraising internal controls, for establishing evidence to support opinions, and for reporting.

In the United States the auditing of federal accounts is administered by the comptroller general, who is the head of the general accounting office, an agency independent of the executive branch of the government and responsible directly to congress. This agency was created in 1921 to be responsible for auditing receipts, expenditures and use of public funds. Most states conduct the audit function through comptrollers' offices, but many municipal and many county units make use of independent accounting firms. In the British Isles the Exchequer and Audit act of 1866 empowers the sovereign to appoint a comptroller and auditor general to examine the accounts prepared by the departments of public service. In practically all European countries there is a department charged with auditing the public accounts, such as the *cour des comptes* in France, and the *Rechnungshof des deutschen Reiches* in Germany. Local boards, large cities, corporations and similar bodies ordinarily have official auditors for the purpose of examining and checking their accounts and looking after their expenditures.

The word auditor is now almost synonymous with professional accountant. In Scotland the title auditor sometimes corresponds with the English taxing master. In France the term refers to legal officers attached to the *conseil d'état.* In many European countries lawyers skilled in military law are called auditors. *See also* ACCOUNTING.

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AUDLEY OF WALDEN, THOMAS AUDLEY, BARON (1488–1544), English lawyer, who was lord chancellor from 1533 to 1544, owed his advancement to the subservience he showed to Henry VIII during the breach with the papacy. Born at Earls Colne, Essex, he studied at Cambridge and the Inner Temple, became town clerk of Colchester, and by 1521 was a justice of the peace for Essex. In 1523 and 1529 he represented that county in parliament. He was chosen speaker of the house of commons in Nov. 1529, and his services in that office led to his appointment first as lord keeper of the great seal (May 1532) and then as lord chancellor (Jan. 1533). As chancellor he presided at the trials of Bishop Fisher and Sir Thomas More in 1535 and of the Lincolnshire rebels in 1536. He also presided, as lord steward, at the trial of the marquess of Exeter (1538) and took a leading part in the attainders of Thomas Cromwell (1540) and Catherine Howard (1542). He was created Baron Audley of Walden on Nov. 29, 1538, and was made a knight of the Garter in 1540. He received a considerable share of monastic property and is remembered as the founder of Magdalene college, Cambridge (1542). He resigned the lord chancellorship, because of ill-health, on April 21, 1544, and died on April 30. (R. B. WM.)

AUDRAN, the name of a family of French artists and engravers. The first who devoted himself to the art of engraving was Claude Audran, born 1597, and the last was Benoît, Claude's great-grandson, who died in 1772. The two most distinguished members of the family are Gérard and Jean.

GÉRARD OR GIRARD AUDRAN (1640–1703), engraver, was the third son of Claude Audran and was born at Lyons on Aug. 2, 1640. He was taught the first principles of design and engraving by his father, and continued his studies in Paris. There, in 1666, he engraved for Charles le Brun "Constantine's Battle With Maxentius," his "Triumph" and the "Stoning of Stephen," which placed Audran in the first rank of engravers at Paris. He spent the years 1667–70 in Rome, where he engraved several fine plates. J. B. Colbert was so struck with the beauty of Audran's works that he persuaded Louis XIV to recall him to Paris. On his return he was appointed engraver to the king, from whom he received great encouragement. He died at Paris on July 26, 1703. His engravings of Le Brun's "Battles of Alexander" are regarded as the best of his numerous works.

JEAN AUDRAN (1667–1756), nephew of Gérard, was born at Lyons. He was 80 years of age before he gave up his work, and nearly 90 when he died. The best prints of this artist are those in which the etching constitutes a great part, and he finished them in a bold, rough style. The "Rape of the Sabines," after Poussin, is considered his masterpiece.

AUDUBON, JOHN JAMES (1785–1851), U.S. artist-naturalist, made known to the world, better than ever before, all the then-known birds of America through the dramatic beauty of his drawings and the vividness of his prose. Born at Les Cayes, Santo Domingo (now Haiti), April 26, 1785, the son of Lieut. Jean Audubon, French naval officer and planter, he spent his boyhood in France in comparative luxury under the care of an adoring foster mother. He early showed an interest in drawing birds, but cared little for school. When 18 years old he was sent to the United States to enter business. His interest in birds and in drawing them increased, but his business ventures were unsuccessful.

In 1808 Audubon married Lucy Bakewell. In 1820 Audubon concentrated his efforts on what was to become his great work, the illustrating of all North American birds. Supported by giving drawing lessons and painting portraits, and by his wife's teaching, he collected and painted birds in the eastern and southern United States.

By 1826 he had enough material to consider publication and took his drawings to Europe, in search of patrons and publishers. In Great Britain his genius was immediately recognized by scien-

tific and art circles. Publication of his plates as *The Birds of America*, to be issued in parts and financed by subscription, was finally undertaken by Robert Havell of London. From 1826 to 1839 his time was divided between Europe and the U.S., with his sons Victor and John as assistants, financing and overseeing publication and completing his projects by gathering material on trips, visiting collections, preparing illustrations and writing with the aid of William MacGillivray. The results were *The Birds of America*, with 435 hand-coloured folio plates (4 vol., 1827–38), the text to it, *Ornithological Biography* (5 vol., octavo, 1831–39), and what serves as an index, *A Synopsis of the Birds of North America* (1 vol., 1839).

Returning to the U.S. in 1839 he settled in New York, prepared a smaller edition of his *The Birds of America* (7 vol., octavo, 1840–44) and threw himself into preparing a new work, *Viviparous Quadrupeds of North America*, with the aid of his sons and that of John Bachman for the text. The plates were issued in 30 parts of five folio plates each (2 vol., 1845–46). The text, three octavo volumes, appeared in 1846–54. Audubon died Jan. 27, 1851.

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AUE, a town of Germany which after the partition of the nation following World War II was located in the district of Karl-Marx-Stadt of the German Democratic Republic, is situated in the western Erzgebirge (Ore mountains) about 20 mi. S.E. of Zwickau on the Zwickauer Mulde river. Pop. (1964) 31,720. The frontier between the German Democratic Republic and Czechoslovakia is about 12 mi. S. of the town. After World War II Aue, in which there were metal, engineering and woven goods enterprises, became the centre of Erzgebirge uranium ore mining. Under the town and in its vicinity extensive deposits of pitchblende were discovered. The Zell Maria monastery was founded in 1173 and its Romanesque church is still standing. Aue received town rights in 1629.

AUENBRUGGER VON AUENBRUGG, LEOPOLD (1722–1809), Austrian physician, discoverer of percussion as a diagnostic procedure, was born in Graz on Nov. 19, 1722, the son of an innkeeper. He studied medicine in Vienna, received his M.D. degree and was appointed physician to the Spanish Military hospital. There he saw many patients with fluid in the chest, and, remembering his ability as a boy in his father's inn to judge the amount of wine in the casks by thumping their ends, he applied this method to the chest. He soon found that he could determine the amount of fluid and its location in the chest and the size of the heart as well. After seven years of investigation, Auenbrugger published in 1761 a description of the method and the results of his investigations in his *Inventum novum*, the first treatise on percussion in any language.

Auenbrugger's reputation as a physician grew, and he was raised to the nobility in 1784. The *Inventum novum*, however, received scant attention, and the method was generally ignored until in 1808, 47 years after its appearance, it was translated into French by Jean Nicholas Corvisart des Marets, personal physician to Napoleon. Corvisart not only translated the work but added his own observations and praised what he called Auenbrugger's beautiful and rightful discovery. It gained world-wide acceptance rapidly thereafter and remains a fundamental procedure in medical diagnosis. Auenbrugger died in Vienna on May 17, 1809.

See M. Neuburger, *Leopold Auenbrugger* (1922). (R. H. Mr.)

AUER, LEOPOLD (1845–1930), Hungarian-born violinist and teacher of many famous violinists. Born at Veszprém, June 7, 1845, he studied at Budapest and Vienna and later under Joseph Joachim at Hanover. In 1868 he was appointed professor of the violin at the St. Petersburg conservatory. He became a Russian subject in 1883. Between 1906 and 1914 he taught for periods in London and Dresden but continued to live at St. Petersburg. In 1917 he left Russia for Scandinavia and in 1918 settled in New York. Among his pupils were Mischa Elman, Jascha Heifetz, N. Milstein, T. Seidel and E. Zimbalist. He wrote *Violin Playing as I Teach It* (1921), *My Long Life in Music* (1923) and *Violin Master Works and Their Interpretation* (1925). He died at Loschwitz, near Dresden, July 17, 1930.

AUERBACH, BERTHOLD (1812–1882), German novelist, known for his tales of village life, was born at Nordstetten in the Black Forest on Feb. 28, 1812, and died at Cannes, France, on Feb. 8, 1882. He studied philosophy under David Strauss and Friedrich von Schelling. He was intended for the Jewish ministry, but was estranged from Jewish orthodoxy by the study of Spinoza and turned to literature. Spinoza's life formed the basis of his first novel (1837), and a translation of Spinoza's works followed in 1841. In 1843 he began publishing the *Schwarzwälder Dorfgeschichten* (Eng. trans., *Black Forest Village Stories*, 1869), and there later appeared novels in the same genre, among them *Barfüssele* (1856; Eng. trans., *Little Barefoot*, 1873) and *Edelweiss* (1861). These works found a wide public and many imitators. They are not realistic studies of rural life and owed some of their popularity to Auerbach's philosophical reflections and romanticism.

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AUERSPERG, ANTON ALEXANDER, Graf von (1806–1876), Austrian poet who wrote under the pseudonym of Anastasius Grün and became known for his political poetry, was born at Laibach, Aus. (now Ljubljana, Yugos.), on April 11, 1806, and died at Graz, Aus., on Sept. 12, 1876. As a member of the estates of Carniola in the diet at Laibach, he was an outspoken critic of the Austrian government, and after 1848 he represented the district of Laibach for a short time at the German national assembly at Frankfurt, to which he tried in vain to persuade his Slovene compatriots to send representatives. In 1860 he was summoned to the remodeled *Verstärkter Reichsrat* by the emperor, who in 1861 nominated him a life member of the Austrian upper house (*Herrenhaus*). Count Auersperg's first publication was a collection of lyrics, *Blätter der Liebe* (1830). His second production, *Der letzte Ritter* (1830; Eng. tr., *The Last Knight*, 1871), celebrates the deeds and adventures of the emperor Maximilian I (1493–1519). But his fame rests almost exclusively on his political poetry. Two collections, entitled *Spaziergänge eines Wiener Poeten* (1831; "Promenades of a Viennese Poet," some of which were translated in K. Francke's *German Classics of the 19th and 20th Centuries*, 1913) and *Schutt* (1836), created a sensation in Germany by their originality and bold liberalism. His epics, *Die Nibelungen im Frack* (1843) and *Der Pfaff vom Kahlenberg* (1850), are characterized by a fine ironic humour. He also produced masterly translations of the popular Slovene songs current in Carniola (*Volkslieder aus Krain*, 1850) and of the English poems on Robin Hood (1864).

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AUERSTÄDT, BATTLE OF, was fought by the French under Davout against the Prussians under King Frederick William III and Charles William Ferdinand, duke of Brunswick-Wolfenbüttel, on Oct. 14, 1806, at Auerstädt, in Saxony, 12 mi. N. of Jena, where Napoleon was simultaneously defeating the rest of the Prussian forces (*see* Napoleonic Wars). On Oct. 12, a week after setting out from the Bamberg region, Napoleon completed his outflanking movement against the Prussian army west of the Saale and closed in on that river line. His right wing, Davout and Bernadotte's corps, was to march north down the Saale while his main forces crossed around Jena to seek the enemy. The right wing thus stood ready either to head off a Prussian retreat to the Elbe or to deliver a flank attack if the enemy stood his ground west of Jena. As Lannes reached Jena, Davout entered Naumburg, 20 mi. downstream, within easy reach of the left bank roads leading from Weimar via Auerstädt toward the Elbe. On Oct. 13

the Prussians decided to retreat along this road, leaving a flank guard of 50,000 men near Jena, however, to follow on as a rear guard when the main army had passed Auerstädt, where it spent the night of Oct. 13. That afternoon Napoleon had mistaken the flank guard for the mass of the Prussian army and ordered up his corps for battle on Oct. 14. Bernadotte did not choose to march with Davout, as he should have done, and appeared on Napoleon's flank after the battle of Jena (6 A.M. to 4 P.M.). At 8 A.M. Davout's excellent III corps, 27,000 strong, appeared on the Weimar road in the path of 50,000 Prussians. He resisted their repeated and vigorous but piecemeal attacks with skill and determination, avoiding an attempt to outflank him and counterattacking when he could, to such effect that the Prussians began to retire at 12:30 P.M. Davout's troops had suffered casualties of 25% in this remarkable passage of arms and could not press the Prussian retreat strongly, but it became a rout when it was met by the fugitives from Jena. The Prussians lost 10,000 killed and wounded and 3,000 captured at Auerstädt. The next day the French began the most celebrated and successful pursuit of the Napoleonic wars. (J. H. N.)

AUGEAS (AUGEIAS or AUGIAS), in Greek legend, king of the Epeians in Elis, a son of Helios the sun-god. He possessed an immense wealth of herds, including 12 white bulls, sacred to Helios. Eurystheus imposed upon Hercules the task of clearing out all Augeas' stalls unaided in one day. This Hercules did by turning the Alpheus river through them. Augeas had promised him a tenth of the herd but then refused this, alleging that Hercules had acted only in the service of Eurystheus. Hercules thereupon led an army against him and finally slew Augeas and his sons.

AUGEREAU, PIERRE FRANÇOIS CHARLES, DUC DE CASTIGLIONE (1757–1816), French army officer, created marshal by Napoleon, was born in Paris on Oct. 21, 1757. His mother, a German, had a fruit shop and his father was a servant. For 16 years Augereau was an adventurer, moving from Russia to Portugal, twice deserting from French regiments and serving in several foreign armies; he knew several languages, was a master of both infantry and cavalry drill and small arms, and was tall, strong and intelligent. The French Revolution soon brought him into the extremist Jacobin party, which in 1793 sent him to Gen. J. A. Rossignol in the west and then suddenly transferred him to the eastern Pyrenees as general of a division. His discipline and care for his men made his division uniformly successful in Catalonia (1793–95) and later under Napoleon in Italy; his firmness turned the battle of Castiglione (Aug. 5, 1796) to victory, which Napoleon never forgot. But he was chosen to carry out the *coup d'état* of 18 Fructidor (Sept. 4, 1797) in Paris, and politics did him no good. He was rewarded with the command in Germany but was deprived of it three months later; he was elected deputy in 1799 and, having opposed Napoleon's *coup* of 18 Brumaire (Nov. 9, 1799), was kept from 1800 to 1805 in relatively minor commands, which he resented. Yet he was sixth of the marshals appointed in 1804.

In 1806 he was again, after nine years, directly under Napoleon, with a corps at the battle of Jena (Oct. 14). His health was broken in Poland. At the battle of Eylau (Feb. 8, 1807) his corps, misdirected in a snowstorm, lost half its numbers, and the marshal, strapped to his horse in his weakness, was badly hurt when it fell. For two years he was able to enjoy his wealth and his château of La Houssaye (Seine-et-Marne). Then, in 1809, he had to take the field, and he chose Catalonia. With 50,000 men he carried through the siege of Gerona, with immense losses from sickness. He then kept some state at Barcelona while his brother contended with the Catalan guerrillas. But Napoleon did not approve of his generals "residing in capitals" and recalled him (April 12, 1810). Preparations for the invasion of Russia in 1812 went on without him; then, at 12 days' notice, he was put in charge of Berlin, where he remained uneasily until Eugène de Beauharnais returned after the retreat from Russia. He was sent to Frankfurt, and by Oct. 1813 had enough conscripts to form a nominal corps. His men disappeared in the battle of Leipzig, from which he escaped with deep indignation against Napoleon. Yet in 1814 he was required to lead the "army of the east" to save Lyons from the Austrians. The emperor trusted to the "name" of his marshal. His small force, partly drawn from Spain, had some fighting, but Lyons was not saved, and the Bonapartists talked of treason. Augereau welcomed Louis XVIII in 1814, and his services were rejected by Napoleon in 1815. He received no command from Louis XVIII, but he was left untroubled in his home, where he died on June 12, 1816. *See* NAPOLEONIC WARS. (I. D. E.)

AUGHRIM (EACHDHRUIM), a small village in County Galway, Republic of Ireland, 99 mi. W. of Dublin by road. Pop. (1956) 121. It is famous for the decisive victory won there on July 22 (new style; July 12, old style), 1691, by the forces of William III under Gen. Heer van Ginkel (later 1st earl of Athlone) over those of James II under the French commander, the marquis de Saint-Ruth, who fell in the fight. The Irish, numbering about 25,000 and strongly posted behind marshy ground, at first maintained a vigorous resistance, but Ginkel penetrated their line of defense, and their general was struck down by a cannon ball at this critical moment. They were overcome and routed with terrible slaughter. The English loss did not exceed 700 killed and 1,000 wounded; while the Irish, in their disastrous flight, lost about 7,000 men and all their military equipment. This defeat was followed by the complete submission of Ireland in October.

AUGIER, (GUILLAUME VICTOR) ÉMILE (1820–1889), French dramatist, shared with Dumas *fils* and Victorien Sardou the mastery of the French stage during the second empire. He was born at Valence, Drome, on Sept. 17, 1820, of wealthy middle-class parents. A disciple of Balzac, he tried to do for the drama what Balzac had done for the novel. While all his plays are to some extent didactic in purpose, this aspect is particularly evident in *Madame Caverlet* (1876) and in *Les Fourchambault* (1878), his last play and one of his best. An unbending moralist, Augier had already in 1849, with a verse-play, *Gabrielle*, challenged the romantic belief in the divine right of passion. Then in 1855, in the harshly realistic *Le Mariage d'Olympe*, he refuted the romantic thesis of the rehabilitation of the prostitute by love, put forward in Dumas's *La Dame aux camélias*. A champion of the institution of marriage, Augier satirized venal adultery in *Les Lionnes pauvres* (1858) and saw in greed, and in money itself, the root of all evil. His best-known play, *Le Gendre de Monsieur Poirier* (1854), which was based on Jules Sandeau's novel *Sacs et parchemins* and written in collaboration with Sandeau, advocated the fusion of the new prosperous middle class and the dispossessed nobility. Augier died at Croissy on Oct. 25, 1889.

See H. Gaillard de Champris, *Emile Augier et la comédie sociale* (1910). (D. Ks.)

AUGITE, a widespread aluminous monoclinic pyroxene mineral, occurs as a major constituent in basic rocks, notably gabbros, pyroxenites and basalts. Augite has been found in meteorites and occurs in slags. Well-developed crystals of augite are common in the Hawaiian basalts. The minerals most commonly found with augite are olivine, orthorhombic pyroxene, amphibole, plagioclase (usually of about labradorite-bytownite composition) and, in some rocks, biotite is common. Several varieties of augite are distinguished; those rich in titanium are called titanaugites and those rich in sodium are called aegerinaugites. Aegerinaugite is found in the alkaline-rich nephaline syenites and leucite-bearing lavas. For further discussion of the occurrence of augite *see* BASALT; GABBRO; PYROXENITE. *See* also ANDESITE; DIABASE; RHYOLITE; TRACHYTE.

The composition of augite, a mixture of aluminum, magnesium, calcium and iron silicates, is variable (*see* PYROXENE); it is best visualized as a solid solution dominantly composed of the $Ca(Mg,Fe)(SiO_3)_2$ series with a limited amount of the $(Mg,Fe)SiO_3$ series plus some aluminum in substitution for both the Si and Mg-Fe atoms in the mineral. Pigeonite is the pyroxene corresponding to augite composed dominantly of the $(Mg,Fe)SiO_3$ series with limited amounts of the $Ca(Mg,Fe)(SiO_3)_2$ series. A gradation between augite and pigeonite is possible.

It is difficult to distinguish augite from the other monoclinic pyroxenes even under the microscope; therefore the term augite is often used as a general term for the monoclinic pyroxenes. In general, the augites are dark green, brown or black in colour.

The complete alteration of augite crystals to an amphibole is rather common and the term uralite or the process uralitization has been given to such occurrences. Alteration to chlorite, talc and serpentine also can occur. (G. W. DeV.)

AUGSBURG, a town of Germany which after partition of the nation following World War II was located in the *Land* of Bavaria, Federal Republic of Germany, lies at the junction of the Wertach and Lech rivers and extends over the plateau country between them. Pop. (1961) 208,659.

The street system of the northern part of the town centres on the cathedral, the west end and crypt of which were built between 944 and 1006 and the Gothic nave between 1331 and 1343. The interior was restored in 1934. The cathedral's chief monuments are the 11th-century bronze doors, the five Romanesque stained-glass windows in the nave, the bishop's throne supported by lions and the altar pieces painted by Hans Holbein the Elder and Christoph Amberger. St. Ulrich's church, at the southern end of the main street from the cathedral, was begun in 1467 by Burkhard Engelberg and completed two centuries later. It contains a Late Gothic statue of the Madonna (*c.* 1500), stained-glass windows in the vestry and a baroque wrought-iron gate (1712). The town hall, in the centre of the town, was built between 1615 and 1620 by Elias Holl, but it was almost completely burned out and its famous "Golden Hall" destroyed during World War II. The main street contains three 16th-century fountains and there is a town museum, two art galleries and a municipal library with a collection of archives, manuscripts, drawings, etc. The house of Leopold Mozart, father of the composer, is now a Mozart museum. Augsburg has an open-air theatre, a sports stadium, and a zoo and botanical garden in the Siebentisch park. Educational establishments include three colleges of music including one named after Leopold Mozart, a philosophy school and the Rudolph Diesel polytechnic, named after the inventor of the diesel engine.

Augsburg, situated on the Frankfurt-Salzburg *autobahn*, is at the junction of several main railway and long-distance bus routes. Munich airport is 40 mi. distant. As an industrial centre, Augsburg is among the most important in southern Germany. There are heavy engineering, textiles, tin, metal, chemical and electrical industries, as well as factories for cars, airplanes, paper and shoes. Many of the manufactured goods are exported, particularly diesel engines and printing machinery.

Signs of an Early Bronze Age settlement have been traced in the southern part of the town. Founded as a Roman colony (Augusta Vindelicorum), by Drusus in 15 B.C., on a triangular piece of ground at the junction of the Lech and Wertach, the Roman town belongs to the reign of the emperor Tiberius. Augsburg must already have been the seat of a bishop in the 7th century. Under Bishop Ulrich the Hungarians were decisively defeated by King Otto in 953 on the Lechfeld to the south of the town. Augsburg became a free imperial city in 1276 and in 1331 joined the Swabian league (*see* SWABIA). The business houses, headed by those of the Fugger (*q.v.*) and the Welser families, were responsible, in the first half of the 16th century, for the vigorous economic development of the town with which was associated the encouragement of both art and science. Hans Holbein the Elder and the Younger and Hans Burgkmair (*qq.v.*) were natives of the town. At the imperial diet of Augsburg in 1530, the Augsburg Confession was read and the League of Augsburg was decided in 1686. Though considerably damaged during World War II, Augsburg retains much of its former beauty. (H. F. De.)

AUGSBURG, PEACE OF, the first permanent legal basis for the existence of Lutheranism as well as Catholicism in Germany, promulgated on Sept. 25, 1555, as part of the recess, or final resolution of the diet of the Holy Roman empire assembled earlier that year at Augsburg.

The emperor Charles V's provisional ruling on the religious question (*see* REFORMATION), namely the Augsburg Interim of 1548, had been overthrown four years later by the revolt of the Protestant elector Maurice of Saxony and his allies. In the ensuing negotiations at Passau (summer 1552) even the Catholic princes had called for a lasting peace, for fear that otherwise the religious controversy would never be settled. The emperor, however, was unwilling to recognize the religious division in western Christendom as permanent and granted a peace only until the next imperial diet.

The diet, which opened at Augsburg on Feb. 5, 1555, was indeed proclaimed by Charles V, but, as he did not wish to lend himself to the inevitable religious compromises, he refused to take part in the proceedings and empowered his brother Ferdinand (the future emperor Ferdinand I) to settle all questions. The diet determined that in future no member of the empire should make war against another on religious grounds and that this peace should remain operative until the denominations were peacefully reunited. Only two denominations were recognized—the Roman Catholics and the adherents of the Augsburg Confession, in other words the Lutherans. Moreover, in each territory of the empire only one denomination was to be recognized, the religion of the prince's choice being thus made obligatory for his subjects; any who adhered to the other could sell their property and migrate to a territory where it was recognized. Those free and imperial cities which had lost their religious homogeneity a few years earlier were exceptions to the general ruling, Protestant and Catholic citizens in them remaining free to exercise their religion as they pleased. The same freedom was furthermore extended to Protestant knights, towns and other communities who had for some time been practising their religion in the lands of ecclesiastical princes of the empire. This last concession provoked vehement Catholic opposition, and Ferdinand circumvented the difficulty by deciding the matter on his own authority and including the clause in a separate article, the *Declaratio Ferdinandea*.

Ecclesiastical lands taken by Lutherans from prelates who were not immediate vassals of the emperor were to remain with the Lutherans if continuous possession could be proved from the time of the treaty of Passau (Aug. 2, 1552), but to ensure the permanence of the remaining ecclesiastical territories, the Catholics gained the condition that in future any ecclesiastical prince who became Protestant should thereupon renounce his office, lands and revenues. Since the Protestants would not accept this so-called ecclesiastical reservation (*reservatum ecclesiasticum*) and the Catholics would not yield, Ferdinand incorporated the clause in the recess on his own authority with a note that agreement had not been reached on it. In fact Protestants were in many cases able to nullify its effect.

The wish for a lasting settlement was so strong that the compromise peace, which satisfied no one completely and had many loopholes, was accepted. In spite of its shortcomings, the peace of Augsburg saved the empire from serious internal conflicts for more than 50 years.

There is a critical edition of the text of the peace of Augsburg with that of the royal declaration, by K. Brandi, *Der Augsburger Religionsfriede vom 25. September 1555*, 2nd ed. (1927).

See also LUTHERANISM.

See W. Friedensburg, "Das Protokoll der auf dem Augsburger Reichstage von 1555 versammelten Vertreter der freien und Reichsstädte über die Reichstagsverhandlungen," *Archiv für Reformationsgeschichte*, vol. 34 (1937); F. Hartung, *Deutsche Verfassungsgeschichte vom 15. Jahrhundert bis zur Gegenwart*, 7th ed. (1959). (E. H. H.)

AUGSBURG, WAR OF THE LEAGUE OF, a name sometimes bestowed, rather mistakenly, on the War of the Grand Alliance (*q.v.*). The League of Augsburg, which was formed on July 9, 1686, between the Holy Roman emperor Leopold I and certain princes and states of the empire (the kings of Spain and of Sweden were members only as holders of imperial fiefs) against the threat of French aggression, neither provoked war nor comprised those states which, after the French invasion of the Palatinate in Sept. 1688, were to be the emperor's most effective allies.

AUGSBURG CONFESSION (Lat. *Confessio Augustana* the Lutheran Reformation's basic particular creed, was presented June 25, 1530, at the diet of Augsburg in equally authoritative German and Latin versions to the emperor Charles V by seven Lutheran princes and two imperial free cities. The chief author was Philipp Melanchthon (*q.v.*), who utilized earlier Lutheran statements of faith. The purpose was to defend the Lutherans against current misrepresentations and to provide a statement of their theology that would be acceptable to the papalist party in

the Holy Roman empire.

The Confession contains 28 articles. The first 21 (on the Trinity, original sin, Christ, forgiveness of sins, the ministry, the new obedience, the church, the objective efficacy of the sacraments, baptism, the Eucharist, private confession, repentance, the use of the sacraments, ecclesiastical order, church rites, civil affairs, eschatology, free will, the cause of sin, faith and good works, the cult of the saints) set forth the Lutherans' over-all doctrine with a view to demonstrating that "they dissent in no article of faith from the Catholic Church." The remaining seven articles discuss "abuses" that had crept into the Western Church in the centuries immediately preceding the Reformation and that the Lutherans had corrected in their domains—communion under one kind, enforced priestly celibacy, the Mass as an expiatory sacrifice, compulsory confession, human institutions designed to merit grace, abuses in connection with monasticism, and the expanded authority claimed by the bishops. On Aug. 3 the theologians of the papalist party replied with the so-called Confutation. The emperor refused to receive a Lutheran counter-reply offered on Sept. 22; but it formed the basis for Melanchthon's "Apology of the Augsburg Confession" (1531).

While the "unaltered" 1530 version of the Augsburg Confession has always been authoritative for Lutherans, proponents of the eucharistic doctrines of Zwingli and Calvin within the Holy Roman empire widely received a modified edition (the "Variata" of 1540), with an ambiguously worded article x.

Richard Taverner translated the Augsburg Confession into English in 1536; its subsequent influence on the Anglican Thirty-Nine Articles and John Wesley's Twenty-Five Articles is clearly traceable. *See* also Confessions of Faith, Protestant: *Lutheran Churches.*

Bibliography.—Critical texts, plus bibliography, of the Augustana and the Apology by Heinrich Bornkamm in Hans Lietzmann (ed.), *Die Bekenntnisschriften der evangelisch-lutherischen Kirche herausgegeben im Gedenkjahr der Augsburgischen Konfession 1930*, 4th ed. (1959); English translations in Theodore G. Tappert *et al.* (eds.), *The Book of Concord* (1959). For the "Confutation" in English, *see* (Johann) Michael Reu, *The Augsburg Confession* (1930). (A. C. Pn.)

AUGUR, in ancient Rome, one of the members of a religious college whose duty it was to observe and interpret the signs (*auspices*) of approval or disapproval sent by the gods in reference to any proposed undertaking. The *augures* were originally called *auspices*, but, while *auspex* fell into disuse and was replaced by *augur*, *auspicium* was retained as the scientific term for the observation of signs. Auspex = *avispex*, "observer of birds"; *augur* probably is to be connected with the root of *augere, augustus*. It seems therefore originally to have meant an expert in fertility magic rather than a diviner.

The early history of the college is obscure. Its institution has been attributed to Romulus or Numa. It probably consisted originally of three members, of whom the king himself was one. This number was doubled by Tarquinius Priscus, but in 300 B.C. it was only four, two places, according to Livy, being vacant. The Ogulnian law in the same year increased the number to nine, five plebeian being added to the four patrician members. In the time of Sulla the number was 15, which was increased to 16 by Julius Caesar. This number continued in imperial times, and the college itself was certainly in existence as late as the 4th century A.D. The office of augur, which was bestowed only upon persons of distinguished merit and was much sought after by reason of its political importance, was held for life. Vacancies were originally filled by co-optation, but by the Domitian law (104) the selection was made, by 17 out of the 35 tribes chosen by lot, from candidates previously nominated by the college. The insignia of office were the lituus, a staff free from knots and bent at the top, and the trabea, a kind of toga with bright scarlet stripes and a purple border.

The science of augury was contained in various written works, including a manual of augural ritual, and a collection of answers given by the college to the senate. The natural region to look to for signs of the will of Jupiter was the sky, where lightning and the flight of birds seemed directed by him as counsel to men. It was the duty of the augur, before the auspices properly so called (those from the sky and from birds) were taken, to mark out with his staff the *templum* or consecrated space within which his observations were intended to be made. At midnight, when the sky was clear and there was an absence of wind, the augur, in the presence of a magistrate, took up his position on a hill that afforded a wide view. After prayer and sacrifice, he marked out the *templum* both in the sky and on the ground and dedicated it. Within its limit he then pitched a tent, in which he sat down with covered head, asked the gods for a sign, and waited for an answer. As the augur looked south he had the east, the lucky quarter, on his left, and therefore signs on the left side were considered favourable, those on the right unfavourable. The practice was the reverse in Greece; the observers of signs looked toward the north, so that signs on the right were regarded as the favourable ones; this practice was frequently adopted in the Roman poets. The augur afterward announced the result of his observations in a set form of words, by which the magistrate was bound.

Signs of the will of the gods were of two kinds, either in answer to a request (*auspicia impetrativa*), or incidental (*auspicia oblativa*). Of such signs there were five classes:

1. Signs in the sky, consisting chiefly of thunder and lightning, but not excluding falling stars and other phenomena. Lightning from left to right was favourable, from right to left unfavourable; but on its mere appearance, in either direction, all business in the public assemblies was suspended for the day. Since the person charged to take the auspices for a certain day was constitutionally subject to no other authority who could test the truth or falsehood of his statement that he had observed lightning, this became a favourite device for putting off meetings of the public assembly. Restrictions were imposed, however, in later republican times. When a new consul, praetor or quaestor entered on his first day of office and prayed the gods for good omens, it was a matter of custom to report to him that lightning from the left had been seen.

2. Signs from birds, with reference to the direction of their flight and also to their singing or uttering other sounds. To the first class belonged the eagle and the vulture, to the second the owl, the crow and the raven. The mere appearance of certain birds indicated good or ill luck, while others had a reference only to definite persons or events. In matters of ordinary life on which divine counsel was prayed for, it was usual to have recourse to this form of divination. For public affairs it was superseded, by the time of Cicero, by the fictitious observation of lightning.

3. Feeding of birds, which consisted in observing whether a bird—usually a fowl—when grain was thrown before it, let fall a particle from its mouth. If it did so, the will of the gods was in favour of the enterprise in question. The simplicity of this ceremony recommended it for very general use, particularly in the army when on service.

4. Signs from animals—*i.e.*, observation of the course of, or sounds uttered by, quadrupeds and reptiles within a fixed space—corresponding to the observations of the flight of birds, but much less frequently employed.

5. Warnings, consisting of all unusual phenomena, but chiefly such as boded ill. Such were various noises, the fall of a stick in a temple, the squeak of a mouse, stumbling, sneezing or the seizure of anyone in the comitia by an epileptic fit. Being accidental in their occurrence, they belonged to the *auguria oblativa*, and their interpretation was rather a matter for the *pontifices* than for the augurs, when the incident was not already provided for by a rule.

Among the other means of discovering the will of the gods were the casting of lots, Sibylline oracles (in the hands of the college *sacris faciundis*), and, more commonly, the examination of the entrails of animals slain for sacrifice. Anything abnormal found there was brought under the notice of the augurs, but usually the Etruscan haruspices (*q.v.*) were employed for this. The persons entitled to ask for an expression of the divine will on a public affair were the magistrates. To the highest offices, including all persons of consular and praetorian rank, belonged the right of taking *auspicia maxima*; to the inferior offices of aedile and quaestor, the *auspicia minora*; the differences between these, however, must have been small. The subjects for which *auspicia publica* were always taken were the election of magis-

trates, their entering an office, the holding of a public assembly to pass decrees, and the setting out of an army for war. They could be taken only in Rome itself; and in case of a commander's having to renew his auspices, he must either return to Rome or select a spot in the foreign country to represent the hearth of that city. The time for observing auspices was, as a rule, between midnight and dawn of the day fixed for any proposed undertaking. The founding of colonies, the beginning of a battle, the calling together of an army, sittings of the senate and decisions of peace or war frequently were occasions for taking auspices. The place where the ceremony was performed was not fixed but selected with a view to the matter in hand. A spot being selected, the official charged to make the observation pitched his tent there several days before. A matter postponed through adverse signs from the gods could on the following or some future day be again brought forward for the auspices. If an error occurred in the auspices, the augurs could, of their own accord or at the request of the senate, inform themselves of the circumstances and advise upon it. A consul could refuse to accept their advice while he remained in office, but on retiring he could be prosecuted. *Auspicia oblativa* referred mostly to the comitia. A magistrate was not bound to take notice of signs reported merely by a private person, but he could not overlook such a report from a brother magistrate. For example, if a quaestor on his entry to office observed lightning and announced it to the consul, the latter must delay the public assembly for the day.

See also ASTROLOGY; DIVINATION.

See articles by L. C. Purser (and others) in Smith's *Dictionary of Greek and Roman Antiquities*, 3rd ed. (1890).

AUGUST (Lat. *Augustus*), the eighth month of the modern calendar, with 31 days. In the early Roman calendar, which began with March, it was the sixth month and was hence called Sextilis, a name it retained until the year 8 B.C., when the emperor Augustus allowed it to be renamed in his honour. The feast of the Assumption of the Virgin (Dormition of the Virgin in the Orthodox Eastern Churches) is celebrated on August 15.

(F. R. WN.)

AUGUSTA, a town of Sicily, province of Siracusa, lies on a long sandy island off the southeast coast, connected by two bridges with the mainland, 48 km. (30 mi.) N. of Syracuse by road. Pop. (1957 est.) 25,437 (commune). The 17th-century cathedral was rebuilt in 1769 after a severe earthquake. The main industry is agriculture—the area being very rich in cereals, olive orchards, vineyards and market gardens. Salt mining is carried on along the coast, also fishing and the preserving of anchovy. The name of the town is not derived from Augustus, as it was founded in 1232 by the emperor Frederick II for the rebellious people of Centuripe and Montalbano, which towns were destroyed because of their disaffection. Frederick called it Augusta Veneranda and it became one of his favourite resorts. It was chosen by the Sovereign Order of the Knights of Malta to be its supply repository at the beginning of the 19th century. In 1860 Augusta became part of the kingdom of Italy and in World War II was one of the ports of disembarkation of the Anglo-American forces for the invasion of Italy on July 10, 1943. (M. T. A. N.)

AUGUSTA, a city of Georgia, U.S., 171 mi. S.E. of Atlanta, at the head of navigation on the Savannah river; seat of Richmond county. It is an inland port on the Savannah river, 90 mi. from the seaport of Savannah.

Population (1960), city 70,626; standard metropolitan statistical area (Richmond county in Georgia and Aiken county in South Carolina), 216,639. The metropolitan area includes the cities of North Augusta and Aiken, S.C. (For comparative population figures *see* tables in GEORGIA: *Population* and SOUTH CAROLINA: *Population.*)

The first white men to visit the area near the present site of Augusta were Spaniards, under the leadership of Hernando de Soto in 1540. In the early years of the 18th century the inland region of the Savannah river attracted the English fur trader before the colony of Georgia was established, and the lucrative trade in pelts was a major factor in the decision of James Edward Oglethorpe, founder of the Georgia colony, to establish a trading post (1735) on the west bank of the river. The settlement was named Augusta in honour of Princess Augusta, mother of George III, king of England.

The fur trade increased not only by means of the river facilities but also along the road that was built in 1740 to connect Savannah with Augusta. Friendly relations with the Indians were important in the growth of the new settlement. In 1763 Cherokees, Choctaws, Creeks, Chickasaws and Catawbas met the governors of Georgia, South Carolina, North Carolina and Virginia at Augusta and agreed to recognize definite boundaries for the Georgia colony. In 1773, at Augusta, Creeks and Cherokees ceded approximately 2,100,000 ac. of land to the Georgia authorities.

At the beginning of the American Revolution, the prevailing temper of Augusta was loyalist, but revolutionary sentiment soon prevailed and the patriots gained control. George Walton, of Augusta, was one of the three Georgia signers of the Declaration of Independence. When Savannah was attacked by the British in 1778, Gov. John Houstoun and his council fled inland to the Savannah river city. The British seized Augusta within a month and the patriot government was forced to abandon the city. In Feb. 1779 a group of patriots led by Elijah Clarke, John Twiggs and John Dooly dispersed a British army and forced the British to move out of the city, but after the fall of Charleston, S.C., in May 1780, the British reoccupied and retained control of the city until June 1781.

Augusta was the capital of Georgia from 1786 to 1795, and there on Jan. 2, 1788, a state convention ratified the constitution of the United States. The town was incorporated in 1789 and given a charter in 1798.

The "Genius of Georgia," a ship propelled by 19 horses walking on an endless belt, made its first trip from Savannah up the river to Augusta in 1820. The Charleston and Hamburg railroad reached the Savannah river opposite the city in 1833. In 1841 the Georgia railroad connecting Augusta and Athens was completed and the Central railroad of Georgia joined Augusta to Savannah in 1854.

When Georgia seceded from the union in 1861, U.S. troops continued to occupy the Augusta arsenal which had been a federal post since 1819. However the arsenal was soon surrendered to Confederate forces. During the Civil War, Augusta was the ordnance centre of the Confederacy.

In the period following the Civil War the city figured prominently in the industrial development of the new south. It became a major cotton centre, and textile manufacturing became the principal industry. Augusta is situated in the heart of rich clay deposits, and its industries include the manufacture of bricks, tile and fine kaolin (used in the making of porcelain). Major features of the comprehensive federal program for the development of the Savannah river basin were to make Augusta a 12-month barge port with a minimum year-round channel of 9 ft., to protect the city and the area along the river from the recurrent danger of floods and to provide low-cost hydroelectric power to the area.

Augusta's Academy of Richmond county, chartered by the state in 1783, is one of the oldest high schools in the United States. The University of Georgia school of medicine, founded in 1828 as the Medical Academy of Georgia, occupies a 45-ac. tract in the city. Paine college (founded as Paine institute, 1883) is an institute for Negroes supported by the Methodists. Augusta college, a junior college, organized in 1925, became a part of the university system of Georgia in 1958.

Fort Gordon, a training school for military police, the signal corps and the corps of engineers, is located about 8 mi. from Augusta.

Augusta, termed "The Winter Golf Capital of America," is the home of the Augusta National Golf course, designed by Bobby Jones and Alistair McKenzie, where the Masters Invitational golf tournament is played annually.

There are many buildings of historic interest: St. Paul's Episcopal church (founded in 1750), the First Presbyterian church (1804) and the manse where Woodrow Wilson spent his boyhood, the Augusta arsenal, established in 1819; and the chimney of the Confederate powder mill, which was the principal source of supply

for the Confederate army. A Celtic cross in St. Paul's churchyard marks the site of Ft. Augusta, built by James Oglethorpe in 1735. It was near Augusta that Eli Whitney set up and operated his first cotton gin. On upper Broad street stands the "White House," now the home of the Augusta-Richmond County Historical society and a museum for relics of the Revolutionary period. (J. N. A.)

AUGUSTA, the capital of Maine, U.S., is a small city at the head of navigation on the Kennebec river, about 60 mi. N.E. of Portland; the shire town of Kennebec county.

Augusta owes its establishment and early growth to its location on navigable tidewater, 40 mi. from the Atlantic ocean. Augusta's recorded history began with the arrival of traders from the Plymouth colony of Massachusetts in 1628. On a site the Canibas Indians called Koussinoc, they established a trading post which became one of the most important on the Atlantic seaboard in early colonial days. John Howland and John Alden were agents there and Capt. Myles Standish made a number of visits to the post. The first permanent structure, Ft. Western, was built there in 1754. In 1919 the fort was restored as a historic monument. In 1797 the settlement was incorporated as the town of Harrington; the name was changed to Augusta later that year. Two years later Augusta became the shire town of Kennebec county.

Augusta became the state capital in 1831, and was incorporated as a city in 1849. In 1959 a council-manager form of government became effective.

Many of Augusta's inhabitants are descended from early English settlers, and many others are of French-Canadian origin. Although a large number of its residents are employed in government service, many are employed in the city's industries, which include the manufactures of cotton textiles, paper, shoes and food products. The city is the commercial centre of a large agricultural area producing apples, garden crops and poultry.

The state capitol, a native granite structure begun in 1829, has been remodeled several times, but retains its original façade designed by Charles Bulfinch in 1829. Nearby is Blaine house, now the governor's residence, formerly the home of James G. Blaine.

A 2,100-ft. bridge of cantilever deck truss design, spanning the Kennebec river in the heart of the city, was completed in 1950. The Kennebec dam (first built in 1837) is head of tide. With the Belgrade chain of lakes 15 mi. N. and the Kennebec river reaching 40 mi. S. to the sea, Augusta is one of the more important summer vacation centres in Maine.

For comparative population figures *see* table in MAINE: *Population.* (R. M. Cr.)

AUGUSTAN HISTORY (*Historia Augusta*), the name now given to a collection of biographies of the Roman emperors (*Augusti*) from Hadrian to Numerian (A.D. 117–284), including associate emperors (*Caesares*) and usurpers. The manuscripts are entitled *Vitae diversorum principum et tyrannorum a Divo Hadriano usque ad Numerianum a diversis compositae;* but the original title is uncertain. The work is mutilated. It lacks the preface, and one cannot be sure whether or not it began with Nerva and Trajan, in continuation of Suetonius' *De vita Caesarum;* the lives of Philip, Decius, Gallus, Aemilian (which fall between 244 and 253) and part of Valerian's life are also missing. Six authors are mentioned: Aelius Spartianus, Julius Capitolinus, Vulcacius Gallicanus, Aelius Lampridius, Trebellius Pollio and Flavius Vopiscus; and dedications to Diocletian and Constantine suggest that they wrote between 284 and 337. Yet, although a case can be made for this dating, the work betrays anachronistic details and reflects political and literary attitudes of the middle or late 4th century, when the pagan traditions revived in reaction to Christianity. It is possible now to go farther than the great German scholar Theodor Mommsen, who assumed that there was an original edition of the time of Diocletian and Constantine, which, he thought, had then been revised, first about 330 and again under Valentinian and Theodosius I (364–395). If the work as a whole is later, the names of authors have to be rejected as spurious, and the question of authorship—whether by one or more writers—remains open. H. Dessau established this approach to the composition of the *Historia Augusta* and concluded that it was the work of one man, writing about 380–395, under Theodosius. In any event it can hardly be later than 409–410. But N. H. Baynes has made a strong case for regarding the work as a propaganda piece written in 362–363 in favour of Julian the Apostate.

The *Historia Augusta* is a work of considerable importance, if only because it is frequently the sole source of information; but it must be handled critically. After allowing for the spurious elaboration of its final form, it can be seen that the narrative falls into two parts of differing historical value. The first part—from Hadrian to Caracalla—contains authentic material from an imperial chronicle and biographies of the emperors and shows sound knowledge of the public administration; much of this may rest upon the authority of Marius Maximus, who in the early 3rd century continued Suetonius in a series of biographies of emperors from Nerva to Elagabalus. The second part—from Geta to Numerian—followed Greek historians of the 3rd century, among whom may be mentioned Dexippus, and (it is widely held) made direct use of the *De Caesaribus* of Aurelius Victor (A.D. 360), which would date the composition after this year, whether immediately under Julian or later under Theodosius. It has also been related to the work of Eutropius (*q.v.*), who wrote under Valens (364–378); but whether this means direct use of Eutropius, which would exclude composition under Julian, or of a lost biographical source of Eutropius, which would permit the dating under Julian, is a matter of dispute. In any event, this part of the *Historia Augusta* betrays spurious elaboration where sound material was lacking; for the alleged extracts from public documents, *e.g.*, emperors' letters and senatorial decrees, are open to serious doubt, so many being palpable forgeries as to create a prejudice against all. Despite its historical deficiencies the work stands in the tradition of imperial biography, as this was adapted to the interests of cultivated pagan circles in Rome during the 4th century. Not only Julian the Apostate but leading senatorial families opposed the glorification of Rome as the city of St. Peter, and they aimed at reviving the old national conception of the Roman empire. If the *Historia Augusta* is taken to be later than Diocletian and Constantine, it gains authority by claiming to belong to the last period of greatness under dynasties founded upon pagan divine right.

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AUGUSTINE, SAINT, OF CANTERBURY (d. *c.* 607), the founder of the Christian church in southern England, and first archbishop of Canterbury. He was a monk in the monastery of St. Andrew in Rome when Gregory I chose him to be the leader of a mission to England, then largely pagan, as the British Christians had retreated to the west and the north since the Anglo-Saxon invasions. On the way the group lost heart and sent Augustine back to Rome, where however he was encouraged by the pope with letters of commendation (596) and set out once more. He landed in Thanet with his monks early in 597 and was well received by Aethelberht, king of Kent, who gave them a dwelling place in Canterbury and allowed them to preach. Augustine at first used the ancient church of St. Martin, where Queen Berhta, a Christian from France, and her chaplain, the Frankish bishop Liudhard, were accustomed to worship. Aethelberht supported the mission, and in the autumn of 597 Augustine was consecrated bishop by Virgilius at Arles. In 601 he received the pallium from Gregory and was given authority over the bishops in Britain. He consecrated Christ Church, Canterbury, and built the monastery of

SS. Peter and Paul, later known as St. Augustine's. At a conference with British bishops he tried in vain to bring about a union between the British (Celtic) churches of north Wales and the churches he was founding. In 604 he consecrated Mellitus as bishop of London and Justus as bishop of Rochester. Augustine died probably before Easter, 607. His feast day is May 28.

See F. M. Stenton, *Anglo-Saxon England*, 2nd ed. (1947).

(PL. GN.)

AUGUSTINE, SAINT, OF HIPPO (AURELIUS AUGUSTINUS) (A.D. 354–430), bishop of Hippo in Roman Africa from 396 to 430, and in his own day the dominant personality of the Western Church, is generally recognized as the greatest thinker of Christian antiquity. His mind was the crucible in which the religion of the New Testament was most completely fused with the Platonic tradition of Greek philosophy; and it was also the conduit by which the product of this fusion was transmitted to the Christendoms of medieval Roman Catholicism and Renaissance Protestantism. This unique significance would have belonged to Augustine had he never written the famous *Confessions*, in which at the age of about 45 he told the story of his own restless youth and of the stormy voyage that had ended, as he believed, 12 years before he put it in writing, in the haven of the Catholic Church. It is easy to forget that the real work of Augustine's life did not begin until the last scene of the *Confessions* was already receding for him into a remembered past. Moreover, the *Confessions* themselves are not so much autobiography as devotional outpourings of penitence and thanksgiving. Augustine's conscientious memory generally can be trusted for the facts; his reflections upon them are those of the bishop on his knees. This is not to say that, in any attempt to understand or appreciate the mind of the bishop, the *Confessions* can be neglected. The picture must be drawn in proper proportion; it is essential to avoid giving undue prominence to what should be no more than its background.

Youth and Conversion.—Hippo Regius is the modern Bône on the Algerian coast, in what was then the Roman province of Numidia. Augustine was born on Nov. 13, 354, of middle-class parents at Tagaste, the modern Souk-Ahras, a small town about 45 mi. to the south. His father, Patricius, was and remained until late in life a pagan; his mother, Monica, was a Christian of intense but simple piety, from whose early teaching Augustine retained a reverence for the "name of Christ" that never left him. But like many another child of Christian parents in those days he was not baptized in infancy. He went through the usual primary and secondary schooling, and soon displayed such intellectual promise that the modest family funds were banked upon securing him an academic career such as might qualify him for government service. As an 18-year-old student at Carthage he was profoundly stirred, by the reading of a treatise of Cicero (the now lost *Hortensius*), with an enthusiasm for "philosophy," which meant not only a devotion to the pursuit of truth but a conviction of the superiority of the life so devoted (the *vita contemplativa*) over any aims of secular ambition. The faith of the Catholic Church indeed seemed to him too hopelessly unphilosophical for any man of culture to entertain; but he was easily carried away by the discovery in Manichaeism (*q.v.*) of a religion that professed to appeal to reason rather than authority.

The Manichaean system as propagated in the Western empire was a materialistic dualism, accounting for the world as the product of a premundane conflict of light and dark substances, and for the soul of man as an element of the light entangled in the dark. Manichaeism claimed to be the true Christianity, preaching Christ as the Redeemer who enables the imprisoned particles of light to escape and return to their own region. In the Manichaean Church the higher order of "elect" were strictly ascetic and celibate, all physical generation being held to serve the realm of darkness. Augustine joined its lower order as one of the "hearers," to whom marriage was permitted as a concession to human weakness. For, after an adolescence that probably was no more licentious than was common in his time and country, he had formed a liaison with a woman of low birth to whom he remained loyally attached throughout the nine years of his association with the Manichaeans. But his first zeal for this "religion of enlightenment" did not last long. The Manichaean experts, intellectually second-rate, proved incapable of dealing with the questions he put to them. He became increasingly disillusioned, and was already falling into a general agnosticism when, at the age of about 28, he left Carthage, where he had worked as a free-lance teacher of rhetoric, and went to Rome in search of more satisfactory pupils. There he made connections that procured for him the appointment to an official professorship at Milan, then the place of residence of the emperor of the west. The bishop of Milan was Ambrose, the most eminent Christian leader of the day (*see* AMBROSE, SAINT). Augustine was introduced to but never became intimate with him. He went to hear him preach, however, and this, his first contact with the mind of a Christian intellectual, was enough to shake his prejudice against Catholic teaching. But though he had abandoned the doctrines of Manichaeism, he retained its materialistic presuppositions, which left him still a skeptic with no satisfying alternative to Manichaean notions of ultimate reality. The being of God and the nature and origin of evil were problems as insoluble as ever.

The solution of both was given to him by a chance introduction to Neoplatonic writings, for which he may well have been prepared by Ambrose's use of them in some of his sermons. Neoplatonism (*q.v.*), in the work of Plotinus, its greatest exponent, is a spiritual monism according to which the universe exists as a series of emanations or degenerations from absolute unity. From the transcendent One arises self-conscious mind or spirit; from mind comes soul or life, and soul is the intermediary between the spheres of spirit and of sense. Matter is the lowest and last product of the supreme unity; and since the One is also the real and the good, the potentiality of evil is identified with unformed matter as the point of maximum departure from the One. Evil itself is thus the least real of all things, being simply the privation or absence of good. Neoplatonic mysticism relies on the principle that the inward is superior to the outward: to reach the good, which is the real, we must "return into ourselves", for it is the spirit at the heart of our inmost self that links us to the ultimate unity. In the seventh book of the *Confessions* Augustine tells us how in such an act of introspection he found God—the "Changeless Light," at once immanent and transcendent, which is the source of every intuitive recognition of truth and goodness. This discovery of God was a more than the conclusion of a process of reasoning: it was a mystical experience, a vision or touch that came and went. But it left behind it the answer to Augustine's unsatisfied questionings. God is light, and evil is darkness, as the Manichaeans said. But neither is a material substance; the changeless light of God is pure spiritual being, and evil is non-entity, as darkness is but the absence of light.

Augustine's mystical experience, his awareness of God, had been momentary and fleeting. He believed that this could be only because he had not made for himself the necessary total identification of supreme value with spirit; he was still himself entangled with the flesh. In fact, Neoplatonism had reinforced the Manichaean principle that the way of return to God must be through escape from the body; and for Augustine this meant primarily and immediately escape from the ties of sexuality. The immortal story of his conversion in the eighth book of the *Confessions* tells of his coming to learn of the heroic achievements of Christian asceticism in east and west, of the self-contempt induced in him by the contrast of his own weakness, and of the final breakdown of resistance in the Milan garden, when, at the sound of a child's voice calling "*tolle, lege: tolle, lege*" ("take up and read"), he opened the Pauline Epistles and read the words: "Put on the Lord Jesus Christ, and make no provision for the flesh, to gratify its desires."

This was in the late summer of the year 386. Vacation was near, and Augustine resigned his chair and went with some young pupils and his mother to a reading party at a country house lent by a friend. The time there was spent in literary study and philosophical discussions, out of which came the earliest of Augustine's surviving works—the dialogues on epistemology and ethics, which display so little of the storm and stress of a religious conversion and so little concern with specifically Christian themes that critics have been led to question the accuracy of the *Confessions* story

written many years later. It is true that Augustine's struggle against the domination of his sexual nature can be regarded as the final phase in that fluctuating pursuit of the "philosophic life" in the form in which his reading of the *Hortensius* had first presented it to him. But there is no sufficient reason for doubting that he was a Catholic Christian in intention when he received baptism at the hands of Ambrose in the spring of 387. What is certain is that when three or four years later he wrote his treatise *De vera religione* (*On the True Religion*) he was still thinking of Christianity in Neoplatonic terms. The divine Word (Logos) in Christ is the mind or spirit of Plotinus, illuminating the reason, through whom the human soul has access to the transcendent Godhead. Christ's human life is our example of the ascetic victory over the pains and pleasures of the flesh; Christian morals serve only to purify the soul for the life of contemplation; and Christian faith is the necessary acceptance of the church's authority in this preliminary stage of training.

Bishop and Christian Philosopher.—Shortly after his baptism, Augustine left Milan with his mother and a small party of friends, to return to Africa. At the port of Ostia, on the journey, Monica died; and Augustine has recorded his last talk with her, in which son led mother, through a discourse formed on the pattern of the Neoplatonic "ascent" from this world to the other, to share with him a momentary experience of the life eternal. Home again at Tagaste, the friends formed a little community devoted to the religious life of contemplation and study. But its peace was soon broken when, on a visit to Hippo in 391, Augustine was forced to accept ordination as assistant priest to its old bishop, Valerius. Five years later Valerius died, and Augustine entered the episcopate in which he was to labour until his death. The bishop in Roman Africa was not only the pastor of a parish, the busy teacher and preacher, but the presiding judge in a much-frequented court of summary jurisdiction in civil cases. Augustine never enjoyed robust health, and the vast extent of his literary output was made possible only by the constant services of stenographers and by an extraordinary capacity for the extempore formulation of ordered thought, of which approximately 500 sermons remain as proof. He was not a systematic theologian. Much of his writing was in response to the appeals that his growing reputation in the Christian world brought to him for the solution of the most diverse problems. Over 200 of his letters have been preserved, many of them having the scale of minor treatises. He was tireless in controversy with Manichaeans, Donatists and Pelagians. But his deepest thought, the real Augustinianism, is to be found in his scripture commentaries and homilies, especially his expositions of the Psalms and his tractates on the Gospel and First Epistle of St. John. The characteristic pattern he imposed upon Christian theology was not the outcome of controversy.

The decisive turn was given to his thinking by his ordination to the priesthood, which dragged him against his will from the *vita contemplativa* into the world, and at the same time diverted his studies from philosophy to Scripture. The realities of pastoral experience among the very imperfectly christianized people of an African seaport, together with the rapid impregnation of his mind with the categories of biblical religion, made it impossible for him to overlook the differences between Neoplatonism and Pauline Christianity. The knowledge of God and of the soul always remained what he had declared it to be on the eve of his baptism—the one and only knowledge that he desired; and Plotinus had not been mistaken in bidding him look within himself if he would find God, for the Bible also tells of a likeness to God imprinted on the soul. But while for the Neoplatonist the soul's likeness to God is that of a depotentiated divinity, for the Christian it is that of a temporal and mutable image of the "Eternal and Changeless." Augustine was assured that it is the task of a Christian philosophy, guided by the scriptural revelation, to seek to know God through his image in the soul; and this was the path he followed in his great treatise *De Trinitate* (*On the Trinity*). He insisted that a true knowledge of the soul's nature can be based only on the immediate deliveries of self-consciousness; and the soul's awareness of itself is of a trinity in unity, which reflects "as in a glass darkly" the being of its Maker. My knowledge of my own being, of my own thinking, of my own willing, is not open to doubt; there is an ego, subject of existence, cognition and conation. But in none of these aspects is the ego self-sufficient or independent: it cannot maintain its own being, produce its own knowledge or satisfy its own desires. Augustine believed that he had learned from the Platonists to find in God "the author of all existences, the illuminator of all truth, the bestower of all beatitude." But his cosmology, epistemology and ethics were his own.

This tripartite philosophy may be summarized as follows:

1. Creation in Plotinus is motiveless and purposeless, the automatic by-product of the divine self-contemplation: in Augustine its source is "the will of a good God that good things should be." The outgoing energy of creative love forms the basic principle of his entire theology. Since nothing can come into being or continue in it but by this divine will to create, all that exists is good "in so far as it has being"; and since there are evidently degrees of goodness, we must also hold that there are degrees of being. But even the formless matter that is nearest to "not being" is essentially good because God made it; the origin of evil is not to be sought in material existence. Augustine persistently refused to unload upon the material conditions of human life the responsibility for human wickedness.

2. How is knowledge possible? Following Plato, Augustine argued that the ability to make true judgments never can be inserted into the mind from outside. The human teacher never can do more than help his pupil to see for himself what he already knew without being aware of it. Of these a priori judgments Augustine's favourite examples are the propositions of mathematics and the appreciation of moral values. They cannot be the construction of the individual mind, for all minds agree in accepting their truth when they have been properly formulated. The individual thinker does not make the truth, he finds it; and he is able to do so because Christ, the revealing Word of God, is the *magister interior*, the "inward teacher," who enables us to see the truth for ourselves when we listen to him.

3. Augustine accepts the basic assumption of ancient ethical theory that conduct is properly directed to the achievement of eudaemonia—the happiness or well-being which is taken to be the one universal desire of humanity. Now Augustine's cosmos is an ordered structure in which the degrees of being are at the same time degrees of value. This universal order requires the subordination of what is lower in the scale of being to what is higher: body is to be subject to spirit, and spirit to God. Man must know his place in the order of the universe, and knowing it must voluntarily accept it; that is, he must set upon himself and upon everything else the relative value that is properly due. Augustine's word for the ethical valuation that influences conduct is *amor* ("love"). *Amor* is the moral dynamic that impels us to action. If it is rightly directed we shall never set a higher value on what is lower in the scale. All lesser goods are to be used as means or aids toward the higher; only the highest is to be enjoyed as the ultimate end on which the heart is set. And because the supreme good is also the universal good, the good of all, it can never be attained if what we are seeking is a private good of our own. The selfish pursuit of happiness must defeat its own end. But the supreme good in whose fruition alone we reach our perfection is for Augustine the God whose nature is *agape*, love in the New Testament sense of the word. If then our love, our *amor*, can rise to the enjoyment of God, it will become a participation in the divine *agape*, *caritas*, charity itself. God will have given himself to us, and by sharing in his love we shall love one another as he loves us, drawing from him the power to give ourselves to others.

Donatist Schism.—The energies of Augustine, both pastoral and literary, were for the first 15 years of his episcopate distracted by the wearisome struggle to end the schism in the African church that had persisted for nearly a century. The Donatists (*q.v.*), who in the country districts and in many towns were actually more numerous than the Catholics, claimed to be the only true church on the ground that their ministry was the only one whose succession had not been stained by apostasy in the great persecution of the years 303 to 313. Imperial attempts to suppress the schism had stimulated the martyr spirit that had always marked African

Christianity, and gained Donatism the support of strong elements in the native population whose grievances were social and economic rather than ecclesiastical. The schism maintained itself by fanatical violence, and Augustine's persevering attempts to settle the questions at issue by peaceful discussion were fruitless. In the end, the imperial government became convinced that Donatism was a danger to the security of Africa. The Donatist bishops were compelled to meet their Catholic rivals at a formal conference held under an official arbitrator at Carthage in 411, the foregone conclusion of which was the victory of the Catholic case.

Donatists and Catholics were agreed that the power of the Holy Spirit is conveyed to the believer through the sacraments administered by the church. The Donatists alleged that the sacraments require for their validity a ministry undefiled by mortal sin; for the Spirit departs from the sinner, who cannot therefore "confer what he does not possess." Augustine replied that the sacraments convey the Spirit in virtue of Christ's ordinance alone, and that this validity cannot be affected by the worthiness or unworthiness of the human minister. The Spirit's supreme gift is charity; it is charity that makes the church one body in Christ, and the ultimate cause of schism is the pride that is the denial of charity. Unfortunately Augustine, who had for long stood out against the use of any means but persuasion to bring the schism to an end, eventually was induced to approve the enforcement of legal penalties upon the schismatics in the interest, as he believed, of the many whom fear of Donatist violence had kept from returning to the church. His famous saying "Love, and do what thou wilt" was in fact a defense of compulsion in the service of charity.

Pelagian Heresy.—As the Donatist controversy was ending, Pelagianism was already beginning to threaten doctrines of sin and redemption traditional in the Western Church. Pelagius (*q.v.*) had set himself to resist the slackening of Christian moral standards. Against those who pleaded human frailty in excuse for their failings, he insisted that God has made every man alike free to choose and to perform the good; that it is the essence of sin to be a voluntary act which God's law forbids and which the sinner was free to avoid; and that were not this freedom real, there could be no justice in God's punishments and rewards. Pelagius himself had not desired to challenge Catholic doctrine; but this reduction of Christianity to a bleak moralism could not avoid conflict with the plain implications of the church's sacramental and liturgical practice. Baptism had always been "for the remission of sins"; and infants were held to need it because they inherit the guilt of Adam's transgression, which, as St. Paul taught, brought death upon the whole race of men. The doctrine of original sin was firmly established in the Western Church before Augustine's time; and when it was openly rejected by Pelagius' disciple Coelestius, there was no escape for Pelagianism from being branded as a heresy. The prevarications of Pelagius were able to persuade Pope Zosimus (417–418) to reverse the condemnation pronounced by his predecessor, Innocent I. But in the spring of 418 the African bishops obtained from the emperor Honorius an edict imposing banishment on the heretics; and Zosimus was obliged to come into line.

Augustine had been the soul of the church's resistance. He had seen at once in Pelagianism not merely a denial of the virtue of Christian baptism but a fatal misconception of the relationship between God and man. For to assert that man can achieve righteousness by his own effort is to contradict the fundamental truth that God is the giver of all good. Before the controversy began, Augustine had worked out his own rationalizations of the doctrines of original sin and divine grace—rationalizations in which the church was to prove unwilling to follow him all the way. Accepting the traditional belief in the fact and in the penal consequences of Adam's transgression, he defined the fact as man's refusal to accept his place in the created order, and the consequences as a dislocation of the order of man's own nature—the revolt of flesh against spirit. Accepting the traditional belief that all men are involved both in Adam's guilt and in its punishment, he argued that this involvement takes effect through the dependence of human generation on the sexual passion, in which the impotence of spirit to control flesh is most clearly seen. It was this linking of original sin with human sexuality that exposed Augustine in his old age to the most damaging criticisms of the Pelagian bishop Julian, who boldly asserted the moral neutrality of the instincts that belong to man's created nature, and charged Augustine with relapsing into Manichaeism in his argument that an impulse which we are bound to fight and conquer must therefore be evil. But it is important to distinguish Augustine's profound understanding of the nature of human sinfulness from his disastrous attempt to explain its propagation. The fall of man means (he said) that in all of us the true order of love has been violated. Departing from the love of God above us, we have followed the love of self and become subject to what is below us. Man has fallen by the act of his own will. He cannot by a similar exercise of will reverse the consequences of that fall: the subjection of spirit to flesh is a slavery from which the perverted will has no power to deliver itself, just because it cannot will the deliverance. What is needed is a kind of reversal of gravity—the substitution of an uplifting for a down-dragging love. And it was Augustine's belief that this could happen only by that gracious descent of the divine love to dwell within the sinner, which is the gospel of the Incarnation and of Pentecost.

Pelagius claimed to recognize the grace of God in creation and revelation. All men have been created free to do what is right when they see it, and Christians have received the needed moral enlightenment in Christ's teaching and example. Augustine knew the unreality of the Pelagian conception of freedom as an innate and absolute power of choice, unaffected by circumstances. He pointed to the inescapable conditioning of all moral activity by the situation of the agent—outside whose control are in general not only the presentation of an object but also the kind of feeling that the presentation excites. But the act of will is dependent on feeling as well as on cognition. In Augustine's words: "Men will not do what is right, either because the right is hidden from them or because they find no delight in it. But that what was hidden may become clear, what delighted not may become sweet—this belongs to the grace of God" (*De peccatorum meritis*, ii, 26). Augustine insisted that without this delight in righteousness there can be no true freedom in well-doing, but only a servile obedience to law. The love of God which is the motive of the Christian life must be free. Yet love of God, as St. Paul said, enters our hearts by the gift of the Holy Spirit; and Augustine found it increasingly difficult to leave room in his doctrine of grace for a genuinely free response on man's part to the Spirit's gift. The unexamined assumption that everything in human life must be ascribed either to God's working or to man's compelled him to hold that God alone is the cause of every human movement toward good. In the first year of his episcopate, the study of St. Paul's argument in Rom. ix–xi had convinced him that no event in time can alter the eternal setting of God's will toward any human soul: his elect are chosen "before the foundation of the world." God knows—not before, but apart from, the time process—how each individual in the course of time will respond to the particular form in which grace is offered to him; and the elect alone receive the grace that will win their acceptance.

The rigour of this doctrine did not soften in face of the Pelagian challenge. In *De civitate Dei* (*The City of God*), the magnum opus on which Augustine was working throughout the Pelagian controversy, he drew a picture, as majestic as it is appalling, of the "beginnings, courses and destined ends" of the two invisible societies of the elect and the damned. The work seems to have been in his mind before the capture of Rome by the Visigoths in 410 had shaken the empire; but it took the form of a Christian apologetic against the pagan claim that the disaster was consequence and punishment of Rome's apostasy from its ancestral religion. Augustine's two cities are not to be identified with Christian church and pagan or secular state. They are symbolic embodiments of the two spiritual powers which have contended for allegiance in God's creation ever since the fall of the angels—faith and unbelief, "the love of God proceeding to disregard of self, and the love of self proceeding to disregard of God" (*De civitate.*, xiv, 28). Neither love is embodied in its purity in any earthly institution; in this world the heavenly and earthly cities

are inextricably intermingled. If there is a philosophy of history to be found in the *De civitate Dei*, it is the religious philosophy of predestination.

Augustine in his old age was hard put to it to reassure some of his own disciples, to whom his doctrine seemed to make moral effort futile and praise and blame alike groundless. But he would retract nothing. His last completed treatises drew out the logic of predestination to its most ruthless conclusions. Though his doctrine in its final form was never accepted by the church, it reappeared virtually unmodified in both Aquinas and Calvin, the most acute thinkers of scholasticism and reform. It may indeed be regarded as product of the too audacious attempt of the time-bound human mind to contemplate existence with the eye of the eternal God.

Influence.—The end of Roman civilization in Africa was near, and the Vandal armies were besieging Hippo, when Augustine died there on Aug. 28, 430. Not many years later, Vincent of Lérins defined Catholic orthodoxy in the famous phrase *quod ubique quod semper quod ab omnibus creditum est* ("What is everywhere, what is always, what is by all people believed"). He dared not call Augustine a heretic in so many words, but it was against the extravagances which he rightly detected in Augustinian doctrine that his definition was aimed. That these extravagances have been a legacy to theology the more noxious because of the weight of authority attached to their author, cannot be denied. But that should not prevent our grateful acknowledgment of the debt which Christian thinking, through the centuries, has owed to the influence that Augustine has continued to exercise upon it, and that has spanned and may one day reconcile the divisions of western Christendom. The secret of that influence is to be found not so much in the brilliance and profundity of his intellect, the magic of his style or the validity of his constructions as in the unique power of his religious genius. St. Anselm of Canterbury and St. Bernard of Clairvaux, the makers of the English Prayer Book and St. Francis of Sales, Pascal, Bossuet and Joseph Butler, Jacques Maritain, Reinhold Niebuhr and Paul Tillich—all these have in their different ways drawn inspiration from one in whom they have been compelled to recognize "the heart of the matter." *Verus philosophus est amator Dei* ("The true philosopher is the lover of God"). In those words from the *De civitate* (viii, 1), Augustine has left us at once the best portrait of himself and the fullest justification of his life's work. St. Augustine has been revered as a doctor of the church since the early middle ages. His feast is celebrated on Aug. 28. *See* also references under "Augustine, Saint," in the Index.

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AUGUSTINE OF HIPPO, RULE OF ST. Of the four rules that at one time or another have been attributed to Augustine, the one known as *Regula Consensoria* is certainly not by Augustine, but of Spanish origin. This leaves three rules that may claim Augustinian authorship. (1) The *Disciplina Monasterii* (*DM*). Except for two sentences serving as introduction and conclusion respectively, *DM* is a terse document of about 350 words, giving to a religious community of men prescriptions for choral prayer, reading and manual labour, observance of monastic poverty, obedience and silence, conduct outside the monastery and maintenance of discipline. (2) The *Regula ad servos Dei* (*RA*), containing the fundamental norms of monastic community life, with emphasis on charity as the foundation of perfection. (3) The female version of *RA* (*EA*), which in many manuscripts and printed editions is combined with Augustine's *Letter* 211 addressed to nuns.

Until about 1940 the most general assumption had been that *EA* was the only rule written by Augustine, while *RA* was explained as a later adaptation from *EA* and, like *DM*, thought to be of unknown authorship. This traditional view was challenged by investigations that threw new light on the text history of the three documents. In almost all the manuscripts from the 6th to the 12th century *DM* and *RA* are found together, constituting, par excellence, the *Rule of St. Augustine*. In this combination they were known to Benedict of Nursia, Caesarius of Arles and others. The two texts were disjoined in the early 12th century when *DM*, some of its main tenets being no longer applicable, was eliminated except for the introductory sentence, which continued its function as preface of the "truncated" *Rule of St. Augustine*.

These findings have produced, roughly speaking, three new theories: the first ascribing to Augustine all three rules, the second limiting his authorship to *DM* and *RA*, the third crediting him with the composition of *RA* only. Though none of these theories is based on incontrovertible evidence, research has clearly established that the combined text of *DM* and *RA*, known as the *Rule of St. Augustine* throughout the middle ages, was an extremely influential document whose existence can be traced back to almost the time of Augustine.

See J. C. Dickinson, *The Origin of the Austin Canons and Their Introduction Into England*, appendices i and ii (1950); G. B. Ladner, *The Idea of Reform: Its Impact on Christian Thought and Action in the Age of the Fathers*, pp. 356 ff., with references given there (1959). (Ru. E. A.)

AUGUSTINIAN CANONS (Austin Canons; also called Canons Regular of St. Augustine), a religious order in the Roman Catholic Church, which rose in close connection with the great reform movement known as the Gregorian Reform. Its main characteristic was the union of clerical status and a full common life. Though the ideal of clerical community life, as it had been understood by its first ardent promoters, Eusebius of Vercelli (d. 370 or 371) and Augustine of Hippo (354–430) (*qq.v.*), had partially and sporadically been revived by later ecclesiastical lawgivers (*e.g.*, Chrodegang of Metz; d. 766), it came to full fruition only during the 11th and 12th centuries. The moral impulse emanating from the Roman synods of 1059 and 1063 and the Gregorian Reform led the canons of many cathedral and collegiate chapters to give up private ownership and to live together according to monastic ideals (*see* Cathedral). Where an entire chapter was unwilling to join the reform, often a few of its canons established a new collegiate chapter. The adoption of the rule of St. Augustine made slow progress at the beginning, but had become almost universal by 1150 (*see* Augustine of Hippo, Rule of St.). Owing to the efforts of bishops who were supporters of the Gregorian Reform, and to the generosity of secular patrons, the order experienced a vigorous growth in Italy, France, England and the empire (especially in Austria, Bavaria and the future Switzerland). By 1215 there were 173 independent houses in England alone. The 14th and 15th centuries saw a second flowering of the order through the rise of reform congregations (Congregation of Windesheim, Lateran and Renan congregations, Congregation of St. George in Alga at Venice).

Many houses of the Augustinian Canons perished in the times of the Protestant Reformation. The French Revolution and later

secularizations put an end to the existence of a great many others. At mid-20th century there were four congregations: Lateran Congregation, divided into five provinces (Italian, French-Belgian-Dutch, English, Spanish-American, Polish), with nearly 500 members; Austrian Congregation with fewer than 300 members; Congregation of Mount Joux (Great St. Bernard) with fewer than 100 members; Congregation of St. Maurice of Agaunum (Switzerland) with about 140 members.

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AUGUSTINIAN HERMITS (AUSTIN FRIARS; ORDER OF THE HERMIT FRIARS OF ST. AUGUSTINE), one of the four great mendicant orders of the middle ages, owing its origin to the centralizing policy of the popes of the 13th century. In 1256 Pope Alexander IV reorganized several congregations of hermits with houses in central and northern Italy into one active order under the rule of St. Augustine (*see* AUGUSTINE OF HIPPO, RULE OF ST.), calling them from their eremitcal seclusion to the lay apostolate in the cities. Though this transfer made the term hermit a misnomer, the official name of the order retained it, since it served to distinguish the Austin Friars, as they were called in England, from the Austin Canons.

Besides following the rule of St. Augustine, the Augustinian Hermits are subject to special constitutions. The order, numbering both priests and lay brothers among its members, is divided into provinces. At the head of the order is the prior general, who is aided by a council (*curia*). Each province is governed by a provincial with his counselors (definitors), and each monastery by a prior. The provincial, priors and definitors are elected every three years by the provincial chapter, the prior general and his *curia* every six years by the general chapter. The legislative power resides in the general chapter. The dress of the order is a black habit with a long pointed cowl and a black leather cincture.

After the Great Union of 1256 the order rapidly spread not only in Italy but also in England, France, Spain and the countries north of the Alps. Its main duty was the care of souls. Learned Augustinian Friars also took a prominent part in university life, in the councils of the church and in practical affairs of ecclesiastical policy. The great geographical discoveries at the beginning of the modern age brought Augustinian missionaries to Mexico, South America and the far east. The most prosperous period of the order was the 14th century. Then gradually signs of decay appeared. Attempts to counteract the decline of monastic discipline led to the organization of several reform congregations. The Reformation, later revolutions and secularization brought about the total or partial disappearance of many Augustinian provinces. In the 20th century the order experienced a revival, especially in Belgium, Germany, the Netherlands, Ireland, Spain and the United States, and in the early 1960s it numbered about 4,000 members. In addition to its apostolic ministry, including foreign missions, the order is dedicated to the advancement of learning by teaching and scholarly research.

The second order, which is the female branch, after the Reformation shared the same fate as the male. There exist about 130 convents of Augustinian nuns. All but three (Cascia and Aquila in Italy, Maarssen in the Netherlands) have passed from the jurisdiction of the prior general to that of the diocesan bishop.

See R. Arbesmann and W. Hümpfner (eds.), *Jordani de Saxonia Liber Vitasfratrum* (1943); *Augustiniana* 6 (1956); and the articles "Augustiner-Eremiten" and "Augustinerinnen," in *Lexikon für Theologie und Kirche*, 2nd ed., vol. 1 (1957), with references given there.
(RU. E. A.)

AUGUSTINIANS, in the Roman Catholic Church, a generic name applied sometimes to the entire group of religious orders and congregations of men and women whose constitutions are based on the Augustinian rule (*see* AUGUSTINE OF HIPPO, RULE OF ST.); *e.g.*, Dominicans, Premonstratensians, Servites, Trinitarians, Ursulines (*qq.v.*), Gilbertines (*see* GILBERT, SAINT), etc. More commonly, however, the name is used to designate two main branches of Augustinians, namely, the Augustinian Canons and the Augustinian Hermits (*qq.v.*), with their feminine offshoots. *See* also MONASTICISM. (RU. E. A.)

AUGUSTUS, the honorific cognomen or additional name first given by decree of the senate in 27 B.C. to the Roman emperor generally so called (life span 63 B.C.–A.D. 14), who in 44 B.C. had changed his original name, GAIUS OCTAVIUS, to GAIUS JULIUS CAESAR (that of his adoptive father), but who for the period 44–27 B.C. is conventionally known in English as OCTAVIAN, though he himself never used the name Octavianus. The cognomen Augustus (Gr. *Sebastos*) was borne in fact by all the succeeding Roman emperors, but is not used by historians to designate them specifically.

Octavius was born in Rome on Sept. 23, 63 B.C., of a wealthy and respectable but obscure family of Velitrae in Latium. His father, Gaius Octavius (d. 58 B.C.), was its first member to become a senator, being praetor in 61 B.C. and governing Macedonia with distinction. His mother, Atia, was the daughter of Julia, the great Julius Caesar's sister, and this connection determined his career. Caesar regarded the younger Octavius as the most promising of his male relatives; he gave him a military decoration at his African triumph, took him with him on his Spanish campaign in 45 B.C., made him a patrician and had him elected a pontifex. Finally in his will Caesar appointed Octavius heir to three-quarters of his estate, in default of a son of his body, and adopted him as his son.

Rise to Power.—When Caesar was murdered in 44 B.C., Octavius was pursuing his studies at Apollonia in Illyria. He crossed to Italy and, learning that he was Caesar's heir and son, determined to take up the dangerous inheritance. His position was very weak. He was an obscure youth of 18, lacking experience and influential connections. He was naturally suspect to the anti-Caesarian party, and he was rebuffed by Mark Antony (*see* ANTONIUS) who was generally accepted as the leader of the Caesarian party and had taken possession of Caesar's money and papers. His only asset was the fact that Caesar had adopted him, and he promptly assumed Caesar's name, paid Caesar's legacies to the people out of his own pocket and celebrated the *ludi Victoriae Caesaris* (games in honour of Caesar's victory) at his own expense. At the same time Octavian ingratiated himself with Cicero, who persuaded himself that he could use the youth as a tool against Antony and then discard him. On Antony's break with the senate Octavian illegally raised a force of 3,000 men from his adoptive father's army veterans and seduced two of Antony's legions from him. When the senate resolved on war with Antony, it regularized Octavian's position on Cicero's proposal, making him a senator, granting him *imperium pro praetore* (*see* PRAETOR) and instructing him to assist the two consuls of the year 43 in the war. Antony was defeated at Mutina (Modena), but both consuls were killed, and Octavian thus found himself in command of the whole victorious army. He promptly demanded the consulship and, when the senate demurred, marched on Rome. He was elected on Aug. 19 43 with his uncle Quintus Pedius, and fulfilled his first duty to his adoptive father by a law proscribing his assassins. He could now negotiate on equal terms with Antony, who had joined forces with Marcus Aemilius Lepidus, the governor of Gaul. The three met at Bononia (Bologna) and agreed to share the supreme power. By the *lex Titia* of Nov. 27, 43, they were created triumvirs (*see* TRESVIRI) with absolute authority until Dec. 31, 38.

To cow opposition and raise funds the triumvirs proscribed 300 senators and 2,000 equites. Antony and Octavian then crossed to Macedonia to crush Marcus Junius Brutus and Gaius Cassius (*qq.v.*). After the victory of Philippi (42 B.C.) Antony took charge of the east, while Octavian returned to Italy, where by ruthless confiscations he provided allotments for the veterans. In 41 B.C. he had to fight the War of Perusia (Perugia) to crush a rebellion raised by Lucius Antonius, Antony's brother, who was abetted by Antony's wife Fulvia. Antony took Octavian's action amiss, but an agreement was patched up at Brundisium (Brindisi) in the year 40, whereby Antony took all the eastern and Octavian all the western provinces except Africa, which was left to Lepidus; to seal the agreement Antony married Octavian's sister Octavia (Fulvia having died). Next year a pact was signed at

Misenum, on the Bay of Naples, with Sextus Pompeius, in which the triumvirs recognized his rule in Sicily, Sardinia and Corsica, and Antony returned to the east. Sextus soon denounced the pact of Misenum, and friction again arose between Octavian and Antony. A reconciliation was effected however by Octavia at Tarentum (Taranto) in 37.

The triumvirate, which had already legally expired, was prolonged for another five years, and the triumvirs agreed to make common cause against Sextus Pompeius. In 36 Octavian and Lepidus launched a joint attack on Sicily; Octavian himself was badly defeated, but his trusty supporter and best general, Marcus Vipsanius Agrippa (*q.v.*), saved the situation, and Sextus was defeated. Lepidus, who quarreled with his colleague after the victory, was deserted by his troops and deposed. Octavian, who had since 38 B.C. adopted as a *praenomen* or forename the word *imperator*—originally used to designate a magistrate vested with military command—and styled himself *Imperator Caesar divi filius* ("son of the god"; *i.e.*, the deified Julius), returned to Rome to celebrate an *ovatio* or minor triumph and among other honours received the sacrosanctity of a tribune (*q.v.*) of the plebs.

Octavian was now master of all the west, as Antony was of all the east, and it was clear that a struggle for supreme power must come. Octavian gained prestige and popularity from his victory over Sextus, which secured the grain supply of Rome, and during the next few years he and his supporters, notably Agrippa, spent generously on public works, while he himself occupied his troops and won more glory by the conquest of Illyricum (Dalmatia) in 35–33 B.C. Meanwhile Antony lost prestige by his unsuccessful Parthian campaigns and alienated Italian feeling by his entanglement with Cleopatra. Octavian thus was able to build himself up as the champion of Italy and Rome against the oriental queen and her degenerate paramour.

The crisis came in 32 when the second five-year period of the triumvirate expired, and Octavian summoned Antony to lay down his powers. Both the consuls and over 300 senators withdrew from Italy and joined Antony, but Octavian forced the vestal virgins to surrender Antony's will and read it to the rump of the senate. It was a most indiscreet document, favouring Cleopatra and Antony's children by her, and exacerbated public feeling against Antony. Octavian was able to organize a "spontaneous" oath of all Italians, whereby they swore personal devotion to himself and demanded that he be their leader in the forthcoming war. All the western provinces followed suit. War was solemnly declared on Cleopatra, and in 31 B.C. Octavian, having regularized his position by assuming the consulship (he was technically a private citizen during 32), assumed command. At the battle of Actium (*q.v.*) on Sept. 2, 31, he decisively defeated the combined forces of Antony and Cleopatra, who fled to Egypt. On Aug. 1, 30, he entered Alexandria; Antony and Cleopatra both committed suicide, Egypt was annexed and a vast treasure captured. Next year Octavian returned to Rome, where he celebrated a magnificent triple triumph for the conquest of Illyricum, the victory of Actium and the capture of Egypt.

Augustan Constitution.—Octavian was now undisputed master of the empire, but his constitutional position was nebulous. From 31 onward he was elected consul year after year, but over and above his constitutional authority as consul, he claimed undefined supreme powers in virtue of the Italian oath of 32 B.C. Now that the war was over he would alienate the republican-minded upper and middle classes of Italy if he continued to exercise such monarchical power. In 28 B.C. he began by abolishing the illegal acts of the triumvirate and, with his fellow consul Agrippa, conducted a census and a drastic purge of the senate, which had swelled inordinately in numbers and contained many unworthy members. Then on Jan. 13, 27, he solemnly resigned his extraordinary powers, remaining merely one of the two consuls of the year. The senate in gratitude conferred upon him the cognomen Augustus on Jan. 16, 27, but begged him not to desert the republic, and he agreed to undertake the pacification of the more unruly provinces. For this purpose he was assigned for ten years a very large province, comprising Spain (except Baetica, the southern part), Gaul, Syria and Egypt, and granted authority to declare war and make treaties. With this exception, which was a temporary measure and had precedents in the extraordinary commands voted to Pompey and Caesar and others in the late republic, the normal republican constitutional machinery was restored. Free elections were resumed, the magistrates, under the guidance of the senate, performed their normal functions, and annual proconsuls governed the ten provinces not assigned to Augustus.* The coins proclaimed Augustus *libertatis populi Romani vindex* ("defender of the Roman people's freedom"), but he retained control of all the legions except a few commanded by the proconsuls of Illyricum, Macedonia and Africa.

Augustus spent the next three years (27–25) in the western part of his own province, where he finally subdued the turbulent tribes of northwestern Spain, the Astures and Cantabri. Every year, however, he stood for the consulship and naturally was elected to it. Such a continuous tenure of the consulship had probably not been envisaged in the settlement of 27 B.C., and it caused mounting discontent. Not only were the nobility aggrieved that their chances of attaining the consulship were halved, but also it was widely felt that it was contrary to the law and spirit of the republic that one man should hold one of the supreme magistracies continuously. Discontent came to a climax in 23 with a conspiracy to assassinate Augustus led by Aulus Terentius Varro Murena, his colleague in the consulship and hitherto a loyal supporter. Augustus saw that if he was to avoid Julius Caesar's fate he must make drastic concessions, and on July 1, 23, he resigned the consulship, never to hold it again save twice (5 and 2 B.C.). He still retained his province (his tenure of which would not expire until 17 B.C.) as proconsul, but to show that he would hold it no longer than necessary, he surrendered the pacified provinces of Gallia Narbonensis (southern Gaul) and Cyprus. In compensation for the loss of the consulship he received certain privileges. It was decreed that he should not, like other proconsuls, forfeit his *imperium* (chief authority) by entering Rome and that he should have *majus imperium* or authority superior to that of other proconsuls, so that he could if need be override their decisions. He was also given special powers to convoke the senate and to introduce business in it. Finally he was granted the powers of a tribune of the plebs (*tribunicia potestas*) for life. The significance of this grant is somewhat obscure. It gave him certain rights, those of introducing legislation and vetoing the acts of all magistrates, which he in fact used very rarely but which might be useful in an emergency. It was probably primarily a propaganda move, designed to enlist the support of the common people, who still regarded the tribunes as their protectors and champions.

In 22 Augustus set out on a prolonged tour of the eastern provinces, from which he did not return to Rome until 19 B.C. If the republican opposition was satisfied by the new arrangements, the people were not. They offered Augustus a dictatorship, an annual and perpetual consulship and other extravagant offices, and in 22 and 20 insisted on electing him to the consulship, though he refused to stand. It would appear that the mass of the people really was afraid that Augustus would withdraw permanently to his province and leave the senate to govern. Alarmed by riots that it was unable to control, the senate pressed Augustus to intervene and celebrated his return with an altar to Fortuna Redux (Fortune that brings back). The republicans were now prepared to make concessions. In 19 B.C., according to Dio Cassius, the consular *imperium* was conferred upon Augustus for life. The accuracy of this statement has been doubted, but henceforth Augustus undoubtedly exercised executive powers in Rome and Italy like a consul. His constitutional position was now complete and no further changes were made in it. He was elected pontifex maximus (*see* PONTIFEX) with acclamation in 12 B.C. on the death of Lepidus, who had previously held the office, and in 2 B.C. he was saluted *pater patriae* ("father of his country"), but these were mere honours. The tenure of his province was renewed at intervals of five or ten years until his death in A.D. 14.

It has been much debated whether Augustus ever really intended to restore the republic, or wished to set up a system of

dual control, a "dyarchy" in which he and the senate should share the government of the empire, or whether he merely established the façade of a republic to satisfy upper-class sentiment. Some of his utterances suggest that at first he may have hoped that, having set the empire in order, he would be able to retire and leave the senate to carry on; but such hopes, if he ever entertained them, soon faded. He certainly endeavoured to stimulate the magistrates and senate into taking a more active part in the government and promoted reforms in the republican administrative system. Certain functions, for instance, previously neglected by the aediles were transferred to newly created boards of senatorial commissioners such as the *curatores aquarum* ("keepers of the water supply"); it was only as a last resort, after many experiments, that Augustus personally took over two of their functions, the fire brigade and the grain supply of Rome (*see* AEDILE). At the same time he interfered as little as possible in the running of the constitution. He appears to have left the elections free, only commending to the people a few candidates whom he favoured, but by the end of his life this *commendatio* had hardened into a right to nominate a limited number of candidates whose election was uncontested. He likewise tried hard to get the senate to revise its own roll of membership, and though he had to carry out the task himself on two occasions (18 and 11 B.C.), he eventually succeeded in his aim in A.D. 4. But he kept the real power firmly in his hands. Above all he never relaxed his hold on the army.

After 19 B.C. Augustus possessed constitutional prerogatives that enabled him to enforce his will in almost any contingency. Outside his own province, however, he preferred to use them as little as possible and to govern through his moral authority (*auctoritas*). Thus while he himself introduced certain laws in virtue of his *tribunicia potestas*, most of the legislation of the latter part of his reign was moved by the consuls though inspired by him. The consuls also conducted most business in the senate, though it was prepared by a small committee over which Augustus presided. Despite his *majus imperium* he gave more advice than commands to proconsuls. In his official titles he ignored his *imperium* and stressed his *tribunicia potestas*. He preferred to be known as the *princeps*, the senior statesman of the republic.

Perhaps the most significant evidence that he never seriously contemplated the restoration of the republic is the care that he took throughout his reign to provide himself with a potential successor. He has been much criticized for assigning this role almost exclusively to members of his own family, but though he may have been partly swayed by personal feelings there were strong political reasons for such a choice. The loyalty of the legions was to the Caesarian family, as Augustus' early career had demonstrated, and the stability of the regime was largely dependent on holding their loyalty. Augustus was unfortunate in begetting no sons. His first marriage—with Scribonia in 40 B.C. —produced only a daughter, Julia, born in 39 B.C. In 38 B.C. he divorced Scribonia and married Livia Drusilla, with whom he had fallen passionately in love, forcing her husband Tiberius Claudius Nero to divorce her. The marriage proved a very happy and lasting one (Livia outlived him), but produced no children. Augustus' only near male relative was Marcus Claudius Marcellus (*see* MARCELLUS), the son of his sister Octavia. Livia had two sons by her first marriage, the future emperor Tiberius and Nero Claudius Drusus (*qq.v.*) who were brought up in Augustus' house.

Augustus' first choice was Marcellus, to whom he married Julia and gave signal preferment. This apparently caused friction with his trusty supporter Agrippa, who in 23 B.C. was placated and removed from the scene by being made Augustus' colleague for five years in his proconsular command and assigned the east as his sphere. Marcellus died the next year, and Julia was promptly married to Agrippa. The marriage produced two sons, whom Augustus adopted as his own, Gaius (born in 20) and Lucius Caesar (born in 17). In 18 B.C. Agrippa's proconsular powers were extended for five years concurrently with Augustus', and he was also made a colleague in his tribunician power for the same period. The plan evidently was that if Augustus died prematurely (his health was always bad), Agrippa would be left in command and would in due course be succeeded by his sons, who were by blood and adoption Caesars. Agrippa's powers were renewed for another five years in 13 B.C., but he died the next year. Augustus then assigned Agrippa's role to Livia's elder son, Tiberius, to whom he married Julia, forcing him to divorce the wife whom he deeply loved. Tiberius was granted the tribunician power for five years in 6 B.C., but almost immediately withdrew to Rhodes and refused to take any part in the government. The reason for the quarrel became apparent when the following year Agrippa's son Gaius Caesar, who was now 15, was elected consul, to assume office five years later, and was acclaimed by the *equites* as *princeps juventutis* ("head of the younger generation"); in 2 B.C. Lucius Caesar was accorded the same honours. Tiberius, who had done sterling service in Pannonia and Germany as Augustus' legate, had no mind to play second fiddle to two boys. Augustus persisted in his policy, assigning a proconsular command to Gaius Caesar in 1 B.C. and entrusting him with the settlement of the Parthian and Armenian problems, but once again he was disappointed in his hopes. Lucius died in A.D. 2 and Gaius in A.D. 4. Augustus was forced to fall back on Tiberius, whom he adopted as his son and associated with himself in the proconsular and tribunician powers for ten years. These powers were renewed and enlarged in A.D. 14, shortly before Augustus' death.

Expansion of the Empire.—Though he was himself no great general, Augustus greatly extended the empire by a long series of wars, some of which he conducted in person but most of which were fought by Agrippa, Tiberius, Drusus and other competent generals. Augustus was not attracted by the lure of eastern conquests and resisted the pressure of public opinion for a war of vengeance on Parthia. In 20 B.C., by a judicious display of force, he induced the Parthian king to surrender the standards and the prisoners captured from Crassus at Carrhae in 53 and to accept a Roman nominee on the throne of Armenia. Having thus restored Roman prestige and satisfied Roman pride he took no further action until A.D. 4, when Gaius Caesar by another show of force again induced the Parthians to acquiesce while he installed a king in Armenia. Augustus confirmed most of the client kings whom Antony had appointed in the east, notably Polemo of Pontus, Amyntas of Galatia, Archelaus of Cappadocia and Herod of Judaea. Galatia however was annexed and added to Augustus' provinces when Amyntas was killed in 25 B.C. An ill-considered attempt to annex Arabia Felix (Yemen) in 26 B.C. proved a dismal failure.

In Europe, apart from the pacification of Spain (26–25 B.C.), Augustus' efforts were mainly directed toward establishing a satisfactory northern frontier; the northern approaches to Italy were still very vulnerable. The first stage was the conquest of the Alps and of Raetia and Noricum up to the Danube, conducted by Tiberius and Drusus (16–14 B.C.). In the next five years (13–9 B.C.) Agrippa, succeeded by Tiberius, subdued Pannonia Illyricum was during this period transferred to Augustus' province Meanwhile Drusus pushed forward east of the Rhine into Germany, reaching the Elbe. On his death in 9 B.C. Drusus was succeeded by Tiberius in this task. For the years of Tiberius' retirement (6 B.C.–A.D. 4) the record is very scanty, but campaigning in Germany went on, and Moesia also seems to have been conquered. When Tiberius returned, a grand strategic plan was formed for the conquest of the Marcomannic kingdom of Bohemia and the establishment of a shorter frontier running up the Elbe to the great bend of the Danube. A converging attack on Maroboduus, king of the Marcomanni, had already been launched in A.D. 6 when the Pannonians broke into revolt. The suppression of the rebellion took three years and strained the resources of the empire severely. It was scarcely complete when Arminius (*q.v.*), king of the Cherusci, trapped P. Quinctilius Varus, the Roman commander in Germany, with three legions and annihilated them in the battle of the Teutoburg Forest (A.D. 9). Discouraged by these successive blows, Augustus abandoned his ambitious plans; Maroboduus remained unconquered, and the legions were withdrawn behind the Rhine. Despite this failure Augustus' achievement was great. He had advanced the northern

frontier to the Danube and added four provinces—Raetia, Noricum, Pannonia and Moesia—to the empire. Incidentally, since these provinces with Illyricum were all added to his sphere, his preponderance in the government of the empire was greatly increased, and since the troops were withdrawn from Macedonia, only one legion was left that was not under his command, that under the proconsul of Africa.

Army.—Augustus at length established the standing army that the empire had long required. After Actium he discharged the greater part of the huge armies he and Antony had collected. He seems to have contented himself with 28 legions (reduced after the Varian disaster to 25), which were maintained as permanent establishments and many of which survived for centuries. From 30 B.C. he signed on recruits for a definite term of years, fixed at 16 originally and at 20 in A.D. 6. The major financial problem, which the senate had never faced under the republic, was the provision of land or bounties for army veterans on discharge. From 30 B.C. to A.D. 6 Augustus bought the land required or paid the bounties out of his own pocket. In the latter year he established a special military treasury for this purpose and despite much opposition from the senate instituted new taxes on Roman citizens to feed it. The auxiliary units that the provincials previously had provided from time to time also were reorganized on a permanent basis, and two standing fleets were established at Ravenna and Misenum. Another military innovation was the transformation of the traditional bodyguard (*cohors praetoria*) of a proconsul into a large standing force of nine cohorts (9,000 men) stationed around Rome. Closely associated with these were the three urban cohorts in Rome itself.

Civil Administration.—To assist him in his multifarious tasks Augustus built up piecemeal a rather rudimentary and uncoordinated administrative machine. He appointed senators of consular or praetorian standing as his delegates (*legati Augusti*) to govern most of his provinces and to command his legions (except those in Egypt). He also appointed a senior senator of consular rank as prefect of the city to maintain order in Rome with the urban cohorts; originally a temporary appointment made when Augustus was absent in Spain in 26 B.C. and repeated for the duration of a visit that he made to Gaul in 16–13 B.C., this office became permanent toward the end of his reign. To command the auxiliary units and govern small provinces he used prefects of equestrian rank; the key province of Egypt, which it would have been dangerous to entrust to a senator, also, by exception, was governed by an equestrian prefect. He also employed *equites* to command the newly organized fire brigade and to manage the grain supply of Rome and to command the praetorian guard. He developed his private household of slaves and freedmen into a central secretariat and financial office. To look after his financial interests in the provinces he used private agents (*procuratores*), who not only managed his private estates but also, in his own provinces, collected the revenues and paid the troops; the principal *procuratores* were usually men of equestrian rank, but some of them, and all the subordinate staff, were Augustus' freedmen or slaves.

The provinces profited greatly by Augustus' rule. First and foremost, they enjoyed peace from the civil wars and their accompanying exactions. Second, Augustus abolished the tithe system wherever it prevailed and with it the extortions of the *publicani* (farmers of the revenues), substituting a fixed tribute based on a census of population and property and collected by the cities themselves. He appointed men of a better type as governors in his own part of the empire and controlled them closely. He sometimes also intervened in virtue of his *majus imperium* to correct abuses in the other provinces and simplified the procedure whereby the provincials could claim redress from extortionate governors.

Social and Religious Policy.—Augustus tried to inaugurate a religious, moral and social reform of the Roman people. He rebuilt derelict temples, restored neglected ceremonies and priesthoods and, in general, attempted to revivify the old state religion with its patriotic associations. In the moral sphere he tried to restore the sanctity of marriage and to stimulate the birth rate by two laws, both passed about 18 B.C., the *lex Julia de adulteriis*, which made adultery a crime, and the *lex Julia de maritandis ordinibus*, which penalized the unmarried and the childless and rewarded parents of large families (the latter law was modified in A.D. 9 by a *lex Papia Poppaea*). In 17 B.C. the advent of a new and better age was inaugurated by the celebration of the Secular games. Later in his reign, by the *lex Fufia Caninia* of 2 B.C. and the *lex Aelia Sentia* of A.D. 4, Augustus regulated and limited the manumission of slaves, seeking to check the excessive adulteration of the citizen body by freedmen.

There was one religious movement that Augustus regulated with great caution. Few things had made Caesar more unpopular than his acceptance of divine honours from Roman citizens. Augustus insisted on his adoptive father's deification and built him a magnificent temple, but as far as he could he allowed no worship of himself by Romans. Even in the provinces he was cautious. The eastern provinces had long been accustomed to worshiping their proconsuls, but he allowed them to build temples only "to Rome and Augustus." He seems however to have come to appreciate the value of this cult as an expression of loyalty to the empire and deliberately introduced it into the more barbarous and recently conquered provinces of the west, inaugurating an altar at Lugdunum (Lyons) in 12 B.C., where the communities of Gaul met to worship Rome and Augustus, and later setting up a similar altar for the Germans at the *oppidum Ubiorum* (Cologne).

Literature and the Arts.—The Augustan age of literature and art is justly celebrated, and Augustus himself did something to stimulate the movement. He was a great builder, who could justly boast that he had found Rome a city of brick and left it a city of marble, and his temples, forums and other public buildings provided commissions for many architects and sculptors. He and his lifelong friend Gaius Maecenas were patrons of the poets and encouraged them to devote their talents to propagating the ideals of the new age. Virgil celebrated the divine origins of Rome (and its present ruler), Horace preached religious and moral reform, and even Ovid popularized the religious revival in his *Fasti*.

Personality and Achievement.—Augustus' character is something of an enigma. During his climb to power he was undoubtedly often unscrupulous and brutal, and his dominating passion seems to have been ambition for power. Having achieved power he mellowed and developed truly statesmanlike qualities. He certainly lived down his youthful excesses and died universally respected and beloved. He was not a genius like his adoptive father Julius Caesar, by comparison to whom he has often suffered, but he possessed political and administrative gifts of a high order. His administrative reforms, in particular the reorganization of the army, were soundly and boldly conceived and stood the test of time. But above all he showed superb tact and skill in gauging and manipulating public opinion. He managed to reconcile all classes, even, it would seem, what remained of the nobility, and succeeded in satisfying the republican sentiment of the educated classes and in rallying it in support of the new regime. It is a testimony to the soundness of his work that the system he established endured with no essential change for three centuries.

Augustus died at Nola in Campania on Aug. 19, A.D. 14.

See also Index references under "Augustus" in the Index volume.

BIBLIOGRAPHY.—A basic document is the *Monumentum Ancyranum* (*q.v.*), the obituary Augustus composed for himself. There is a brief sketch of his career by Velleius Paterculus, who was a young man at the end of his reign, and a full and detailed narrative, based on good sources, by Dio Cassius (books 45–56). Suetonius' *Life of Augustus* contains much interesting information, particularly of a personal character. The life and times of Augustus are very fully treated in the *Cambridge Ancient History*, vol. x, ch. i–xviii (1934), where full bibliographies are given. The most notable later work is R. Syme, *The Roman Revolution* (1939). *See* also for the constitution and administration, A. H. M. Jones, *Studies in Roman Government and Law* (1960). (A. H. M. J.)

AUGUSTUS II THE STRONG (1670–1733), king of Poland who was also elector of Saxony as FREDERICK AUGUSTUS I, was born in Dresden on May 12, 1670, the second son of John George III, elector of Saxony. He became elector of Saxony on the death of his brother John George IV in 1694. In 1695 and 1696 he led the Holy Roman emperor's troops against the Turks. When John III

Sobieski died in 1696, Augustus was a candidate for the Polish crown and, to further his chances, became a Roman Catholic—a step that was strongly resented in Saxony. He secured his election and coronation on Sept. 15, 1697, and his principal rival, the prince de Conti (François Louis de Bourbon), abandoned the contest.

Augustus continued the war against the Turks, which ended with the treaty of Karlovci in 1699. In the same year he made an alliance with Russia and Denmark against Charles XII of Sweden in order to conquer Livonia, not for Poland but for his own house. The Poles refused to assist this project. Augustus led his Saxons into Livonia in 1700, but was defeated by Charles at Kliszow (near Pinczow) in Poland in July 1702. Deposed in Poland on July 13, 1704, he fled to Saxony. Charles invaded Saxony in 1706 and compelled the elector to sign the treaty of Altranstädt (Sept. 1706), whereby Augustus recognized Stanislaw Leszczynski as his successor in Poland and abandoned the Russian alliance. During the War of the Spanish Succession, Augustus fought for the emperor in the Netherlands but, after the defeat of Charles XII at Poltava in July 1709, he turned his attention to the recovery of Poland and declared the treaty of Altranstädt void. Because of Peter the Great's support, he recovered the Polish crown on Oct. 20, 1709, but the Polish nobles, fearing his absolutist plans, formed the confederation of Tarnogrod against him in 1715. Peter, however, mediated between him and the confederation. The "pacification diet" of Feb. 1717, under Russian protection, limited the Polish army to 24,000 men.

From 1719 Augustus tried to free himself from Russian influence. He entered into various futile diplomatic combinations—even proposing a partial partition of Poland—with a view to making Poland a hereditary monarchy and to gaining territory for his sons in various parts of Europe. A man of extravagant and luxurious tastes, he cannot be called a good ruler, though he did much to develop Saxon industry and trade and greatly embellished the city of Dresden (founding, for instance, the famous Zwinger art gallery). The Meissen china manufacture was also his creation. He sought to govern Saxony in an absolute fashion and, in spite of his declaration that his conversion was personal only, did much to promote the spread of Roman Catholicism. His wife, Christine Eberhardine, a Hohenzollern, left him when he became a Roman Catholic. Augustus died in Warsaw on Feb. 1, 1733, leaving a son, Frederick Augustus, who succeeded him in Poland and in Saxony, and many illegitimate children, among whom was the famous marshal of France, Maurice de Saxe (*q.v.*).

BIBLIOGRAPHY.—C. Gurlitt, *August der Starke*, 2 vol. (1924); P. Haake, *August der Starke* (1927); E. von Watzdorf, *August der Starke* (1933).
(EM. R.)

AUGUSTUS III (1696–1763), king of Poland who was also elector of Saxony as FREDERICK AUGUSTUS II, was born at Dresden on Oct. 17, 1696, the only legitimate son of Frederick Augustus I (the future Augustus II of Poland). He followed his father's example by joining the Roman Catholic Church in 1712. In Aug. 1719 he married Maria Josepha, daughter of the Holy Roman emperor Joseph I. He became elector of Saxony on his father's death in Feb. 1733. A candidate at the same time for the Polish crown, he secured the emperor Charles VI's support by assenting to the Pragmatic Sanction and the Russian empress Anna's by recognizing Russia's claim to Courland, and was elected king of Poland by a small minority of electors on Oct. 5, 1733. Helped by the Russians, his troops drove Stanislaw Leszczynski from Poland, and Augustus was crowned in Cracow on Jan. 17, 1734, and was generally recognized as king in Warsaw in June 1736.

On Charles VI's death in 1740, Augustus, as a son-in-law of the previous emperor, Joseph I, claimed a portion of the Habsburg territories. In 1742, however, he was induced to support Maria Theresa, and Saxon troops took part in the Austrians' struggle against Prussia during the Silesian campaigns of the War of the Austrian Succession and again when the Seven Years' War began in 1756. Saxony was in that year attacked by the Prussians, and the Saxon army was forced to capitulate at Pirna in October. Poland, however, remained neutral throughout Augustus III's reign. He was thus able to take refuge in Warsaw, returning to Saxony only when the treaty of Hubertusburg was concluded in Feb. 1763.

Augustus had 11 children and was mostly concerned with dynastic plans. He was content to leave Saxony to the rule of his ministers and Poland under the influence of Russia. His reign was a period of the greatest anarchy in Poland. Between 1736 and his death all diets were brought to nothing by the exercise of the "free veto." After the empress Elizabeth's death (1762), moreover, the house of Saxony lost the support of Russia. In the years 1762–63 his opponents, the powerful Czartoryski and Poniatowski families assisted by Catherine II, were preparing a *coup d'état*. In this troubled situation Augustus died at Dresden on Oct. 5, 1763. He took great interest in music and painting and added to the collection of art treasures at Dresden. His eldest son, Frederick Christian, succeeded him in Saxony. (EM. R.)

AUGUSTUS I (1526–1586), elector of Saxony from 1553, was born at Freiberg on July 31, 1526, the third son of Duke Henry the Pious and Catherine of Mecklenburg. In 1553, on the death of his brother Maurice of Saxony at the battle of Sievershausen (July 7), Augustus inherited not only the electorate but also the leadership of German Protestantism.

In the second half of the 16th century, however, just as the Lutheran theologians were becoming more dogmatic, so were the Lutheran political leaders inclined rather to consolidate the gains made by their predecessors than to concern themselves further with European issues (for instance, the religious conflict in France and in the Netherlands). Thus it was that under Augustus I, who was imperturbably peace loving and loyal to the Habsburg dynasty, Saxony lost its traditional place at the head of German Protestantism to the vigorously Calvinistic Palatinate. Augustus had Maurice's coolly realistic attitude toward politics but lacked his gifts of statesmanship and his wide-ranging intellect. His ambition was governed by considerations of reasonableness and circumspection, and he was always more interested in consolidating and developing territories already won than in making further acquisitions. Idealistic motives were unknown to this hard and unemotional man. He had approved and supported his brother's self-seeking policy in the war of the league of Schmalkalden (by which Maurice had won for himself the electoral title and extensive territories but had also earned the scorn of his coreligionists), but he renounced Maurice's dream of making the Albertine branch of the Wettin dynasty (*see* WETTIN; also SAXONY) a great power in central Germany and, by the treaty of Naumburg (1554), restored the greater part of Thuringia to the Ernestine branch, while securing the rest of his brother's inheritance to his own house. Convinced that neither the Protestant nor the Roman Catholic forces in Germany would win final supremacy, he accepted, as advantageous to himself, the peace of Augsburg (*q.v.*) in 1555, which brought to an end the Reformation proper in Germany. Whereas Maurice had felt himself obliged, as leader of the Protestant princes, to take up arms to induce the emperor Charles V to liberate the two leaders of the league of Schmalkalden, Philip of Hesse and John Frederick I of Saxony (*qq.v.*), Augustus returned to the traditional Albertine policy, namely support for the Habsburgs and the maintenance of peace within the empire.

In his religious policy, in strong contrast to the strict Lutheranism of the Ernestine Wettins of Weimar, Augustus at first followed a Lutheranism tempered by the doctrines of Philipp Melanchthon. When, however, a group of his advisers and theologians tried to lead him toward a moderate form of Calvinism, he proceeded with severity against the "crypto-Calvinists" and, from 1574, directed his ecclesiastical policy along the lines of orthodox Lutheranism. By achieving widespread consent to the "Formula of Concord" he managed to unite most of the Lutheran princes on a doctrinally conservative basis, but this only served to widen the split between the Lutherans and the Calvinists. Despairing of a united Protestant policy within the empire, he detached himself not only from the disturbingly active electors of the Palatinate but also from the Protestants in the Netherlands and from the Huguenots, regardless of their need for help from Germany.

With his own practical approach encouraged by his able and vigorous wife, Anna of Denmark (1532–85), Augustus devoted himself to the economic and administrative development of his lands. His exceptional success in this field won the admiration of

his contemporaries and made his dominion the model Lutheran state.

Augustus had 15 children by Anna of Denmark, including his successor Christian (1560–91). Three months after Anna's death, he married, on Jan. 3, 1586, the 12-year-old Agnes Hedwig of Anhalt (d. 1616). He died, however, a few weeks later, on Feb. 12, 1586, at Dresden.

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(WA. HE.)

AUK, generally speaking, any bird of the nonpasserine family Alcidae, short-winged sea divers including the guillemot, murre and puffin. The name is often restricted to the now extinct great auk (*Pinguinus impennis*) and to the razor-billed auk (*Alca torda*). The 22 species of the auk family are restricted to the North Pacific, North Atlantic and Arctic oceans and their coasts. They differ considerably in appearance, ranging from 7 to 30 in. in length and from black to grayish in colour. Most are white below, sometimes with a black throat during the breeding season, and several species have a white wing patch and ornamental head plumes. The bill is often brightly coloured and may be either short and stout, rather long and slender, or laterally compressed and conspicuously sculptured. The compact body is held erect since it is supported by short legs set far back. The feet are webbed.

Auks and their kindred are the most gregarious of birds. They breed in vast, often mixed colonies on ledges of cliffs and in rock crevices or burrows adjacent to the sea; the stormy winter months are spent at a distance from land. The large eggs (one or two) may be white, deep buff or pale green, and either immaculate or variously spotted or scrawled with brown. Being pointed at one end, they tend to roll in a circle and thus avoid falling from exposed nesting sites. Incubation is from 24 to 43 days. In some species the young may be fed in the nest for as long as 40 days, after which they are deserted by the parents. Auks and their relatives are wholly dependent upon the sea for their food, which consists of fish, Crustacea, mollusk and plankton. The largest and most notable member of its family was the great auk, a flightless black-and-white goose-sized bird of the North Atlantic, which was hunted to extinction by seamen in 1844. A few skins, skeletons and eggs have been preserved.

ALBERT E. GILBERT

ONE OF THE AUKS, THE COMMON AMERICAN MURRE OR EUROPEAN GUILLEMOT (URIA AALGE)

The razor-billed auk, also of the North Atlantic, resembles a miniature (17 in.) great auk but has a compressed, white-ringed bill. The cliffs bordering the Pacific coast of North America are populated by numerous other species.

See also GUILLEMOT; PUFFIN. (E. R. BE.)

AULARD, FRANÇOIS ALPHONSE (1849–1928), French historian and one of the leading authorities on the revolutionary period in France, was born in Montbron, Charente, July 19, 1849. Educated at the École Normale Supérieure, he took his doctorate in 1877 and then taught French literature in various provincial universities (1878–84). In 1879 he began the study of parliamentary oratory during the French Revolution and from 1882 until his death in Paris (Oct. 23, 1928), he devoted himself to research in the archives and to the publication of many important contributions to the political, administrative and social history of his chosen period. He was professor of the history of the French Revolution at the Sorbonne from 1887 to 1922, and became president of the Société de l'Histoire de la Révolution française in 1904.

Aulard's principal works include *L'Éloquence parlementaire pendant la Révolution française. Les orateurs de l'Assemblée constituante* (1882); *Les Orateurs de la Législative et de la Convention*, 2 vol. (1885); *La Société des Jacobins*, 6 vol. (1889–97); *Études et leçons sur la Révolution française*, 9 series (1893–1924); *Recueil des actes du comité de salut public*, 16 vol. (1889–1904); *Paris pendant la réaction thermidorienne et sous le Directoire. Recueil de documents pour l'histoire de l'esprit public*, 5 vol. (1898–1902); *Paris sous le Consulat*, 4 vol. (1903–09); *Paris sous le premier empire*, 3 vol. (1914–23); *Taine, historien de la Révolution française* (1907).

See Georges Belloni, *Aulard, historien de la Révolution française* (1949).

AULIC COUNCIL (from Lat. *aula*, "court"), the English name for the *Reichshofrat* or court council of the Holy Roman empire, an organ originally intended for executive work but acting chiefly as a judicature, which worked from 1498 to 1806. Already in the early middle ages the emperor had had his *consiliarii*, but these at first formed only a fluctuating body of personal advisers. From these advisers, some of whom were known as privy councilors or *secretarii*, there grew up in the emperor Henry VII's time (early in the 14th century) a council with permanent and paid members, many of whom were legists. Its business was largely executive, and it formed something of a ministry, but it had also to deal with petitions addressed to the king and accordingly acted as a supreme court of judicature. It was thus parallel to the king's council in medieval England, while by its side, during the 15th century, stood the *Reichskammergericht*, composed of the legal members of the council, in much the same way as the Star Chamber stood beside the English council. The real history of the aulic council, however, begins with Maximilian I, who on Feb. 13, 1498, created a new *Hofrat* to deal with "all and every business which may flow in from the empire, Christendom at large, or the king's hereditary principalities." It was thus to be the supreme executive and judicial organ, discharging all business except that of finance and the drafting of documents. Under Charles V the new institution functioned irregularly, but Ferdinand I set it on a new footing with an ordinance of April 3, 1559. From this date, in rivalry with the *Reichskammergericht*, it dealt with judicial matters and litigation in addition to advising on domestic and foreign affairs. By its ordinance of March 16, 1654, the council authorized the nomination of Lutheran members to it. In the 18th century, with the decline of the *Reichskammergericht*, the importance of the aulic council was correspondingly increased.

The aulic council eventually comprised about 20 members, including its president, its vice-president and the vice-chancellor of the empire. It followed the person of the emperor and therefore had its permanent seat at Vienna; it was paid by the emperor, and he nominated its members, whose office terminated with his life. Its executive powers were small, and it gradually lost all except the formal business of investiture with imperial fiefs and the confirmation of charters, its other powers being taken over by the Geheimrat (privy councilors, already constituted as a definite body for dealing with imperial affairs by 1527). In its judicial aspect the aulic council, exercising the emperor's judicial powers on his behalf, had exclusive cognizance of matters relating to imperial fiefs, criminal charges against immediate vassals of the empire and cases "reserved" for the emperor.

See R. Schröder, *Lehrbuch der deutschen Rechtsgeschichte*, 6th ed. (1919); O. von Gschliesser, *Der Reichshofrat* (1942). (A. LH.)

AULNOY (AUNOY), **MARIE CATHERINE LE JUMEL DE BERNEVILLE,** BARONNE D' (1650 or 1651–1705), French writer, is remembered chiefly for her fairy tales, *Contes nouveaux ou les Fées à la mode* (1698), in the manner of Charles Perrault but with sardonic touches reflecting her personal experience; and also for a number of pseudohistorical novels and secondhand accounts of court intrigue, the most noteworthy being *Histoire d'Hippolyte, comte de Douglas* (1690), *Mémoires de la cour d'Espagne* (1690) and *Relation du voyage d'Espagne* (1691). Married in 1666 to François de la Motte, baron d'Aulnoy, a middle-aged financier, she conspired with her mother and their two lovers to accuse him falsely of high treason. The plot miscarried (1669), and she had to live abroad for many years. Eventually she won success with her writings, which went through many editions and

translations. She died in Paris on Jan. 14, 1705. (J. G. R.-S.)

AULOS, in ancient Greek music the word for "pipe," corresponding to the Latin *tibia* and denoting especially the double pipe sounded by reeds, which, with a variety of names, was the principal wind instrument of most ancient peoples and lasted in Europe up to the early middle ages. The two pipes, of cane, wood or metal, were held one in each hand and sounded simultaneously. The Greeks used double reeds of cane held in the pipes by bulbous sockets. The technical details mentioned by classical authors are too few and too obscure in meaning to explain further how the instrument was played. Typologically similar is the modern Sardinian pipe, the *launedda*. *See* WIND INSTRUMENTS: *Reed Instruments*.

See T. Reinach, "Tibia," in C. V. Daremberg and E. Saglio, *Dictionnaire des antiquités greques et romaines* (1877–1919); C. Sachs, *The History of Musical Instruments* (1940). (A. C. BA.)

COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM, LONDON

AULOS. BRONZE FLUTES DECORATED WITH HEADS OF MAENADS

AUMALE, a town in Normandy (in the modern French *département* of Seine-Maritime, 47 mi. N.E. of Rouen), which gave its name first to a medieval countship, then to a duchy.

The first line of counts of Aumale was founded by Odo of Champagne, brother-in-law of William the Conqueror, duke of Normandy and king of England. The heiress of this line, Hawise, brought the title to her third husband, Baldwin of Béthune, but he died in 1213, and in 1214 William de Fors, Hawise's son by her second husband, William de Fors (d. 1195), was confirmed in the title by King John. When Philip II Augustus of France had annexed Aumale with the rest of Normandy to the French crown, the title count of Aumale was nevertheless retained by William's descendants, these being generally known in English history as earls of Albemarle (one of the many variants of the name Aumale). The countship of Aumale itself was granted first by Philip Augustus to his son Philip, then by Louis VIII of France to Simon, count of Dammartin, whose daughter Jeanne transferred it, together with the countship of Ponthieu, to the house of Castile by her marriage with Ferdinand III (1238). Thence it passed by successive marriages to the counts of Harcourt (1340) and to the house of Lorraine (1476). In 1547 Aumale was made a peerage duchy of France. By the marriage of Anne de Lorraine (1618) the duchy passed to the ducs de Nemours, of the house of Savoy. Louis XIV of France bought it from the house of Savoy in 1686 for his natural son Louis Auguste, duc du Maine, from whom it passed to his brother Louis Alexandre, comte de Toulouse. After the duchy had been transferred to the house of Orléans by the marriage of Toulouse's granddaughter, the title duc d'Aumale was given specifically to Henri (1822–97), fourth son of Louis Philippe, king of the French (*see* BOURBON).

AUMONT, the name of a noble French family. Pierre I d'Aumont (d. 1381) was councilor and chamberlain to John II and to Charles V. Jean V (d. after 1521) governed Burgundy under Louis XII and Francis I. Jean VI (1522–95), knight of the Order of the Holy Ghost in 1578 and marshal of France in 1579, fought against the Huguenots under the last Valois kings but was among the first to recognize Henry IV, who rewarded him with several governments; he died fighting against the duc de Mercoeur's supporters in Brittany.

Jean VI's grandson Antoine (1601–69), also a marshal of France (1651), was governor of Paris (1662) and became the first duc d'Aumont (*duché-pairie;* 1665). Louis Marie Augustin (1709–82), duc d'Aumont, rose to the rank of lieutenant general in the army (1748) but was famous as a connoisseur and collector of works of art and books.

Louis Marie Céleste (1762–1831), duc de Piennes, then duc de Villequier and finally duc d'Aumont, served in the Spanish, in the French royalist and in the Swedish armies, 1793–1814. During the Hundred Days he effected a descent on Normandy.

AUNGERVILLE (AUNGERVYLE), **RICHARD** (1287–1345), commonly known as RICHARD DE BURY, English bibliophile and author of *Philobiblon,* a treatise on the care and study of books, was born near Bury St. Edmunds, Suffolk, on Jan. 24, 1287, and educated at Oxford. His career began in the exchequer at Chester, in the service of Edward of Windsor (later Edward III), and for several years he seems to have been Edward's tutor. In 1326 he joined Queen Isabella and her son in France, and after the prince's accession in 1327, Richard's promotion was rapid. He was in close touch with the king as keeper of the privy seal (1329–33) and was twice sent to the papal court at Avignon, where he met Petrarch. In Oct. 1333 Pope John XXII appointed him to the episcopal see of Durham. In Feb. 1334 he was made lord treasurer, an appointment he exchanged later in the year for that of lord chancellor. This charge he resigned in the next year, but he was repeatedly employed in the king's service abroad and in the defense of northern England.

Richard's large collection of letters, the formulary known as his *Liber Epistolaris*, was probably compiled while he was tutor to Edward. It reveals acquaintance with the foreign correspondence of the chancery, the collections of Pietro della Vigna and of Thomas of Capua and the *Arenge* of Petrus de Loro. As means and opportunity grew, Richard became a patron of scholars and a collector of books; his feeling for books and his experience as a collector inspired the famous *Philobiblon,* which was finished shortly before his death. This book reveals his mastery of rhythmical prose and his ability as a stylist. Richard had lavished his resources on his collection and in the extravagance of a great household, and he died in debt on April 14, 1345. His executors probably sold his library, which was scattered, so that few of his books can now be identified.

The *Liber Epistolaris* was edited by N. Denholm-Young for the Roxburghe club in 1950; the latest edition of the *Philobiblon*, by A. Altamura, was published in 1954.

BIBLIOGRAPHY.—The best critical guide is N. Denholm-Young's "Richard de Bury" in his *Collected Papers on Mediaeval Subjects* (1946). In the *Bodleian Quarterly Record*, vii, no. 80, pp. 325–328 (1933), Denholm-Young revealed the brief but good life of Richard in a Durham chronicle to be a section of a composite work, viz., reminiscences given by William de Chambre, marshal of Durham priory to the monk in charge of the chronicle. On Richard's bibliographical interests, J. de Ghellinck's article in the *Revue d'histoire ecclésiastique*, xviii, pp. 271–312, 482–508; xix, pp. 157–200 (1922–23) is essential. The share of Robert Holcot, to whom the *Philobiblon* has often been ascribed, and who may have been Richard's confessor and prepared and edited some of the manuscripts, has been discussed by B. Smalley in *Archivum Fratrum Predicatorum,* xxvi, especially pp. 8–9 (1956). (F. M. P.)

AUNG SAN (1916?–1947), Burmese political leader, venerated as his country's greatest national hero, was born at Natmauk, Magwe district, in central Burma, of a family distinguished for its part in the resistance movement after the British annexation of 1886. As secretary of the students' union at Rangoon university he, with U Nu, led the students' strike of Feb. 1936. After graduating in 1938 he worked for the revolutionary Dobama Asi-ayon ("We Burmans association"), becoming its secretary-general in 1939. After a secret journey to Tokyo in 1940–41, he became commander in the Burma Independence army which assisted the Japanese invasion of Burma during World War II. In Ba Maw's puppet government he was minister of defense (1943–45). He fell foul of the Japanese over their treatment of the Burmese forces which were reorganized as the Burma National army, founded the Anti-Fascist organization late in 1944 to oppose them and in March 1945, switched his forces to the Allied cause. He next founded the Anti-Fascist People's Freedom league and the People's Volunteer organization to fight for national independence. Becoming deputy chairman of the governor's council on Sept. 26,

1946, he visited London and negotiated the Attlee-Aung San agreement (Jan. 27, 1947) providing for Burma's independence within one year. In the election for a constituent assembly held in April 1947 his party won 196 out of 202 seats. On July 19 he and six of his colleagues were assassinated at the instigation of U Saw, a political rival, in the council chamber in Rangoon while the executive council was in session. (D. G. E. H.)

AUNIS, an ancient province (*pays*) of France, bounded on the north by Poitou, on the west by the Atlantic and on the south and east by Saintonge, and corresponding to the northern part of the modern *département* of Charente-Maritime with the southern part of Deux-Sèvres. Its principal town was La Rochelle (*q.v.*); other towns were Châtelaillon, Marans and St. Jean-d'Angely. Its ancient name (*pagus Alnensis*) may have the same derivation as that of Châtelaillon (*castrum Allionis*). In feudal times Aunis early became subject to the counts of Poitiers and so shared the political fortunes of Poitou. Ecclesiastically it was part of the diocese of Saintes until 1648, when it was joined to the former diocese of Maillezais to form the diocese of La Rochelle. For the administration of justice the presidial of La Rochelle was under the *parlement* of Paris. For military purposes, Aunis constituted a *gouvernement général* which included the islands of Ré and Oléron and had its headquarters at La Rochelle.

See L. de Richemond, *Documents historiques inédits sur le département de la Charente-Inférieure* (1874); L. Papy, *La Côte atlantique de la Loire à la Gironde*, vol. ii (1941).

AURANGABAD, a city in India, headquarters of Aurangabad district, formerly in the dominions of the nizam of Hyderabad (*q.v.*) and after May 1, 1960, in the state of Maharashtra. It is a railway station on the Hyderabad-Godavari line. Pop. (1961) 87,579. The city is situated on the Kaun river, 138 mi. N.E. of Poona and 207 mi. E.N.E. of Bombay. Originally called Khirki, it was founded in 1610 by Malik Amber. Aurangzeb (*q.v.*), who erected there a mausoleum to his wife, which has been compared to the Taj Mahal at Agra, made the city the seat of his viceroyalty of the Deccan and renamed it Aurangabad. It remained the capital of the nizams, after they became independent of Delhi, until they transferred their seat to Hyderabad, whereupon Aurangabad began to decline. In 1956 the district became part of the then Bombay state and the city became the headquarters of a division. Aurangabad is the seat of the Marathwada university, founded in 1958. On the northern outskirts of the city are Buddhist caves (mainly 6th–7th centuries A.D.).

AURANGABAD DISTRICT has an area of 6,314 sq.mi. with a population of 1,532,341 (1961). In the north of the district is the Sahyadri range which includes the Ajanta and Jasna hills, and the main river, the Godavari, flows eastward along its southern border. Its tributaries, the Purna and the Dudhana, have their sources in the Ajanta hills. The southern part of the district is fertile and a variety of crops is raised, including cotton and oilseed. The Kannad and Khuldabad talukas are famous for wheat cultivation and the district has a surplus production of jowar (*Sorghum vulgare*). The chief industries are hand loom and wool weaving, *himroo* (gold brocade) and oil pressing. The Hyderabad-Manmad section of the Central railway passes through the centre of the district. Aurangabad is connected by roads with Jalna, Bhir and Ajanta. The renowned caves of Ellora and Ajanta (*q.v.*) are in the district. The 13th-century fort of Daulatabad (*q.v.*) is also famous. Paithan is an important holy place on the Godavari river and is also the scene of the death of the Vishnuite saint Shri Eknath (17th century). Khuldabad is known for the tomb of the emperor Aurangzeb and other Muslim monuments (14th–18th centuries). *See* also TEMPLE ARCHITECTURE. (M. R. P.)

AURANGZEB (MOHI-UD-DIN MOHAMMED; also called ALAMGIR I) (1618–1707), the last of the great Mogul emperors of India, a zealous Muslim during whose reign (1658–1707) the empire reached its greatest extent but lost its inner cohesion. Born on the night of Nov. 2–3, 1618 (all dates new style), at Dohad in Gujarat, he was the third son of the emperor Shah Jahan (*q.v.*) by Mumtaz Mahal. He received a good education, and his correspondence reflects his scholarly knowledge of Arabic and Persian, of the Koran and the Hadith or traditional sayings of the Prophet. His mother tongue was Urdu, but he also conversed in Hindi and Chagatai Turki. His appointment in 1636 as viceroy of the Deccan provinces first brought him into prominence; but unfriendly relations with his father and the rivalry of his elder brother Dara apparently account for his resignation in 1644. In 1645, however, he was appointed governor of Gujarat; in 1647 he was sent to be governor and commander in chief in Balkh and Badakhshan, as Shah Jahan was attempting the reconquest of the Mogul's ancestral lands in central Asia. Operations against the Uzbeks, however, were indecisive and a severe drain upon the imperial finances. Aurangzeb proved his courage and skill, but the ravaged land could not support his army, and he was ordered to retreat before the winter. In 1648 he was made governor of Multan, to which Sind was added in 1649. In 1649 he was also ordered to relieve Kandahar, besieged by the Persians, but it had surrendered before his arrival, and, lacking heavy siege artillery, he was unable to dislodge the Persian garrison; he had but nominal command of a second attempt in greater force in 1652, which also failed. In summer 1652 he was again appointed viceroy of the Deccan. There he reformed the administration and sought to increase the revenues. His aggressive wars against Golconda (1656) and Bijapur (1657) were both halted by Shah Jahan.

Shah Jahan's serious illness in Sept. 1657 was the signal for a war of succession, in which Aurangzeb experienced little difficulty in destroying his brothers. Shah Jahan himself was closely confined in the fort at Agra from June 1658 until his death in 1666. On July 31, 1658, Aurangzeb crowned himself emperor with the title Alamgir ("Conqueror of the World").

The first half of his long reign was devoted to consolidating his power in northern India. He seized western Assam (1662; lost 1667); quelled the pirates of Chittagong (1666); pacified but could not crush the Pathan tribes in the province of Kabul (1667; 1672–*c.* 1680); and attacked the two principal kingdoms of Rajputana, overrunning Marwar (Jodhpur) in 1679 and making peace with Mewar (Udaipur), after an inconclusive war, in 1681. The second half of his reign, from 1681, was spent fighting in the Deccan, principally against the Marathas. By his conquest of the Muslim Shi'ah kingdoms of Bijapur (1685–86) and Golconda (1685–87), the Mogul empire, then at its most vast, was extended to reach from the Coromandel Coast to Chittagong and the Hindu Kush; but within it the Marathas, unsubdued, grew in strength. His Deccan campaigns proved both a military and a political miscalculation: by long absence from the centres of power and wealth in the north he lost control there; by ceaseless wars he exhausted the imperial treasury and desolated his lands. Despite his narrow efficiency as administrator and general and his masterly duplicity, his authority was everywhere in dispute when his last illness came upon him. This failure was due partly to his reversal of Akbar's policy of conciliating the subject Hindu population.

Unlike Akbar, Aurangzeb was a militant orthodox Sunni Muslim, who had claimed the throne as the champion of orthodoxy against the heretical views of Dara. His accession was followed by increasingly puritanical ordinances enforced by *muhtasibs*, or censors of morals; *e.g.*, the Kalima or Muslim confession of faith was removed from all coins lest it be defiled by unbelievers; and courtiers were forbidden to salute in the Hindu fashion.

His treatment of Hindus was severe: their fairs were prohibited and religious festivals restricted; their idols, temples and shrines were often destroyed; the employment of Hindus in the administration was discouraged; the defiant Sikh *guru* Teg Bahadur was arrested and, refusing to embrace Islam, beheaded; and in 1679 the *jizya* or poll tax on non-Muslims, abolished by Akbar, was reimposed. Furthermore, since Akbar's day the general revenue demand had risen from one-third to one-half of the gross produce. Eventually his inflexible and intolerant policy produced a widespread Hindu reaction; in the Deccan the Maratha revolt spread, and in northern India the Rajputs, Jats, Sikhs and others were prompted to revolt. Aurangzeb died on March 3, 1707, in Ahmednagar, leaving to his successors an empire restless and overstrained.

See J. Sarkar, *History of Aurangzib*, 5 vol., 2nd ed. (1925–30); *Anecdotes of Aurangzib*, 2nd ed. (1925). (P. H.)

AURAY, a town in Brittany, France, in the *département* of Morbihan, lies on the Auray estuary 12 km. (7½ mi.) from the sea. Pop. (1962) 7,802. The town, called Alré in Breton, grew up around the castle and the priory of St. Gildas. The castle, residence of the dukes of Brittany, played an important part in the history of the dukedom. In 1364 Charles of Blois was defeated and killed at Auray, as a result of which the dukedom passed to the house of Montfort (*see* BRITTANY). On the battleground John of Montfort, the victor, built a collegiate church which later became a Carthusian monastery and is now a school for deaf-mutes. In 1442 Duke Francis I married Princess Isabella of Scotland in Auray castle (demolished in 1558). A monument near the monastery commemorates the killing of 952 Chouans (*q.v.*) in 1795; Georges Cadoudal, who was born at Korléano near Auray, was one of the leaders. In 1776 Benjamin Franklin landed at Auray as a member of a commission from America; a plaque is on the house where he stayed and his portrait is in the town hall. The house is in the quarter of St. Goustan where are most of the medieval houses. The Gothic-Renaissance church of Ste. Anne is the largest centre of pilgrimage in Brittany. The chief industry of Auray is furniture making, for which there is a training school in the ancient headquarters of the Knights of the Holy Spirit. The oyster beds of Auray are some of the biggest producers of "natives" in the world.

AURELIAN (LUCIUS DOMITIUS AURELIANUS) (d. A.D. 275), Roman emperor from 270 to 275. A native of the lower Danube, he was a professional army officer when, about A.D. 260, the frontiers of the Roman empire suddenly collapsed. The Persians overran the eastern provinces and Germanic tribes ravaged Gaul and the Balkans and were threatening Italy. In ejecting the invaders, the armies of the east and of the Rhine hailed their respective leaders as emperors. Moreover, Aureolus, whom the legitimate emperor Gallienus had appointed to command a central corps of Dalmatian cavalry in northern Italy, rebelled in 268. Aurelian, with his compatriot Claudius (*see* CLAUDIUS II), then led the loyal cavalry against Aureolus, but successfully conspired to depose Gallienus in favour of Claudius. Claudius died 18 months later, and Aurelian succeeded him as emperor in May 270, despite some three months' opposition from Claudius' brother Quintillus.

Aurelian's achievement was to reunite the empire. A series of battles expelled the Alamanni and their allies from northern Italy; the lower Danube was secured by withdrawing to the left bank the army and civilian population of Dacia, probably in 271. Aurelian then undertook the recovery of the eastern provinces, which for ten years had obeyed the rule of the princes of Palmyra (*q.v.*). Zenobia, regent of Palmyra for her infant son, was captured by autumn 272, and the city taken. After a second revolt Palmyra was looted and its walls leveled.

In 274 Aurelian marched west. Gaul, Spain and Britain were subject to Tetricus. Beset by a German invasion and by conspiracies at home, Tetricus secretly appealed to Aurelian, and, as their armies were preparing for battle near Châlons, deserted to him. The leaderless army of the Rhine was then speedily defeated. Aurelian rewarded the former emperor with the governorship of Lucania.

In Rome, Aurelian began the 12-mi. city wall, much of which still stands. He reformed the coinage and encountered bloody street fighting initiated by the mint workers. He tried to rally the divergent religions of the empire around the cult of the Unconquered Sun and began to surround himself with the ceremonial of divine majesty, telling his armies that it was the god, not they, who made emperors and requiring suitors to kiss his toe instead of his cheek. This enhanced majesty tended to make assassination more difficult, but even so, early in 275, on his way to initiate a campaign against Persia, Aurelian was murdered by a group of officers, allegedly misled by a guilty secretary into believing themselves marked down for execution. The army council then requested the senate to name a civilian ruler, and after six months, during which the government was continued in the name of Aurelian's widow, Ulpia Severina, the senate nominated the elderly M. Claudius Tacitus (*q.v.*). (JN. R. M.)

AURÈS, a mountain massif in northeastern Algeria, fronted by rugged cliffs in the north and opening out in the south into two parallel fertile valleys of the Wadi Abiod and Wadi Abdi facing the Sahara. The region was formerly inhabited by two important aggregations of the Zenaga (*q.v.*; a tribe of Berber origin) —the Jerawa and the Hawara—and by more restricted groups of Jewish origin, like the Ulād 'Aziz, or Arab, like the Ulād Ziyan, which wandered into the region. It is now occupied by the Ulād 'Abdi and the Ulād Daud, who claim descent from Burak the Blind, traditionally an Arab who settled with the first wave of Hilal invasions in the 11th century. (*See* ALGERIA: *History*.)

Christianity spread rapidly through the Jewish community after its introduction *c.* A.D. 185—at one point there were as many as 60 dioceses—but its effect was only superficial and by A.D. 710 it had been replaced by Islam. The last stand for Berber independence was made by the prophetess Kahena at the head of the judaized tribe of the Jerawa. There is no trace of these events in present popular tradition, doubtless because the earlier peoples were driven westward. While Berber is still found in place names and has remained (in a highly corrupt form) the language of love songs, Arabic is the language spoken in the Aurès, through the gradual preponderance of Arab nomads from the Sahara who settled there.

The peasants of the Aurès practise seasonal migration based on villages regulated by collective granaries. Their agricultural customs and their social organization are the same as those in the rest of north Africa. *See* also AFRICA: *Ethnography (Anthropology): North Africa.* (J. H. SE.)

AURIC, GEORGES (1899–), one of the French composers who reacted against the Impressionism of Debussy, was born at Lodève, Hérault, on Feb. 15, 1899. He studied composition under Vincent D'Indy in Paris, and in 1920 became associated with Francis Poulenc (*q.v.*) as a member of "Les Six," the group of composers sponsored by Jean Cocteau. In his early works he developed a type of musical irony, mingling popular tunes with sophisticated harmony. The series of his skilful scores for French, English and U.S. films began with *Le Sang du poète* (1931). His first three ballets were produced between 1924 and 1927 by Serge Diaghilev, and his later ballets by Jean Louis Barrault, Cocteau and Roland Petit.

See Antoine Goléa, *Georges Auric* (1958).

AURICULA (*Primula auricula*), an alpine plant and a favourite spring flower. It thrives best in a cool soil and shady situation. The florists' varieties are grown in rich composts.

Auriculas are best germinated in a cold frame or cool greenhouse, in September or October, in a rich but light soil. They can be planted in the rock garden or border, preferably in mild climates, the following spring. Auriculas may also be propagated by offsets or division, which is to be done in early spring. When seed has been saved from the finer sorts, the operation is one of considerable nicety since it not infrequently happens that the best seedlings are at first exceedingly weak. They generally flower in the second or third year, a few good sorts being all that can be expected from a large sowing. The summer heat in the United States makes the cultivation of auriculas rather difficult.

AURICULAR CANAL, the tube leading from the external ear to the eardrum. It is about one inch long and is lined by thin skin which is tightly bound to the cartilage and bone on which it rests. The outer one-third is formed by cartilage, the inner two-thirds by bone. The few short crisp hairs at the entrance of the canal serve as a barrier to dust and small insects. In the skin of the outer portion are glands which secrete a sticky yellow material called cerumen, or wax. This also serves to catch small particles. The cerumen sometimes becomes packed in, causing hearing impairment, and should then be removed by a physician. The short straight, constricted tube connecting the auricular with the ventricular portions of the embryonic heart is also known as the auricular canal. *See* also EAR, ANATOMY OF; HEART, ANATOMY OF; NERVOUS SYSTEM.

AURIGA (the charioteer), in astronomy, a conspicuous constellation in the Milky Way which passes nearly overhead in middle northern latitudes in the evenings of winter. It was symbolized by the Greeks as a man holding a goat and two kids in

his left arm and a bridle in his right hand. The brighter stars of the constellation, including a star of the neighbouring Taurus, outline a muffinlike figure. The brightest of these is Capella, one of the three brightest stars of the northern celestial hemisphere; it is a yellow giant star at the distance of 45 light-years.

A small triangular figure southwest of Capella, marking the place of the kids, includes the star Epsilon Aurigae, an eclipsing double star revolving in the unusually long period of 27 years. (R. H. Br.)

AURILLAC, the capital of the *département* of Cantal in Auvergne, south central France, lies on the banks of the Jordanne, 2,040 ft. above sea level, dominated by the Cantal mountains to the north. Pop. (1962) 23,179. The Palais de Justice (1872) in neo-Greek style and the Gothic church of Notre Dame aux Neiges (1339) are in the central square of the town. Among the houses of the old quarter stands the church of St. Géraud (founder of the town in the 9th century), which incorporates parts of two 10th-century churches. The castle, which has an 11th-century dungeon, is now used as a school. The J. B. Rames museum, with its galleries for local natural history, as well as for regional prehistory and folklore, is the cultural centre of Aurillac. There is a big municipal library. The first French pope, Gerbert, who was known as Silvester II (999–1003), was educated at the old Benedictine abbey of St. Géraud, founded in 894. Aurillac is on the railway from Clermont-Ferrand to Toulouse. It is a communications, commercial and tourist centre for the Cantal, where the raising of cattle and the production of dairy foods are the most important industries. Two Cantal cheeses, Fourme and Bleu d'Auvergne, are specialities. At the many fairs, some surviving from the middle ages, cheeses, cattle and horses are bought and sold. Some of these products are exported. Many small enterprises include the making of umbrellas, gloves, fishing nets, confectionery and leather goods. (He. D.)

AURIOL, VINCENT (1884–1966), French statesman, president of the Fourth Republic from 1947 to 1954, was born at Revel, Haute-Garonne, on Aug. 27, 1884. A lawyer and journalist at Toulouse until his election as deputy in April 1914, he became secretary-general of the Socialist parliamentary group in 1919. In Léon Blum's first government (June 1936–June 1937) he was minister of finance and as such was responsible for devaluating the franc in order to meet his country's financial crisis. In July 1940, during the collapse of France in World War II, he was one of the 80 French parliamentarians who voted against according full powers to Marshal Pétain. Arrested in Sept. 1940, he was released in April 1941. Having gone into hiding in Oct. 1942, he escaped to London in 1943. He was a member of the French Consultative Assembly in Algiers and in Paris and, in Nov. 1945, joined Gen. Charles de Gaulle's government as minister of state. In 1946 he was president of both the first and the second Constituent Assembly. Elected president of the republic on Jan. 16, 1947, he strove constantly to make the machinery of the new constitution work. At the end of his term (1954), he refused to stand again. He resigned from the Socialist Party in December 1958. Under the Fifth Republic, he became a *de jure* member of the Constitutional Council (1959) but ceased to sit on it from July 1960, in protest against the new regime's tendency to arbitrate rule. He died in Paris on Jan. 1, 1966.

AUROBINDO, SRI (1872–1950), Indian seer, philosopher, poet and patriot, was born in Calcutta on Aug. 15, 1872. He was educated at Loretto Convent school, Darjeeling, before going to England in 1879 where he continued his schooling and then read classics at Cambridge. He returned to India in 1893 and joined the Baroda state service. For the next 17 years, in Baroda and later in Calcutta as principal of the new National college, Aurobindo was one of the revolutionary nationalist leaders agitating for independence. At the same time he was initiated into yoga. After his trial and acquittal in connection with a bomb case in 1908, he left politics and in 1910 retired to Pondicherry, where he continued to live until his death on Dec. 5, 1950.

Sri Aurobindo's political life had been inspired by spiritual motives, and afterward he devoted himself to discovering the way by which the universe might be made divine. With the collaboration of a French woman, endowed with rare spiritual qualities, called the Mother, he founded an *ashram,* or settlement, which grew into an institution with a centre of education attached to it. It is distinguished by having no creed or ritual other than the practice of meditation and concentration. Its inmates are not ascetics but ordinary men and women who are assigned specific duties which they perform in a spirit of love.

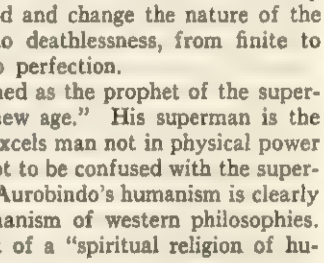
The message of Sri Aurobindo's philosophy is one of hope, for he envisaged cosmic salvation in which man and the universe are destined to become divine. This is decreed by the law of evolution; for as creation is the descent of the Absolute Spirit (Sachchidananda) into supermind, mind and matter, so evolution is the ascent of matter to life, mind and supermind and finally to Sachchidananda. So far only the first three stages of evolution have emerged, but the time has come for evolution to take the step that will carry it to the supermind and change the nature of the universe, a change from death to deathlessness, from finite to infinite and from imperfection to perfection.

Sri Aurobindo has been acclaimed as the prophet of the superman, as the hierophant of the "new age." His superman is the God-man, the gnostic being who excels man not in physical power but in things of the spirit and is not to be confused with the superman of Nietzsche. Similarly, Sri Aurobindo's humanism is clearly different from the restricted humanism of western philosophies. He has called his standpoint that of a "spiritual religion of humanity."

Sri Aurobindo's works are very numerous, comprising writings on philosophy, yoga, sociology and politics, as well as poems, plays and literary criticism. Among his chief books are *The Life Divine* (1940), *Essays on the Gita* (1928), *The Synthesis of Yoga* (1948), *Savitri: a Legend and a Symbol* (1950).

For an account of his life and lists of his works *see* A. B. Purani, *Life of Sri Aurobindo* (1958); K. R. Srinivasa Iyengar, *Sri Aurobindo: a Biography* (1950); *see* also publications and lists of the Sri Aurobindo Ashram. (S. K. Ma.)

AUROCHS, the extinct wild ox of Europe (*Bos taurus primigenius* or *B. primigenius*), from which domestic cattle are descended. It was mentioned by Julius Caesar as the "urus," and, known as *tur*, survived in Jaktorow forest of central Poland until 1627; engravings after an oil painting of 1500 show its conformation and colour. It was enormous, six feet high at the shoulder, black in colour and with spreading, forwardly curved horns. Skulls and bones of the aurochs are common in Pleistocene deposits in England and on the continent of Europe. Some breeders in Germany have claimed that they have re-created this race since 1945 by crossing Spanish fighting cattle with longhorns and other breeds. Their animals have a superficial resemblance to the aurochs with the exception of its great size, but the genetic constitution cannot be identical. The semiwild park cattle of Chillingham, Eng., and elsewhere are not directly descended from the aurochs; they show greater affinity with the Bronze Age shorthorn (*B.t. longifrons* or *B. longifrons*), a later mutation of the aurochs. The name aurochs has sometimes been erroneously applied to the European bison (*q.v.*) or wisent. *See* also Buffalo. (L. H. M.)



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AUROCHS (BOS TAURUS PRIMIGENIUS), WOODCUT FROM HISTORIA ANIMALIUM BY KONRAD VON GESNER, 16TH-CENTURY NATURALIST

AURORA, Latin for Eos, the Greek personification of the Dawn, a purely mythological figure, not a goddess with a cult. According to Hesiod she was the daughter of the Titan Hyperion and Theia, and sister of Helios and Selene. By the Titan Astraeus she was the mother of the winds Zephyrus, Notus and Boreas, of Hesperus and the stars; by Tithonus she was the mother of Memnon (*q.v.*). Homer represents her as rising every morning from the couch of Tithonus and drawn out of the east in a chariot to carry light to gods and men. From the roseate shafts of light

that herald the dawn, she bears in Homer the epithet "rosy-fingered."

Aurora is also represented as the lover of the hunter Orion, the representative of the constellation that disappears at the flush of dawn; and of the youthful hunter Cephalus, by whom she was the mother of Phaëthon (*q.v.*). In works of art Eos is represented as a young woman, fully clothed, walking fast with a youth in her arms; or rising from the sea in a chariot drawn by winged horses; sometimes, as the goddess who dispenses the dews of the morning, she has a pitcher in each hand.

In Latin writings the word Aurora was used (*e.g.*, by Virgil) for the east. (T. V. B.)

AURORA, a city of Kane county, Ill., U.S., on the Fox river, 39 mi. W. of downtown Chicago. Founded as a trading point and mill site near a Potawatomi village in 1834, the townsite was platted in 1836. Aurora was incorporated as a city in 1857.

Aurora is both a residential and an industrial city. Its major industrial enterprises include the manufactures of machinery, metal furniture and fixtures; and printing and publishing. Many residents commute to Chicago to work. Aurora college, founded in 1893 by the Advent Christian Church of America and administered and supported by its members, is located there. Recreation facilities are available in the Fox Valley Park district and in municipal parks.

The city's population was 63,715 in 1960. For comparative population figures *see* table in ILLINOIS: *Population*. (WA. B. H.)

AURORA BOREALIS: *see* AURORA POLARIS.

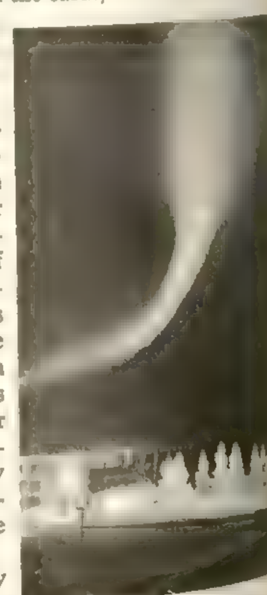
AURORA POLARIS, or the polar light, is a familiar and often beautiful sight in high latitudes. In the northern hemisphere it is called the aurora borealis or northern lights, and in the southern hemisphere, the aurora australis or southern lights. This light is not a reflection, like the rainbow, whose apparent position depends on where the observer stands; the aurora comes at any instant from definite places in the atmosphere, where the air is for the time luminous like a flame. But the auroral light is not due to something burning away, like a gas jet; it is more akin to the light from an electric discharge bulb. The lights are called polar or (in the northern hemisphere) northern because they are most commonly seen in high latitudes; only rarely are they visible in southern Europe or the southern United States. Yet when seen in these lower latitudes the appearance at times is very striking; it is therefore not surprising that several of the ancient Mediterranean authors, Greek and Roman, refer to it. Not unnaturally, in earlier times, and particularly during the dark ages, the northern lights were viewed with superstition, in parts of Europe where they were seldom seen, as divine portents of coming calamities.

In each hemisphere the aurora appears most frequently in a belt called the "auroral zone" that lies about 20° to 25° from the earth's magnetic axis pole. In the northern hemisphere this pole is near Thule in northwest Greenland. On the average the auroral zone, where auroras appear on almost every clear night, extends from north central Alaska through Labrador and northern Norway. Outside the zone displays are seen less frequently, but they are often observed in the northern United States and Europe and on rare instances have been seen as far south as Mexico City and Greece. The zone is not stationary but shifts toward the equator during the time of sunspot maximum and toward the pole near sunspot minimum. At latitudes below the auroral zone this shift helps provide an increased number of displays near sunspot maximum. Through the year auroras most often occur from March to April and from September to October.

There is some correlation between the occurrence of auroras and activity on the surface of the sun. On a statistical basis it appears that an aurora, if it can be associated with a particular solar flare, is likely to follow the flare after a period of one day or so. This delay time suggests that the disturbance is propagated to the earth with an average speed of about 1,000 miles per second, or somewhat less than 1% of the speed of light.

The aurora has many connections with the earth's magnetism; the centres of the auroral zones are close to the ends of the earth's magnetic (rather than geographical) axis, and the highest point of a distant auroral arc is usually nearly in the direction of the magnetic north. The auroral bands extend from east to west in a direction nearly perpendicular to the compass direction, and the rays and flutings of the bands, and the bands themselves, are not vertical, but are inclined to the vertical nearly along the direction taken by a freely balanced magnetic needle at the spot where the aurora is located: that is, along the direction of the magnetic dip. Moreover the aurora is most active, and advances farthest toward lower latitudes, when the earth's magnetic field is highly disturbed, corresponding to what is called a magnetic storm. At such times telegraphic and radio transmissions are likewise usually disturbed, and even electric power lines may be put out of action. Such occurrences tend to coincide with the presence of active spots and eruptions on the sun's visible disk. Like sunspots, they wax and wane in frequency and intensity in the course of the 11-year sunspot cycle.

The origin of the aurora is not well understood. The symmetry of the auroral zones about the earth's magnetic poles suggests that electrically charged particles are guided to earth by the magnetic field and these particles cause the auroral light. The relationship between solar and auroral-magnetic activity suggests the sun as the source of these particles. This viewpoint was supported by L. Vegard's discovery in 1939 that the auroral spectrum contained light emitted by hydrogen. A. B. Meinel found in 1951 that this hydrogen emission was slightly bluer than similar light in the laboratory, which demonstrated that the hydrogen gas was bombarding the earth with speeds up to several thousand miles per second. Still, the manner in which hydrogen and perhaps other elements ejected by the sun in ionized gas clouds or streams is able to penetrate the earth's magnetic field and produce an aurora is not fully understood. Although various theories have been proposed for the propagation of solar gas through interplanetary space and the eventual bombardment on the earth, none of these theories has been successful in explaining the auroral zone along with the height and appearance of the auroral forms.



PHOTOGRAPH, V. P. HESSLER

THE AURORA BOREALIS. PHOTOGRAPH TAKEN IN ALASKA

It is likely that auroral excitation is produced by the bombardment of protons (hydrogen nuclei) and electrons on the upper atmosphere with speeds of hundreds and even thousands of miles per second. A collision between one of these fast particles and an atom or molecule in the upper atmosphere produces a quantum of light whose colour is characteristic of the atom or molecule involved. In an average auroral display probably 100,000,000 protons and electrons strike one square inch of the earth's atmosphere per second.

In the 18th century fairly successful attempts were made to determine the actual height and location of the aurora in the atmosphere, by observing its direction from two places miles apart. Such determinations are nowadays made by photographs taken simultaneously from two or more distant stations, connected by telephone. These observations were initiated in Norway by Carl Störmer; auroras seen from Oslo may be located high in the atmosphere over Norway, or may be over the Arctic sea to the north of Norway, or sometimes to the south over Denmark or Germany. Commonly, the aurora is most extended along a nearly east-west direction, parallel to the auroral zone. Though at times it appears as a diffuse formless volume of luminosity, its most distinctive form is that of a long wavy band or curtain, often with folds and flutings in it, high up in the sky, with the lower edge at about the same height above

the earth all along the band. Though its lower edge is thus nearly horizontal, the band appears as an arc or arch, owing to perspective, when seen from afar (usually, in Europe or the United States, to the north). The band may extend to right and left down to the horizon. Sometimes the aurora is visible almost overhead, and when it can be seen "edge on" it is evident that it is extremely thin; thus in this respect also it is like a curtain, thin compared with its breadth and its length from top to bottom. The lower edge of an auroral band is often at a height of about 70 mi. Its height is seldom much less, though it may be decidedly greater (up to 100 mi. or more). The bands or curtains sometimes extend upward to very great heights, of 400 or even 500 mi., though the distance from lower to upper "edge" (the latter especially is often ill-defined) may on other occasions be only 20 or 30 mi.

It has been found that the highest auroras are in regions of the air which lie within the rays of the sun's light, though the sun may be several degrees below the horizon of the observer. These very high auroras give direct evidence of the presence of appreciable air at unexpectedly great heights. Owing to their great height above the ground auroras can be seen from very distant places, and an aurora seen low above the horizon will be several hundreds of miles away.

The appearances of auroras are most varied; more than one arc or curtain may be visible at once, and they may change and appear and disappear with great rapidity, though also they may long remain constant, or move only slowly across the sky. Sometimes, when it is nearly overhead, one can look up into a great fold in an auroral drapery, so that the rays or flutings along it, seen in perspective, seem to converge toward a point: such an appearance is called an auroral corona. The fine rays that form draperies and coronas are often only a few hundred feet in diameter.

Faint auroras may appear colourless; for the brighter auroras the most common colour is yellow-green, which is produced by atomic oxygen at low pressure. The higher auroras may show red, which arises from atomic oxygen at still lower pressure. An active aurora may on rare occasions show red on the lower border of an otherwise green display. The red in these cases arises from molecular nitrogen (N_2) and ionized molecular oxygen (O_2^+). The high sunlit auroras may show a bluish tinge, produced by ionized molecular nitrogen (N_2^+). (S. Cn.; J. W. Cn.)

AURUNCI, the name of an ancient tribe of Campania, in Italy, that occupied the strip of coast in what is now the province of Caserta, between the Volturnus and Liris (Volturno and Liri) rivers, with its capital at Suessa (modern Sessa Aurunca). The Romans conducted a succession of campaigns against them between *c.* 345 and 295 B.C., when they were completely exterminated. No record of their speech survives, but their geographical situation and the frequency of the *co*-suffix in that strip of coast suggest that they spoke the same language as their northern neighbours the Volsci (*q.v.*). Ausones, the Greek form of the name Aurunci, came to denote the inhabitants of the whole of Latium and Campania.

AUSCHWITZ: *see* Oswiecim.

AUSCULTATION, a medical term applied to the act of listening to sounds within the body in order to detect certain defects or conditions, such as heart valve malfunctions or pregnancy. Auscultation originally was performed by placing the ear directly on the chest or abdomen, but it has been practised mainly with a stethoscope since R. T. H. Laënnec invented that instrument in 1819.

The technique of auscultation is based on characteristic sounds produced, for example, in the head and elsewhere by abnormal blood circuits, in the joints by roughened surfaces, in the lower arm by the pulse wave and in the abdomen by an unborn child or intestinal disturbances. However, it is most commonly employed in diagnosing diseases of the heart and lungs.

The heart sounds consist mainly of two separate noises occurring when the two sets of heart valves close. Either partial obstruction of these valves or leakage of blood through them because of imperfect closure results in turbulence in the blood current, causing audible, prolonged noises called murmurs. In certain congenital abnormalities of the heart and the blood vessels in the chest, the murmur may be continuous. Murmurs are often specifically diagnostic for diseases of the individual heart valves; that is, they sometimes can determine which heart valve is causing the heart condition. Likewise, modification of the quality of the heart sounds may reveal disease or weakness of the heart muscle. Auscultation is also very useful in determining the types of irregular rhythm of the heart and in discovering the sound peculiar to inflammation of the pericardium, the sac surrounding the heart.

Auscultation also reveals the modification of sounds produced in the air tubes and sacs of the lungs during breathing when these structures are diseased.

See Diagnosis: *Auscultation.* (H. B. Sp.)

AUSGLEICH, a German word meaning treaty, compact or compromise. It is specifically used to describe the compact, finally concluded in Feb. 1867, that regulated the relations between Austria and Hungary following the establishment of the dual monarchy. *See* Austria, Empire of.

AUSONIUS, DECIMUS MAGNUS (*c.* 310–*c.* 393), Latin poet and rhetorician remarkable chiefly for his preoccupation with the provincial scene in Gaul, was born of Gallic stock at Bordeaux, where his father practised medicine. After the usual education in "grammar" and rhetoric, first at Bordeaux, then under his uncle Arborius at Toulouse, he began to teach in the famous schools of his native town, first as *grammaticus,* then as rhetor. His success is attested by his call to Trier (*c.* 365) by Valentinian I to superintend the education of Gratian, who, on his accession, elevated Ausonius first to the prefecture of Africa, Italy and Gaul, then to the consulship in 379, thereby proving Juvenal's assertion about the power of fortune to make consuls out of rhetoricians. Gratian's murder in 383 ended these years of eminence, and Ausonius returned contentedly enough to his estates on the Garonne to cultivate friendship and literature. Though he was a Christian, it was only in the sense that he was not a pagan, and his last years were saddened by the incomprehensible conduct of his pupil Paulinus (later bishop of Nola), who deserted literature for a life of Christian retirement. Nothing could make Paulinus see reason, and Ausonius's death concluded their correspondence on this inexpressibly painful subject.

An incorrigible trifler and victim of what he called *poetica scabies,* Ausonius has left few works of any consequence. His prose work, *Gratiarum actio* ("thanksgiving"; *i.e.,* for the consulship), is a composition of surpassing dullness and childishness. His longest poem, on the Moselle (*Mosella*) river, has flashes of an almost Wordsworthian response to nature, never a common quality in Latin literature, but its rhetorical flavour spoils it for modern readers. *Cento nuptialis* is a patchwork in which lines of Virgil are pieced together to form a shockingly explicit account of the consummation of a marriage. Ausonius reveals a sentimental fondness for old associations in the works of his retirement, *Parentalia,* a series of poems on deceased relatives, and *Professores Burdigalenses,* on the professors of Bordeaux, delightful portraits that give a valuable picture of the lives of quiet provincial people. *Ephemeris* is a somewhat self-conscious account of the daily round. A characteristic piece of trifling is the *Technopaegnion,* a set of hexameter poems in which each line ends in a monosyllable. Of his epistles may be mentioned the correspondence with Paulinus and Symmachus. There are useful autobiographical *Praefatiunculae; Eclogae,* mnemonic verses on astronomy and astrology; *Ordo urbium nobilium* ("order of noble cities"); *Ludus septem sapientum* ("play of the seven sages"), a forerunner of the morality play; many epigrams, including adaptations from the Greek Anthology, and a vast assortment of learned curiosities.

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Association, 24:28–41 (1927); M. J. Byrne, *Prolegomena to an Edition of the Works of Ausonius*, with extensive bibliography (1916); F. J. E. Raby, *History of Secular Latin Poetry*, 2nd ed., vol. 1, pp. 54–66 (1957). (WM. BR.)

AUSSIG: *see* USTI NAD LABEM.

AUST-AGDER, a *fylke* or county of south Norway, extends 105 mi. northwestward into the mountains from the coast line on the Skagerrak. Pop. (1960) 77,061. Area 3,562 sq.mi. Pre-Cambrian bedrock covers the county, which has a broken and uneven landscape. Setesdal valley in the west is bounded by steep mountains reaching to 3,500 ft., while the branching valleys in the middle of the county are divided by smaller hills. The uplands are covered with sandy morainic drift giving sufficient soil for coniferous forests. Nearly 75% of the population lives in the coastal district where the towns of Arendal (seat of provincial administration, pop. [1960] 11,425), Risor, Grimstad and Lillesand are situated. Until the middle of the 19th century these were important ports for exporting timber, but they are now commercial centres with a few industries. Summer tourists are attracted to the coast, Lillesand, with its white-painted wooden houses, being especially popular. Horticulture is carried on in some areas, while in the middle valleys the main occupation is forestry, and in Setesdal, livestock products. The railway and main road from Oslo to Stavanger pass through Aust-Agder, and bus services connect the rural districts with the towns. (L. H. HG.)

AUSTEN, JANE (1775–1817), English novelist, was born on Dec. 16, 1775, the second daughter and seventh child of George Austen, rector of the parishes of Steventon and Deane in Hampshire, and of his wife Cassandra Leigh. The Austens were of Kent, the Leighs of Gloucestershire and Warwickshire, and on both sides were connections with the academic clergy of Oxford. Jane Austen, like her brothers and her sister Cassandra, was born in the parsonage of Steventon, which remained her home for the first 26 years of her life. In 1801 her father resigned his duties to his eldest son, James, and retired to Bath, where he died in 1805. Not until 1809, when the third son, Edward, provided his mother and sisters with a home on his Hampshire property at Chawton, were they again settled in a house of their own. Chawton was Jane Austen's home until she went to Winchester in May 1817, in search of medical attention. She died there on July 18 and was buried in the cathedral.

Although neither foreign travel nor public life diversified the even tenor of her way, Jane Austen spent considerable periods in the homes of three of her brothers: James at Steventon, Edward (who had been adopted as heir by Kentish cousins) at Godmersham, Henry in London—besides paying visits to friends and relatives. The narrowness of her experience and meagreness of her opportunities have been exaggerated. Likewise, when her life is described as uneventful, it should be remembered that two of her brothers, Francis and Charles, were sailors in a time of almost continuous naval warfare. It is of such events that women's lives have consisted.

Composition and Publication.—In respect of only half Jane Austen's novels are the dates of composition and publication directly related, and a chronological account must reckon with revision, work left uncompleted, and work never designed for publication. From an early age (certainly before 16), she was writing burlesques of current fashions in fiction, and her "Plan of a Novel," prompted by an occurrence in 1815, shows that she did not lose her zest for this game. By 1792, however, she was engaged on a piece of serious fiction, "Kitty or the Bower," which interested her enough to prompt subsequent revision; yet a year later she was making fair copies of some of the juvenile burlesques. In 1795 she completed a novel in the form of letters, "Elinor and Marianne," which was to afford the basis of *Sense and Sensibility*. Between 1796 and 1797 she was writing "First Impressions," which, after considerable revision, was to appear as *Pride and Prejudice*. The manuscript was rejected by Thomas Cadell. In 1798–99 she wrote *Northanger Abbey* (then called "Susan," after the original name of its heroine). This manuscript, after undergoing some revision, was sold in 1803 to Richard Crosby, who took no steps to publish it. To the unsettled years in Bath and Southampton belong only *The Watsons*, a fragment, and *Lady Susan*, probably set aside unfinished and completed, half in jest, on the occasion of making a fair copy. Thus, when Jane Austen had once more a settled home, at Chawton, she had in hand the manuscripts of three completed novels, and, before her first published work appeared, she was already engaged on one of the novels of her maturity: *Mansfield Park* was begun in Feb. 1811, *Sense and Sensibility* published in November of that year. Meanwhile she was at work again on "First Impressions," which, as *Pride and Prejudice*, was completed by Nov. 1812, and appeared in Jan. 1813. *Emma* was begun in Jan. 1814; *Mansfield Park* appeared in May of that year. In the summer of 1815, *Persuasion* was begun, and in December of that year *Emma* was published. This was the last of her novels that Jane Austen was to see in print: she completed *Persuasion* in July 1816, but rewrote the end in August. Between January and March of 1817 she was at work on the fragment we know as *Sanditon*. *Northanger Abbey*, which she now referred to as "Catherine," had been bought back from Richard Crosby in 1816, and reconsidered for publication, but set aside once more; it was published with *Persuasion* in the winter after her death.

The Novels.—When Jane Austen decided to risk financial loss by publishing *Sense and Sensibility*, she had grounds for misgiving, two of her three completed novels having been, in effect, rejected for publication. She never, however, lacked appreciation and encouragement at home. All her transactions with publishers were conducted by her father or one of her brothers; and it was evident from the fair copies she made of this or that piece of juvenile burlesque for one and another of her family circle that the welcome given to it there had outlasted the original occasion. The perpetuation of her delight in the improbabilities and other absurdities sanctioned by the tradition of the 18th-century novel may have owed something to their being a shared joke: she refers to her family as "great novel-readers and not ashamed of being so." Her own enjoyment of Richardson is on record, and can be inferred from her novels, if due allowance is made for differences of time and temperament. Her taste in reading may have been virtually formed by the time she began writing for publication—that is, some years before the end of the 18th century; but it amused her, when she revised her manuscripts, to bring the literary allusions in them up to date; and a reference in a letter of 1814 shows that she was even then in no doubt as to the identity of the author of *Waverley*.

Although her surviving references to her own work are few, informal, even playful—they almost all occur in family correspondence—yet their fundamental consistency allows some inferences to be drawn as to the principles of her art. Keenly aware to the end, of the power of convention over the novelist—even *Sanditon* glances ironically at the situation to be expected in a novel—she valued fidelity to observed truth, and believed in keeping the subject well within range of observation. The point of view from which each story is related remains constant; though we may have something to learn from the conversation of any of her characters (whether directly or ironically conveyed), and must always listen for the occasional, unobtrusive comment in the narrator's own voice, yet the heroine remains firmly established at the centre of the composition; her mind is fully opened to us (more fully, sometimes, than to herself); to her judgment, even when it is clouded by prejudice, to her sensibility, even when it is coloured by love, every issue of significance is referred. What is withheld from her—the former transactions between Darcy and Wickham, the change in Captain Wentworth's feelings for Anne—can never be fully intelligible to us until she is apprised of it, though sufficient intimations are vouchsafed to prevent a false impression from taking hold. Notwithstanding this focus of Jane Austen's attention on her heroines (reflected in talk and in letters—Elizabeth Bennet was to her "as delightful a creature as ever appeared in print," Emma Woodhouse a heroine whom no one but herself would much like, Anne Elliot almost too good for her), in none of them can we discern any inclination toward self-portraiture. Moreover, the world that is reflected in this carefully arranged mirror of their consciousness is smaller than that

with which she was herself acquainted. "Three or four families in a country village," she observed contentedly, "is the very thing to work on." By the time she wrote that, she was familiar with London, as she had not been when she carried Elinor and Marianne Dashwood thither; but she had come to prefer that it should be a place known chiefly by hearsay to her central character, visited rather by Harriet Smith than Emma.

Jane Austen's art is selective to an uncommon degree. She took or discarded what she deemed requisite, not only from the stuff of her own observation and experience but also from the matter and manner of the English novel, especially as it had developed since Richardson's *Pamela*. It may have been from the novel-in-letters that she derived the notion of constructing her plots with reference to the almanac of a particular year; and its fixed vantage point is likely to have suggested the importance of establishing a point of view in the consciousness of a central character. In her development of this convention, however, she obtained an instrument of greater flexibility than any series of fictitious letters could afford. Other elements in the tradition of the novel she rejected or altered radically. It was not against the assumptions of Gothic romance alone that she saw reason to discriminate: even the novel of domestic life had not disencumbered itself of artifices derived from the stage, notably from sentimental comedy—emphatic and symmetrical plots, formal and arranged passages of witty dialogue, and the lavish use of an unknown quantity to assist the arithmetic by which mischance and misunderstanding add up to "happy ending." When Jane Austen acknowledged that Catherine Morland's circumstances were inauspicious, since "there was not one family among [her] acquaintance who had reared and supported a boy accidentally found at their door—not one young man whose origin was unknown," she was shaking one of the pillars of the conventional novel. Her own use of coincidence was sparing and discreet. Few of the hindrances she opposes to love—that is, to the eventual happiness of her sympathetic characters—spring solely from incident; their source is rather to be found in temperament and the sum-total of circumstances. The crisis of each novel (with the possible exception of *Mansfield Park*) is to be understood in terms of self-discovery, on the part of hero or heroine or both; and, for a condition of things in which they may misinterpret their own or one another's feelings, she requires little more than a family of which the natural head has abdicated his authority, like Mr. Bennet or Mr. Woodhouse, misused it, like Sir Walter Elliot, misdirected it, like Sir Thomas Bertram—or shirked his responsibility, like John Dashwood. As a precipitant of the unfavourable circumstances thus produced, she is generally content to use a newcomer to that village in which her "three or four families" are settled: a prepossessing young man whose morals prove to be inferior to his manners, but who can seldom be characterized by a much harsher term than opportunist. "Pictures of perfection . . . make me sick and wicked," she wrote, with regard to idealized characters; she might well have spoken in equally strong terms of unmitigated badness. Even for the odious Mrs. Norris she can find excuses; and she sets narrow bounds to the harm done by foolish or reprehensible conduct, or by ill nature. "Guilt and misery" are not ignored, but they are conveyed to our imagination through their impact on those "not greatly in fault themselves," whom she is "impatient to restore . . . to tolerable comfort"; and so their effects are transient.

Jane Austen's selective process is directed not only by her fidelity to what she judged probable and what she knew herself capable of representing but also by obedience to her own comic vision. There have always been readers to maintain that she ignores too much of life, but what she leaves out never falsifies what she puts in, because of her incorruptible consistency. The perspective is true, because the parts are justly related: characters exert the right degree of pressure on one another, and the dialogue carries that part of the responsibility for acquainting us with their interaction which it is fitted to bear. Judged as a medium of communication, and compared with that of other novelists, it appears both delicate and tough: for the sake of elegance and clarity, differences are minimized—after *Sense and Sensibility*, we find no downright vulgarisms—but a sense of the uniqueness of the individual is not lost in the process. Nor, on the other hand, is the function of dialogue sacrificed to the demands of character and the delight of the ludicrous: it is not always realized with what essential economy Miss Bates conveys to us information regarding events to which she alone can bear witness. Thus, the wit of Henry Tilney or Elizabeth Bennet, the dry humour of Mr. Bennet and the pleasantries of the Crawfords never resemble those passages in stage comedy which, being offered for their own sake, must sometimes be bought at the price of verisimilitude. Furthermore, they remain in harmony with the narrator's own comments; for what is witty in both may be imagined as spoken without premeditation. It displays no coruscating facets, no jet of epigram nor play of metaphor. It consists primarily in a command of well-timed understatement, whose meaning is gradually perceived. She expected of her readers just such a close and lingering attention as she had given to her writing.

Reputation.—Jane Austen's literary reputation established itself unobtrusively but steadily. Within her own generation she obtained recognition: Scott was among her earliest and most spontaneous admirers; but, to the generation that followed, her novels necessarily appeared old-fashioned: the very language belonged to the past century. Macaulay's enthusiasm, when he likened her to Shakespeare and Molière, was premature, and perhaps unguarded. Other writers, from Southey to Henry James, have been content to cherish a private appreciation of her art. General approbation grew, however, until (in 1910) E. V. Lucas could call her "an English classic." Since A. C. Bradley recalled critical attention to the peculiar quality of her genius (in 1911), her standing as a novelist has not been seriously challenged; detraction has fastened on her character, alleging that her apprehension was dull, her temperament cold, her mind and heart narrow —despite the contrary witness of biographical accounts based on personal recollection or family tradition. Appreciation of the moral sensibility and seriousness discoverable in her novels has lately advanced, at some cost to the enjoyment of her wit. Happily, at the time when her idiom began to require occasional interpretation, she obtained the devoted service of the editor she deserved, alike for the novels, the extant letters and fragments of her work and play which survive in manuscript.

Bibliography.—All of Jane Austen's extant writings have been edited by R. W. Chapman: the six novels, 5 vol., 3rd ed. (1933); the letters, 2 vol., 2nd ed. (1952); *Lady Susan* and *Sanditon* (1925); *The Watsons* (1927); and two of the three notebooks containing fair copies of her *Juvenilia* (1932 and 1951)—all three now appearing with the rest of the fragmentary pieces as *Minor Works* (1954). The primary biographies are: J. E. Austen-Leigh, *A Memoir of Jane Austen* (1870), and the authoritative work by W. and R. A. Austen-Leigh, *Jane Austen, Her Life and Letters: a Family Record* (1913); but biographical accounts derived directly or indirectly from personal recollection include: Lord Brabourne's preface to his edition of some of the *Letters of Jane Austen* (1884); Constance Hill, *Jane Austen, Her Homes and Her Friends* (1902); J. H. and E. Hubback, *Jane Austen's Sailor Brothers* (1906); M. A. Austen-Leigh, *Personal Aspects of Jane Austen* (1920). Biography and criticism in varying proportions compose: C. L. Thomson, *Jane Austen: a Survey* (1929); Elizabeth Jenkins, *Jane Austen: a Biography* (1938); Mary Lascelles, *Jane Austen and Her Art* (1939; rev. 1959); R. W. Chapman, *Jane Austen: Facts and Problems* (1948). Among reviews, lectures and other brief critical pieces, these are notable: Sir Walter Scott's review of *Emma* for the *Quarterly Review 1815* (1816); Richard Whately's review of *Northanger Abbey* and *Persuasion*, for the *Quarterly Review* (1821); A. C. Bradley in *Essays and Studies by Members of the English Association* (1911); Virginia Woolf in *The Common Reader* (1925); Lord David Cecil, *Jane Austen*, his Leslie Stephen Lecture (1935); E. M. Forster in *Abinger Harvest* (1936). *See* G. L. Keynes, *Jane Austen: a Bibliography* (1929); R. W. Chapman, *Jane Austen: a Critical Bibliography*, 2nd ed. (1955).

(M. M. Ls.)

AUSTERLITZ, BATTLE OF, a French victory over the Russians and Austrians, won on Dec. 2, 1805, near Austerlitz (Czech, Slavkov) in Moravia. Napoleon's masterpiece, it dramatically reversed his militarily and politically dangerous situation, secured his imperial regime and gave him the initiative in Europe with which he was soon to obtain his greatest triumphs (*see* Napoleon I; Napoleonic Wars). The Austrians, 80,000 strong, had invaded Bavaria on Sept. 8, 1805, without waiting for the first of the two Russian armies marching to their support,

although Napoleon was bringing an excellent army twice their size against them. By Oct. 20 about 49,000 Austrians had surrendered at Ulm; only one division of their invading force escaped to join the 30,000 Russians under M. I. Kutuzov, who had reached the Inn river and who now retired before Napoleon's superior numbers. The French entered Vienna on Nov. 13 and crossed the Danube to pursue the Russians into Moravia. Napoleon's position soon became critical, demanding an early victory if he was not to be overwhelmed, for not only had the second Russian army joined Kutuzov and the Austrians already before him, who now turned about at Olmütz (Olomouc), 90,000 strong, but also the French right flank was menaced by the approach of the Austrian archduke Charles (recalled from Italy) with 80,000 men. Prompt success was necessary also to avert Prussian intervention. Napoleon halted his extended advance at Brünn (Brno). His 100,000 men were disposed over a distance of 90 mi. to observe the opposing forces while he waited for the chance to concentrate against either to fight a decisive battle. Welcoming Kutuzov's rather ill-advised advance in the last days of November, Napoleon encouraged him to seek battle by retiring a short distance to adopt a position 7 mi. S.E. of Brünn, where he succeeded in quickly and secretly concentrating as many as 73,000 men behind the Goldbach stream. His tactics were of a piece with his masterly strategy, for he left his right unstrengthened to tempt the Russian forces to strike at his thus virtually uncovered communications with Vienna. As he had foreseen, the Russian army, 87,000 strong deployed along an already overlong front across the valley, fell into the trap, descending the Pratzen plateau in the centre of their position early on Dec. 2 to turn the French right. Napoleon's left and right wings held fast as the heavy French forces sent to the plateau pierced the weakened allied centre, where determined Russian counterattacks failed to prevent them from exploiting their dominating advantage. The allies' left wing was completely routed in the ensuing debacle, and their army's losses increased in the vigorous pursuit that followed. They lost about 26,000 men and 180 guns, the French between 7,000 and 8,000 men. The Austrian emperor Francis I signed an armistice on Dec. 6, and the broken Russian army was withdrawn under a truce. (J. H. N.)

AUSTIN, ALFRED (1835–1913), English poet who succeeded Tennyson as laureate, was born in or near Leeds, May 30, 1835. Educated at Stonyhurst, Oscott and London university, he was called to the bar in 1857, but began to write (*Randolph*, 1854; recast as *Leszko the Bastard: a Tale of Polish Grief*, 1877) and also entered politics, standing unsuccessfully as a Conservative, and becoming leader writer for the *Standard* (1866–96) and editor of the *National Review* (with W. J. Courthope, 1883–87; alone, 1887–95). His appointment to the laureateship, in 1896, was attributed to his flattery of Lord Salisbury. His inept official verses, beginning with a fulsome ode on the Jameson raid, his lack of judgment (he criticized the leading poets as "essentially childish," and regarded attacks on his own work as equal to those made on Byron and Keats), his snobbishness, and his genius for writing bad verse —of which his lines on the illness of the prince of Wales

> Across the wires the electric message came
> 'He is no better, he is much the same'

are a famous example—made him a critical butt. Swinburne called him "the Austin creature." *Punch* ran a series on "sickly, broken-winded Austin" and the *Athenaeum*, announcing his death (at Ashford, Kent, June 2, 1913) commented that the laureateship, virtually vacant since Tennyson's death, was now actually so.

Yet there is good in Austin. He could write simply in praise of the English and Tuscan countryside, and his prose "garden diaries," his only popular successes, have charm. Even at his most jingoistic, he might claim to represent popular feeling, although he lacked the touch to transmute it into poetry.

Of his voluminous writings, the following are typical: *The Season: a Satire* (1861); *The Human Tragedy* (1862; expanded 1876, 1880, 1891); *England's Darling* (Alfred the Great; 1896); *Soliloquies in Song* (1882); *Sacred and Profane Love* (1908); *The End and Limits of Objective Poetry* (1887); and *The Garden That I Love* (1894).

See Norton B. Crowell, *Alfred Austin: Victorian* (1953); *Times Literary Supplement* (Nov. 13, 1953).

AUSTIN, FREDERIC (1872–1952), English singer and composer, best known for his arrangement of *The Beggar's Opera*, by John Gay (*q.v.*), for its first modern production, by Nigel Playfair, at the Lyric theatre, Hammersmith (1920–23). Born in London, March 30, 1872, of a musical family, he studied singing while teaching harmony at Liverpool and made his first London appearance in 1902. From 1908 he took leading baritone roles at Covent Garden. As a composer, Austin was interested in modern music, and sang in the first performance of Delius' *Sea Drift* (1908) and in Rutland Boughton's operas at Glastonbury. He also became well known in Germany, the Netherlands and Denmark. His editing of the music of *The Beggar's Opera* showed his experience as a singer and his sound musical training in its realization, in a modern harmonization, of 18th-century style. He himself at first took the part of Peachum. In 1923 he arranged the sequel, *Polly*, and in 1924 he became artistic director of the British National Opera company. His compositions include songs, church music, chamber works and incidental music to plays. He died in London, April 10, 1952.

AUSTIN, HERBERT AUSTIN, 1st Baron (1866–1941), of Longbridge, the founder of the Austin Motor company and its first chairman, was born on Nov. 8, 1866, at Little Missenden, Buckinghamshire. He spent much of his early life in Australia, becoming manager and later director of the Wolseley Sheep-Shearing Machine company, the manufacture of whose machines he controlled in England. In 1895 he designed the first Wolseley car—a three-wheeler—and in 1900 drove the first Wolseley four-wheeled car, which he also designed, through the Thousand Miles trial. Austin began his own production of motor cars at Longbridge works, Birmingham, in 1906 and founded the Austin Motor company the same year. Later, this company's lightweight Austin Seven model greatly influenced British and European light car design. During 1951–52 the company was merged with Morris Motors Ltd. to form the British Motor corporation.

In 1917 Austin received a knighthood and from 1919 to 1924 was member of parliament as a Conservative for King's Norton. In 1936 he was created a baron. The title became extinct on his death near Bromsgrove, Worcestershire, on May 23, 1941. (St. J. C. N.)

AUSTIN, JOHN (1790–1859), the most influential English writer on jurisprudence after Jeremy Bentham, was born on March 3, 1790. After five years in the army he began to study law in 1812 and from 1818 to 1825 practised unsuccessfully at the chancery bar. His powers of rigorous analysis and his uncompromising intellectual honesty deeply impressed his contemporaries and in 1826 when the University of London was founded he was appointed its first professor of jurisprudence. He spent the next two years in Germany studying Roman law and the German civilians whose ideas of classification and systematic analysis exerted an influence on him second only to that of Bentham. Both Austin and his talented wife Sarah were ardent Utilitarians, intimate friends of Bentham and of James and John Stuart Mill and much concerned with legal reform. Austin's first lectures in 1828 were attended by many distinguished men but he failed to attract students.

He resigned his chair in 1832 in bitter disappointment and after delivering in 1834 a shorter but equally unsuccessful version of his lectures he abandoned the teaching of jurisprudence. He was appointed in 1833 to the Criminal Law commission, but resigned in frustration after signing its first two reports. In 1836 he was appointed a commissioner on the affairs of Malta. The Austins then lived abroad, chiefly in Paris, until 1848 when they settled in Weybridge, Surrey, where Austin died in Dec. 1859. Bouts of nervous illness and self-distrust prevented Austin from fully deploying his great powers; his life, as his widow wrote, was one of "unbroken disappointment and failure" in ironic contrast with his posthumous fame and influence.

Austin's best-known work is *The Province of Jurisprudence Determined*, a version of part of his lectures published in 1832. Here, in order to clarify the distinction between law and morality blurred by doctrines of Natural Law, he elaborated his definition

of law as a species of command. Commands are expressions of desire that another shall do or forbear from some act, accompanied by a threat of punishment (the "sanction") for disobedience. Commands are laws "simply and properly so-called" when they are general and are "set" by the "sovereign"; *i.e.*, the person or persons to whom the bulk of a society renders habitual obedience and who renders no such obedience to others. This is the mark distinguishing "positive law" both from the fundamental principles of morality which are the "law of God" and from "positive morality" or man-made rules of conduct, such as etiquette, conventional morality and international law, which do not emanate from a sovereign. *The Province* also contains a version of Utilitarianism in which "utility" is regarded as the index of God's commands and the test of the moral quality of general rules of conduct rather than of particular actions.

Austin viewed the doctrines of *The Province* as "merely prefatory" to the study which he termed "general jurisprudence." This was the exposition and analysis of the fundamental notions forming the framework of all mature legal systems. Hence he devoted the main part of his lectures (published only in 1863) to a detailed analysis of such "pervading notions" as those of right, duty, persons, status, delict and sources of law. This general or analytical jurisprudence was distinguished from the criticism of legal institutions which Austin called the "science of legislation"; he thought both were important parts of legal education.

Austin's work has exerted a profound influence on English jurisprudence and legal education. A long succession of English writers have echoed or elaborated his doctrines or, when opposing them, have accepted his conception of the analysis of legal concepts as the central concern of jurisprudence. In the United States jurists such as J. C. Gray and O. W. Holmes welcomed his bold distinction between law and morality as a major clarification.

When the reaction came with the turn of the century it was severe. The command theory has been condemned as a misidentification of all law with the product of legislation and a distortion of many types of legal rule. The severance of a purely analytical jurisprudence from moral criticism of law has been criticized as sterile verbalism obscuring the social function of law and the judicial process. Some critics consider that the doctrine of sovereignty confuses the ideas of legal authority and political power; others have even held "legal positivism" responsible for subservience to state tyranny or absolutism.

Some of these criticisms are well founded, but in spite of its mistakes Austin's work is of permanent value. The rigour and clarity of his analysis have demonstrated the complexity of many important legal and political concepts and the perennial need for just such an analytical study as he proposed; and repeated efforts to show precisely where his simple distinctions between law and morality are wrong have increased the understanding of both.

See J. S. Mill's review of the *Lectures on Jurisprudence* reprinted in *Dissertations and Discussions*, vol. iii; R. A. Eastwood and G. W. Keeton, *Austinian Theories of Law and Sovereignty* (1929).

(H. L. A. H.)

AUSTIN, MARY (née HUNTER) (1868–1934), U.S. novelist and essayist, is best remembered for her works on Indian cultures. She was born at Carlinville, Ill., on Sept. 9, 1868. She graduated at Blackburn college there in 1888, taught for a time, and then moved to California, where she became the friend and chronicler of the nearby Indian tribes. Her first book, *The Land of Little Rain* (1903), a description of desert life in the west, won her immediate fame, and was followed by *The Basket Woman* (1904) and *Lost Borders* (1909), both volumes of short stories, and *The Arrow Maker*, a play (1911).

After 1905 Mrs. Austin lived in Carmel, Calif., abroad and in New York city before settling at Santa Fe, N.M., in 1924 where she died on Aug. 13, 1934. She became a prolific writer, publishing 32 volumes and about 200 articles in her lifetime, including such "problem" novels as *A Woman of Genius* (1912) and essays about socialism, feminism and the various social problems she was concerned with through her association with the group of artists and writers revolving about Mabel Dodge in New York. Except for her nature essays, lively in observation and transcendental in tone, her work is heavily didactic and primarily of historical interest.

BIBLIOGRAPHY.—*Earth Horizon* (1932), an autobiography; H. M. Doyle, *Mary Austin, Woman of Genius* (1939); and estimates in H. C. Tracy, *American Naturists* (1930), and Van Wyck Brooks, *The Confident Years: 1800–1915* (1952).

AUSTIN, STEPHEN FULLER (1793–1836), an American frontier colonizer and founder of the principal settlements of English-speaking people in Texas during the 1820s, while that territory was still a part of Mexico. He was born Nov. 3, 1793, in Austinville, Va., the oldest son of Maria Brown, of Quaker descent, and Moses Austin (1761–1821), who had himself inaugurated the project for the colonization of Texas during the last year or two of his life. Moses was caught in the financial panic of 1819 and left the lead mining region of southeast Missouri, where he had settled, for Texas. There he obtained a grant of land for colonization purposes (Jan. 1821) but died six months later, leaving his son to carry out the enterprise. Stephen F. Austin had been educated at Bacon academy, Colchester, Conn., and at Transylvania university, Lexington, Ky., and had served in the territorial legislature of Missouri from 1814 to 1819, when the slavery question was raised to a high pitch over the Tallmadge proposal to exclude slavery upon the admission of Missouri as a state. Involved in his father's business misfortunes, he joined a general migration into the new territory of Arkansas and opened a farm at Long Prairie, on the Red river, as a step toward Texas; but proceeding to New Orleans he learned that the approaches to Texas from that city were better. There he began the study of law and assisted in editing the *Louisiana Advertiser*, until the middle of July 1821, when, with all the vigour of a young man, he entered Texas and, during the following winter, planned a substantial settlement near the coast between the Brazos and the Colorado rivers. Meanwhile a successful revolution had occurred in Mexico and it became necessary for him to go to Mexico City to secure the confirmation of his grants. For some years thereafter he was one of the main factors in the struggle between two civilizations for the possession of Texas.

In the interest of the slaveholding element of Anglo-Americans, Austin successfully defeated the efforts of Mexican statesmen, who were supported by British agents and diplomats, to keep Negro slavery out of Texas. In 1833, when he failed to induce the Mexican government to make Texas a separate state in the confederation so that the American settlers might have the liberty and self-government they considered indispensable, he wrote home recommending the organization of a state without waiting for the consent of the Mexican congress, and was thrown into prison. He was released in 1835, the Texas revolution followed, and Austin secured help from people in the United States. In the end he found himself and his colonies practically submerged by the flood of adventurers and immigrants, and the revolution was successful. Sam Houston (*q.v.*) defeated him in a campaign for the presidency, and Austin died on Dec. 27, 1836, while serving as secretary of state. As a colonizer on an advancing frontier where there was a contest between two civilizations and where one had to restrain his own followers and conciliate the defense, Austin's work was of a high order, and it constitutes his chief title to fame.

See also TEXAS: *History*.

See Eugene C. Barker, *Life of Stephen F. Austin* (1925), and his *Mexico and Texas, 1821–1835* (1928). (T. P. MA.)

AUSTIN, a city of Minnesota, U.S., 90 mi. S. of Minneapolis and St. Paul, on the Red Cedar river; seat of Mower county. The first settler's cabin on the site of Austin was erected in 1853. Austin was platted in 1856 and chartered as a city in 1873. The trading centre of a rich corn and hog-raising area, the city's major industry is meat packing. Other industries include railroad shops and a plant manufacturing corrugated paper. Austin junior college, founded in 1940, is located there.

For comparative population figures *see* table in MINNESOTA: *Population*. (H. T. H.)

AUSTIN, the capital city of Texas, U.S., and seat of Travis county. It lies in a valley near the centre of the state, on both banks of a sprawling meander of the Colorado river, and is sur-

rounded by timbered hills and ravines. The business district is embraced within the bend of the river and bisected by Congress avenue, which dips into the valley, crosses the river and ascends directly to the pink granite capitol building, beyond which and higher rises the 27-story bell tower of the University of Texas.

The site was first settled in 1835. In 1838 Mirabeau B. Lamar, who became the president of the Republic of Texas, stopped there on a hunting trip, and in 1839 it was selected for the capital and named for Stephen F. Austin (*q.v.*). When the Mexicans invaded Texas in 1842, Sam Houston, then president of the republic, moved the capital to Houston. The citizens of Austin, fearing that Houston would become the permanent capital, retrieved the archives from a company of Texas rangers sent to carry them to Houston, and the incident became known as the archive war. By 1845 the capital was secure again in Austin.

During the years of the republic various diplomats lived in the city, and the old French embassy is maintained as a historic site. The governor's mansion (1853), a showpiece of southern colonial architecture, overlooks the capitol and its lawns. The mansion's east façade was decorated with fluted Greek pillars with Ionic caps, which were shaped from pine logs hauled from nearby Bastrop by slave labour. The residents of Travis county voted against secession from the union, 704 to 450, but they sent many young men to defend the Confederacy.

The original capitol, a one-story frame building, was protected from Indians as late as 1845 by an eight-foot stockade. A Chicago syndicate built the new capitol, second in size to the national capitol in Washington, D.C., in 1883–88 in return for 3,000,000 ac. of public land in the Texas Panhandle. In 1894 metal light towers, 165 ft. high, were erected, and 27 of them still suffuse the Austin evenings with their mercury vapour glow.

Of the city's labour force only 1 in 13 persons is employed in the 250 manufactories, while 1 in 5 works for the state, 1 in 5 in services and 1 in 6 in the retail trades. Apart from services and trade, the working population of the city is employed in construction, real estate, insurance, finance, printing, agriculture, furniture, and stone, clay and glass industries.

Austin, the political city of the state, is also an educational, cultural and artistic centre, the home of many of the state's artists and writers. William Brann launched his *Iconoclast* there. O. Henry (*q.v.*) bought him out and published his humorous weekly, *The Rolling Stone*. Elisabet Ney, the sculptress, worked there in her castlelike home and studio.

The city maintains a symphony orchestra, a civic theatre and an art gallery. A library was first opened in 1873 "to elevate the tone of our society"; after the mid-20th century the city library contained 120,000 volumes and a free film and record service.

The University of Texas, founded in 1881, has its main campus at Austin. Its library, with about 1,500,000 volumes, includes the following collections: Texas collection, Latin-American collection (founded on Garcia library), archives, newspaper collection and the rare book collection, including priceless first English editions in the Wrenn and Stark libraries. Several other institutions of higher education are located in Austin: St. Edward's university, a Catholic men's school founded in 1885; Concordia college, a Lutheran junior college founded in 1926; Huston-Tillotson college, a Negro institution founded in 1876; the Austin Presbyterian Theological seminary, founded in 1902; and the Southwest Episcopal seminary, founded in 1951.

Several state public assistance institutions, the state museum and state library are located in Austin. Bergstrom air force base is near the city.

Hydroelectric power dams built by the Lower Colorado River authority form Lake Austin, Lake Travis, Granite Shoals lake, Marble Falls lake, Inks lake and Buchanan lake. They form a chain of lakes descending from 60 mi. N. to the city, providing the region with an excellent recreational area.

Pop. (1960) city, 186,545; standard metropolitan statistical area (Travis county), 212,136. For comparative population figures *see* table in TEXAS: *Population*. (R. E. DU.)

AUSTRALASIA, a term that has never had a precise definition and that was originally employed to denote land believed to exist south of Asia. In its widest sense it has been taken to include besides Australia (with Tasmania) and New Zealand, the Malay archipelago and the Philippines; Melanesia (New Guinea and the island groups lying east and southeast of it as far as and including New Caledonia and the Fiji Islands); Micronesia (the island groups extending from Pelew Island and the Ladrones east-southeast to include the Marshall and Gilbert groups); Polynesia (the scattered groups of islands extending eastward from the above groups to about longitude 130° E.). But the Hawaiian Islands, and even Antarctica, have been included under the heading "Australasia." The word is falling out of use although it is still employed by Australian companies and societies operating beyond the Australian continent. *See* also OCEANIA.

AUSTRALIA, COMMONWEALTH OF, occupies the smallest, most arid and least densely populated of the continents. It is a self-governing member of the Commonwealth of Nations (*q.v.*) and its capital city is Canberra. With an area of 2,971,081 sq.mi. (mainland alone, 2,944.866 sq.mi.), it is about the size of conterminous United States and more than three-fourths the size of Europe. (Tasmania and other adjacent islands are included in the above area, but not Papua or the trust territories.) Australia's maximum east-west extension is about 2,400 mi. and its north-south distance about 1,970 mi. With a coast of 12,210 mi., giving a proportion of 1 mi. of coast to 244 sq.mi. of land surface, Australia is a markedly compact land mass. This fact, in conjunction with its shape and latitudinal position, influences the climate and hence the general geographical character of the country. It lies wholly in the southern hemisphere between longitude 113° 9′ and 153° 39′ E. and latitude 10° 41′ and 43° 39′ S. (mainland, 39° 8′ S.). It derives its name from the Latin *terra australis* or "southern land."

The isolation of Australia is one of the most significant factors in its geography. Only in the northwest does it face the outposts of Asian civilization at no great distance (Darwin-Timor, about 400 mi.); and the northern area is in general difficult country. Hence contacts with the islands to the north, though probably intermittent throughout historic time, did not become significant until the mid-19th century. On all other sides Australia is surrounded by wide expanses of ocean. Nevertheless, it is the largest land mass, with the largest and most technically advanced population, within the Pacific, and indeed it may be said to dominate the whole of the southwest of that ocean.

Australia, like New Zealand, is remote from the British Isles but is linked to the mother country by two sea routes, one through the Suez canal and the other through the Panama canal. The distance by the London-Suez-Colombo-Fremantle route is 9,537 nautical miles; by the Liverpool-Panama-Sydney route it is 12,222 nautical miles.

This article contains the following sections:

I. PHYSICAL GEOGRAPHY

A. GEOLOGY

Australia, like all other continents, consists of a core or shield of ancient Pre-Cambrian rocks flanked and, in some places, covered by younger rocks. In the case of Australia this shield of ancient rocks, ranging from 3,000,000,000 to 600,000,000 years old is very large and underlies most of the western and central parts of the continent, the eastern part of the continent is an accretion to the shield and has been built up within the last 600,000,000 years

The continent may be divided into the three structural units shown in fig. 1. The Pre-Cambrian shield established the framework of the western half of the continent by the end of Pre-Cambrian time; the Tasman geosyncline built up the eastern states of the continent in Paleozoic time, 600,000,000 to 200,000,000 years ago; the east central depression became evident about 200,000,000 years ago, in Mesozoic time, and gave rise to an irregular corridor of sea and lakes between the fold mountains of the Tasman geosyncline in the east and the Pre-Cambrian shield in the west.

Although admittedly an oversimplification, the growth of the continent seems to have followed a general pattern of consolidation progressing eastward and northeastward from the southern portion of Western Australia. The Paleozoic fold belt, now comparatively stable, marks the present eastern limit of the continent, but farther north and east lie the less stable Mesozoic and Tertiary fold belts trending through New Guinea and island arcs to New Zealand.

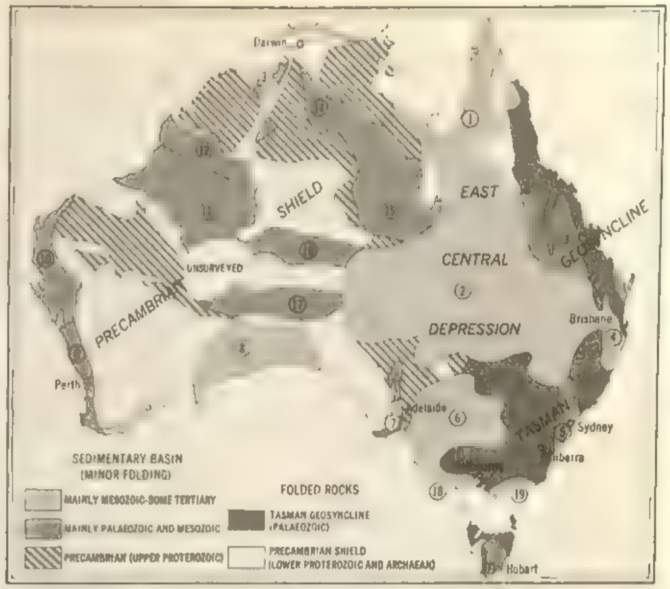
Pre-Cambrian.—Outcrops of Pre-Cambrian rocks are widespread in Western Australia, South Australia and the Northern Territory. This great area of Pre-Cambrian rocks is referred to as the Australia Pre-Cambrian shield; it extends into western Queensland and western New South Wales. Areas between outcrops of these old rocks are occupied by a thin cover of younger sedimentary rocks, sand or alluvium or by thicker sediments deposited in basin-like depressions in the Pre-Cambrian basement. The names of the basins that are of particular interest in the search for oil and water appear on fig. 1. Isolated outcrops or "windows" of Pre-Cambrian basement rocks appear in the Tasman geosyncline in northeast Queensland and in Tasmania. The history of the Pre-Cambrian period, which accounts for about five-sixths of the whole of geological time, is essentially that of the growth and consolidation of this shield which has been fairly stable since the end of Pre-Cambrian time.

Archean.—The rocks of this era, from more than 3,000,000,000 to perhaps 2,000,000,000 years ago, include some recognizable but altered sedimentary rocks, lavas and many other types of igneous rocks including many granites now altered to gneisses. The most representative rock types are schists and gneisses derived by metamorphism from original sedimentary or igneous rocks. Slate, quartzite and "greenstones" (altered basic lava flows) are prominent in Archean sequences in Western Australia. Rocks considered to be definitely of Archean age are everywhere severely folded and compressed.

Proterozoic.—The record of Proterozoic rocks is more understandable than that of earlier times: the degree of metamorphism is less and deposition of normal sediments in troughs and basins by recognized geological processes can be more easily traced. Lower Proterozoic rocks are at present best known in the Northern Territory and western Queensland, but rocks of the same general age are probably represented in some areas of South Australia and Western Australia. In most places these rocks occur in fairly well-defined belts and include many little-altered sediments like sandstone, graywacke, shale and limestone deposited in geosynclines; but some have been metamorphosed and resemble Archean rocks. The rocks have been folded to varying degrees but, in general, are much less deformed than Archean rocks. Many Proterozoic granites intrude Lower Proterozoic and Archean rocks; these, for the most part, show little alteration.

Upper Proterozoic rocks provide, in general, a marked contrast with the older Pre-Cambrian; they consist mainly of unaltered sediments and lavas deposited in broad basins within the older rocks. They have been little folded, are not intruded by granites except in the Adelaide geosyncline and, in many places, rest almost horizontally on steeply inclined older beds. This applies particularly to Western Australia and to the Northern Territory where consolidation of the shield was well advanced in Upper Proterozoic time; local severe folding of Upper Proterozoic rocks occurs in a few places, notably at Yampi sound in the far northwest.

A major fold belt of Upper Proterozoic rocks is the Adelaide geosyncline in South Australia where an immense pile of sediments was deposited in a trough which existed through Upper Proterozoic



(1) CARPENTARIA; (2) GREAT ARTESIAN; (3) BOWEN; (4) CLARENCE-IPSWICH; (5) SYDNEY; (6) MURRAY; (7) SAINT VINCENT; (8) EUCLA; (9) PERTH; (10) CARNARVON; (11) CANNING; (12) FITZROY; (13) BONAPARTE GULF; (14) DALY; (15) GEORGINA; (16) AMADEUS; (17) OFFICER; (18) OTWAY; (19) GIPPSLAND

FIG. 1.—GEOLOGICAL FORMATIONS IN AUSTRALIA SHOWING SEDIMENTARY BASINS

and part of Cambrian time. The Upper Proterozoic sediments constituting the Adelaide system consist mainly of sandstone, graywacke, dolomite and red beds; the system has been divided into four series of which the second youngest includes sediments derived from glaciation of the land surface in Late Proterozoic time.

The sequence of Upper Proterozoic rocks in Western Australia and the Northern Territory can be broadly correlated with the Adelaide system although they cannot yet be split into four series. However, in places the Upper Proterozoic can be divided into two; the lower sequence consists mainly of sandstone with lava flows and some iron ore beds (red beds); the upper includes sandstone, dolomite, shale and red beds with glacial sediments which may be broadly correlated with those of the Adelaide system.

Economic Geology.—In Australia, as in other parts of the world, the Pre-Cambrian shield provides the richest source of minerals. The greater part of Australia's total production of gold, lead, zinc, iron and uranium has been won from the shield, mainly from Archean and Lower Proterozoic rocks.

Upper Proterozoic rocks are largely unmineralized and have contributed much less than the older Pre-Cambrian; they provide some uranium in the Northern Territory but their main contribution has been from the iron-bearing beds at Yampi sound in northwestern Western Australia and in the Constance range in northwestern Queensland.

Paleozoic.—Events in the Paleozoic era took place in two different environments. A broad meridional mobile belt—the Tasman geosyncline—was initiated in eastern Australia where sedimentation and recurrent folding and igneous intrusion persisted throughout Paleozoic time; contemporaneously, the more stable Pre-Cambrian shield, although for the most part a land area, developed depressions in which sediments were deposited. These depressions formed seaways across the shield in Lower Paleozoic time but were restricted to four major embayments along the western coast in the Upper Paleozoic—the sites of the Bonaparte gulf and the Canning, Carnarvon and Perth basins. Sedimentation continued into Mesozoic time in all basins and persisted into the Tertiary in the Carnarvon and Perth basins.

The relative stability of the Pre-Cambrian shield in contrast with the Tasman geosyncline, first apparent in the Early Paleozoic, persisted as a basic feature of the structural evolution of the continent. The contrast in environment is reflected in both type of sedimentation and structural history; thick, folded sequences of graywackes are typical of the Tasman in contrast with thinner,

little-folded successions of sandstone, limestone and shale in the basins on the shield.

Lower Paleozoic (*Cambrian, Ordovician and Silurian Periods*).—Sedimentation began in the Tasman geosyncline in the Cambrian period. The oldest-known sediments there are fossiliferous Middle Cambrian graywackes and volcanics in Victoria and Tasmania where submarine volcanic activity was intense, but unfossiliferous metamorphic and volcanic rocks in Tasmania and near Brisbane may represent Lower Cambrian sedimentation.

The record of Ordovician and Silurian times is less obscure and presents a general picture of a geosyncline with widespread sedimentation but not entirely covered by sea at any one time; details emerging in many places indicate that ridges and islands existed within the geosyncline and that sedimentation probably took place in smaller troughs and basins. At different times and places supplies of sediments apparently came from the west, from island ridges and from land that formed the eastern boundary of the geosyncline, now submerged beneath the Tasman sea.

Sedimentation was interrupted from time to time and rocks were followed by orogenies (episodes of structural deformation) beginning in Tasmania about the end of Cambrian time (Tyennan orogeny). Succeeding, fairly widespread orogenies accompanied by granite emplacement occurred about the end of Ordovician time (Benambean or Benambran orogeny) and toward the close of the Silurian (Bowning orogeny). None of these orogenies affected all parts of the geosyncline but resulted in a changing pattern of sedimentation, folded uplift and erosion.

Ordovician rocks, mainly trough deposits of the graywacke suite, were laid down in many areas along the full length of the geosyncline. Similar rocks were deposited in the Silurian, but calcareous rocks including limestone became prominent, particularly in northern Queensland and southern New South Wales, and tremendous outpourings of acid lavas dominated Middle and Upper Silurian sequences in the latter area.

On the Pre-Cambrian shield, the Adelaide geosyncline was filled up mainly with sandstone, dolomite, limestone and shale in the Lower and Middle Cambrian. A seaway, in which similar sediments were deposited, may have developed from this geosyncline northward to central Australia and certainly extended from there to the northwestern coast in Lower and Middle Cambrian time. Toward the end of Middle Cambrian time, South Australia became dry land and the seaway possibly trended eastward from central Australia to join the Tasman sea. This pattern continued throughout the Ordovician with further sedimentation in the Amadeus basin in central Australia; but the seaway trended west rather than northwest from central Australia reaching the northwest coast of the continent through the Canning basin. A southerly arm probably flooded the Officer basin. The southwestern coast of the continent was submerged to initiate the Carnarvon and Perth basins, certainly in the Silurian and possibly in the Ordovician. With the exception of these two basins, the entire shield consisted of dry land in the Silurian. Sedimentation in the Adelaide geosyncline and in the Amadeus and Officer basins in central Australia had finished, but the coastal basins had been founded in embayments in the shield and had received further sedimentation in Upper Paleozoic and later time.

Upper Paleozoic (*Devonian, Carboniferous and Permian Periods*).—The gradual process of consolidation of the Tasman geosyncline can be clearly seen in events taking place in Devonian time; in fact, much of Tasmania, Victoria and parts of New South Wales and Queensland were essentially stabilized by one or both of the last two grand orogenies in these areas which took place about mid-Devonian (Tabberabberan orogeny) and in Late Devonian or Carboniferous time (Kanimblan orogeny). Granites accompanied these two orogenies.

Deposition occurred in troughs in many areas in Lower and Middle Devonian time, particularly in central Victoria and in northeastern New South Wales and eastern Queensland, but the onset of the Tabberabberan orogeny radically changed the picture. Sediments were folded in northeastern Queensland, central and southern New South Wales, Victoria and Tasmania; northeastern New South Wales and eastern Queensland (the New England trough) were apparently little affected by these movements [illegible] sedimentation continued.

Uplifts following this orogeny were short-lived and soon most of the geosyncline was again under water in the Upper Devonian. There was, however, a change in the environment and in the type of sedimentation in Upper Devonian time. Although trough deposition continued in eastern New South Wales and was revived in a few localities elsewhere, the Upper Devonian was a time of widespread deposition in shallow basins and in shallow seas that spread across the geosyncline. Volcanic activity was prominent only in southeastern New South Wales and in central Victoria; typical sediments were sandstone, shale and red beds. The same pattern continued into Early Carboniferous.

The Kanimblan orogeny, the last of the grand orogenies to have widespread effects throughout the geosyncline, interrupted sedimentation except in the New England trough. The movement raised much of the geosyncline well above sea level and the Upper Carboniferous sea was restricted to the eastern margin of the continent from Cape York peninsula to 100 mi. N.E. of Sydney. Both marine and terrestrial sediments were laid down in Queensland and New South Wales. Upper Carboniferous deposits in Queensland include lava flows and marine sandstone, shale and limestone; and, while, in northeastern New South Wales, mudstone, chert and lava flows continued to be laid down in the New England trough, thousands of feet of lava accumulated along its southwestern margin about 100 mi. N.E. of Sydney. The lavas are overlain by glacial deposits with plant fossils; these, in turn, pass upward into marine and terrestrial sediments, including Coal Measures, of definite Permian Age.

The Permian period is noteworthy for two events: the second widespread glaciation of the continent and the deposition of Australia's major Coal Measures. There is evidence of two stages of glaciation, a severe glaciation in the Lower Permian (apparently starting in Late Carboniferous time in eastern Australia) and a milder glaciation later in Permian time. The Permian seas inundated mainly the eastern seaboard of the continent and the western Australian basins, but many low-lying areas within the continent received a mantle of terrestrial sediments mainly derived from glaciated mountain ranges.

The Tasman geosyncline was now so far consolidated that earth movements produced broad basins rather than abrupt troughs and apart from the filling of the New England trough, sedimentation in the Permian took place in basins everywhere. Along the western margin of the Permian sea in eastern Australia and in [illegible] of the Perth basin in Western Australia, lay great swamps choked with vegetation from which developed, by subsequent compaction, the major Coal Measures of the continent. The great Bowen basin in Queensland and the Sydney basin in New South Wales originated in Permian or Late Carboniferous time and received great thicknesses of sandstone, shale, limestone, glacial sediments and coal seams; in places volcanic rocks were poured out.

Toward the end of Permian time the Hunter-Bowen orogeny took place mainly along the present eastern seaboard; this folded and uplifted Permian and older sediments in the New England trough and in eastern and northeastern Queensland; granites were emplaced in the same areas but the orogeny had little effect farther west and south.

The pattern of sedimentation established in Lower Paleozoic time in the sedimentary basins along the western margin of the shield continued throughout the Upper Paleozoic. By the Middle Devonian the ancestral Indian ocean again flooded these basins and in the Fitzroy basin sedimentation was dominated by reefs which fringed its northeastern margin.

In the Lower Carboniferous, sandstone, limestone and other calcareous sediments were deposited in all of these basins but, except for an area in the Fitzroy basin, the embayments were apparently raised above sea level in Upper Carboniferous time. In Permian time much the same type of sedimentation took place in the Western Australian basins as in those near the eastern seaboard, but volcanism was absent and the only economic coal measures were laid down south of Perth. Deposits in the Carnarvon and Canning basins consisted of limestone, sandstone and

shale with glacial sediments prominent in the lower part of the Permian sequence. The Canning basin extended far to the southeast where marine sediments passed into terrestrial glacial deposits. Similar glacial deposits found in South Australia and remnants found in the Northern Territory complete the evidence for widespread glaciation in Permian time.

Economic Geology.—Mineralization of Cambrian Age has been recognized only in the Adelaide geosyncline, but gold, silver, lead and copper were introduced by Silurian granites in places within the Tasman geosyncline. Lower Paleozoic sedimentation of the shield began the sequences within the sedimentary basins that have become sources of underground water and focal points in the search for oil.

Granites accompanying the Tabberabberan, Kanimblan and Hunter-Bowen orogenies were responsible for the introduction of the greater part of the gold, tin, copper and silver-lead deposits of eastern Australia. Apart from the metals, the principal economic interest lies in the vast reserves of bituminous coal, mainly in the Bowen and Sydney basins in eastern Australia. From a broader viewpoint, the initiation in Permian time, along the eastern coast of the continent, of sedimentary basins that were not subsequently subjected to severe folding or intrusion was the starting point of real prospects for oil in the Tasman geosyncline.

Mesozoic.—(*Triassic, Jurassic and Cretaceous Periods*).—In Mesozoic time (220,000,000–70,000,000 years ago) sedimentation in both eastern and western Australia took place in the basins but, whereas deposition followed the established pattern in the Western Australian basins, the relative instability of eastern Australia gave rise to new sedimentary basins.

In the Triassic in eastern Australia the belt running northward into southeast Queensland was at last uplifted, but sedimentation continued in the Bowen and Sydney basins until about the end of the period. From the Jurassic onward, the east central depression gradually dominated the scene and gave rise to a tremendous area of gradually subsiding lakes and swamps in Queensland and to smaller depressions or embayments in New South Wales and Victoria; thus were initiated the Carpentaria, Great Artesian, Murray, Otway and Gippsland basins. In these, fresh-water sediments, mainly sandstone with shale and coal seams in places, alternated with marine shale and calcareous sediments resulting from incursions of the sea. Sedimentation continued into the Tertiary period, particularly in the southern basins. In the Great Artesian basin the main marine incursion occurred in Lower Cretaceous time followed by gentle uplifts which returned the basin to an area of swamps and fresh-water lakes.

Events in eastern Australia in the Mesozoic can be recognized in the sedimentary record of the Western Australian basins; these were largely drained in the Upper Triassic but further sedimentation followed in the Jurassic and Lower Cretaceous when the basins were intermittent lakes barred from the sea for most of the time, with infrequent marine incursions from the west. Sandstone, siltstone and calcareous sediments, both marine and terrestrial, were the principal sediments laid down.

The pronounced sagging in the Early Cretaceous affected two other areas of the shield. The northern part of the Northern Territory foundered and a shallow sea, in which fine shaly sediments were laid down, spread from the Great Artesian basin northwestward to the Bonaparte gulf. Farther south a new basin (Eucla) was initiated in an embayment along the southern margin of the shield. Gentle uplifts toward the end of the Mesozoic drained these seas and the continent then extended southward to include Tasmania and northward to include part of New Guinea.

Some volcanic activity occurred in eastern Australia in the Mesozoic, notably in Queensland, but it was only a faint echo of the outbursts that occurred in the Paleozoic. Great dolomite sills were intruded in Tasmania and some granite was emplaced in eastern Queensland, associated with mild orogeny toward the end of the era (Maryborough orogeny).

Economic Geology.—Some minerals were introduced by granites in Queensland but of more importance were the occurrence of bituminous coal in Queensland, Victoria, Tasmania and South Australia, the deposition of the sandstone aquifers which store most of the underground water in the Great Artesian basin, and the laying down of additional source and reservoir rocks for oil in most of the sedimentary basins.

Cenozoic.—(*Tertiary and Quaternary Periods*).—The series of lakes in the east central depression persisted from Cretaceous into Tertiary time. Fresh-water sediments were deposited in parts of the Carpentaria and Great Artesian basins in the Lower Tertiary, and sedimentation, both marine and terrestrial, continued until about the end of Tertiary time in the Murray, Otway and Gippsland basins. Large swampy lakes developed in Victorian basins in Lower Tertiary time and, in the Gippsland basin, gave rise to the major brown coal deposits of Victoria.

Similar, but very much smaller, lakes and swamps developed in many parts of the continent, and sand, gravel and mud with lignite in places collected in the depressions; lake limestone is found particularly in northern and western Australia.

In the western part of the continent, the Canning basin received only scattered terrestrial sediments but marine calcareous sediments were laid down continuously from Cretaceous until Upper Tertiary time in part of the Carnarvon basin. The Perth and Eucla basins were again briefly flooded in the Lower Tertiary; the Eucla basin received extensive limestone deposits which now crop out over much of the Nullarbor plain and along the coast of the Great Australian bight.

In Lower Tertiary time there was a widespread but generally quiet outpouring of basaltic lava in eastern Australia (the older basalts). In many places lake deposits and valleys with flats and terraces of stream gravels were overridden by basalt; many of these have been preserved below the hard basalt and are termed "deep leads"; the stream gravels commonly contained alluvial gold or tin which has since been recovered in places.

Probably toward the end of the Lower Tertiary, widespread but gentle uplifts drained the sea from most of the coastal basins and the continent then extended slightly farther east and west than it does now and probably had land bridges southward to Tasmania and northward to Papua. The climate seems to have been temperate to tropical and pluvial throughout and gave rise to widespread laterization by deep leaching of the soils and underlying rock.

The approximate present shore line of the continent was established by further crustal movements in Early and Late Upper Tertiary time (Kosciusko uplift); faulting and downwarping, particularly in the earlier of these movements, severed Australia from New Guinea and Tasmania and established the Gulf of Carpentaria and Bass strait. More basalts poured out in eastern Australia (the newer basalts) toward the end of Upper Tertiary time; they were more restricted than those of the Lower Tertiary and occurred principally in central and western Victoria and in southeastern and northern Queensland.

The principal geological events in Quaternary time were the continuation of some of the crustal adjustments and of volcanic activity noted in the Late Tertiary, the Pleistocene Ice Age, and the fluctuation in sea level due to the waxing and waning of polar icecaps. Many features of the Australian seaboard are the results of these fluctuations; the sheltered deepwater harbours are drowned valleys, cut when sea level was hundreds of feet lower than it is now; and the coastal flats and lagoons are legacies of the fall in sea level during the Recent epoch. Deposits of the period include some volcanics, all of the unconsolidated sediments of the coastal plains, sand dunes and much of the cover of the alluviated inland plains.

Probably the most spectacular crustal movements in the Early Quaternary were the faulting and tilting of crustal blocks in central South Australia which produced the large depressions which occasionally flood and become vast lakes (Lake Eyre, etc.). The very gradual sinking of the continental shelf along the north Queensland coast began about this time and initiated the Great Barrier reef which continued to build upward as the shelf sank.

Economic Geology.—Of first importance are the extensive brown coal deposits of Victoria which provide most of the state's electric power and solid fuel. Deep leads have been prolific producers of alluvial gold and tin. Australia's bauxite deposits are

the result of Tertiary laterization. Commercial concentrations of rutile, zircon and ilmenite took place in beach sands, particularly along the coast of south Queensland and northern New South Wales in Quaternary time.

Tertiary sequences in the major sedimentary basins provide some additional source and reservoir beds for petroleum; but, in general, Tertiary sediments seem more important as cover rocks to confine oil within older sequences than as producers themselves.

B. Geomorphology

Many of the unique features of the continent, in particular its general flatness and lack of high mountains and the absence of permanent snow fields, glaciers and active volcanoes, stem largely from two salient features of its structural evolution—a tremendous area of Pre-Cambrian shield and the lack of fold mountains younger than Paleozoic. Mesozoic and younger strata, which form the greater part of the world's high fold mountain chains (like the European Alps), are generally subhorizontal and little disturbed on the Australian continent.

However, the surface of the continent still reflects, with muted relief, the three structural units of which it is composed. The greater part of the Pre-Cambrian shield is a plateau, little more than 1,000 ft. above sea level, whose monotonous, flat or gently rolling surface is the result of long periods of uninterrupted erosion and beveling across rocks and structures, extending back to Pre-Cambrian time in places. The surface is, in fact, a composite one consisting of remnants of land surfaces of many ages, some of which can be roughly dated as pre-Middle Cambrian, pre-Permian, pre-Cretaceous and Lower Tertiary. Widespread, mature laterization, which took place mainly on Lower Tertiary land surfaces, is the most useful time marker because it can be recognized in parts of the other two units. The monotony of the old peneplain is broken, in places, by isolated ranges, like the Harts range in central Australia, which generally mark the more mobile zones in the shield, or by mesas and plateaus.

The east central depression is represented by a wide, irregular belt of lowlands whose flat or gently undulating surface, developed in Cenozoic time, differs in origin from the peneplains of the shield; the surface of the lowlands reflects the softness and horizontal attitude of the underlying Mesozoic strata and has not been beveled across folded rocks. In the central and northern sections the Lower Tertiary lateritized surface can be traced, mainly on mesas standing above the more recent plains, but toward the southern end of the lowlands the sedimentation antedates the main period of laterization.

Eastward the lowlands gradually rise to the low mountain chain that borders the eastern coast of the continent, along the site of the Paleozoic fold mountains of the Tasman geosyncline. These mountains were worn down by the beginning of the Cenozoic era and since uplifted, by recurrent movements, as plateaus which streams have greatly modified. Remnants of a Cretaceous or Lower Tertiary peneplain can still be discerned in places as can the younger, lateritized Lower Tertiary surface that had considerable relief in some areas.

See also Precambrian Time and separate articles on the systems and periods of the Paleozoic, Mesozoic and Cenozoic eras as Cambrian System; Ordovician System; etc. (L. C. N.)

C. Physiography

Australia is in general the most archaic of the continents, the least affected by the Tertiary earth movements which built the Alps, the Himalayas, the American cordilleras and the Atlas mountains. The mountains of Australia are for the most part masses of rounded highlands, old fold mountains that have been worn down and then again uplifted, warped and faulted. There is no true alpine country; even around the highest mountain, Kosciusko (7,316 ft.), snow does not normally lie for the whole year, though in winter there are large areas of snow fields. The dominants of the Australian landscape are great plains and plateaus, and for the most part even the areas of rugged relief owe their ruggedness to the dissection of old plateaus.

The western two-thirds of Australia is formed essentially of a great shield of very ancient (Pre-Cambrian) rocks; occurrences of the *Glossopteris* plants and of Permo-Carboniferous glacial deposits overlying the older rocks clearly link this shield with the similar areas of peninsular India, Africa, eastern South America and Antarctica—all, according to theories of continental drift once part of the ancient continent Gondwanaland. There are a few areas of later deposition, mostly marginal to the shield; such deposition is Cambrian in the Barkly tableland (northeast), Permian in the northwest desert basin, Mesozoic along the west coast, Tertiary in the Nullarbor plain or Eucla basin at the head of the Great Australian bight. The heart of the continent is occupied by the low much-eroded Macdonnell and Musgrave ranges but in large areas (Gibson, Great Victoria, Great Sandy and Simpson deserts) the solid rocks are hidden by fixed dunes. Very little of this immense area exceeds 2,000 ft. in height.

The eastern margin of the continent is very different: a belt of highlands, curving through about 2,400 mi. from Cape York to South East cape (Tasmania). It seems probable that Australia once extended far to the north and east, so that the true boundary of the Pacific basin is the line New Guinea-Solomons-New Hebrides-New Zealand; in any case much of this area for long ages formed the Tasman geosyncline, the folded, warped and broken sediments of which form the series of ridges and plateaus that make up the Eastern highlands. These are generally around 2,000 ft. high north of 28° S. and 2,000–6,000 ft. in New South Wales and eastern Victoria. It should be noted that the term Great Dividing range is a misnomer; there is no continuous range and the divide itself coincides only here and there with a well-marked ridge. Erosion by short rivers on the rainier eastern flanks and diversion of drainage by basalt flows or by differential earth movements have brought the watershed in many places well to the west of the general line of maximum elevation.

Between the Eastern highlands and the western shield is a broad depression (mostly less than 500 ft.) from the Gulf of Carpentaria to western Victoria; this is floored for the most part by relatively soft rocks (Jurassic-Tertiary) and contains the Great Artesian basin and that of the Murray-Darling, by far the largest river system of the continent. On the southwest this great lowland is flanked by the fault blocks of the Mt. Lofty and Flinders ranges of South Australia.

The landscapes of the continent are thus in general subdued, since the highest point is not much more than 7,000 ft. above sea level; indeed only about 180,000 sq.mi. (about 7% of the area is more than 2,000 ft., a proportion far smaller than that of any other continent. The east coast is dissected by fairly deep valleys forested with eucalypts or occasionally with jungles of Indo-Malayan affinities. At intervals there are small coastal plains or wider valleys, such as those behind Brisbane and Sydney; well watered and moderately fertile, these are among the most prosperous regions of Australia. The highest elevation is close to the Pacific coast with its rain-bearing southeast trade winds and there is little marked elevation in more than three-quarters of the continent. These facts largely account for the aridity that is so marked a feature of Australian geography and is by far the most serious impediment to economic development. West of the Eastern highlands the vegetation of Australia is predominantly drought-resistant—open eucalypt woodland, savanna, *Acacia* (mulga) or eucalypt (mallee) scrub, steppe and desert.

Rivers and Drainage.—A girdle around Australia has normal ("exoreic") drainage to the sea, but even this is broken in three places by riverless areas abutting on the coast. Only in the south-east quadrant—the Murray-Darling basin—has the girdle much depth. Over much of this normal drainage area the rivers flow only in the wet season, or even only once in several years.

Between longitude 120° and 135° E. and latitude 18° and 33° S., there are virtually no rivers. This "areic" area reaches the coast in the desert basin in the northwest and in the Nullarbor plain; while on the South Australia-Victoria border is another small riverless area. This lack of drainage is partly the result of lack of rainfall and partly because of the cover of sand over porous rocks, while the Nullarbor plain is a limestone area riddled with solution channels, such water as there is coming out in springs

along the cliffs on the coast.

The joint Murray-Darling basin covers about 440,000 sq.mi., but of these only about 158,000 sq.mi. are effective catchment; nearly two-thirds of the basin normally supplies no water to the two trunks. The Darling, Australia's longest river (1,702 mi.), has been dry for as long as 18 months; the Murray (1,609 mi.), the only really great river, has dried up on three occasions (1830, 1912, 1922). The Paroo normally fails on the last 30 mi. before it joins the Darling, but in the 1870 floods it was navigated for 180 mi. above the confluence and had spread to a width of 60 mi. On the plains the rivers of this system branch and reunite to an extent only excelled by those of the Channel country. This feature is associated with the very slight gradients, low banks and occasional but very violent flooding.

Though the Murray and the Darling and two or three of their tributaries receive enough rain in the highlands to reach the main stream (with diminished flow downstream), really well-developed perennial streams are restricted to the extreme southwest corner of the continent, the north coasts and the Eastern highlands. There is very little river navigation, except for short coastal reaches in the east and for 50–100 mi. or so on some of the northern streams, where navigation tends to be very hazardous. The development of railways and irrigation killed the once-flourishing traffic on the Murray-Darling.

Of the many inland ("endoreic") drainage basins, that of Lake Eyre is the largest—nearly 500,000 sq.mi. The complex branching or braided patterns of the Murray-Darling are repeated on a grander scale in the Channel country, the Queensland portion of the basin, by the Barcoo river (Cooper creek), the Diamantina, the Mulligan and other "rivers"; some of these simply disappear into Simpson desert, while the Hay has perhaps never flowed during the past century. The main channels, however, have water holes which are generally permanent and may be several miles long; indeed in much of Australia the word river really implies a chain of sausage-shaped pieces of water. The waters of this immense basin, when there are any, converge on Lake Eyre (39 ft. below sea level) or on one of the other remnants (Gregory, Frome, etc.) of a lake that in Pleistocene times covered 40,000 sq.mi. Lake Eyre itself, 90 mi. by 40 mi., is usually a sheet of salt on which a truck can be driven; the "shore" is formed in part by the fossil delta of the Barcoo. In 1950, however, the Barcoo and the Queensland rivers were in high flood and the lake lived up to its name.

The "lakes" dotted about the maps of Western Australia are for the most part mere playas, normally only salt flats. The Eastern highlands and the Murray valley, however, contain many small lakes of various types, posing the most interesting problems of origin. The best known is Lake George, near Canberra, which occupies a tiny interior drainage basin in well-watered country. When full, three or four times in a century, Lake George is 15 mi. long, but it is generally dry land used for pasture.

Artesian Water and Irrigation.—Problems of water supply and conservation are among the major preoccupations of Australians. The aridity of the interior is to some extent mitigated by the presence of a number of artesian basins (fig. 1), including the Great Australian or Artesian basin, which occupies no fewer than 678,000 sq.mi. (including the intake) and is by far the largest artesian area in the world, covering most of the Darling and Lake Eyre catchments and extending north to the Gulf of Carpentaria. The aquifers are mainly Jurassic, capped by impermeable Lower Cretaceous shales and sandstones. The theory that the water is plutonic—originating at great depth—is generally abandoned; the intake is mostly from a narrow but continuous belt on the western flanks of the highlands, from the gulf to Dubbo in New South Wales. Under the artesian pressure some waters rise to the surface in "mound springs," volcanolike hillocks or even small hills, up to 130 ft. high, of calcareous sinter; there is a notable group of these south and east of Lake Eyre.

As the water supply is the rainfall of the intake belt, it is quite possible for exploitation to exceed replenishment, and indeed of 2,000 bores drilled in Queensland in about 60 years, 1,300 had ceased to flow by 1943. There are altogether approximately 7,500 artesian and subartesian bores, down to 7,000 ft. deep, producing more than 300,000,000 gal. per day. Individual bores have yielded 4,000,000–5,000,000 gal. daily. As in other Australian artesian basins (though less so than in most), the water is as a rule too saline for continuous irrigation. It is used here and there for gardens, but is most valuable for watering stock: perhaps 20% of Australia's sheep are wholly or partly dependent on artesian supplies. But, although it is possible that equilibrium may be reached in some areas, the diminution of flow gives rise to some anxiety and more economic utilization is essential. Most of the bore water is lost by seepage or evaporation from tanks or from thousands of miles of open earth channels and it is obvious that the lining of these or, better, their replacement by pipes, would be a long and costly process.

The Murravian basin is on the whole much more saline than the Great Artesian, but the waters of its southern half are extensively used for stock in the Victorian mallee. None of the other basins is exploited on more than a local scale in places for town supplies.

Irrigation in Australia is mainly in the Murray valley: of a total of less than 2,000,000 ac. irrigated, the Murray and its tributaries Murrumbidgee and Goulburn account for 88%. Of the total, nearly two-thirds is used for pastures, lucerne (alfalfa) and fodder for dairy cows and sheep. Most of the remainder is used for cereals, mainly wheat, though practically all Australia's rice is grown by irrigation from the Murrumbidgee. For the rest, vines and citrus fruits are the main items; irrigation began in 1887 in "Sunraysia," the home of the dried fruits industry around Mildura, Victoria, and most of this industry depends on pumping irrigation from the Murray there and in South Australia. The largest works are the Burrinjuck dam on the Murrumbidgee and the Hume on the Murray; the latter impounds 1,250,000 ac.ft., enough to keep the river in flow for two years; Burrinjuck's capacity is half this. The diversion into the Murray basin of water from the Glenelg and the Snowy will add appreciably to irrigation potential.

Possibilities of expansion are hardly spectacular. Apart from its salinity, artesian water is in general uneconomic. Australia's irrigation storage capacity could perhaps be multiplied two and a half times, commanding perhaps 5,000–7,000 sq.mi. But this would still be mainly in the southeast, with a few fair-sized units in Northern Territory and a large number of small ones in Queensland. Such development would, of course, take a very long time and would still affect only a minute fraction of the continent, leaving almost untouched the more arid areas.

For the rest, the Australian continent, especially in the more or less marginal pastoral areas, is dotted with thousands of small tanks, fed by artesian wells, wind or engine-driven pumps or the local rain. There are also many miles of pipeline from hill reservoirs for domestic or stock supplies. The 350-mi.-long pipe to Kalgoorlie, for example, was largely turned to agricultural or pastoral uses as the gold fields and their demand declined.

D. Soils

The core of Australia—the enormous area bounded by the line of 15-in. rainfall in the north and the 10-in. line in the south —is occupied by desert or semidesert soils: desert loams; sand dunes; gibber plains of wind-faceted pebbles; or bare rock. There is as a rule more vegetation than in the Sahara. In the north there are large areas of skeletal "tableland" soils. The groups so far mentioned account for 56.5% of the total area of Australia and, if used at all, support only a very few cattle or sheep.

Around this arid core are: the semiarid brown, gray and solonized soils; the subhumid red-brown and black earths; and the humid podsolized soils (fig. 2).

In the first group, the heavier gray and brown clays, with discontinuous lime or gypsum horizons, deposited in old alluvial or lacustrine plains, carry steppe or very lightly treed savanna and form as a rule very good grazing lands, as do the lighter brown soils. The mallee soils, associated with the stunted eucalypt

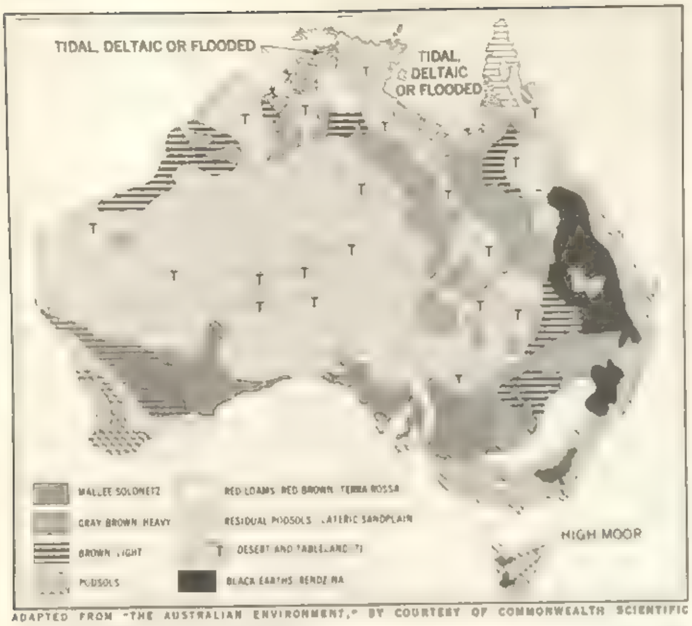


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FIG. 2.—MAJOR SOIL GROUPS IN AUSTRALIA

of that name, are highly calcareous and alkaline, generally sandy though with some clays; developed in areas with 17 in. of rain or less, they have been leached by saline waters and in the south have been much affected by wind action, which has produced long east-west sand ridges. The mallee soils have been largely reclaimed for wheat and sheep farming and are better than the much-leached acidic *solonets* soils of Western Australia. In detail, the soil pattern in the largest continuous area of agricultural importance, the Murray basin, is very complex, an important role being played by the "fossil levees" of a prior (Pleistocene) semi-deltaic river system.

The best soils of Australia are the subhumid: black earths, deep alkaline or neutral clays; *rendzinas*, alkaline light clays or loams: these are developed mainly on the downs of Queensland. The red-browns are formed in the 15- to 25-in. rainfall zone, under Mediterranean conditions (dry winter) in the south and monsoon conditions (dry summer) in the north; as a rule, leaching has concentrated soluble salts in an alkaline clay layer, above which is an acid loam; these are particularly valuable wheat lands. Also in this group are scattered red loams on basalt and terra rossa on limestone, the former being among the most fertile soils of the continent.

With more than 20 in. of rain, podsols and podsolized soils tend to be developed; textures (usually rather light) and structures are very variable. In some areas these are associated near the surface with ironstone or ironstone gravel, which are relics of former widespread laterization. The soils of this group usually carry sclerophyll eucalypt forest, breaking down to scrub or heath on the poorer lateritics. The more heavily leached podsols are not very acid but by and large the level of fertility in the whole of this group is low or very low.

There are relatively few areas of very fertile soil in Australia. In the southwest the soils are highly saline and in the southeast overirrigation or poor drainage can result in deleterious saline concentrations in mallee soils and even in the heavier brown and gray soils. Notable advances have been made in the improvement of Australian soils by the addition of trace minerals such as manganese, copper, cobalt, zinc, etc.

Deforestation and overgrazing produced serious soil erosion, by water or wind, particularly on the southern Eastern highlands (gullying), the mallee country (wind erosion under cultivation) and most of the Darling basin and the country north of the south Australian gulfs (wind erosion through overgrazing).

E. CLIMATE

The overwhelming importance of climate in Australian life is reflected in the speech of the people; the ordinary man talks of the amount of rain received during the season in points (a point is 0.01 in.) and knows how far it is above or below normal.

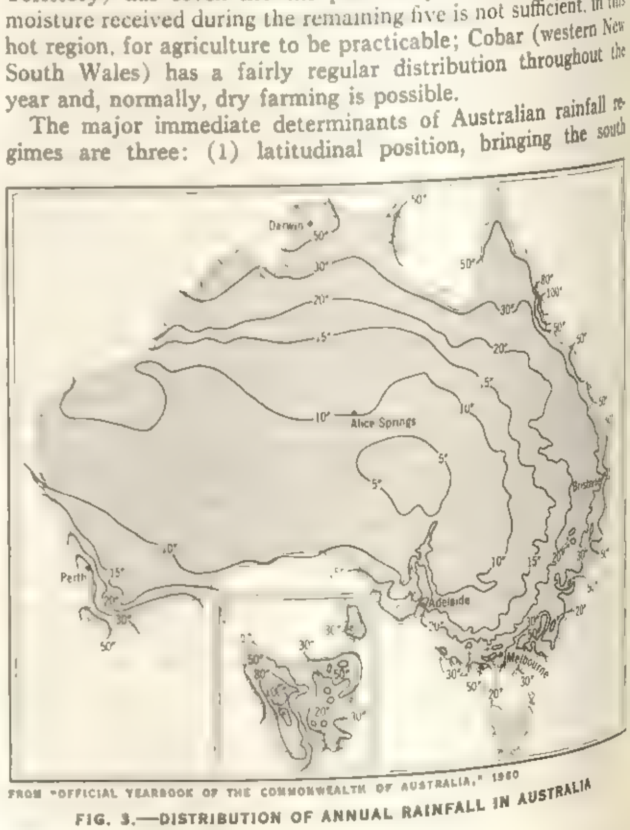
A compact land mass, mainly in trade-wind latitudes, Australia tends to have a continental climate. This tendency is to some extent masked by the fact that the great bulk of the population lives in areas accessible to much maritime influence. Temperature ranges are not indeed great—only in the interior, in a broad belt along the Tropic of Capricorn, are they more than 30° F.; but the seasonal change is enough to produce a monsoonal effect over the northern third of the continent. The northern coasts range from means of 75° F. in July to more than 85° in January, the south from 50°–55° to 65°–75°. The southern part of the Eastern highlands and much of Tasmania fall below 45° F. in July, and the winter there is too cold for continuous plant growth. Snow falls on the highlands as far north as Brisbane, but only very occasionally at altitudes below 2,000 ft.; only above 5,000 ft. or so is it at all common. South of 25° S. frosts may occur from June to August even on the lowlands, and some crop damage may be caused by spring frosts. The southwest and southeast of the mainland may indeed be compared to Mediterranean Europe.

A marked feature of spring and summer in the south is the succession of low-pressure troughs bringing first very hot, dry (often dust-laden) northerlies, called brickfielders, from the interior, followed by the cool and moist southerly winds, called busters, from the sea; the short but intense spells of heat can seriously injure young crops. North of the tropic, practically all the coastlands have at least six months with mean wet-bulb temperatures of more than 70° F., which is high enough to cause discomfort.

Fig. 3 shows how small a proportion of Australia can be called humid; actually only 11% of the area gets more than 40 in. of rain, while two-thirds has less than 20 in. Australia is easily the most arid of the continents.

The seasonal distribution of rain, however, is practically as significant as its amount. G. Taylor's comparison of four stations, each with an average of 15 in., brings this out. In Western Australia, Roebourne's average includes yearly totals as low as 0.13 in. and as high as 42 in.; Northam, in the southwest, has most of its rain during the winter months, and this concentration is enough for good wheat farming; Tennant Creek (Northern Territory) has seven months practically without rain, and the moisture received during the remaining five is not sufficient, in this hot region, for agriculture to be practicable; Cobar (western New South Wales) has a fairly regular distribution throughout the year and, normally, dry farming is possible.

The major immediate determinants of Australian rainfall regimes are three: (1) latitudinal position, bringing the south



FROM "OFFICIAL YEARBOOK OF THE COMMONWEALTH OF AUSTRALIA," 1960

FIG. 3.—DISTRIBUTION OF ANNUAL RAINFALL IN AUSTRALIA

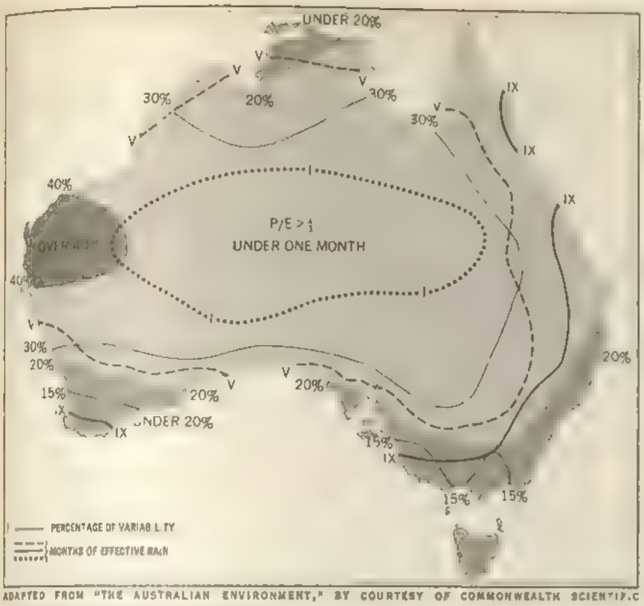


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FIG. 4.—VARIABILITY AND EFFECTIVENESS OF RAINFALL IN AUSTRALIA (*see* TEXT)

within the range of temperate westerly cyclones when the main planetary pressure belts swing north in winter; (2) the marked monsoonal effect, with high pressures dominating the north in the dry winter and a summer low pressure bringing rain; (3) the long coast exposed to the southeast trades blowing across open seas and bringing relatively high and regular rain to the Eastern highlands. "The climate [of the western two-thirds] is of the orthodox monsoonal type north from about 20° S. and is orthodox Mediterranean south from about 32° (or farther north near the Indian ocean), the intermediate desert zone lying too far away from the tracks of rain-bearing storms to benefit regularly either in summer or winter." (G. W. Leeper, *The Australian Environment* [1950].) It must be added that the northern coasts, though averaging more than 35 in., are subject to a dry season of up to nine months, which severely limits agricultural possibilities.

The east coast is generally well watered at all seasons. The highest rainfall of Australia, 179 in., is found at Tully (near Cairns), and only the extreme southeast corner, around Cape Howe, gets less than 40 in. Inland conditions are not so favourable: southeast Queensland and northeast New South Wales are reasonably humid for nearly all the year; but even in the wetter eastern half of the Murray basin (at least away from the highlands), though the distribution of rain throughout the year appears fairly regular when averaged, the summer rain is so unreliable as to be in practice ineffective.

Variability is indeed of supreme importance. Except for the winter rain areas of the south, Australia has a variability greater than the mean world variability and for much the greater part of the continent the deviation from the world figure is more than 10%. Fig. 4 shows variability by the mean deviation from the average expressed as a percentage of that average; it should be noted that roughly one year in five will have a rainfall departing from the average by the percentage given in any area *and below that average*. Variability shows a strong tendency to increase with a decrease in the total amount—an inverse correlation; another factor that adds greatly to the precariousness of agriculture in marginal regions.

This discussion may be summed up by considering the effectiveness of rainfall (*see* again fig. 4). Effectiveness for agriculture depends on the relation between the retention of moisture in the soil (P) and the loss by evaporation (E). On open water surfaces evaporation is greater than total rainfall everywhere except in the Eastern highlands; loss from the soil is much less, but this fact alone is clearly significant. Computation of effectiveness is becoming more refined every year, but the formula used on the map, which seems generally adequate for Australian conditions, considers effective rain to be that greater than one-third of evaporation from open water $\left(\frac{P}{E}>\frac{1}{3}\right)$, computed for each month. The five-month line is critical: with less than five months' effective rain, agriculture is practically ruled out except for some quick-growing crops in areas with a high water table (valley bottoms, etc.) in the tropical monsoon region. With more than nine months' rain, intensive dairying and agriculture are possible, except where winter cold or rugged terrain (or both) inhibit them. From all this it will be seen that only the southwest corner and the eastern fringe of Australia are really well favoured agriculturally, with a broader inner belt where conditions are more or less marginal and precarious. (O. H. K. S.)

F. Vegetation

Effects of Rainfall.—The vegetation of Australia is distributed generally according to the same pattern as the annual rainfall. Indeed, it may be said that varying aridity of the environment and moisture conditions of the soil are the dominating factors. Thus the water supply tends to increase from the interior coastward, with the rainfall contours and zones of vegetation roughly parallel to the periphery of the continent.

Only in the southern parts of southwestern Australia, in the Darwin area of the north and down the east coast from Cape York to Brisbane is there a vegetation approaching the tropical forest. In the southwest such forests are dominated by the giant gum trees, many of which attain an average height of more than 200 ft. In the warmer regions of the north, mixed forests with hoop and bunya pines, belonging to the same genus, *Araucaria*, as the monkey puzzle tree of South America, are important constituents. Many broad-leaved trees are also met in the rain forests of the extreme north. In a slightly lower rainfall area forests of *Eucalyptus* are characteristic, occupying a curved belt roughly in the zone where there is about 20 in. of rainfall or even less. As conditions become drier, toward the interior, there are areas where the characteristic vegetation is either the dwarf *Eucalyptus* scrub, known as mallee, or dwarf *Acacia* scrub, known as mulga. As the rainfall diminishes these scrub communities pass into characteristically more sparse desert vegetation. There, as a result of the high evaporation, the soil becomes saline and a saltbush type of vegetation develops in which species of *Atriplex, Kochia* and *Salicornia* are conspicuous features, while where the open community is sandy and less saline, tufted grasses with very sharply pointed leaves are characteristic; of these the most prevalent are species of porcupine grass (*Triodia* species) and cane grass (*Spinifex paradoxus*). The Nullarbor plain, so-called from the

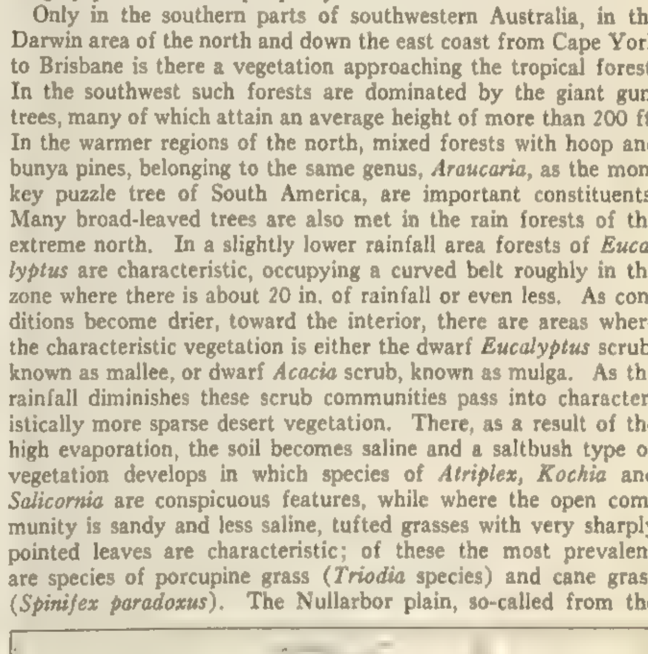

FIG. 5.—GENERAL FEATURES OF THE VEGETATION ZONES IN AUSTRALIA

absence of trees, constitutes the southern part of a stretch of desert that extends from the coast of the bight in the south, practically to the northwest coast near Port Hedland. This plain, in effect, isolates southwestern Australia which is bounded by the open sea toward the west and by the vast expanse of desert on the east. Corresponding with this environmental isolation the vegetation of southwestern Australia is exceedingly rich in endemic species.

Endemics and General Characteristics.—Australia as a whole, however, is characterized by the occurrence of many groups that do not occur elsewhere and by the marked preponderance of certain families and genera. The myrtle family (Myrtaceae) is one such. To this family belongs the genus *Eucalyptus* which is represented in Australia by probably more than 600 species ranging from the stunted mallee types of the arid interior to giant trees such as the so-called mountain ash *Eucalyptus regnans*, which is sometimes more than 300 ft. high. To the same family belong the endemic fringeflowers (*Verticordia*), the Geraldton waxflowers (*Chamaelaucium*), the brilliant bottle brushes (*Callistemon* species), *Melaleuca* and many others. *Eucalyptus* trees are evergreen with foliage that has a polished surface that looks rather dull in the brilliant sunshine of midday but glints in the low-angle sunlight of early morning and evening.

Other characteristic features of the Australian flora are the plants of the genus *Acacia*. Many different kinds are known throughout the continent; they range from bushes, which are thorny and quite small, to large trees. Nearly all the Australian species have leaflike structures that represent flattened leafstalks (phyllodes) and it is usually only in the juvenile foliage of their seedling stages that the pinnate leaflets are developed.

A visitor to Australia would also be struck by the grass trees belonging to the endemic genera *Xanthorrhoea* and *Kingia*; these have stems bearing a large tuft of grasslike leaves and in the former genus dark reed-macelike spikes of flowers. From the base of the old leaves a resin is produced which renders them peculiarly inflammable. There are a number of other characteristic families and genera (*e.g.*, Goodeniaceae, Dilleniaceae, Stylidiaceae and many Rutaceae).

Among the more interesting endemic trees of Australia may be mentioned the parasitic Christmas tree (*Nuytsia*), the bottle tree of Queensland (*Brachychiton rupestris*) and the coniferous *Phyllocladus rhomboidalis*, which forms dense forests in Tasmania and bears deciduous leaflike twigs, the leaves themselves being mere scales.

Most members of the flora are characterized by a thick, relatively impermeable cuticle, which serves as a marked check to loss of water. Although many of the Australian shrubs are thus particularly resistant to drought they are often difficult to cultivate and intolerant of root disturbance.

As a result of the aridity of the climate bush fires are frequent and the seeds of many species are not only fire-resistant but rarely germinate freely except after fire has passed over them; as a consequence, *Acacia* seedlings are often abundant after the first rains following a forest fire.

Regional Vegetation.—The vegetation of the southwest bears a striking resemblance to that of southwest Cape of Good Hope, but the large number of species of heath (*Erica*) that characterize the South African area is replaced in Australia by plants of similar habit belonging to the Epacridaceae. Again, the members of the family Proteaceae, a family that also occurs in Cape of Good Hope, are a striking feature of the southwest Australian flora but the place of the proteas in the South African vegetation is taken by species of *Banksia* and *Dryandra* in the Australian. There is evidence from fossil remains that the Proteaceae in Australia were more widespread in recent geological times than they are today. The members of this group have usually dense inflorescences and crowded small flowers in which the insertion of the four stamens on the tips of the perianth segments is a characteristic feature. Other important Australian genera of this group are *Grevillea* and *Hakea*. It is a family that illustrates to a marked degree the development by vegetation of mechanical resistance to water loss, the anatomical structure of the leaves being of such a character that it is extremely difficult for them to shrink. Indeed, after being exposed all day to the hot Australian sun they look little different from when first gathered. Another group common to Australia and the Cape of Good Hope is the rushlike Restionaceae. The remarkable *Cephalotus follicularis*, which feeds on insects and has pitcherlike leaves, is found in swamps of the southwest. The monotypic lycopod, *Phylloglossum drummondii*, occurs locally in damp sandy areas.

The drier parts of Australia are rich in terrestrial orchids while epiphytic orchids are found in the rain forests of the north and east. Among the terrestrial orchids, two of the most remarkable are subterranean saprophytic species belonging to the monotypic genera *Rhizanthella* and *Cryptanthemis*, both of which possess minute flowers crowded in daisylike heads, borne on a stout underground stem, which emerge at the surface before seed dispersal. In the drier parts, also, switch plants with a restricted leaf surface are common and a particularly striking example is seen in the she-oaks belonging to the genus *Casuarina*. In these the leaves are reduced to mere scales and the green twigs of the tree, which carry on the normal function of leaves, are strongly ribbed with the stomata restricted to and protected in the grooves.

The desert areas after the spring rains are often carpeted with sheets of annuals, especially the small everlastings belonging to the genus *Helipterum*, a particular species being frequently dominant over extensive areas. These and the other desert annuals germinate with remarkable rapidity and may pass through their entire life history within a few weeks. Since the rainfall when it occurs is frequently in the form of a few heavy storms, sometimes more than one season may elapse before conditions are again favourable for germination.

The coastal regions of western and southern Australia are often characterized by marked soil deficiencies, notably zinc, copper, cobalt and sometimes molybdenum. The cobalt is important in the nutrition of the ruminants and the other three trace elements are often the limiting factor in the growth of vegetation. Artificial replacement of these elements and the use of the introduced subterranean clover revolutionized the agriculture of these areas.

Particularly in parts where man has modified the natural vegetation, there is a great prevalence of introduced species, especially those from South Africa and the Mediterranean, some of which have become major pests. At one time the American prickly pear was spreading in Queensland at the rate of 1,000,000 ac. a year, but this was biologically controlled by the moth *Cactoblastis* (*see* NATURALIZATION, PLANT AND ANIMAL). In southern Australia the Mediterranean bugloss *Echium plantagineum* is significantly known as Patterson's curse, the poisonous South African iridaceous *Homeria* rendered many pastures toxic to cattle, while many citrus orchards display a yellow carpet of the South African soursob, *Oxalis pes-caprae*, which was originally introduced to Australia as a garden plant. (E. J. S.)

G. Animal Life

Because Australia is the most isolated of the continents, many forms of life, long since exterminated elsewhere, survive there. Among these are the world's only egg-laying mammals or monotremes (platypus and echidna), whose method of reproduction and whose certain other features directly link them with the reptiles. Australia has air-breathing lungfish (*Neoceratodus*), which are among the only survivors of a group that was widespread and prominent in the Devonian period. There is also an interesting primitive mountain shrimp (*Anaspides*). An example of animals that now have a very patchy distribution, including that in Australia, is the group of fresh-water tortoises known as the Chelidae. All Australian tortoises belong to this group, which occurs elsewhere only in New Guinea and South America, intermediate areas being occupied by other types that may, therefore, have secondarily replaced the chelids in those areas. A further consequence of Australia's isolation is seen in cases where only a single stock within a group has been able to colonize the continent and this stock has radiated out to fill all the available "niches," or ways of life. Apart from the well-known case of the marsupials, which represent an old group, this can be well seen in the snakes. Almost

all Australian snakes belong to the Elapidae, the front-fanged snakes, whereas elsewhere in the world this group takes second place to the fangless or rear-fanged Colubridae. An interesting side light here is that the elapids are believed by herpetologists to be derived from colubrids; if this is so it would mean that, in contrast with the situation in mammals, it was the progenitors of a relatively "advanced" type that was able to colonize Australia and undergo radiation, not the older ancestors themselves.

It is an oversimplification, but nevertheless helpful, to think of the animal life of the Australian continent at three levels: (1) the older forms that have remained relatively unchanged for considerable periods of time or that antedate the Tertiary, which is the period when Australia is believed to have become cut off from the rest of the world (estimated at 50,000,000 years)—the tortoises referred to above and many invertebrates can be placed in this category; (2) those forms of life that largely developed by radiation within the continent during the prolonged period of isolation—most of the marsupials fall into this category; and (3) the more recent arrivals that have colonized the continent by "island hopping" from Asia—rodents and bats are examples of this category.

Early History of the Animal Life.—The early history of plant and animal life on the Australian continent is vague and little known. Extensive invertebrate fossil beds occur extending back to the Cambrian, if not before. Fish faunas from the Silurian, Devonian and thence through to the Triassic occur in various places and have been analyzed. Labyrinthodonts from the Permian and Triassic are known, including a fine 11-ft.-long *Cyclotosaurus*. Ichthyosaur, plesiosaur, turtle and some dinosaur fossils are well developed in the extensive Cretaceous beds that outcrop over much of the interior of Queensland. The fossil reptile faunas of Australia have, however, not been the subject of extensive survey and study as have those of other continents. The oldest known fossil marsupial (*Wynyardia*) is Upper Miocene and both types of monotreme are known from the Pliocene in Australia. The rarity of good Tertiary fossil deposits has meant that little has been learned of the ancestral history and early stages in the radiation of the Australian marsupials.

As elsewhere, giant forms of animal life flourished in Australia during the Pleistocene. These included giant ratites, a varanid lizard that is estimated to have been 16 ft. long, and a series of large marsupials that included *Diprotodon*, a bulky vegetation feeder that resembled a rhinoceros in size, a kangaroo (*Palorchestes*) said to have been 10 ft. high and a marsupial cave "lion" (*Thylacoleo*).

At one time zoogeographers were much impressed by apparent direct relationships between the floras and faunas of Australia and South America (and to a lesser extent Africa), it being postulated that, in former geological times, there must have been a direct contact between these continents by way of Antarctica. The general tendency now, however, is to regard the southern continents as sanctuaries in which animal types that formerly had a world-wide range have been able to persist.

The Living Animals.—The land and fresh-water fauna of Australia today is made up of about 240 mammal species (119 marsupials and 2–3 monotremes, the rest placentals), 520 birds, about 380 reptiles, 112 frogs (but no urodeles), 180 fresh-water fish, 750 mollusks and perhaps 40,000–50,000 insects, as well as a reasonably rich fauna of crustacea, earthworms and other invertebrates. In keeping with Australia's being the smallest continent the gross number of animal species, however, is dwarfed by the larger land masses.

Mammals.—The marsupials, which compose almost half the fauna, are remarkable not only for the degree to which they have radiated in Australia but for the way in which the resultant ecological types have come to mimic, in shape and form, the corresponding but unrelated placental mammals occupying the other continents of the world. Thus there is a marsupial "wolf" (*Thylacinus*), a marsupial "mole" (*Notoryctes*), marsupial "cats" (*Dasyurus*) and a marsupial anteater (*Myrmecobius*). The kangaroolike animals (Macropodidae), which range in size from that of a hare to species in which the male may exceed six feet in height, are the browsing animals of the Australian countryside. The phalangers (Phalangeridae), only slightly less important than the macropodids, are tree dwellers living either on foliage, insects or nectar, or a combination of these. Some species have developed gliding membranes similar to those of the flying squirrels of the northern hemisphere and the "flying lemurs," or colugos, of Asia. There are many species of small marsupials that, superficially, are ratlike and shrewlike. The koala (*Phascolarctos*) is a highly specialized arboreal eucalyptus leaf feeder. The wombats (*Phascolomis*, etc.) are heavy-bodied, terrestrial, burrowing species that feed on grass.

Australia has a land and fresh-water placental mammal fauna that approximates, in number of species, that of the marsupials. All, however, are either bats or rodents, except for one dog. The ancestors of the first two obviously reached Australia by "island hopping," a form of colonization presenting little problem to the volant bats, with the rodents apparently using drifting logs. The dingo was introduced by aboriginal man as a camp dog, about 6,000 to 8,000 years ago.

Birds.—Included here are two large flightless birds (emu and cassowary), the lyrebird (*Menura*), well known for the mimicry, remarkable tail and elaborate dancing displays of the male, and the bowerbirds (Ptilonorhynchidae), most of which build play mounds. The honey eaters (Meliphagidae) have radiated into 67 species, and there are about 50 parrot species, ranging from small nectar feeders to large, heavy-bodied seed-eating and cone-eating cockatoos. There are numerous species of ducks, kingfishers, cuckoos, quail, flycatchers and warblerlike birds.

Reptiles and Amphibia.—Included in the reptile fauna are about 130 snake species, perhaps 240 different lizards, 13 fresh-water tortoises and 2 crocodiles. Though a high proportion of the snakes are venomous only a half-dozen species are dangerous to man.

The Australian frogs include a wide diversity of ecological types. An extreme adaptation to environment is seen in the desert water-holding frog, *Cyclorana platycephalus*. This species, with the drying out of the water holes it frequents, buries beneath the bed to a distance of a foot or more, distends its body with water so that it has a roundness suggestive of a tennis ball and, in a miniature chamber partly sealed by dried mucus, survives until the next rain. Alternatively the tiny black and yellow corroboree frog (*Pseudophryne corroboree*), living for the most part above the 5,000-ft. level, is able to survive beneath the snow for four to five months.

Invertebrates.—Most insect groups exhibit the effects of prolonged geographic isolation. Thus some groups of grasshoppers, leafhoppers, termites, ants and others have undergone a marked radiation in the manner of the marsupials, parrots and elapid snakes. Primitive species appear in many groups; *e.g.*, the termite *Mastotermes*, extinct elsewhere, survives in northern Australia as the world's most primitive termite. Likewise the rare ant *Nothomyrmecia* of the southwest of the continent is possibly the world's most primitive ant. In contrast with these cases, of course, the greater part of the insect fauna generally approximates that found elsewhere in the world. Among the invertebrates there is also the giant earthworm of Gippsland, Victoria, which at fullest extent measures ten feet or more.

Summary.—The mammalian fauna has suffered greatly from European settlement. The clearing of the forest and the hunting have had a direct effect. There has also been a general, and inadequately documented, indirect effect due to the ravages of the introduced rabbit and fox, and the widespread development of the pastoral industry. Over wide areas the rabbit and sheep have removed the ground cover so necessary to some of the smaller marsupials. The effect of this has been shown by a survey of the marsupials of New South Wales by B. Marlow in which it was disclosed that approximately 40% of the species has not been recorded since 1910. Some of these, of course, have never been common and others still occur farther afield. The survey has, however, indicated the perilous state of a sizable segment of the marsupial fauna. Fortunately, other animal groups are not so vulnerable. Probably not more than three bird species have become extinct since settlement.

Australia has become conscious of the need for national parks

during the 20th century, though the areas set aside for conservation vary greatly from state to state. The koala has been nurtured in special reserves and is building up in numbers in the wild in various parts of the range. The two unique egg-laying mammals, the platypus and echidna, are quite common. (A. K.)

II. THE PEOPLE

Until 1788 Australia was inhabited only by aborigines (*see* AUSTRALIAN ABORIGINES), numbering then about 350,000, though some estimates have put the figure as low as 150,000. Contact with white settlers resulted in their constant decrease until fewer than 40,000 full bloods remained by 1930. They are now increasing. There are also more than 39,000 aborigines of mixed blood (including those assimilated in the general community) and more than 5,000 Torres strait islanders. Apart from a very few mixed bloods, no Tasmanian aborigines remain. European settlement, begun in Jan. 1788 with just over 1,000 persons, reached 405,000 in 1850, 3,765,000 in 1900 and almost 7,000,000 in 1939.

According to the census of 1961, 10,418,761 were of European stock, 9,535,665 being British; 91.5% of the latter were Australian by birth. There were 9,984,709 persons of British nationality (allegiance). The non-British Europeans included roughly 454,000 of southern and central European birth and 347,000 from northern Europe. Persons of non-European stock, excluding aborigines and Torres strait islanders, numbered 36,608; *i.e.*,.35% of the total population (10,508,186). These included 20,382 Chinese; 4,195 from India, Pakistan and Ceylon; and 1,063 Malays. These figures reflect a large number of Asian students.

A vigorous immigration policy has been implemented since World War II. Persons arriving between Oct. 1945 and March 1964 and residing in Australia either permanently or for a long term numbered 2,090,175, including 280,930 refugees and 1,039,216 assisted immigrants. Of the total, 1,056,832 were British and 503,000 southern and central European (383,000 being Italians and Greeks). Of northern, non-British Europeans, the Dutch (134,555) were the most numerous. Births to immigrants (1945–64) were estimated at 3,740,760. Nearly half of the 933,343 non-British immigrants have been naturalized. Newspapers and journals in about a dozen languages are produced by and for the non-British immigrant groups. Some of these have formed their own separate clubs. There are also international clubs and good-neighbour councils that encourage assimilation. The language newspapers and "national" clubs do the same, as well as minister to the nostalgia that immigrants must feel in the transition period of settling in large numbers in a new country. The children, however, attend the general schools and become part of, and are accepted into, the Australian community. The newcomers, especially the cultured refugees of the periods before and after World War II, brought a quickened interest in the arts and new ideas about food; but it is doubtful whether they noticeably influenced Australian culture and life.

Just under 60% of Australians are concentrated in the heavily industrialized mainland state capitals and in the important industrial regions of Newcastle and Wollongong. The existence of vast semiarid and arid regions inland, and of the difficult, tropical and often rugged northern regions, retards intensive development of the continent, apart from a 200-mi. (320-km.)-wide strip on the east and southeast and on the southwest. Progress there depends on more scientific research. In the meantime, sparse, pastoral occupation of half the inland area is reasonably effective.

In addition to the European, aboriginal and very small Asian racial stocks in Australia, the populations of the territory of Papua and the trust territory of New Guinea (including the northern end of the Melanesian islands) must be considered. They are administered together. The population figures for these territories (1961) were 1,947,031 indigenous, 19,962 European and the rest, 5,368, Chinese, mixed-blood and others. The Chinese are mostly in the trust territory, where they have lived since before World War I.

The indigenous racial constitution is complex. A reasonable view is that Australoids occupied parts of the main island in their general movement south. Later came Papuasians, descended from the same main stock but with a fuzzy hair mutation. They mixed in some regions with the Australoids and also became differentiated into subgroups through the isolating nature of the environment and normal genetic processes; *e.g.*, the pygmy groups in the island are Papuan dwarfs. Finally, some Melanesians entered from the east.

Intensive research in physical anthropology has shown that the problem is even more complicated. It suggests that an early population occupied the coastal regions, north and south, but moved up to the highlands because of better conditions. They were especially marked by possessing the S gene in high frequency, but little or no M. A later immigrant wave, possessing little or no S but a moderate frequency of M, imposed itself on these, pushing them back and mixing with those who did not go. Later other people intruded sporadically, especially at the eastern end, causing different blood pictures. As a result of mixing and of normal variations over a long period, the highland peoples are now of a uniformly shorter stature than the coastal peoples and also have a greater frequency of light-coloured skins (near white) and different physical appearance. Further, there are distinct enclaves of peoples in some rugged regions who have not mixed to any appreciable extent with either the highland or coastal inhabitants. The Kukukuku are an example. Finally, by 1960 no light had been shed either on the problem of enclaves or on the racial relationships of New Guinea peoples to any peoples of Asia and Oceania so far studied. (*See* AUSTRALIAN LANGUAGES.)

(A. P. E.)

III. HISTORY

Early Beliefs.—The long delay in the discovery and settlement of Australia was caused by many factors—vastness of the Pacific ocean, ideas from antiquity of the impassability of the torrid zone, fears of being cast against the east or west coasts of Terra Australis by prevailing winds and lack of any sign that the land possessed anything worth having.

In the 13th century Marco Polo referred to a well-governed kingdom in the south which grew spices and drugs. This was taken to mean a land much south of the equator, but it seems that Marco Polo meant nothing farther south than Sumatra. The mistaken interpretation, however, influenced European geographers; they continued to refer to a southern continent, and monarchs and navigators continued to be interested in its discovery. There were Portuguese, Spanish and French voyages into the Pacific and Indian oceans and the waters around Indonesia in the 16th century. Some discoveries were made, but it seems that none of the very early voyagers into these regions actually saw Australia.

It was not until 1577 that the first expedition primarily designed to search for lands in the vicinity of Australia actually took place. The main interest was still in trade but there was also hope of obtaining gold and silver. This had arisen from claims made by the 1567 expedition of Alvaro de Mendaña de Neyra from Peru in respect to the discovery of the Solomons. Soon there were signs of activity in England. A group of men in Devon described a beautiful Terra Australis with civilized natives with whom favourable relations could be easily established and from whom large quantities of gold and silver could be obtained. Following upon this attractive and mostly imaginary picture, instructions were drafted in 1577 for Capt. Francis Drake to pass through the Strait of Magellan and to sail west to latitude 30°. He was expected to find new lands, establish headquarters for the sale of English cloth, and to obtain gold, silver, spices, drugs and other commodities. It seemed reasonable to assume that territory like that of the East Indies, containing many of the same products, would extend to the south and east. However, once he had entered the Pacific, Drake turned north to Peru instead of sailing west. His realism is believed to have led him to where he knew gold and silver was to be had for the taking, rather than to explore an unknown ocean in search of gains conjured up in fertile imaginations. Although Drake did not search for Terra Australis as instructed, the event shows a practical English interest in discovery in the Pacific and the reasons for it.

Discovery.—Spanish and Dutch voyages into the Pacific from the east continued. In 1605–06 Willem Jansz sailed close to the northern coast of Queensland but did not actually pass through the strait between it and New Guinea. He was probably the first European actually to reach the coast of Australia. Five months later Luis de Torres, in the one vessel left of an expedition sent by Philip III of Spain, sailed through Torres strait from the east and probably sighted the northern point of what is now Cape York. The impressions gained in these expeditions were of a desolate coast, inhabited by "wild, cruel, black savages" and promising no commercial advantage whatever.

Then began Dutch voyages from the west, but none of the navigators seemed willing to go far enough to reach the Australian coasts. From about 1610, several Dutch captains serving the East India company came into contact with the coast of west Australia on their voyages to the East Indies around the Cape of Good Hope. These contacts led the company to become interested in the lands to the south. In 1623 vessels from Amboina visited the coasts of the Gulf of Carpentaria but no reports likely to encourage further attention were made. In 1642 a Dutch expedition planned by Anton van Diemen, governor general of the East Indies, set out to investigate to the west and south of Australia.

This was the first expedition of Abel Janszoon Tasman, who was given instructions to seek a southern route along the westerly wind belt to Spanish South America. He left Batavia and sailed in the direction of Mauritius, then swept south and east with the westerly winds and eventually reached the western shore of Tasmania, naming it Van Diemen's Land. Tasman sailed on to the south of Tasmania but could give no indication of the extent or nature of land to the north. Continuing his eastward voyage he reached New Zealand in Dec. 1642. Passing to the north of the north island he came into the ocean swell from the east and was satisfied to conclude that there would be an uninterrupted ocean passage to South America. Tasman believed that New Zealand was a projecting part of Terra Australis, now believed to extend to the south of it. He then proceeded north, and finally west, to pass on the north side of New Guinea and return to Batavia. Tasman had completely circumnavigated Australia, as though this had been his intention, and had not actually proved a passage to South America. However, his general interpretation was correct.

In 1644 he set out again to try to sail south of New Guinea into the Pacific, and to discover if there was a sea passage between the land around the Gulf of Carpentaria and that known to be farther west. Tasman's report was that there was no Torres strait (the voyage of Torres was unknown to the Dutch), but he was correct in that his voyage westward revealed no sea passage south of New Guinea. Tasman's work brought to an end the phase of exploration associated with the Dutch East India company.

In 1688 William Dampier, one of a crew of pirating adventurers searching for plunder in the East Indies, visited west Australia "to see what the country could afford," but found it most unsuitable for his purposes. However, Dampier published an account of his visit which proved sufficient for the authorities in England to give him command of H.M.S. "Roebuck" to continue exploration of northern Australia. His voyage extended knowledge of New Guinea and New Britain, but did little for lands farther to the south except maintain interest.

There was little of importance in the 60 years that followed Dampier's visit, but the beginning of the second half of the 18th century showed both Britain and France to be interested in further developments. In addition to commercial motives, reasons connected with naval power, scientific discovery and missionary work produced this interest.

In 1768 James Cook was given instructions similar to those given to Drake in 1577. The admiralty was mainly responsible but the Royal society wanted to have astronomical observations made from Tahiti of the transit of Venus. Cook sailed around Cape Horn and reached Tahiti without encountering any land mass, then continued to New Zealand and so removed any doubt about the existence of a clear route from South America. Cook, who

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FIG. 6.—THE ROUTES OF CHIEF EXPLORERS AND EARLY NAVIGATORS OF AUSTRALIA

was a man of tenacity, skill and balance, went on although his contact with New Zealand probably satisfied his orders, and on April 20, 1770, became the first European to reach the east coast of Australia. Passing northward along the coast, Cook's voyage revealed country that Joseph Banks, the English explorer-naturalist, was able to report upon favourably for use and settlement. For the first time European navigators had seen that part of Australia that did appear suitable for settlement. Reaching the northern point of Queensland, after a hazardous journey, Cook took formal possession of eastern Australia on Aug. 23, 1770. Cook's second voyage in 1772 and his third in 1776 added a great deal to European knowledge of the Pacific and showed that successful voyages could be made from Europe.

Settlement.—In the later stages the main work of discovery of Australia had been done by Englishmen who took possession of it on behalf of the English crown. Settlement of Australia ensured that almost the only influences determining its character were British.

There has been some difference of opinion about the causes of the foundation of a settlement in Australia (*see* E. O'Brien, *The Foundation of Australia* [1936]). Opinion was divided as to whether the settlement was established "deliberately in order to relieve the overcrowding of the gaols," or whether the British government was founding not "a mere gaol but an industrial colony." Few people ever held the latter view without serious qualification.

The first suggestion for the establishment of a British colony in Australia was made before a committee of the house of commons in 1779 by Joseph Banks, who with Cook had seen Australia for himself. Transportation overseas of persons convicted of offenses against the law in England had been practised during the 17th and 18th centuries, but the Revolutionary War then being fought in the American colonies prevented further transportation there of convicted persons. The eventual victory of the American colonies, the continued practice of judges of sentencing convicted persons to transportation and the marked increase in offenses caused by the social upheavals of enclosure of land, obsolescence in several lines of manufacture and trade, and the sudden growth of towns in England made it certain that a new outlet for offenders had to be found. Banks believed that Australia was ideally suited for this purpose. It was so distant from any other civilized place that escape would be difficult; there was little chance of opposition from the natives; the climate was mild; the soil was capable of sustaining a large number of people; there were no beasts of prey; and there was an abundance of timber and fuel.

In addition to wanting a place to which convicts could be sent, the government thought it would have to provide a home for

American loyalists in difficulties resulting from their enemy's victory. But when the Pitt government came to office (1784) it was concerned only with the practical problem of getting rid of convicts. To solve the problem an order in council dated Dec. 6, 1786, appointed "the eastern coast of New South Wales or some of the islands adjacent" as the place to which offenders might be transported. Capt. Arthur Phillip of the Royal Navy was commissioned as the first governor. At this date Great Britain, under the belief that New South Wales might be separated from what the Dutch called New Holland, did not lay claim to all Australia, but just the eastern coast and all islands adjacent in the Pacific. The governor was to take the usual oaths of office; he was given power to pardon and reprieve offenders, to levy forces for the defense of the colony, to withstand pirates and rebels, enforce discipline, make land grants and to exercise general jurisdiction. The powers and duties of the governor made it clear that the British government intended the colony to be controlled as a jail and meant the governor, through his staff and "police," to employ directly most of the convicts and to keep their produce as a government stock. The possibilities of private land ownership and employment of convicts and others were always visible but it was clear that the British government considered that for many years the government in the colony would perform most of the administrative and directive work. It was clear also that the British government intended to devote the very minimum in money and materials to the settlement. Between his appointment and the departure of the first fleet for Botany bay nine months later on May 13, 1787, Phillip had persisted in efforts to obtain more stores and equipment for his expedition, so much so that it has been concluded that by the time it sailed the idea of founding a commercial settlement was very definitely afoot. It was, however, never much more than "in the air." The first fleet was very poorly equipped and the convicts and their guards arrived with very little with which to contend with the forests of New South Wales. Whatever had been the intention of the government in 1787, the outbreak of war with France in 1793 made it certain that little time and money would be devoted to a convict settlement on the other side of the world.

The Early Years.—Soon after arrival Phillip decided that Botany bay was unsuitable and moved his 11 vessels to Port Jackson. This harbour, which he described as the "finest in the world," became the scene of his settlement and of Australia's greatest city. There reached Sydney 736 convicts, of whom 188 were women. Guarded by 191 marines, under 19 officers, they reached a country accurately described as "forest-clad, unkempt, uncanny and unknown," and one on which Phillip reported: "No country offers less assistance to first settlers." Hardly had the fleet arrived when the marine guards, claiming that their duties did not extend beyond the voyage out, refused to act any longer. A special unit, the New South Wales corps, was enlisted in England to act as guards, or a police force, in the colony.

In the meantime Phillip had to do the best he could but found his community of convicts were as well behaved as most of the towns in England from which they had come. Expecting supplies and assistance, he was soon dismayed to see the second fleet—three ships—loaded not with provisions but with more convicts. It left England with 1,017 aboard; 267 died on the voyage and 486 of those who did arrive were sick. Of these, 50 died in the first month, and those "not classed as sick were hardly able to attend themselves." It was described as a "ghastly company of sick and dying. . . . Great numbers were slung over the ships side in the same manner as they would sling a cask." However, Phillip showed an energetic devotion to the growth of the settlement, which was in part shared by many of these poor, cruelly treated people, and he felt very soon able to report a belief that "This country will prove the most valuable acquisition Great Britain ever made." But other officers of the colony were of a different opinion, seeing at first no future in the colony for themselves and then no future in it for anyone but themselves. Some obstructed the governor in his work, as well as encouraging the British government to do nothing to change a policy of neglect.

During Phillip's time there was therefore revealed a political separation of interests—on the one side capable, energetic free men with privilege and money anxious to obtain control of convict labour on slave conditions and of all commercial activities; and on the other a government with a considerable measure of responsibility to see to the employment and rehabilitation of the convicts.

Houses and public buildings were erected of timber and, when bricklayers were discovered among the convicts, of bricks. Phillip led exploration of the colony, and settlements were established at Parramatta, on the Hawkesbury river and at Norfolk Island. Almost immediately grants of land were made to men who had arrived free, and convict labour was provided for its working. By 1791 more land was in use under government direction than private, but by that year 150 persons were in possession of farms. Cultivation had been attempted on all farms, but crops were poor, for hardly any rain fell in the year before Phillip's departure from the colony. By the middle of 1790 only 38 convicts had been assigned to private employment and care was being taken to see they were properly employed and treated. By 1792 the settlement was producing its requirements in several types of manufactured goods.

Failing health compelled Phillip to relinquish his command, but by his departure in 1792 the settlement had progressed sufficiently far to allow it to be said that by that date the foundation of Australia had been achieved. Phillip was able to report: "The colony is approaching to that State in which I have so long and anxiously wished to see it." Further, he felt confident that "Time will remove all difficulties." While the achievement had been remarkable, there were great difficulties ahead, but never was there any doubt of importance that the settlement would survive.

Exploration, 1796–1845.—Australia was explored both by land and sea. George Bass and Matthew Flinders in 1796 explored much of the coasts of New South Wales in small whaleboats, and in 1798 Bass made a long and successful voyage in his small whaleboat around the east and south coasts of the colony proving the existence of a strait between the mainland and Tasmania (*see* fig. 6).

Until 1813 nothing was known of New South Wales beyond a coastal strip about 150 mi. long and no more than 50 mi. wide. The colony was shut in much more by the Blue mountains on the west than by the sea on the east. In 1813 Gregory Blaxland, William Lawson and W. C. Wentworth penetrated through this canyoned plateau, almost as deep as it is high, on a journey that marked the beginning of the occupation of the interior, as well as the beginning of the problems of its more extensive exploration. Soon it would be no longer any easier to confine the graziers to the boundaries of settlement than "to confine the Arabs of the desert within a circle drawn on the sands." From the bases established beyond the mountains a few small expeditions went farther and discovered rivers flowing west and southwest. The nature of the country farther to the west was not, however, to be revealed for a good many years.

In the meantime land to the north and the south of the main centre of settlement was explored. John Oxley, G. V. Evans and Allan Cunningham went north, and Hamilton Hume and William Hovell and Thomas Mitchell went south. The northern explorers discovered great tracts of land suitable for settlement, and in 1823 Oxley traveled nearly 700 mi. N. of Sydney, discovering on the journey the Brisbane river which was to become the site of the capital of the northern state of Australia. In 1824 Hume and Hovell began what was to prove the most important journey since the Blue mountains were first crossed. They traveled southwest to reach first the Murrumbidgee river, then Australia's greatest river—the Murray, as it was later named—and then to cross the full width of what was to become the state of Victoria. This expedition revealed not only great possibilities for the extension of settlement in New South Wales but even greater possibilities farther to the south. At about the same time, Cunningham carried out more exploration in the southern part of Queensland.

Concerned with the problem of the large rivers flowing west Gov. Sir Ralph Darling sent out Charles Sturt in 1828 to try to discover their course and destination. Sturt traveled more than

300 mi. to the west to reach a large river which he called the Darling. The problem still remained unsolved. In 1831 Sturt traveled down the Murrumbidgee river and into the Murray. This journey of nearly 2,000 mi. proved the Murray to be the centre of a northern network of rivers, but still there were rivers farther to the north that flowed out to the west; perhaps they flowed toward some inland sea, perhaps they came to an end in dry, shingly beds. In 1836 Thomas Mitchell traced the Darling river southward to the Murray, and then continued south across the western end of Victoria to reach the coast at Portland, where he discovered a settlement already established. The Hentys, who were there, had traveled by sea from Tasmania. Mitchell continued from Portland diagonally across Victoria on his return to Sydney. The expedition demonstrated not only the extent of land available for settlement but also its fertility and accessibility. However, in 1840–41 the great efforts of Edward John Eyre in exploring land to the north and west of Adelaide were unrewarded by such discoveries. His journey toward the centre of Australia revealed dry salt pans instead of an inland sea, and that along the coast of the Great Australian bight again revealed land totally unsuited for use of any description. In 1845 Charles Sturt added greatly to the knowledge of the area toward the centre but he found nothing to justify any optimism about it. Later journeys toward the centre did witness the rare sight of Lake Eyre full of water.

Later Exploration.—Exploration of northern Queensland continued about the same time. In 1844 Ludwig Leichhardt traveled through the swamps, forests and grassy plains extending around the Gulf of Carpentaria in an expedition of 19 months' duration. This journey caught the imagination of the colonists and produced great enthusiasm for the extension of settlement. In 1848 Leichhardt attempted the hazardous crossing of the continent from east to west but he was never heard of again.

Ten years later the main interest concentrated upon crossing the continent from south to north. In 1860 John McDouall Stuart set out in an attempt to win £10,000 offered by the government of South Australia to the man who first made this journey. Stuart successfully reached the centre of Australia, but soon afterward had to abandon his journey. The following year he again failed at much the same latitude.

About the same time the Victorian government and public provided funds for a similar expedition to travel from Melbourne to the Gulf of Carpentaria. Equipped at a cost of £12,000 this expedition set out in 1860. It had been planned to establish bases, and those sections that were able to move more rapidly were to go on ahead and prepare for those bringing the more bulky supplies. Having reached the Barcoo, Robert O'Hara Burke, the headstrong leader, impatient of the arrival of others of his party, decided to make the rest of the journey to the gulf with only three companions, William John Wills, John King and George Grey. These four men actually succeeded in reaching the sound of the sea, but were unable to penetrate the swamps and jungle scrub. On the way back, Grey died of exhaustion. When the others returned to the base at the Barcoo the camp was deserted. The rest of the party, instructed to remain three months, waited just over four, but had left the very morning of the day Burke, Wills and King staggered in. They were able to find food, deposited in a marked spot, which would have been sufficient to get them to the nearest town, but Burke decided to make for Adelaide. After traveling many miles Wills was left with a supply of food and water, while the other two, better able to travel, went in search of a native camp. Two days later Burke died of sheer exhaustion. King returned to the place where Wills had been left and found him dead. He struggled on until he found a native camp and remained three months with the natives, until eventually he was found by a search party. This ill-fated expedition of Burke and Wills demonstrates just how tremendous a task the exploration, let alone settlement and development, of Australia was.

In 1862 Stuart further extended knowledge of the territory north of Adelaide by traveling well beyond the most northerly point he had reached the year before. He continued through Arnhem Land, along a river he believed to be the Adelaide but later claimed to be the Mary (a large river farther to the east), and to the shores of the Indian ocean. In 1874 explorations based at Perth in west Australia began: John Forrest traveled north and then made a wide sweep toward the centre of Australia. In the same year Ernest Giles traveled from Adelaide to Perth across the northern part of the Nullarbor plain and then, leaving Perth, turned north for 600 mi., finally crossing the central Australian desert in an easterly direction. The expeditions from Adelaide and Perth during the 15 years before 1875 proved a large part of Australia to be unsuitable for settlement.

By 1875 all the main geographical features of Australia were known. However, a good deal of exploration of Western Australia, Queensland and the Northern Territory was carried out after 1875—indeed there was still room for a good deal more in the second half of the 20th century. These later explorations were usually searches for minerals or for greater knowledge of the aboriginal natives. While it is true that very little of Australia remained unexplored at mid-20th century there was still a great deal of Australia about which very little was known. The demand for uranium, for example, gave new interest and value to parts of Australia previously regarded as useless.

The New South Wales Corps.—When Governor Phillip departed in 1792, the senior officers of the New South Wales corps took over control. Probably no less than 16,000 ac. of land were granted between Phillip's departure and the arrival of Gov. John Hunter in 1795. The small group of corps officers and their friends possessed a great advantage in trade—few others received income in currency that was acceptable by those who shipped goods to the colony. What is more they possessed powers to apply the law or not to apply it, even if not the actual power to say what the law was. Acquisition of land, of advantages in trade and of favour at the hands of "the law" ensured that they would become a wealthy and powerful group.

Hunter's main problems continued to be those of making the colony survive—the employment of convicts and emancipists (convicts who had served out their sentences) and the production of food and other necessities; but it was soon apparent that the activities of the New South Wales corps, particularly the officers, represented a serious difficulty. The governor endeavoured to apply the policy laid down by the British government, with the aid of men whose interests were that it should not prevail. The substance of this political conflict was economic interest. The officers and their associates desired to have convicts assigned to them for employment at their own terms and to dispose of their products at the best prices obtainable. They desired to buy, or otherwise acquire, goods at prices most favourable to themselves and enter directly into the disposal of them. They desired nothing less than a monopoly of the import trade, particularly that in rum. The early governors, on the other hand, proceeded to employ many convicts on government land, to take their produce into government stores and to dispose of it at prices determined by considerations other than making the most profit. Goods were also imported by the government and sold from its own stores. This practice had arisen because at first there had been no other way and then because of the existence of men able to exercise monopoly powers.

The acquisition and disposal of rum, in particular, became a problem. It became the customary currency, the normal means of paying wages, and its possession depended either upon having silver and gold money which shippers would accept or upon distilling it unlawfully. This "exchange economy based on tyranny and rum," which on balance was most harmful to the small community and its future, produced also the kind of initiative and ambition that gave Australia, in its very early years, the sheep industry upon which all its future prosperity was to depend. John Macarthur, the pioneer of the wool industry, was not only the personification of all that had produced so much evil and so much good but he was the man whose egotism and drive was directly responsible for so much of it.

While the colony in its first decade was growing in population (only a trickle of it was free), in land under cultivation, in output and range of goods, in the number of buildings erected and the

extension of settlement, difficulties with the group led by the corps officers grew also. Hunter returned to England in 1800 exhausted by his labours. Uprisings by Irish and other convicts early in the 19th century were perhaps more dramatic but far less significant than the acquisition of power by the corps. P. G. King, Hunter's successor as governor, a man of strong character and fiery temperament, believed he could do better. However, despite his orders and his indignation, the balance of political, social and economic power continued to move in the direction of the corps officers. Conditions of life and employment of convicts and emancipists—well over 90% of the community—did not improve during King's term of office, but the colony made progress. The conflict of governor and corps officers came to a head in King's time with a duel between Macarthur and his own senior officer, William Paterson, who was carrying out the governor's orders. The opposition led by Macarthur was not completely successful and Macarthur himself was sent to England to face court-martial. King, however, was left in a weakened position and was soon recalled. Macarthur, in England, took the opportunity to resign from the corps and to develop his plans for land and sheep farming in Australia.

Sharpening of the Conflict.—The appointment in 1805 of William Bligh (famous for the "Bounty" mutiny) as governor of the colony made a sharpening of the conflict inevitable. Bligh knew what his instructions meant and he determined to carry them out. The general lines of British government policy remained the same throughout the years 1788–1821, and Bligh proceeded to give effect to it. His defeat at the hands of the New South Wales corps merely meant that the British government realized that its governors could not work without power independent of the dominant colonial pressure group; and, under Macquarie, the policy the corps sought to defeat triumphed. Issues that led to an insurrection by the New South Wales corps centred in matters of trade, particularly illicit dealings in rum, and in the acquisition of land rather than in anything relating to wool growing or the affairs of the pastoralists. Bligh's policy was recognized by the "little men" to be in their interests, but the power of the corps officers in effecting Macarthur's aims was too great.

Following Bligh's arrest in Government house and his detention, the main activity of the military government was that of granting land, strengthening its own position and clipping the wings of its competitors. The employment of convicts became little better than slavery and the retention of a society permanently divided into free and unfree seemed certain.

Macquarie.—The success of the New South Wales corps and Macarthur was their undoing. Orders were given for the corps's removal to England and Macarthur, too, left the scene of his conquests for some time. Lachlan Macquarie was appointed governor with the power to bring his own regiment to the colony. With this power to enforce his own decisions, Macquarie arrived to find the select group, "pure merinos" as they were later to be called, in a dominant economic and social position. Macquarie has often been described as a despot, and no doubt a despot he was to those people who desired to see a colony of great inequality between free and unfree, rich and poor. His policy increased the prospects of emancipation for convicts and their chances of gaining status and of becoming small farmers in their own right. He caused public buildings and roads to be constructed, established a bank, encouraged exploration and the pastoral industry and introduced currency to take the place of rum. He redressed the balance of social and economic power over a period of ten years and, as during these years it became certain that no section of the community would ever succeed in completely dominating all others, production and settlement increased and extended. No doubt there would have been more economic progress in certain fields if sectional initiative, if not ruthlessness, had been given its head, and by 1817 there was room for a change in policy in certain directions. Complaints uttered about Macquarie's administration led to the appointment in that year of Commissioner J. T. Bigge to investigate. The British objected strongly to the amount of Macquarie's public works expenditure, and some influential persons in England and Australia desired the emancipists to be given less and the big landowners more scope. This conjunction of interests resulted in the termination of Macquarie's period of office in 1821.

It could now be truly said that Australia was established on a firm economic foundation and in a manner that would not allow any great disparities to develop between groups of its people. Both Macarthur and Macquarie deserve credit for this situation, the first for vigour and personal ambition and an interest that served the colony well, and the second for holding a proper balance within the colony itself and for determining to give it the public facilities essential if it was to function.

Growth of Self-Government.—Sir Thomas Brisbane, who succeeded Macquarie for four years, permitted the colony to put forth its economic, social and political strength. It was not until near the end of Brisbane's term of office that new lines of policy were applied. In the early 1820s there were demands for a more liberal form of government and for more power to be centred in New South Wales rather than in the British government and exercised by governors. The other aims of the time were for more land to be secured in large lots and for more labour to be available at lower wages. In 1823 an act, based on Bigge's report, established a small council of persons to be appointed in New South Wales to advise the governor on the passage of laws and imposition of taxes for local purposes. It also provided a jury of military officers.

Sir Ralph Darling succeeded Brisbane in 1825 and he immediately strengthened the hand of the large landowners and those who desired to limit the powers of government. He reported in 1830 of the "humiliating condition of my few radical opponents who are in fact driven from society." This was not the case, but during Darling's term of office land grants took place on a colossal scale. In 1828 alone 91 new grants were made, totaling about 150,000 ac.; 30 were of 2,560 ac. each. At the same time it was decided that no grant of less than 320 ac. was to be made and a grant of land to a Sydney bootmaker was refused because it was "not the policy of the government to make grants to tradesmen or those without capital." Capital was required for speedy development and it was believed that this policy would encourage people with capital to come from England to the colony. It had some measure of success and the foundations were laid for a marked development of the pastoral industry in the 1830s.

Darling was followed by Sir Richard Bourke, a man of more liberal mind and more generosity to tradesmen and those without capital. However, by 1835 those who were politically of significance did not differ much in what they wanted. Not only was expansion taking place but the population was increasing as a result of the schemes of assisted migration that had been adopted. The emancipist leaders and many of the native-born had become rich, the emancipists had been able to break down many of the social barriers and many within these groups began to approximate to the "exclusives" in their aims. Bourke reported at the end of his term that ". . . there would soon be an irresistible demand for a Representative assembly unless some sensible concessions were made." Not only was a more representative government wanted but a more responsible one was wanted also. In the latter part of the 1830s there was a strong demand for a transfer of power from the British government to the colony, but there was no strong demand for anything like a fully representative government. Those with influence wanted a restricted property franchise but no power given to the government to upset the social pattern. Legislation passed in England in 1842 answered these requirements. The new council was to consist of 36 members, 12 to be appointed by the queen and 24 to be elected on a property franchise. The council acquired control of all revenue other than that required for the governor's household, but the control of land sales and the revenue therefrom remained in England.

The end of the 1830s, a decade of expansion and prosperity, saw a severe depression. Free and assisted immigration had been a disappointment; although land had been made available, labour was scarcer and dearer than employers desired. The first serious financial crisis that came in 1841 depressed activity for two years and

Sydney, capital of New South Wales, showing the Sydney bridge spanning the harbour from Dawes point to Milson's point. Situated in the Sydney basin, the city lies on the shores of Port Jackson. North Sydney is in the foreground

City hall of Brisbane, capital of Queensland. The city is on the Brisbane river

Franklin square, a park in Hobart, capital of Tasmania, at the foot of Mt. Wellington on the Derwent river

Government buildings at Canberra, national capital of the Commonwealth, in the Australian Capital Territory. The Parliament building is in the centre

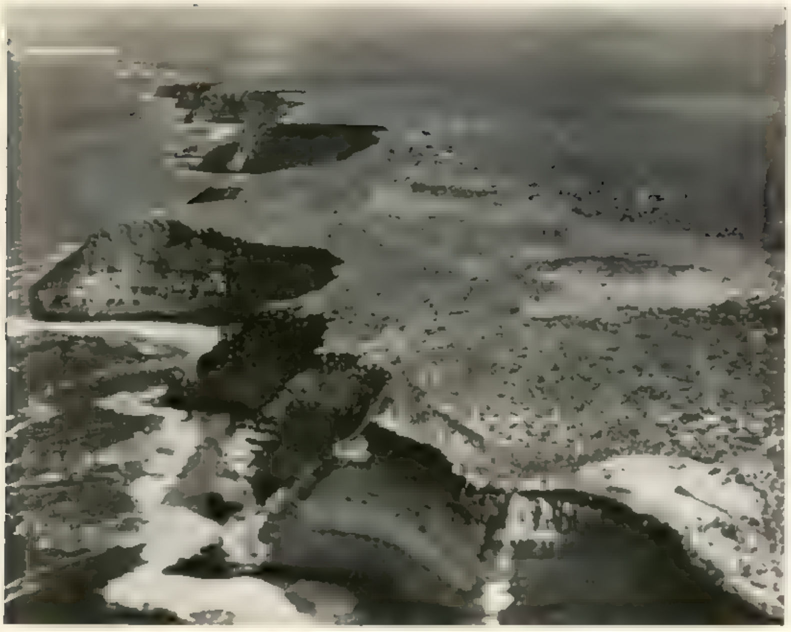
Perth, capital of Western Australia, seen from King's park. Perth lies on the banks of the Swan river

Melbourne, capital of Victoria, on the Yarra river along the northern shores of Port Phillip bay

PRINCIPAL CITIES OF AUSTRALIA

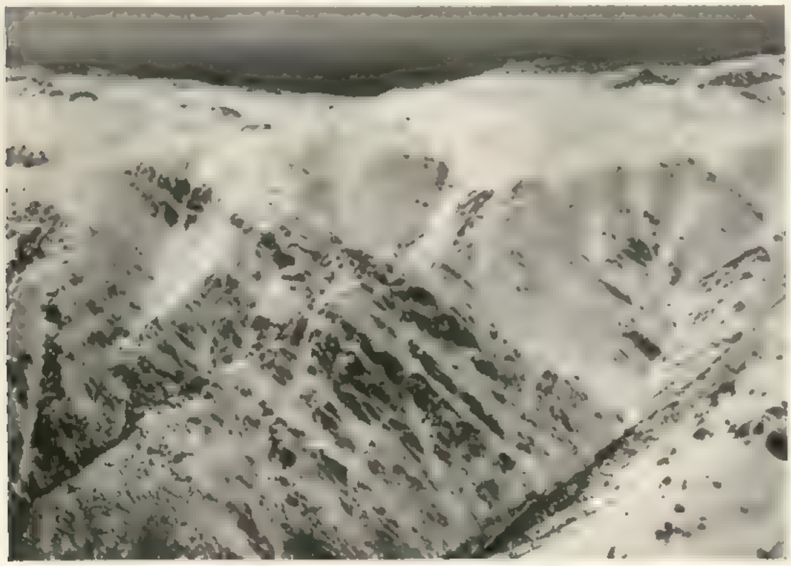
BY COURTESY OF (TOP LEFT) AUSTRALIAN NATIONAL TRAVEL ASSOCIATION, (TOP RIGHT) BRISBANE CITY COUNCIL DEPT. OF WORKS, (CENTRE LEFT AND RIGHT, BOTTOM LEFT) AUSTRALIAN NEWS AND INFORMATION BUREAU; PHOTOGRAPH, (BOTTOM RIGHT) AUTHENTICATED NEWS

AUSTRALIA



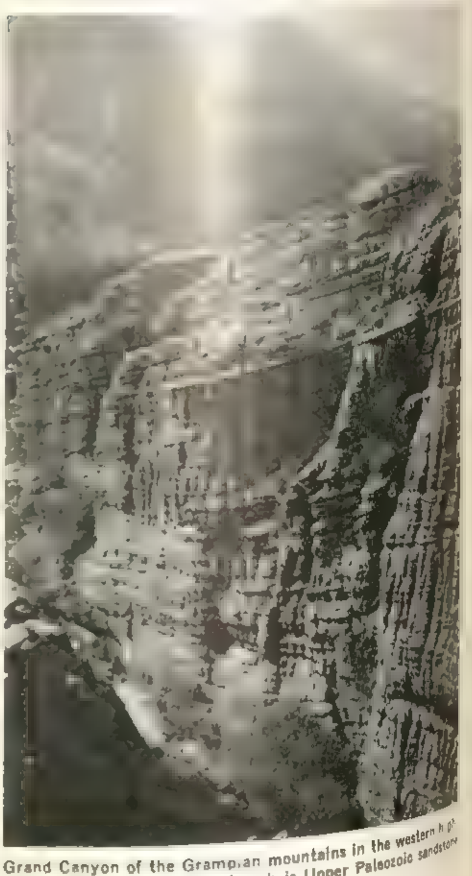
Waves cutting into the steep cliffs which form the coast of the Eyre peninsula at Anxious bay, South Australia

Forest of karri trees (*Eucalyptus diversicolor*) near Pemberton, in the extreme southwest of Western Australia. There are more than 600 species of *Eucalyptus* native to Australia



Mt. Kosciusko, in the Eastern highlands of New South Wales. Australia was unaffected by the Tertiary period folding which produced most of the world's highest mountains. Kosciusko, at an altitude of 7,316 ft., is the highest peak of the continent

Aborigine hunters standing on the edge of the Rawlinson ranges overlooking the plains of the Gibson desert in Western Australia. Broad flat plains and plateaus are the characteristic features of the Australian landscape

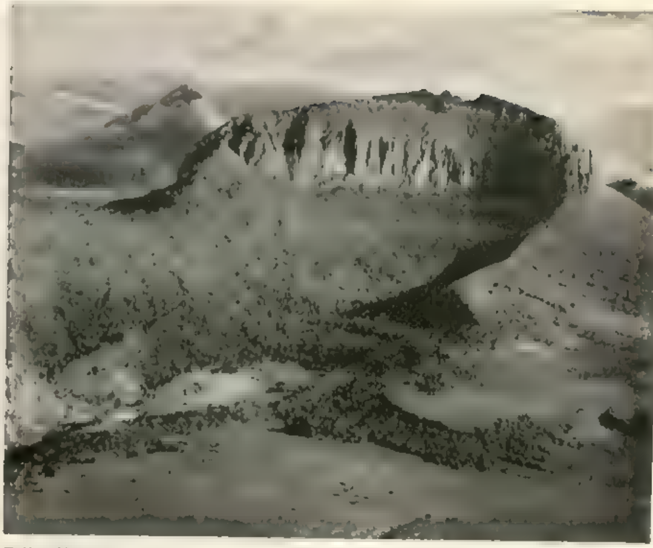


Grand Canyon of the Grampian mountains in the western highlands of Victoria. Exposed rock is Upper Paleozoic sandstone

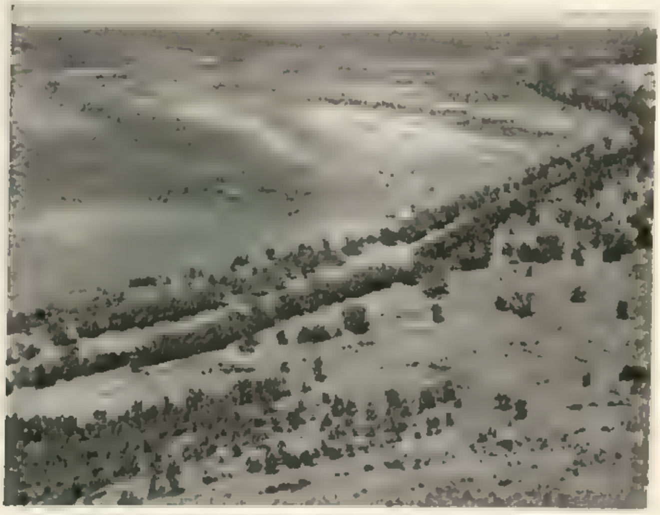
PHYSICAL FEATURES OF AUSTRALIA

BY COURTESY OF (TOP LEFT, CENTRE LEFT) AUSTRALIAN NATIONAL TRAVEL ASSOCIATION, (TOP RIGHT) WESTERN AUSTRALIA TOURIST AND PUBLICITY BUREAU, (BOTTOM RIGHT) AUSTRALIAN NEWS AND INFORMATION BUREAU; PHOTOGRAPH, (BOTTOM LEFT) AUTHENTICATED NEWS

Cascade in the Morialta Falls reserve situated in a gorge of the Mt. Lofty-Flinders ranges, South Australia

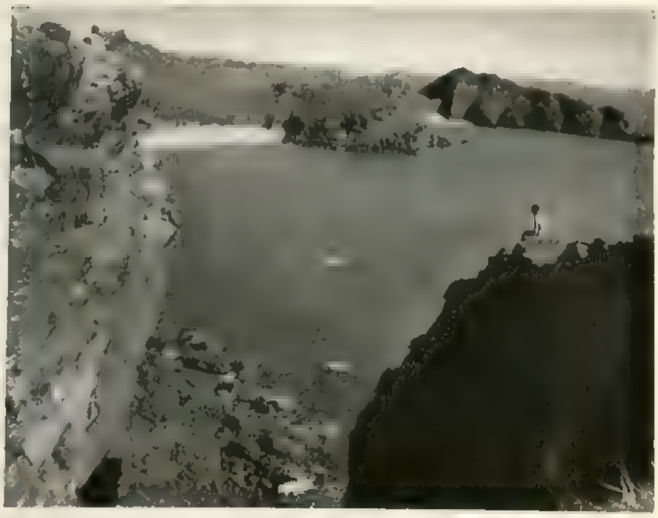


Pelion West, a dolerite residual, sculptured by glacial action, on the great central plateau of Tasmania



Homestead in the Hamilton river region near the border of the Northern Territory and South Australia. Scrub acacias are the principal vegetation on the sandy soils of this broad flat plain, with gallery forest along the often dry river courses

Great Palm island, one of the habitable sections of the Great Barrier reef, the largest coral reef in the world, stretching for more than 1,100 mi. along the northeast coast of Queensland



View of Yampi sound, on the northern coast of Western Australia, from the rugged sandstone and basalt rocks which surround it

ASPECTS OF THE AUSTRALIAN LANDSCAPE

BY COURTESY OF (TOP LEFT) SOUTH AUSTRALIA PUBLICITY & TOURIST BUREAU, (TOP RIGHT CENTRE RIGHT) AUSTRALIAN NATIONAL TRAVEL ASSOCIATION, (BOTTOM LEFT) AUSTRALIAN NEWS AND INFORMATION BUREAU, (BOTTOM RIGHT) WESTERN AUSTRALIA TOURIST & PUBLICITY BUREAU

AUSTRALIA

Hume reservoir on the Murray river between New South Wales and Victoria. The largest in Australia, the Murray-Darling system supplies water to 90% of the land under irrigation

Flock of merino sheep ne[illegible]rra, Australian Capital Territory. Australia supplies about 7[illegible] the merino wool sold on the world market

Cattle crossing the Macintyre river, Queensland. Contributing more than a third of the output of beef and veal, Queensland is Australia's leading cattle-producing state

Harvesting wheat in Morph[illegible]e, South Australia. Wheat is a primary agricultural comm[illegible] that contributes to the support of the sheep industry

Whaling station in Western Australia. Re-established after World War II, whaling has grown into an important enterprise in Australia

Industrial complex operated by the Broken Hill Proprietary Ltd. at Newcastle, New South Wales. It is here that the majority of Australia's pig iron and ingot steel are produced and the bulk of rolled metal products manufactured

AGRICULTURE AND INDUSTRY IN AUSTRALIA

BY COURTESY OF (TOP LEFT, CENTRE LEFT) AUSTRALIAN NATIONAL TRAVEL ASSOCIATION, (TOP RIGHT, BOTTOM RIGHT) AUSTRALIAN NEWS AND INFORMATION BUREAU, (CENTRE RIGHT) SOUTH AUSTRALIAN GOVERNMENT, PUBLICITY & TOURIST BUREAU, (BOTTOM LEFT) WESTERN AUSTRALIA TOURIST AND PUBLICITY BUREAU

although there was a slight improvement after that, the whole of the 1840s was a period of very slow growth.

Land Policy and Transportation.—Upon his arrival in 1838 the governor, George Gipps, soon became aware of his most serious problem—on the one hand to do justice to those who had obtained use of large areas of land under licence for grazing their sheep, and on the other "to hold land as a trustee for the population of the future." The first six years of the 1840s were full of the events of economic depression and the conflict of Governor Gipps and the "squatters" (sheep owners). Sheep were boiled down for tallow because wool and meat would not sell. Unemployment was widespread and there was a great deal of discontent in the towns. Gipps endeavoured to balance his obligations but he, too, was denounced as a despot.

Wage earners, small farmers and shopkeepers all supported Benjamin Boyd, W. C. Wentworth and the Macarthurs in their demands, first, for colonial control of land policy, and second, for the grant of a title or security to the squatters. Many people in this alignment against the governor had nothing to gain and much to lose from the success of these aims. Squatters and large landowners did gain much, but much was held for posterity and there was no change at this point in the control of land policy.

The year 1847 brought evidence that economic conditions had changed for the better, and brought too a new issue in colonial politics. Transportation of criminals from England to New South Wales had come to an end in 1840. In 1846 the colonial secretary, W. E. Gladstone, pointed out that the reintroduction of transportation was a matter for the colony alone, but her majesty's government "were disposed to doubt whether the absolute exclusion of transported convicts from New South Wales should continue." Henry Parkes believed that in 1847 the reintroduction of "the transportation of British convicts to the colony was assuming irresistible importance." Decisions in the legislative council were sometimes against, sometimes for it, and in all this it became evident that wage earners, shopkeepers and town dwellers were opposed to transportation while the squatters or graziers favoured it. On the strength of a council decision in favour, the British government sent out a ship full of convicts. The "Hashemy" arrived in Melbourne in 1849 and public protests against the landing of the passengers caused the authorities to move the ship on to Sydney. There the public protest was even greater and the "Hashemy" moved on to Brisbane where the convicts were landed. Antitransportation leagues were formed and great public agitation led to a slight change in the composition of the legislative council. In Aug. 1849 a resolution was passed "that no more convicts ought under any circumstances be sent to any part of the colony."

Political Development.—These contests over land policy and transportation were of great importance in the political development of the colony. They had a great deal more influence on the growth of democracy there than the people who regard the effects of gold discoveries as of primary importance in this respect have been disposed to represent. New South Wales proceeded a long way toward democratic or representative government, if not responsible government, in the 1840s. However, both representation and responsibility had to await the discovery of gold for fuller realization. Gold in 1851 changed a pattern of trade and rural depression and slow desultory growth in population into one of fantastic expansion. But by 1850 New South Wales and the Port Phillip district were politically if not economically ripe for such events. Responsible government particularly was seen to depend upon the colony's producing a sufficient level of wealth to allow its costs to be met within the colony. Gold allowed certainty to take the place of doubt in respect to this. But it was clear even before 1850 that the British government considered that how far the colony's government should be representative or democratic was a matter mainly for the people who lived there.

In 1850 the Australian Colonies Government act was passed in England. It separated Victoria from New South Wales and the franchise for the colonial parliaments was made a little more representative, but the government in England was not willing to transfer control of land policy and revenue from land sales to the colonies. But in 1852 the British government pointed out that the discovery of gold had "thus advanced the people in wealth and prosperity" and it was decided that complete control of land could be transferred to the colonies after certain constitutional changes had been effected. The government in England was eager to see a bicameral legislature, but otherwise was less concerned with the franchise than with the way in which the costs of colonial government would be met. Now that the colonial parliaments had power to make their own constitutions they turned at once to the job. However, within Australia almost all the influences that were at work in hammering out the first one were found in New South Wales. Wentworth led the group that tried to establish a hereditary upper house, but opposition was too great and its supporters had to be satisfied with a house nominated by the governor on the advice of the assembly, which itself was elected on a fairly wide male franchise. The constitution in Victoria followed closely on the lines of what had been done in New South Wales, but Victoria, following advice from England, established a council elected on a property franchise.

From 1823 Van Diemen's Land (renamed Tasmania in 1853) had an appointed council to advise the governor in the same way as New South Wales and this act applied until 1850. South Australia acquired the broadened council provided in the act of 1842. These colonies also acquired new constitutions in the years after 1853. In all the colonies adult males elected the assemblies, but the upper houses, the councils, remained appointive as in New South Wales, or elected on a restricted property franchise. An adequate understanding of Australian constitutional developments requires reference to the development of the whole British colonial empire toward self-government (*see* COMMONWEALTH OF NATIONS).

Discovery of Gold.—While these political changes were going on, Australia was in the midst of the economic upheaval of the gold discoveries. Gold had been discovered in Australia before and there is no doubt that it had been kept quiet for fear of the disturbances that would follow. Continued depression in Australia and loss of population to California after discoveries of gold there changed the situation. In 1851 E. H. Hargraves, who had been in California, returned to New South Wales and found gold in payable quantities near Bathurst. Soon after, a committee in Victoria was offering rewards for the discovery of gold in that state. They had not long to wait. Discoveries began near Clunes, at Anderson's Creek, near Buninyong and in amazing richness at Ballaarat and Bendigo, and in 1851 gold worth more than £1,000,000 was obtained. At first the prices of all goods and of land rose to fantastic heights; wages too became spectacular. There was a movement of labour from all occupations into the search for gold. Production fell off and, with money demand so great, prices and wages continued to rise. These events received dramatic publicity all over the world and stories of senseless extravagance were legion. Before many months had passed Port Phillip bay was full of ships that had brought people from all over the world as well as goods of all sorts for sale. In 1850 the population of New South Wales and Victoria together had been 265,503 but by 1860 it had become 886,393, and 537,847 of them were in Victoria.

A licence was required for lawful gold prospecting. For those who were successful the cost of the licence was no burden, but for the many unsuccessful diggers it was often more than they could afford. They all objected to the manner in which the law was applied and the possession of licences enforced. Early in 1853 there had been a threat of armed resistance at the Turon in New South Wales, but it was at Ballaarat, the most law-abiding of all the camps, that discontent became a rebellion.

Toward the end of 1854 the Ballaarat Reform league was formed. Its demands included abolition of licences, political reform including four of the six Chartist points and the release of four diggers who had been imprisoned for burning a hotel, the licensee of which had been acquitted of the killing of one of their comrades. Mining licences were burned at a mass meeting on Nov. 29 and on Dec. 2 diggers, after a skirmish with soldiers, assembled in a rough stockade on the Eureka and raised a blue flag bearing the Southern Cross. On the morning of Dec. 3 the stock-

ade was attacked and 30 diggers and 4 soldiers were killed in the fighting. There has always been some difference of opinion about the exact number killed. Martial law was established and changes were made, particularly in the personnel of the police, with the result that many of the grievances were removed.

It was not long before alluvial discoveries began to fall off and deep shafts had to be driven down and mining carried on with the aid of a considerable amount of machinery. Nearly £17,000,000 of gold was obtained in 1852 in Victoria, £12,000,000 in 1853, £8,600,000 in 1854, rising again to £13,000,000 by 1856, then falling continuously until it reached £7,800,000 in 1861. After 1857 opportunities for miners to make a living on the gold fields began to decline seriously. Other occupations soon became oversupplied with labour and attention was turned to the land. Many of the diggers had been farm labourers and they wanted to become farmers. But much of the land that was suitable had been purchased by graziers or was held under licence by squatters. In these circumstances the universal demand became one of "unlocking the lands." Political organizations grew up in Victoria and New South Wales to secure this objective.

Land Reform.—In Victoria about 31,000,000 ac. were held under licence by squatters. In New South Wales the position was that almost all land that could be used for agriculture was already owned or held under licence for grazing. The former diggers had little money, for gold discoveries had not amounted to much for most of them, and for many who had made money the chances of buying land were hardly better, for their money had gone easily. What is more, graziers did not want to sell land but to secure a better title for themselves. In the New South Wales assembly in 1855, Henry Parkes moved that a committee be appointed to inquire into agriculture. Resolutions of this kind were defeated, with reducing majority, until in 1858 John Robertson, a great advocate of change, became secretary for land and works. In 1859 the assembly passed a bill allowing selection of land to be made before survey. This would have allowed farmers to select land from squatters' runs; but the opposition in the council, where the squatters were in the majority, was too great and the bill was defeated. In one form or another conflicts between the assemblies and the councils took place in all the colonies during the next 30 years on issues in which sectional interests were as clear-cut as this one. In 1861 a compromise measure was passed in New South Wales which allowed selections of land to be made, but squatters were able to retain a pre-emptive right to $\frac{1}{25}$ of the run, with an option or prelease over three times the amount they purchased. During the next five years more than 17,000 families settled on the land and some measure of success could be claimed for the legislation. However, the squatters continued to do more than hold their own by methods of "peacocking" (picking out the best parts of the runs, water holes, creeks, etc., so that others could not make use of the rest) and "dummying" (buying land on behalf and in the name of all members of the family and even friends and imaginary persons). In Victoria public agitation was probably more extensive than in New South Wales. A land convention or "peoples' parliament" met near Parliament house in Melbourne. Following upon the introduction of the adult male franchise for the assembly in 1857 great preparations for the following election began. It was a victory for the land reformers. Soon after, a bill was passed in the assembly to allow land to be obtained but it was quickly defeated in the council. Another election soon followed and there was a bigger majority for land reform. Again law was proposed but this time a compromise was reached. This law, called the Gavan Duffy act, met with little success, but in 1865 the first Grant act was passed and in 1869 a second one. Under the first act (from 1864 to 1869), cultivated land rose by 200,000 ac., while under the second (from 1869 to 1878) it rose by 1,102,205 ac.

Economic Difficulties.—During most of these years the Victorian parliament saw great stresses in its battles over protective tariffs. The assembly and the council were again divided—the assembly being mainly elected by those who wanted to set up workshops and factories and by those who wanted to work in them, while the council was mainly elected by those who wanted to buy imported goods as cheaply as possible and export freely. In 1866 the assembly and the tariff supporters won, and Victoria gained its protective tariff. New South Wales continued to remain free-trade. The decade and a half following the exhaustion of alluvial gold was a period of depression. Despite the great flow of gold from the ports, there was a surplus of labour and a shortage of money to employ it. Queensland had been separated from New South Wales in 1859 and for some years economic conditions were difficult there. Throughout the period there had been persistent demands for public works to relieve unemployment. From about 1873 there was a more influential demand, led perhaps by Sir Hercules Robinson, governor of New South Wales, for public works as a fundamental prerequisite for colonial development.

Between 1871 and 1892 at least £220,000,000 was borrowed overseas by New South Wales and Victoria and a good deal of this money was spent on public works—at least £64,000,000 was spent alone on railways in these two colonies. Despite the existence of the great depression in England and no great demand for Australian wool (prices fell throughout most of these years although there was a marked increase in the volume of exports) employment and business began to improve after 1873. Improvement gradually changed into a boom and from 1883 the boom got out of hand into a speculative and unhealthy price inflation.

Further loans were refused in England, at first temporarily. Then a brief lease of life was followed by a complete termination. Building societies, land companies and other purely speculative institutions became bankrupt and the banks began to crash one after another. Strict economy prevailed for several years. It was perhaps necessary to eliminate the large unhealthy section of the economy, but it nevertheless delayed development and recovery.

The Labour Movement.—During the years of the expansion the Australian labour movement began to develop into a new phase. As early as 1824 coopers in Sydney had been committed for trial for "combination." In 1831 there was a Boat Builders Benefit society in Sydney and during the next decade several other trades became similarly organized. In the 1840s trade union or friendly society activities declined but more attention was paid to the organization of political groups. During the 1850s shortage of labour again encouraged the development of trade unions which were successful in obtaining an eight-hour day as well as many advances in wages. However, the gain in organizational and ideological strength had not been great. During the 1860s labour surplus and unemployment compelled the unions to become totally defensive and none was able to hold all its gains. Some unions went out of existence. There was no noticeable increase in their strength until the end of the 1870s. Unions then increased in number and membership. Many of their aims were taken from "New Unionism" in England, from the Socialist league and the Social Democratic federation, branches of which were established in Australia. As the land boom came to an end, employers were no longer willing to grant wage increases as they had done and strikes began to increase. The great strikes of 1888–95 resulted in the total defeat of the trade unions. Unemployment, and the powers of the government that were used against the unions, faced them with defeat or revolution for which they were neither qualified nor very anxious. Their defeat convinced them that they must set up permanent organizations for the exclusive purpose of achieving political power; *i.e.*, of getting their members elected to parliament. They had always been interested in political action but in ways spasmodic and not well-organized. Labour electoral leagues were set up and finally the Australian Labor party came into existence.

Federation.—The financial crisis, while it strengthened the desire for a national structure and government, with a view to greater self-sufficiency and less competition between borrowers on overseas money markets and more financial co-ordination at home, delayed it on balance. Recognition of the need for some over-all co-ordinating machinery had come with the separation of New South Wales and Victoria in the first place. At first the sugges-

tion came from England and led to the appointment in 1851 of the governor of New South Wales as the governor general of Australia. Then advocacy for an Australian nation and government began in New South Wales and Victoria. The first colonial conference met in Melbourne in 1863 and similar conferences continued to meet for a number of years. The object was to reach agreement about matters on which the several state parliaments should legislate uniformly. The adoption by Victoria of a protective tariff in 1866, and its increase in later years, raised a difficulty in the path of federation. In 1880, at a colonial conference, Sir Henry Parkes suggested the formation of a federal council and in 1884 an imperial act created one. It was to exercise certain defined powers but it amounted to nothing in practice, for New South Wales refused to join in. Parkes complained that "this rickety body" would delay making a federation into a real government, but New South Wales had stronger reasons for holding back. The necessary economic conditions for a federation had been created by 1890, but for a time federation had to take a back seat to all the problems that arose from the great strikes, the financial crisis and the bank failures. The main obstructions, however, were the tariff issue separating Victoria and New South Wales and the desire of conservative interests to retain powers for the state government in view of their own strength in the legislative councils. Labour also did not completely favour federation. Some said it was another name for government by the financial interests, particularly those abroad, though it is difficult to see their reasons for these beliefs.

It is difficult to accept the more or less traditional view that the people rose and swept aside these sectional interests and demanded federation. Only 30% of the qualified electors voted for it in the 1898 referendum, and 43% in 1899. Federation came to Australia in 1900 mainly as a result of a cautious compromise of the interested parties, pushed to some extent by organizations seeking nationhood; many of the people opposed it and most of them were far from enthusiastic about it. It meant, however, that an important stage in the development of Australia had been formally registered. It was a development destined to have a great influence upon the future.

An imperial act dated July 9, 1900, federated the colonies into the commonwealth of Australia. The act was later passed in all the parliaments of the colonies. A proclamation was issued in September of the same year, setting out that on Jan. 1, 1901, the people of New South Wales, Victoria, South Australia, Queensland, Western Australia and Tasmania should be united in a federal commonwealth of Australia. The central government obtained certain limited defined powers and the states were left with the residual powers. The commonwealth parliament first met in Melbourne. In Oct. 1908 it was decided to establish a federal capital at Canberra and the first parliament met there in May 1927.

Social Legislation.—These first years of the commonwealth were part of the period of social and economic reconstruction following upon the crisis of 1888–95. They were also years in which new social and political forces produced for the first time a national alignment and policy. The formation of the commonwealth was a historically logical development of the events of the last three decades of the 19th century, but inherent in these events was the determination of labour, through the trade unions and its new political party, to share the control of industry (or the distribution of national income) as well as the control of parliament. The lines of national policy—deliberate action to secure a distribution of national income according to "fair and reasonable" standards—soon became apparent.

The first commonwealth parliament was an assembly of political leaders many of whom had been prominent in state politics and much of whose work was done. Party alignments were difficult to find but no less so than any signs of policy. Most of the members seemed to stand for either protection or free trade. This parliament had to create the machinery for federal administration and had time for little else. The second election in 1903 seemed at first to make little change, but the second prime minister, Alfred Deakin, showing a primary attachment for protective tariffs but also a personal philosophy favourable to social legislation, began soon to skilfully barter arbitration, conciliation and the promise of pensions legislation against Labor party support for tariffs.

In 1904 Australia was not a country in which there was a great deal of social legislation. Education had been in the hands of the churches and private individuals until 1848. In that year a state system began in New South Wales. It was not until about 1880 that education had become mainly secular and paid for by the state, but in 1904 it was not completely costless in the primary stages, and beyond that costs were sufficient to place it beyond the reach of many people. The first Friendly Society acts to regulate the affairs of private organizations had been passed in the 1850s. In 1862 the first Coal Mines Regulation act was passed in New South Wales, and in 1873 the first Australian Factories act was passed in Victoria. It was not until 1885 that an act of much effect in the regulation of factories came into existence. Health acts were passed in most of the colonies between 1870 and 1890. In South Australia the first serious move to provide law for the setting up of courts of conciliation and arbitration came up in 1890 but it was unsuccessful. In New South Wales in 1892 such an act was passed but in practice it had little effect. In 1895, as part of its factory laws, Victoria adopted the system of wages boards, which became of quite wide significance in factory employment. It cannot be said that social legislation in Australia at the turn of the 20th century touched more than a little the lives of many people, nor that it changed appreciably their living conditions.

"New Protection."—Developments during the first decade of the 20th century in the commonwealth and state parliaments consisted of some extension of social legislation and the application of a system of protective tariffs to the commonwealth. In 1904 the commonwealth parliament passed legislation to set up a court of conciliation and arbitration and in 1906 two pieces of tariff legislation became law—the Customs Tariff (Agricultural Machinery) act and the Excise Tariff (Agricultural Machinery) act. The first of these imposed a substantial duty on agricultural machinery imported to Australia, and the second one allowed a rebate of excise duty on such machinery manufactured in Australia, provided that it was the product of labour paid "fair and reasonable" wages. This was known as the "new protection," and it served to tie together the interests of employers and workers in securing a tariff system.

In 1907 the new commonwealth court of conciliation and arbitration was asked to say if the employees of Australia's largest agricultural machinery manufacturer were employed under "fair and reasonable" conditions. The decision was that they were not and that the manufacturer was obliged to pay the excise duty. In expounding this judgment, Justice H. B. Higgins defined the Australian basic wage. While this decision was the subject of appeal before the commonwealth high court, parliament went on with its plans to extend tariff protection to a much wider range of manufactured goods, which the Labor party was induced to support because it believed that new protection or a "fair and reasonable wage" in all such protected industries could be enforced and because the government undertook in return to extend the age and invalid pensions, which had existed in Victoria and New South Wales since 1901, to the commonwealth. This alignment of parties resulted in the passage of the Pensions act on June 4, 1908 (although pensions were not paid until 1910), and the general Customs Tariff act on June 5 of the same year.

But on June 8 the high court held that the principle of new protection was invalid. This meant that there was now little common ground between Labor and the Deakin ministry, and the removal of Labor support brought Deakin together with the free-trade conservatives or, as he put it, with "the whole of my opponents since Federation." The Deakin-Cook administration managed to hold out until the election in 1910, but the Labor party was then returned with a large majority in both houses of the commonwealth parliament. Australia was now definitely a country with a substantial and general tariff, but nothing of substance had yet been gained by Labor as a result of legislation.

The parliaments of the states had been busy during these years

with matters of detail rather than of general policy. Slowly Labor strength increased in several of them and in 1910 the Labor party was in office in New South Wales with a large majority. In the other states the Labor party had been able to exercise the role of a balance of power party and in several of them the structure of social legislation increased as a result. The years 1910 to 1913 were years of general prosperity and the first commonwealth Labor government with a majority, led by Andrew Fisher, was able to round off and extend the social legislation of its predecessors. This was possible also in Queensland, New South Wales, Victoria and South Australia under somewhat different circumstances. In the 1910 session of the commonwealth parliament 40 acts became law. Attempts to secure new protection by constitutional amendment were made but they failed. The Australian Notes act, which confined the issue of notes solely to the government, became law in 1910, and 1911 saw the setting up of the Commonwealth bank. Although a good deal of the program of the Labor parties had become law by 1913 there were signs by that date of a good deal of dissatisfaction with parliamentary action as a means of reform. It was felt that Labor had been outmaneuvered; that they had given their support for tariffs without securing that wages should be kept at such a level that workers would get their share of the gains of the protected industries. However, the commonwealth court of conciliation and arbitration had begun its long job of making decisions about wages and working conditions which, on the whole, up to 1913, had been favourable to the workers. The Fisher government also provided legislation for the establishment of an Australian navy.

The Constitution.—Little happened in the years 1900–14 to the commonwealth constitution. On the whole the high court, the final arbiter of the meaning of the document and of the extent of government powers, adopted a general principle of interpretation that was definitely restrictive of the commonwealth. The principle was that the commonwealth should not be permitted to enter, by way of one of its powers, upon fields that were left under other powers to the states. Soon after World War I, however, there were signs that the high court was to turn for a time to an interpretation more consistent with the growth of a more distinctly national government. However, before this, other changes were to take place and the commonwealth was to become involved by almost universal consent in World War I.

Defense.—Australia's awareness of the problem of defense and its interest in external affairs began almost as soon as the first settlement. In these early days there was some concern at the possibility of French competition for Australian territory. Nothing came of it; indeed there was almost certainly nothing whatever in it. Later, in the 1840s and 1850s, concern with the chance of Russian invasion led to the building of fortified points in Sydney and Melbourne. There was certainly no more in this fear than in the fear of the French. In the 1870s Australia, or sections of it, looked apprehensively at foreign activities in places like New Guinea, and in this mood it sent representatives to the royal commission on the defense of the empire in London in 1880–82. Successive offers of military assistance had been made by Australia to Great Britain in the later 1870s and in 1881 South Australians volunteered for service in South Africa. The first contingent of artillery and infantry ever to leave Australia served in the Sudan in 1885. In 1883 the government of Queensland, impatient with British action, annexed New Guinea in an effort to combat German influence there. In 1889 Maj. Gen. Bevan Edwards visited Australia from England and made a report recommending that the forces of the colonies be placed on a uniform basis under one authority. Soon after this, interest and concern with defense and war seems to have declined in Australia, although the accepted need for a national defense structure did encourage federation.

World War I: Economic Effects.—At the outbreak of World War I in 1914 Australia was in the midst of a commonwealth general election. There was immediate general agreement among all parties that Australia would, and should, give all possible assistance to the prosecution of the war. Andrew Fisher as prime minister, elected as leader of the Labor party with a very substantial majority, pledged Australia in 1914 "to the last man, and the last shilling."

World War I in Australia was not a "total war." Despite a marked increase in manufacturing in the decade before 1914, Australia was predominantly a producer of primary goods. Manufacturing output then accounted for only 27% of total production. Australia was not thought to be in a strong financial position, despite the few years of prosperity, at the outbreak of war. State and commonwealth debts had greatly increased in the years before the war and the orthodox method of acquiring funds for war from loans at home and abroad was adopted. Increases in the note issue and expansion in bank credit followed the increase in expenditure resulting from the disposal of loan funds. A pronounced rise in prices was associated with this, but on the whole the economy was left to accommodate war expenditure within a normal peacetime structure, the government relying upon loans to finance the war. Taxation, of course, increased and the Commonwealth bank and other banks expanded credit. But the war was paid for in Australia very largely by a transfer of income payable later from the community to lenders overseas and at home. The government did enter directly and indirectly into the running of the economy more than ever before, but the Australian economy during World War I remained essentially a market one. There was a decline in productivity and effective wages fell from 975 in 1913 to 865 in 1915, with a recovery before the end of the war to about 950.

Considerable impetus was given to the development of manufacturing. The number of factories increased, there was a widening of the range of products and Australia acquired an iron and steel industry for the first time. The value of manufacturing production, at constant prices, rose by 32%. Agricultural production rose also by 28% but pastoral production fell by more than 21%. The relative rate of industrialization in Australia during World War I can easily be overstated, but it is true that the war shifted the balance sufficiently far to give secondary industry (employers and employees combined) overwhelming political power. Associated with the growth in manufacturing was a growth in the number of trade unions and in their membership. Soon after the war the formal links that had existed between the engineers and woodworkers in Australia and in England were severed because of law and practice widely different in the two countries. Another reason was that the Australian unions had developed a national structure and were of more substantial proportions than before the war. The Tudor tariff of 1921, Australia's most protective up to that time, was an outcome of the increase in industrial bargaining power. The formation of the Australian Country party just after the war was another. From that time the political leaders of Australian farmers were out to secure, by political means, special advantages for farmers of the same economic nature as tariffs and legal minimum wages.

World War I: Military Contribution.—During World War I Australia enlisted 416,809 volunteers, of whom 329,883 served overseas. As the result of war service 59,342 were killed. Australia's first contribution to the war was to hand over to the British government unconditionally the ships and men of the Australian navy and to provide an expeditionary force of 20,000 men for service overseas. The speed at which volunteers offered enabled the size of the Australian imperial force to be rapidly increased. It was at first intended that the Australian troops should go to the main centre of war in Europe, but because training resources in England were overtaxed by British and Canadian troops the Australians were landed in Egypt. After they had helped to repel the Turkish attack on the Suez canal, it was decided that the Australians should take part with the British 29th division and the New Zealand troops in an attempt to force the Dardanelles. On April 25, 1915, the landing at Gallipoli was made. Persistent and heroic fighting continued almost to the end of 1915, when it was finally realized that the geography of the region was such that the limited size of the forces available made final success unattainable and the evacuation was ordered. It was achieved without a single casualty. Soon after

the Australian troops were again encamped in Egypt and it was decided to take all the infantry to France and to keep the light horse brigades, the flying corps and the imperial camel corps in the middle east. These troops remained to play a distinguished part in that theatre of war.

The Australian infantry first entered the western front near Armentières, but by July 1916 the two Australian divisions, now joined by a third, were on the Somme. When they were withdrawn in September they had lost approximately 21,000 men during nine weeks of desperate fighting. The Anzac 1st corps was then moved to the Ypres salient for a short "quiet" period and afterward, reinforced by the 5th Australian division, returned to the Somme. The winter stalemate which followed meant that the troops had to endure all the wretchedness of flood, mud, snow and frost until Feb. 1917, when renewed Allied pressure was rewarded by the German withdrawal to the Hindenburg line.

The Australian troops were engaged in desperate fighting at Arras and Bullecourt, and then the 3rd Australian division, under Maj. Gen. Sir John Monash, took part in the highly successful battle of Messines ridge, north of the Lys river. Then followed the titanic struggle east of Ypres. Australian troops had great success from time to time, finally ending the salient near Polygon wood by a great advance in Oct. 1917. Winter saw the Australian troops in action near Passchendaele, finally to be relieved from complete exhaustion after losing 30,000 men in three weeks' fighting. Soon after this the Australian and New Zealand troops were separated, and the name Anzac was officially dropped.

March 1918 brought the great German offensive and the Australian divisions were hurried back into the fighting. April, June and July found them at Villers-Bretonneux and in Aug. 1918 the Australian and Canadian corps, with British tanks and artillery, took part in the great advance beyond Le Hamel described by Gen. Erich Ludendorff as "the turning point of the war." Finally, Australian troops played a significant part in clearing the way for the assault on the Hindenburg line, which was won on Sept. 29, 1918. Before this, however, several Australian brigades played a vital role in carrying the advance for more than two months; during this period they suffered 21,000 casualties, but took more than 29,000 prisoners as well as capturing 338 guns and a vast amount of other material. The pinnacle of Australian achievement during World War I was the point of the last withdrawal from Montbrehain just a few days before the Armistice.

Postwar Prosperity, 1920–30.—Australia entered the 1920s with a political situation very different from that which preceded the war. The wartime prime minister, W. M. Hughes, had returned to Australia in 1916, convinced that the voluntary system of enlistment for the armed forces should be replaced by conscription. This matter was put to the vote on two occasions in a national referendum and was defeated. But many Labor party leaders including Hughes, W. A. Holman, W. G. Spence and several others—in fact, most of those who had led the party since its organized entry into state and commonwealth politics in the 1890s—supported conscription and were finally expelled from the party. Some of these men joined the opposing parties, Hughes to emerge as leader and to continue as prime minister.

During the three years immediately after the war a new party —the Australian Country party—was formed to capture the vote of country people. Previously many country votes had gone to Labor, and some of the leading figures in the Labor party were returned for country electorates. The rise of the Country party and the severe losses to Labor resulting from the difficulties and defections over conscription meant a marked postwar shift in political power, and Australia was to be governed in the 1920s with very little influence from the labour movement.

The symbol of the new situation was the coming to office of the Bruce ministry in 1923. This was a combination of the Nationalist and Country parties and the slogan "men, money and markets" was soon to set the tone of all that was done. The aims were development of manufacturing and rural industry, immigration and provision of capital from overseas. For the first time since the 1880s the Australian economy became dependent upon money borrowed overseas—this kind of debt rose from £A443,000,000 to £A980,000,000 in the period. Export prices were favourable for most of the time and significant economic development did take place. In 1926 the Patterson butter scheme showed the way farmers wanted to go now that they had obtained new direct political power. It provided for a voluntary levy on all butter sold in Australia (which meant a price higher than it otherwise would have been); out of the proceeds of the levy, farmers who produced the butter were paid a subsidy on that portion of total production that was exported. Simply, this meant a transfer of income within Australia from butter consumers to butter producers, so that Australian butter could be sold at a more competitive price overseas.

Empire development had been emphasized during this decade. But immigration to Australia was a disappointment. Only in one year did immigration exceed half that of 1913 and although much money was borrowed, British investment in Australia could not have increased by more than £A10,000,000 a year. Emphasis upon "men, money and markets" did not mean that much that was "artificial" had not entered into the scheme of things. But much of that which was artificial was noted for its lack of motive force. In economic conditions which on the surface seemed good there was much unrest and uncertainty. Strikes among seamen occurred in 1925 and among timber workers in 1929. Many people felt that protective tariffs had become much too high and an inquiry took place in 1927. The result was a not unreasonable conclusion that tariffs had been beneficial in that the existing (1927) population could not have been supported at the existing standard of living without them, but that tariffs were imposing excessive costs upon certain sectors of the economy. The Bruce-Page ministry went to the people in 1929 on a proposal for the abolition of arbitration in all but the maritime industries. It was overwhelmingly defeated and the prime minister, S. M. Bruce, defeated in his own seat, retired from Australian politics. James Scullin, the leader of the Labor party, became prime minister in an attempt to govern without effective power, for the senate was firmly in the hands of the opposition. In these circumstances the 1930 fall in export prices to an average of about half that of 1928, with the sudden and definite termination of all overseas loans, left Australia in a completely undermined economic situation.

The decade saw interesting developments in the Australian constitution. Barriers that had arisen against commonwealth powers and technical and financial limits upon the states operated to bring the commonwealth and state governments together. Concern with this problem gave rise in 1921 to suggestions for a constitutional convention, but they came to nothing. A royal commission on the constitution, in 1929, produced a report of some practical importance, but the real achievements were in the field of combined commonwealth-state action. In 1928 the Financial agreement resulted in the commonwealth's taking over all state government debts, and the Loan council was set up to control all future borrowings. The Murray River agreement between the commonwealth and the three states—Victoria, New South Wales and South Australia—introduced a plan for water conservation and for irrigation projects to be carried out by the three states. The Main Roads agreement introduced the method whereby the commonwealth provided money so that the state governments could carry out work on main roads. These agreements established the principle that was certain to determine a good deal of the development within the Australian constitution. It meant a central source of finance and a decentralization of the work performed.

Australia ended the decade conscious of its complete dependence on external factors and its inadequacy by internal management to keep up its national income. In traditional manner attention was directed to the distribution of this income.

Depression of the 1930s.—In Aug. 1929 wool prices fell heavily and in the same month London financial houses refused any further long-term loans. The Scullin Labor government came into office in October. They met the situation by orders "mobilizing" Australian gold, and in December large shipments of gold were made to London in an effort to meet current demands

on Australia for payments. The exchange rate of the Australian pound began to depreciate rapidly and seriously. All this was insufficient to stem demands on Australia for payment. In April 1930 there was a heavy increase in a wide range of import duties and in many items direct prohibition of import except on license was imposed. During July and August Sir Otto Niemeyer, representing the Bank of England, visited Australia and presented a statement to the premiers' conference. It proposed the maintenance of parity with sterling and the gold standard (although sterling itself was soon to be forced from it), a policy of balanced budgets at much lower levels and severe reductions in salaries and wages. This proposal would have meant a reduction in national income of at least 50% (the actual reduction between 1929 and 1932 was about 30%) and was so deflationary that any plan less so was able to be described as the "middle way."

The technical advisers of the Australian governments resisted the most stringent deflationary proposals. They pointed out that the "first problem of economic readjustment is to distribute the first loss of income fairly among all classes according to their capacity to bear the burden" ("A Plan for Economic Adjustment," a memorandum prepared by D. B. Copland, L. F. Giblin and E. C. Dyason [1930]). Their recommendations included depreciation of the currency to restore real income of exporters to within 10% of that of 1929; a reduction in real wages of 10%; and a general reduction in all government expenditure of 10%. There was a possibility that the first recommendation might have a nondeflationary effect as foreseen, but the other proposals reflected the assumption that a loss of national income had been suffered and should be borne equitably.

In Oct. 1930 the Lang Labor government was elected in New South Wales. In January the commonwealth arbitration court ordered a reduction of 10% in the basic wage, and in February the exchange rate, after its free depreciation, was fixed at £A130 = £100 sterling but by December it had become £A125 = £100 sterling. In May 1932 the Lang government was dismissed by the governor for allegedly unconstitutional procedure, and the depression had reached something like rock bottom. Unemployment had reached more than 500,000 persons, shops were empty, houses sought tenants at almost any rent, factories were idle, families were broken up and bankruptcy was common. During the year government expenditure was cut by more than 10%; even pensions, low as they were, were cut below subsistence level. National income was 30% below 1929 and average unemployment in industry was 29% of the labour force.

Although bank advances and government securities increased after 1931, the increase was almost entirely in government and municipal securities held. Advances did not really begin to increase until 1934, remaining at £A249,000,000 in 1932, £A253,000,000 in 1933 and £A255,000,000 in 1934. The commonwealth government in 1931 proposed the raising of £A18,000,000 from the Commonwealth bank, £A12,000,000 for public works and £A6,000,000 for a subsidy to wheat producers. The governor of the bank refused to make the money available and the state of law and political climate was such that the bank prevailed over the government.

The policy of the Australian governments during these years of depression is sometimes quoted as a significant departure from the normal method of deflation. On the contrary, it is clear that the Australian depression was dealt with by the normal method of income and, therefore, by cost reduction, calculated to bring the Australian economy into line with similar movements overseas. Only when this had gone sufficiently far did recovery commence and then it was almost entirely the result of private business initiative. The depression in Australia served again to emphasize how much the country was dependent upon external economic conditions and how little it had departed from the market economy, not that it had acquired any significant national economic independence or any means for planned, positive economic action.

World War II.—Australia followed within a few hours Great Britain's declaration of war on Germany on Sept. 3, 1939. As in 1914, no voice in parliament, or of influence elsewhere, was raised against it. In Sept. 1939 few of Australia's resources, although substantially more than in 1914, were devoted to war. The economy had developed sufficiently to make its rural and manufacturing production a substantial factor. In 1939 Japan was an ally of Germany and many Australians felt that it would not be long before it came into the war. Two issues were involved which, even if not clearly recognized at the beginning, were likely to make war policy contentious—first, whether service should be in the armed forces or in industry and in what proportions and, second whether Australian armed forces should be used in Europe and the middle east or in the Pacific.

In May 1940, very soon after the appointment of a commander in chief, a director, with almost dictatorial powers, was appointed to organize industry for war production. Training of the armed forces was extended and before the end of 1939 Australian forces left for the middle east. In Sept. 1940 a general election gave the Menzies administration a renewed but slight majority. During 1940 Australian forces were engaged in the Mediterranean and Italian Cyrenaica, and in 1941 in Greece, Crete and the western desert, where Tobruk was held for eight months after surrounding territory had been overrun by Erwin Rommel's German-Italian forces. In these engagements 2,200 were killed and 6,000 taken prisoner.

By Oct. 1941 Australian governments under both R. G. Menzies and A. W. Fadden proved unable to carry on, and a Labor government was formed with John Curtin as prime minister. The Japanese attack on U.S., British and Dutch territory came almost immediately. After losing 22,000 prisoners in Malaya and Indonesia, Australia had very few troops at home trained and equipped to fight. It was decided to transfer two Australian divisions from the middle east and to seek close co-operation with the United States. The Australian government recognized that defense of Australia was its primary duty, and that Britain could not be expected to spare large resources for the Pacific. On March 17, 1942, Gen. Douglas MacArthur transferred his headquarters to Australia.

The Labor party, traditionally opposed to conscription, introduced the most far-reaching control and direction of manpower in history. The Japanese were halted at sea, largely by U.S. forces in the battles of the Coral sea and Midway, and then in New Guinea by Australians at Gona, Buna, on the Kokoda trail across the Owen Stanleys and at Milne bay. Soon the campaign to remove the Japanese from New Guinea and adjacent islands began. By Sept. 1944 Australian forces had suffered 70,000 battle casualties, the air force had lost 12,000 men and the navy 2,500.

The Curtin government, returned with a large majority in Aug. 1943, determined upon the reinforcement of the production line with a net transfer of 57,000 men from the armed forces. With the U.S. forces "island hopping" in their advance toward Japan Australians embarked upon a campaign of isolating and destroying Japanese forces in Bougainville, New Britain, Wewak and Borneo. Atom bombs on Japan in Aug. 1945 brought the war to an end without the need for the completion of these campaigns. Throughout the war the Australian air and naval forces co-operated with the British in the defense of Great Britain, in the air attack on Germany and in naval operations all over the world.

World War I had done much to strengthen Australia as a manufacturing country, but World War II changed it into a highly industrialized one. The circumstances of the war raised Australia to a strength and independence in international relations that changed its role in international affairs for a few years.

Postwar Years.—World War II proved to be not only a substantial military effort by Australia but also a successful economic one. Despite a most significant transfer of manpower and resources from peacetime productive uses (595,740 people were in the armed forces at the end of the war and, probably, another 400,000 were in war work) and then back again in 1946 and 1947 there was no inflation or unemployment and living standards continued to rise.

The Re-establishment and Employment act (June 1945) provided the general pattern of demobilization, re-employment and training. By Feb. 1947 demobilization was completed with the transfer of about 900,000 people from the armed services and

war work. The Commonwealth Reconstruction Training scheme provided for the training of service personnel in 400 different occupations and professions. By Sept. 1948, when the scheme was at its height, 285,000 ex-service men and women had been accepted for benefits and 227,000 were actually in training.

By 1948 it was apparent that the main postwar problem was to be inflation, not, as had been anticipated, unemployment. The need for reconstruction in many countries and, soon, the "cold war" meant a high level of demand for goods of all kinds. Inflation came to Australia through high prices for exports. As earlier with unemployment, the danger of inflation was at first overestimated. The Labor government, led after Curtin's death in 1945 by J. B. Chifley, held on firmly to controls, while the Liberal-Country party in opposition raised the cry of freedom, self-interest and profit. Although the Labor government could claim to have established a "welfare state" between 1944 and 1949, it had not, by the latter year, made much change in the distribution of income. Financial activity, in general, followed wool prices, and government spending was high. Wage rates were automatically adjusted for price increases every three months. With little in the way of a positive policy, nothing to redress the balance for those of its own supporters who had lost from inflation, and a controversial issue in the 1947 Bank Nationalization act, the government unsuccessfully went to the polls on Dec. 10, 1949. Its defeat brought in a Liberal-Country government headed by R. G. Menzies, with a policy of decontrol. Application of this policy, however, coincided with a vast increase in export money income. Prices rose rapidly and overseas funds soon fell as imports rose even more rapidly than exports. In the resulting crisis the "no control" Liberal government turned to rigorous control of imports. But, except for a short period, almost full employment was maintained. Economic production began to increase and to diversify durable consumption goods. This was sufficient, even when automatic wage adjustment was abolished, to allow people to pay more attention to the government's cry of "Communists" than to inflation.

The Liberal government alleged that the danger from Communism was so great that the Communist party in Australia must be outlawed and Communists debarred from holding certain offices or positions. A referendum to permit this was defeated in 1951, but the issue was kept alive by the appointment of a royal commission on espionage following the defection of a member of the Soviet embassy in Canberra in 1954. A splinter group set up inside the Labor party in 1955, under the influence of the political wing of Catholic Action, proceeded a considerable distance toward its objective of capturing that party in Victoria to use it in its fight against Communism, but its success produced a split both in the party and in the church, which reduced the electoral strength of the Labor opposition throughout Australia. Favourable economic circumstances, fear of Communism and the weakening of the Labor party all contributed to further Liberal party victories in the general elections from 1951 to 1966. Immediately after World War II, Australia had looked primarily to the United Nations for security, and supported those countries in Asia seeking political independence. The change of government in 1949 from Labor to Liberal-Country party had brought a change of emphasis, which derived from the new government's antagonism toward Asian revolutionary nationalism. As it became more apprehensive of the growing independence of nations in Asia, the Liberal-Country regime placed greater stress on close alignment with the United States and with Asian anti-Communist governments.

The ANZUS treaty (Sept. 1951) between the United States, Australia and New Zealand, an offset to Japanese rearmament, was the first attempt to formalize these relations. The establishment in Sept. 1954 of the Southeast Asia Treaty organization (SEATO) was aimed at checking the growing Communist influence in the area. Australia took part in the Korean War, gave assistance in South Vietnam and sent troops to Malaya. There was no claim that any of this was done under any of the treaties. However, the result was that Australia began to take sides with one Asian country or interest against another, and for the first time, since perhaps 1938, the possibility of an external threat to Australia became a reality. Indonesia's desire to obtain West New Guinea (West Irian) from the Netherlands provided the Australian government with a delicate diplomatic problem.

The formation of the federation of Malaysia and Indonesian objections to the inclusion in the federation of Sabah and Sarawak led to Indonesian hostility toward Malaysia (expressed in the Indonesian government's policy of "confrontation") and forced Australia to choose between one Asian country and another in a dispute. For a time Australian troops were openly committed to combat against Indonesia, but the ending of the "confrontation" (Aug. 11, 1966) was followed almost immediately by the withdrawal of the Australian troops that had been stationed in Sabah. Similarly, allegations by the United States of aggression by North Vietnam resulted in an agreement by Australia to send troops to fight in South Vietnam.

Early in 1966 Sir Robert Menzies, who had held office as prime minister continuously since 1949, resigned and was succeeded by the former federal treasurer H. E. Holt. In Feb. 1966 a decimal system of currency was introduced in Australia.

Australia's population (about 11,500,000 by the late 1960s) and economic production continued to grow so that in industrial capacity the country became the strongest in southeast Asia. After World War II, immigration proved of great significance—more than 1,250,000 people entered Australia at rates seldom exceeded by any country at any time. Not only did this contribute much to the strength of the nation, but it also made an important difference in its composition. From being predominantly British, Australia became a nation with increasingly large numbers of people from other European countries, thereby creating a more colourful and diverse community. (J. F. C.)

IV. POPULATION

The total population of the commonwealth of Australia in June 1966 was 11,544,691. The previous census, taken on June 30, 1961, had returned a total population of 10,508,186.

Population of Australia

States and territories (with capitals in parentheses)	Area in sq.mi.	Population			
		1961 census	Density per sq.mi.	1966 census	Density per sq.mi.
States					
New South Wales (Sydney)	309,433	3,917,013	12.7	4,235,030	13.7
Queensland (Brisbane)	667,000	1,518,828	2.3	1,661,240	2.5
South Australia (Adelaide)	380,070	969,340	2.6	1,090,723	2.9
Tasmania (Hobart)	26,383	350,340	13.4	371,217	14.1
Victoria (Melbourne)	87,884	2,930,113	33.3	3,217,832	36.6
Western Australia (Perth)	975,920	736,629	0.8	835,570	.85
Territories					
Australian Capital (Canberra)	939	58,828	62.6	95,913	102.1
Northern (Darwin)	520,280	27,095	0.05	37,166	.07
Total	2,967,909	10,508,186	3.5	11,544,691	3.9

These figures were exclusive of full-blooded aborigines, estimated to number 40,081 in 1961 and found principally in Western Australia, the Northern Territory, northern Queensland and South Australia. There are signs that the aborigines are increasing in number. All but an estimated 4,000 live in or near settlements. In addition to the full bloods, there were, in 1961, 39,172 classified as half-caste aborigines. Most of these live in settled areas and are included in the total population figures above. Before European settlement the aboriginal population of Australia and Tasmania may have numbered, according to varying estimates, from 150,000 to 350,000.

Apart from aborigines the population is almost entirely of European stock, 99.1% being described at the 1961 census as of European racial origin, 0.4% aboriginal half-caste and the rest Asian (mainly Chinese) and Polynesian. Immigrants to Australia since its foundation have been overwhelmingly of British descent. Before 1946 the only other European groups that contributed significant numbers were Germans, Italians and Greeks. Between 1947 and 1961 the immigrant population increased from 733,000 to 1,779,000, of whom 228,000 were from Italy, 109,000 from Germany, 102,000 from the Netherlands and 77,000 from Greece. Non-British subjects constituted 5% of the population in 1961.

Between 1947 and 1964 Australia's population increased by 3,556,000, or nearly one-half, at an average annual rate of 2.4% (*cf.* United States 1.7%, India 1.9%, United Kingdom 0.5%). To this rapid rate of population growth a relatively high rate of natural increase (1.4%) contributed three-fifths, an ambitious immigration program two-fifths. In this postwar period the birth rate averaged about 23 per 1,000, compared with 17 per 1,000 in the depression years of the 1930s.

The death rate continued to fall in Australia, the expectation of life at birth in 1953–55, 67.14 years for males and 72.75 years for females, being among the world's highest. In 1947, with 1,004 males per 1,000 females, the sexes were very nearly in balance. The postwar wave of immigration, like earlier waves, tended to raise the male proportion, which reached 1,017 males for 1,000 females in 1964. The male proportion was higher in rural than in metropolitan areas and higher also in the states and territories with small populations than in Victoria and New South Wales.

With 3.8 persons per square mile, Australia remained the least densely populated of the continents. Even Victoria, the most densely populated state, had only 33 persons per square mile in 1961. By comparison, Europe (excluding the U.S.S.R.) had an estimated density in 1961 of 224, Asia (excluding the U.S.S.R.) of 163, North and Central America of 28, Africa of 22 and South America of 20. At least 10,000,000 of the total population of 10,508,186 were found in the better-watered areas of nontropical Australia. Tropical Australia (northern Queensland and parts of Northern Territory and Western Australia) had a population of less than 400,000. The area south of the tropics with a rainfall exceeding 15 in. (381 mm.) annually amounts to about 560,000 sq.mi. (1,450,000 sq.km.) (less than one-fifth of the country). Beyond this area, apart from mining towns, the density reached one person per square mile only in irrigated areas of the Murray and its tributaries and on wheatlands in South Australia, Western Australia and Victoria (mallee district).

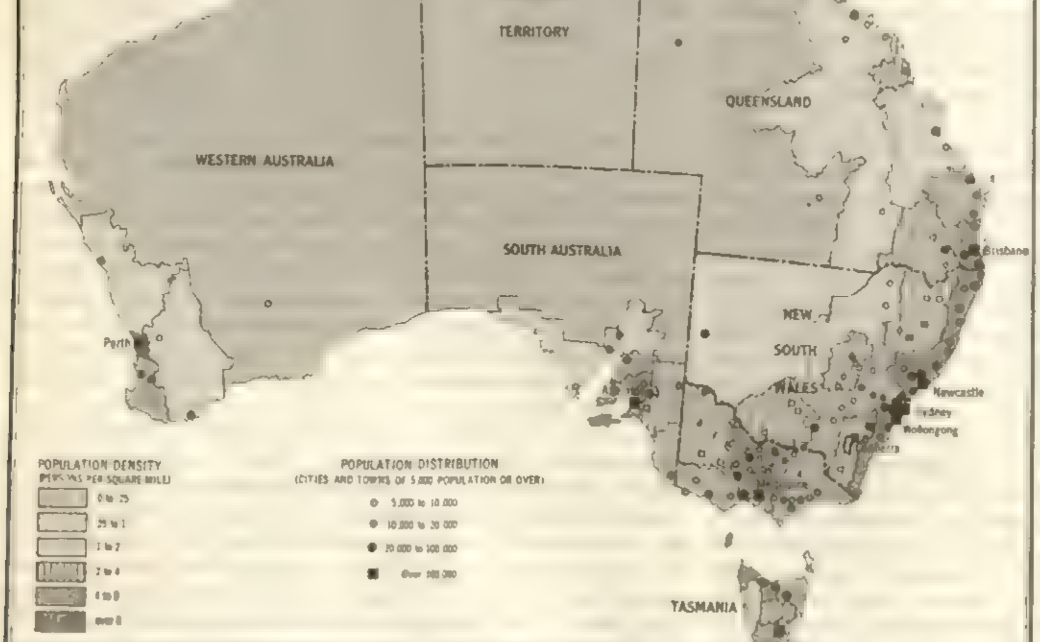
A feature of the population distribution was the heavy concentration in the capital cities. With 59% of its people in cities with more than 100,000 (1961 census), compared with just over 40% for the United Kingdom, about 30% for the United States, nearly 40% for the Federal Republic of Germany and nearly 30% for Japan, Australia had a more urbanized population than any other country in the world. Apart from the state capitals (1961 metropolitan population: Sydney 2,183,388, Melbourne 1,911,895, Brisbane 621,550, Adelaide 587,957, Perth [including Fremantle] 420,133 and Hobart 115,932), there were only 2 cities of more than 100,000 (Newcastle and Greater Wollongong) and 23 others of more than 20,000, including the rapidly growing national capital, Canberra, whose population had reached 56,449.

The high urban proportion is reflected in the industries in which the economically active population is engaged. Agriculture, fishing and forestry employed only 10.9% of the working population in 1961, while manufacturing (including public utilities) accounted for 29.2% (*cf.* United States, 1950, 25.1%), commerce and finance for 19.6% and professional and public services for 13.7%. Rural industries absorbed a diminishing proportion of the working population during this period, while the share taken by manufacturing rose continuously except during the depression of the early 1930s.

Conditions of Settlement.—Climate has been and remains the governing influence on settlement. The size of the continent stretching from the tropical north to the temperate latitudes of Tasmania, provides great variety of climatic conditions. But opportunities are seriously limited by the continent's geographical position and topographical structure. The fact that its greatest extension is east-west in subtropical latitudes, combined with the flatness of the whole land mass except along the eastern coast line, where a mountain range lies athwart the major rain-bearing winds, results in an immense area of insufficient and irregular rainfall in the centre and western half of the continent. Lack of high land in the tropics, where it might mitigate temperatures, and the location of most mountainous parts in temperate latitudes, where the land would be more valuable were it low, are further impediments to settlement.

These basic features go far toward explaining the peripheral character of settlement along the eastern, southern and western coasts of the continent. Although there is strictly no "dead heart" —the flourishing little town of Alice Springs lies right in the centre—it is only in the southeastern corner, with its regular, good rainfall, that intensive settlement has moved far from the coast. Elsewhere, the interior remains at best a barely populated area comprised of vast pastoral stations, with only widely scattered mining centres.

It is difficult to feel that basic geographical or climatic features account for the other major characteristic of settlement in Australia—the concentration of more than half the population (1961 census) in the metropolitan areas of the six capital cities. There historical, social and economic factors have probably been more influential; for instance, the fact that its people have been drawn from the most urbanized country of Europe, the early bias toward a large role for government given by its historical origin in convict



COMMONWEALTH BUREAU OF CENSUS AND STATISTICS, CANBERRA, AUSTRALIA

FIG. 7.—POPULATION DENSITY AND DISTRIBUTION IN AUSTRALIA: BASED UPON 1961 CENSUS

colonies, and the preponderant influence of extensive pastoral production in its economic development, which has discouraged intensive farming and at the same time raised incomes to levels at which demand for the products of secondary and tertiary industries has been high.

Immigration.—Immigration into Australia has generally been a major concern of governmental policy. Until the middle of the 19th century the issue of convict transportation versus free immigration dominated the scene. Thereafter immigration policy was characterized by three main features: alternating support for and opposition to large-scale immigration, closely linked to conditions of domestic prosperity; strong preference for immigrants of British origin; and, from the later decades of the 19th century, exclusion of coloured immigrants.

The main phases of large-scale immigration were as follows: 1852–58, 1876–91, 1909–13, 1921–25 and 1948– . Each phase corresponded to a period of domestic prosperity and rapid economic development. This prosperity and the consequent labour shortage attracted immigrants and induced governments to assist and encourage immigration, while large-scale immigration, in turn, stimulated domestic economic activity, chiefly through the actual and anticipated demands of immigrants for houses and other capital equipment.

Government assistance generally concentrated on payment of the whole or part of immigrants' passages to Australia, though in the post-1948 phase in particular the official immigration program included activity in the selection, transport, settlement and care of migrants.

Up to 1920 assisted migration was controlled entirely by the various state governments. In that year the commonwealth government assumed responsibility for the recruitment and transport of immigrants. In 1925 it entered into an agreement with the British government for the large-scale settlement of British migrants in Australia. While these schemes were generously conceived, the results were disappointing. Immigration reached a fairly high level during 1921–25, but after 1927 a decline set in and the depression years after 1929 saw a net loss of population, resulting from extensive emigration from the commonwealth. After a brief revival in 1938 and 1939, World War II put a stop to migration until 1945.

Then a new phase began. Optimism about the economic future of the country, coupled with a general feeling that the war had shown the danger of Asian attack to which an underpopulated white continent was exposed, stimulated a determined effort to develop a large immigration program. The temporary availability of large numbers of potential migrants in the unsettled conditions of postwar Europe added a further incentive. A separate department of immigration was established in 1945, led first by a Labor and then by Liberal ministers who shared an almost crusading zeal for the immigration program. Under an agreement with the British government, a new scheme for free passages for British ex-service men and women and assisted passages for other British migrants came into operation in March 1947; by June 1959 it had brought 322,000 migrants into the country. During 1947–52, 170,000 refugees, mainly Latvian, Lithuanian, Estonian, Polish and Yugoslav, were brought from the displaced persons' camps of Europe under agreement with the International Refugee organization. Assistance was also given to certain categories of European ex-servicemen and U.S. veterans. In addition to assisted migrants under these official schemes, thousands of British and non-British migrants went at their own expense. In 1952–53 Australia negotiated agreements with the Netherlands, Italy, the Federal Republic of Germany and the Intergovernmental Committee for European Migration (with respect to migrants from Trieste, Greece and Austria), involving joint assistance toward cost of passages by the governments concerned and selection of migrants according to employment opportunities in Australia. In the early years of the official assisted passage schemes, non-British migrants assumed an obligation to work for two years in public construction or other work assigned to them, but this requirement was later dropped. The emergence of some unemployment in 1952 reinforced widespread doubts that had developed earlier on other grounds about the ability of the economy to absorb immigrants at the 1949–52 rate. As a result of a government decision the rate of intake fell to 75,000 in 1953 but exceeded 100,000 in every subsequent year in keeping with the aim of maintaining net annual migration as nearly as possible at 1% of the population. In 1964 it was decided to extend to the countries of the middle east the areas from which the commonwealth would actively seek new settlers.

Meanwhile, the "white Australia" policy, officially termed "restricted immigration policy," remained a cornerstone of the immigration program. It arose gradually during the second half of the 19th century from fears of competition by Chinese immigrants and by imported labour from the Pacific islands. While economic support for it was centred in the labour movement, the policy was supported by all classes on both social and defense grounds.

However, after 1950 there was increasing discussion of its compatibility with Australia's need to live on good terms with its Asian neighbours. While the "white Australia" policy still enjoyed widespread public support, there was demand in some quarters for quota schemes. The "dictation test" that had been used to exclude coloured and other undesired immigrants was replaced in 1959 by an entry permit system, and in the early 1960s this was being administered in an increasingly liberal manner. Coloured students, tourists and businessmen had been admitted, since 1905, under temporary permits, and after 1945 large numbers of Asian students were encouraged to study at Australian universities and schools. (H. W. A.; A. J. Ro.)

V. ADMINISTRATION AND SOCIAL CONDITIONS

The Australian political system is closely modeled on that of Britain, the principal novelty being the federal division of functions between the national (commonwealth) and regional (state) governments. In this respect it resembles the federal system of the United States. Although the commonwealth government has been in existence since 1900, the six state governments (Queensland, New South Wales, Victoria, South Australia, Western Australia and Tasmania) remain responsible for police administration, education, hospitals, public housing, land settlement, irrigation and an ambitious range of fuel, power and transport undertakings.

More complex arrangements involving both levels govern the regulation of industrial conditions and standards, agricultural marketing, public health, and the courts and legal system. Fiscal resources, however, are highly centralized, and state governments depend for two-thirds of their revenue on commonwealth grants. Both commonwealth and state governments are liable to check by the high court, which pronounces upon the constitutionality of statutes. Local government in Australia is not strongly developed, and local authorities (of which there are roughly 1,000) are primarily concerned with road making.

In addition to the state governments there are two federally controlled territories—the extensive but sparsely populated Northern Territory and the small Australian Capital Territory. The latter includes the federal capital of Canberra. The federal legislature, like that of the United States, consists of two houses: the house of representatives, whose membership is drawn from the states according to their population, and the senate, in which all states are represented equally. Australia follows the British system of placing executive powers in the hands of a cabinet, headed by a prime minister and responsible to the lower house of the legislature. Members of the federal judiciary are appointed by the government, hold office for life and have a high degree of independence. The head of the judicial system is the high court of Australia.

The various public services are of somewhat uniform design despite the fact that each is quite self-contained. Officials are organized in ministerial departments free from political interference in recruitment and promotion and enjoy permanent tenure. Egalitarian sentiment for a long while successfully opposed direct recruitment of university graduates to administrative positions, which were filled by promotion from below. Extradepartmental boards are widely used for regulatory and advisory services,

as well as for work of a commercial or industrial character. A genial pluralism allows major interests a preponderant influence in domestic policy matters: farmers in marketing, manufacturers in the tariff, trade unions in wage fixation and the professions in occupational registration.

Living Conditions.—Since 1945 Australians have enjoyed conditions of remarkable prosperity, though an acceleration of inflation in several periods has caused the benefits of this prosperity to be awkwardly distributed. Throughout these years governments in Australia had little trouble with their postwar promises to maintain high and stable levels of employment. The distribution of income, which had long been one of the most egalitarian in the world and which wartime developments carried still further, has tended since the early 1950s to become more unequal, though labour's share in the national income has remained stable at 55% to 60%. Taxation is at American rather than British levels, almost half is still indirect and income taxation has become less steeply progressive. International comparisons of living standards put Australia among the richest eight or nine countries in the world—health statistics in particular being extremely favourable. The 40-hour working week was adopted in 1948.

Welfare Services.—Although Australian governments were early pioneers in the field of welfare legislation, measures to promote social security were somewhat spasmodic and limited up to World War II. Providing a living wage was the initial policy in this field. But as time went on, Australian governments supplemented this basic goal with additional social services. Before 1939, however, social services developed very unequally in different parts of the country and had not in total extended very far.

New benefits introduced during World War II and in the immediate postwar years in an effort systematically to meet causes of income deficiency included child endowment (family allowances), widows' pensions, unemployment and sickness benefits, hospital benefits, pharmaceutical benefits and free drugs, allowances for wives and children of invalid pensioners, funeral benefits, benefits for tuberculosis sufferers and their dependents and home nursing services. Expenditure on welfare services has not risen greatly as a proportion of the national income under full employment conditions.

The failure of the federal Labor government to win the support of the medical profession for its free medical and dental services left a serious gap in the security edifice, only partly filled by the introduction by the succeeding Liberal-Country party coalition government in 1951 and 1952 of voluntary insurance schemes for medical and hospital expenses. Nearly 70% of the population is insured for medical benefits. In 1964 the federal government paid £A12,000,000 to help them meet their doctors' bills. Many of the uninsured are covered by the pensioner medical service or by repatriation benefits paid to ex-servicemen.

Apart from the health services, all Australian welfare benefits are noncontributory, being paid from consolidated revenue. Most, however, and in particular the age pension, are only paid subject to a means test.

Education.—Primary and secondary education in Australia is mainly the responsibility of the state governments: they educate three-quarters of all children of school age. About one-fifth go to Roman Catholic schools, and the remainder to other private schools (principally Protestant owned); neither type receives public financial assistance on any scale. The state schools are notable for their highly centralized administration and their freedom from popular and political control. Although the compulsory school-leaving age has not everywhere been raised to 15, a very high proportion of pupils do in fact remain on voluntarily, though the enrollment ratios of the age groups 15–19 and 20–24 years in Australia compare unfavourably with those of many other countries. Expenditure on education as a proportion of gross national product places Australia 15th on international lists. The problem of reaching children in remote and sparsely settled areas led to a number of interesting experiments in correspondence teaching, area schools and school broadcasting. The Australian Broadcasting commission's "Kindergarten of the Air" was an original venture that proved highly successful. Kindergartens, which spread widely only after the 1940s, are a municipal responsibility. Technical education, including agricultural training, is highly organized, and children have in practice a free choice between three types of secondary education—technical, academic and general.

There is a well-established university in each of the seven capitals, the universities of Melbourne and Sydney being among the oldest in the Commonwealth of Nations outside of the U.K. Both cities have set up second universities to cope with increasing student numbers. A purely research institution, the School of Advanced Studies of the Australian National university, Canberra, began work in 1947 in the fields of medicine, the physical sciences, the social sciences and Pacific studies.

The Australian Universities commission set up in 1959 was given wide responsibilities in the field of university development, matching the increased and now predominant federal contribution to university finances.

Substantial equality of opportunity in education in Australia has, however, been only a late achievement, and the proportion of university graduates educated in private schools has greatly exceeded these schools' share in the total school population. Commonwealth scholarships for undergraduate (and postgraduate) study for most students with the requisite ability have improved matters, and the main neglect of talent is now at the secondary level. All states have established adult education services, in some cases building on privately developed workers' educational associations.

Health.—All levels of government—federal, state and municipal—are concerned with public health; the municipalities function largely as agents for the administration of state government policies in this field, the commonwealth government's concern being with the administration of benefits and medical research. An example of work involving all three levels was the Salk polio vaccination campaign, in which the commonwealth procured and paid for the serum, the states organized the distribution and provided doctors, and the local authorities provided premises and publicity.

Each state department of health is responsible for infant welfare and school medical and dental services, for the treatment of infectious and contagious diseases and tuberculosis, for industrial hygiene programs, for the maintenance of food and drug standards, for public hospitals and the regulation of private hospitals and for mental hospitals. The National Health and Medical Research council, a committee of senior commonwealth and state health officers and medical specialists, advises the federal and state governments on public health policies and supervises the distribution of the main federal grants for medical research. The commonwealth government maintains a large number of specialist medical research institutions, among the most notable being the Commonwealth Serum laboratories, the Commonwealth Acoustic laboratories, the Commonwealth Bureau of Dental Standards, the School of Public Health and Tropical Medicine, the Institute of Child Health, the X-ray and Radium laboratory and the Australian Institute of Anatomy.

Housing.—While both commonwealth and state governments assisted house purchases and some states had slum clearance schemes, housing was not widely regarded before 1939 as a public responsibility. The 1939–45 shortage and the pressure of postwar migration (at the peak of the program Australia was attempting to absorb a population increase of 3% annually including natural increase) brought public housing to the forefront of official preoccupation. In 1945 the commonwealth undertook the subsidizing of state-built houses to the order of about 10,000 each year. The renewal of the agreement in 1957 with a change of commonwealth government eliminated rent subsidies and needs tests and removed the emphasis on rental housing but maintained the level of output.

The emphasis on home ownership in Australia is remarkable, approximately 63% of the dwellings being owned or in process of purchase by occupiers. Houses are of reasonably high standard, with an average of 1.4 rooms per person in all residences. One of the most striking features of housing after World War II was

the high proportion of new houses that were owner built. In 1950 both Sydney and Melbourne prepared town plans, for unregulated sprawling had begun to impose serious difficulties on the development of public utilities.

Justice.—The Australian legal system is derived from, and still closely follows, that of England. Australian courts pay high regard to English judicial decisions, and common law supplements law made by parliaments and their delegates. Each state has a supreme court and a system of subordinate courts with a variety of names. Judges are appointed by executives, but convention secures them a high degree of immunity from executive interference. Juries are used in the more serious types of criminal prosecutions; they are not used in petty criminal courts, and only to a limited extent in civil cases. Unpaid justices of the peace, usually without legal training, are extensively used in subordinate courts.

The federal high court is a general court of appeal from the state supreme courts, as well as being the court of original jurisdiction for cases involving constitutional issues. The federal constitution gives a limited right of appeal from the high court to the privy council, but the leave of the high court itself is necessary and is rarely given (only a handful of major cases on the interpretation of the federal constitution has gone to the privy council since federation).

The growth of administrative tribunals in Australia has been steady; it has been estimated recently that three-quarters of all cases are heard outside the courts.

Defense.—Subject to the authority of the cabinet, the federal minister and department of defense are responsible for the formulation and general application of a unified defense policy. Within that policy separate ministers and departments of the navy, army and air are responsible for the administration of the services, and the department of supply for meeting the supply and production requirements of the services. The department of defense maintains three major policy-making bodies: (1) the defense committee, comprising the secretary of the department of defense and the chiefs of staff of the three services, which advises on policy as a whole; (2) the chiefs of staff committee, which is responsible for strategic appreciations and military plans, the control of special forces and control of war operations if a commander in chief is not appointed; and (3) the joint war production committee, which relates industrial war potential to strategic plans.

The numerical strengths of the three services, including citizen forces, in 1964 were navy 19,000, army 54,000 and air force 18,000. Expenditure on war and defense has averaged about 16% of expenditure by public authorities.

The government's three-year program of defense announced in 1964 would raise total defense spending by almost 50%. It introduced a selective compulsory training and service scheme for men aged 20. The new defense program would also hasten the modernization of the army and the further re-equipment of the navy and air force. In all three services the developments were primarily identified with a defensive role, but they could provide an offensive potential against an aggressor in southeast Asia if the need for one should arise. (A. F. Ds.)

VI. THE ECONOMY

Important changes took place in the structure of the Australian economy during and after World War II. The share of the gross national product earned by the agricultural and mining industries (primary) showed a relative decline, while a much greater proportion could be traced to manufacturing and building (secondary and tertiary) industries. There were similar changes in the distribution of labour. Employment in the primary industries declined relatively (although growing absolutely), whereas employment in the manufacturing and building industries grew both absolutely and relatively.

The importance of the pastoral and agricultural industries does not lie in their direct contributions to national wealth but in their export earnings. Fluctuations in world prices for primary products cause considerable variations in export earnings, but as the reserves of exchange have been built up the internal Australian economy has become less susceptible to swings in the level of business activity in the world at large.

Changes in the structure of the economy are also reflected in the composition of Australia's imports. A decreasing proportion consists of elaborately transformed articles, while an increasing share is made up of raw materials for Australian factories. Thus, the traditional view of Australia as a predominantly agricultural and pastoral economy, exporting foodstuffs and raw materials and receiving in return elaborately manufactured goods, is outmoded; an increasing proportion of Australia's requirements in goods and services is now being supplied from local sources.

A. Production

Agriculture.—*Environment and the Use of Land.*—The use of land in Australia is influenced by both the physical environment and the socioeconomic environment. Among the factors making up the physical environment are the topography, soils, vegetation and—of overriding importance in this continent—the climate, particularly the incidence and reliability of rainfall in relation to the rate of evaporation (see *Climate*, above). Aridity and the distance from markets prevent the commercial use of about 34% of the total land area of Australia; all attempts to introduce stock into this region, which stretches north from the Great Australian bight and includes large portions of South Australia, Western Australia and the Northern Territory, have failed. Another 42% of the land area, to the north, east and west of this arid zone, receives only enough rain to support cattle and sheep. Less profitable than sheep, cattle are found in the drier interior tracts, in the hot humid areas in the north and in humid upland and coastal areas in the southeast.

Elsewhere sheep grazing predominates except in areas suitable for crops. (For land use map *see* Agriculture.) The remainder, about 24%, receives sufficient rainfall to support agriculture, but much of this area is mountainous or has poor soils. Thus, the area suitable in all respects for the cultivation of crops is no more than 8%, but a considerable part of this is used for intensive sheep and cattle raising and dairy farming. Only a little more than 1% is actually under cultivation.

There have been many changes in the socioeconomic environment since the beginning of the 19th century. For example, mechanization made possible the extensive cultivation of wheat; refrigeration encouraged the development of beef production to supply northern hemisphere markets; and irrigation, particularly around the Murray river and its tributaries, permitted the growth of intensive mixed farming. At any given time, therefore, local and world market conditions, the accumulation of wisdom gained from practical experience and the state of technology considerably influence the actual use made of land within the broad limits set by the physical environment.

Special mention must be made of floods and droughts, pests and diseases. In northern areas of Australia, monsoonal summer rains bring road transport to a standstill and close stock routes, whereas during the winter dry season watering points are essential on properties and stock routes. Over most of the western half of Queensland extending into northern New South Wales, northeast South Australia and the southeast of the Northern Territory, water for stock can be obtained from the Great Artesian basin (see *Artesian Water and Irrigation*, above). In general this underground water is too high in mineral content for irrigation purposes. The presence of carbonate of soda, for instance, makes a hard pan of all but the sandiest soils. In southern areas winter rains cause flooding in some parts of the eastern coastal plain, while the relatively dry summer makes hand feeding or the movement of stock to more favoured areas a common practice in some regions of the inland pastoral zone.

Australia is well endowed with natural fodders; saltbush is nutritious and drought resisting, and a wealth of ephemerals, chiefly composites and grasses, are found after rains. In many parts of the extensive pastoral country the problem is to maintain even the present low carrying capacity by better management (improved watering, fencing, resting pasture and conservative stocking). In climatically more favoured zones pasture improvement

has been achieved by sowing introduced species and better strains of plants and by correcting soil nutrient deficiencies. The area under sown grasses and clovers increased substantially. Introduced species include perennial rye grass, cocksfoot, white clover, paspalum, Rhodes grass and, of particular importance, subterranean clover. Most Australian soils are deficient in nitrogen and phosphate, and the joint use of legumes, such as subterranean clover, and superphosphate and trace elements, such as copper, zinc and molybdenum, has done much to improve pastures in southern areas.

A wide range of plant and animal pests and diseases exists in Australia. In the inner more sparsely populated areas dingoes still cause heavy losses (up to half the calves and lambs born in some districts). Various control methods have been adopted, such as barrier fences, traps and poisoned baits, and a bounty is paid for each dingo killed. Rabbits were again becoming a serious pest by 1960 even though their numbers had been greatly reduced early in the 1950s by the use of the virus myxomatosis. Major pests in the pastoral industry are the blowfly, which attacks sheep, and the cattle tick, the monetary loss from which has been estimated at £A10,000,000 annually. Agricultural crops are subject to a wide range of insect, fungal, bacterial and virus diseases.

Sheep and Wool.—Sheep constitute the most important single element in the Australian pastoral industry. After 1947 (following a severe drought in 1945) there was a continuous upward trend in sheep numbers. These amounted to 160,000,000 in 1963 (17% of the world total) and produced about 30% of the world's wool.

There is a direct relationship between rainfall and sheep density. Densities are greatest in areas receiving from 15 to 20 in. (381 to 508 mm.) of rainfall each year. Below 15 in. the density decreases, but above 20 in. the density remains fairly constant until 30 in. (762 mm.), when sheep give way to cattle. Merinos predominate in areas having less than 20 in. annually, but relatively dense populations of crossbreds and British breeds are found in areas that receive up to 30 in. in temperate to cold climates. Sheep seem to do best when the average annual rainfall is between 15 and 25 in. and average temperatures are between 55° and 70° F. (12.7° and 21.1° C.). There are, however, dense sheep populations where midwinter average monthly temperatures are below 55° F. (coupled with relatively high rainfall), such as in the highlands of southeastern Australia, and where midsummer temperatures are above 70° F. (coupled with relatively low rainfall), such as in central Queensland. However, sheep are not run in such areas as the eastern coastal fringe and the far north, which experience both high rainfall and high temperatures.

A threefold specialization occurs within the sheep industry. First, in the semiarid areas with unreliable rainfall, emphasis is placed on the production of fine wool; most of the sheep are Merinos because of their ability to survive unfavourable conditions of heat and humidity and because of the high value of their wool. Second, in the wheat and sheep areas, which have higher and more regular rainfalls, there is a tendency to run dual-purpose crossbred animals producing wool and meat of good quality for local and overseas markets. Third, in southern Australia, with high rainfall and reliable seasons, the emphasis is on fat lamb and mutton production, with coarse wool as a by-product. The Merino is the dominant breed in most areas followed by comeback (Merino crossed with any English breed and offspring crossed back to Merino), crossbred and other. Carrying capacity reaches one sheep per acre on natural pastures throughout fairly large areas in the higher rainfall country but falls to one sheep per 30 ac. in the drier areas; country with a lower carrying capacity than this is generally used for cattle, which can seek fodder farther away from watering places.

The size of Australia and the wide variations in climate permit shearing to continue all the year round. The quality composition of the Australian clip is: 70s and finer, 2.7%; 60s to 70s, 72.0%; 50s to 60s, 22.7%; below 50s, 1.0%; and oddments, 1.6%. (The quality, 60s, etc., is a measure of the fineness and texture of wool for spinning purposes; broadly, it means the number of hanks of yarn, each 560 yd. long, that can be spun from one pound of combed wool; *i.e.*, wool of 60s quality will produce 60 such hanks.) Australia is particularly well suited climatically for the production of extra fine Merino fleeces and supplies about one-half of all Merino wool. After being graded, baled and transported to selling centres in the capital cities and main country towns, the wool is sold at open auction to buyers from all over the world. The annual production of wool in 1963–64 on a greasy equivalent basis exceeded 1,750,000,000 lb., of which (including raw wool, woolen tops, and woolen and worsted yarns) about 93% was exported, mainly to Japan, the United Kingdom, Italy and France. The average annual export of wool was about 35%–38% of all merchandise exports. The production (carcass weight) of mutton and lamb in 1963 was 594,000 tons.

Beef Cattle.—The Australian cattle industry has not attained a position comparable to that of the sheep industry, and, in general, cattle are found in areas not suitable for other pastoral activities (although most sheep farms have at least some cattle).

About 25% of the beef cattle are found scattered along the eastern and southern seaboards or over parts of the continent having temperate or subtropical climates, and generally only in the rougher country or as a means of controlling rapid growth on sheep properties. The other 75% of the cattle are in the north and northwest of the continent, where the conditions of summer heat, humidity and rank growth are unsuitable for sheep. The cattle there are run on large holdings, chiefly under open-range conditions: the carrying capacity in some areas being as low as one beast per square mile. In the least-favoured areas on holdings commonly exceeding 1,500 sq.mi. (the largest, Alexandria), the main concern is with breeding animals that, on reaching maturity are moved for fattening to smaller holdings in the better districts.

The southern area produces a greater proportion of Australia's beef than the share of the cattle numbers might suggest, because the turnoff is higher than in the north (where most beasts killed are at least four years old), because cattle numbers are increasing at a higher rate and because a considerable amount of beef comes from dairy cattle.

From the northernmost areas cattle move to the export meatworks on the Queensland coast; it is normal for cattle to be driven several hundred miles along stock routes (with watering points 20 and sometimes 70 mi. apart) to railheads and thence to the coast in stock trains. Arriving in deteriorated condition, the cattle are refattened, the average carcass weight of cattle slaughtered at the Queensland export meatworks being about 650 lb. From south-central Queensland the cattle move toward the main local markets in the southeast, 470,000 cattle (the equivalent of about 100,000 tons of beef) move into New South Wales each year and some move from New South Wales into Victoria.

In 1963 beef cattle in Australia totaled about 13,400,000. The important breeds are Shorthorns, Herefords, Aberdeen Angus, Devon and Red Polled, but crossbreeding occurs widely.

Australia consumes 56% of its beef output, cans 6% and exports 38%. The Australian industry was at a disadvantage until it was shown that beef could be successfully transported from Australia to the United Kingdom in a chilled condition. Chilled beef shipments began experimentally in 1932–33, but World War II put a temporary stop to this trade. After the war the export of chilled and frozen beef was resumed.

Dairy Farming.—In the early 1960s there were approximately 5,000,000 dairy cattle in Australia, of which about 65% were dairy cows. The main dairying areas are in the eastern mainland states, particularly Victoria, coastal New South Wales and southeastern Queensland, with smaller concentrations in the western lowlands of Tasmania, in the Mt. Lofty ranges east of Adelaide and south of Perth.

Some cattle, usually those producing whole milk for town supply, are given supplementary rations under stall-feeding conditions and are almost independent of climatic conditions. Some are raised on irrigated areas that generally are used to full capacity for nine months of the year, but most are maintained on dry pastures so that their production is related to climatic variations. Climatic conditions make it unnecessary to house cattle.

Field Crops.—The average acreage under cultivation in the early

1960s in Australia was about 30,000,000, of which 67.9% was cereals for grain, 14.9% green fodder, 10.0% hay, 1.7% industrial crops, 1.0% orchards and fruit crops, 1.4% vegetables for human consumption, 0.4% vineyards and 2.7% various other crops. It has been estimated that after taking into consideration climatic, physical and soil conditions, as well as competing land uses, this acreage is about half the maximum possible for cultivation, although expansion of the area is largely dependent on economic considerations. However, in some areas, notably in Victoria, crop acreage could increase only at the expense of other land uses. The agricultural areas of Australia consist of the wheat belt (which includes areas producing most of the barley, oats and sorghum) and intensively farmed areas where there is fertile soil and good supplies of rainfall or irrigation water.

Wheat.—The greater part of the wheat crop is grown in areas having between 15 and 20 in. (381 and 508 mm.) of rain annually, but the amount of rain between April and October, the growing season, is extremely important. Generally, wheat is sown on cultivated fallow land; to conserve moisture and assist nitrification the land is given an initial plowing in winter or early spring and then kept weed free until the following winter when the crop is sown. More commonly, in districts with adequate rainfall the fallow period is shortened to reduce soil erosion and to allow clover-based pasture to be introduced into rotation. Nitrogenous fertilizers are unnecessary, but superphosphate is applied to most parts of the wheat belt except in northern New South Wales and Queensland, and in some areas trace elements are also added. The area under wheat increased from an average of 14,345,000 ac. (5,805,000 ha.) in the 1930s to 16,900,000 ac. (6,839,000 ha.) in the mid-1960s. Yields increased from 11.8 bu. per acre pre-World War II to 20 bu. per acre in the mid-1960s.

Although Australian yields are low by European standards, output per man is high. This is because of the highly mechanized nature of the industry, the flat to undulating country and the exceptionally dry conditions at harvest time, which allow the grain to be reaped and threshed simultaneously in combine harvesters. The total size of the typical wheat farm is about 1,000 ac. (larger, however, in the drier districts), and the area of wheat per man is 200 ac. About one-third of the Australian sheep population is run on wheat farms; usually they are kept for fat lamb production, but in more remote districts the emphasis is on wool production. On smaller farms the whole area may be under wheat, with the sheep grazing on fallows and stubbles, but on larger properties perhaps only one-quarter of the area may be under cultivation.

Wheat varieties have been developed to suit local conditions, and include early maturing varieties and others resistant to diseases. Of the 45 varieties grown the most popular are Gabo, Bencubbin and Bungalla.

Annual exports of wheat (including flour in terms of wheat) average about 200,000,000 bu. (72% of the crop). In the 1960s China became the main buyer of Australian wheat, taking 35.3% of the exports in 1961–62 and 47.5% in 1962–63. No wheat is imported. Usually 70% of the wheat export is sent abroad as grain, mainly as complete cargoes in charter vessels. Most Australian wheat belongs to the soft white class; and although it has a poor protein quality (9%–10%), its high extraction rate and its whiteness make it popular for mixing with the hard red wheats of North America.

Other Cereals.—Oats and barley occupy approximately 15% and 11%, respectively, of the area sown for cereals for grain.

Oats are produced chiefly in the wheat-growing belt in Victoria, New South Wales, South Australia and Western Australia. Average production in the early 1960s was 64,000,000 bu., of which 28% was exported, chiefly to the Federal Republic of Germany, the Netherlands, China and the United Kingdom.

Barley is grown as a specialized form of cereal production in certain favoured regions of the wheat belt, with South Australia (particularly Yorke peninsula) and Victoria as the chief producing states. Average production in the early 1960s was 41,500,000 bu., of which half was exported.

Maize (corn) is cultivated chiefly along the eastern side of the continent from the Atherton plateau in Queensland south to Victoria. New South Wales and Queensland accounted for most of the 210,000 ac. (85,000 ha.) planted to this crop and for most of the production of 7,000,000 bu. The maize acreage has declined since before World War II and is now mainly a sideline activity on dairy farms.

Grain sorghum was of minor importance before World War II, but after the war the area planted and production both expanded to reach about 380,000 ac. (150,000 ha.) and 9,700,000 bu., most of it being grown in the higher-rainfall areas of Queensland and New South Wales. This crop has tended to replace maize in some of the drier areas because of its superior capacity to withstand low soil moisture conditions and because it can be handled mechanically from planting to harvesting.

Rice is grown commercially mainly in the Murrumbidgee and Wakool irrigation areas of New South Wales. Commercial production began in 1924–25 and, favoured by tariff protection and high average yields, expanded sufficiently to meet Australia's domestic requirements by the early 1930s. Further expansion occurred during and after World War II. By the early 1960s there were 55,000 ac. devoted to this crop, which produced 7,000,000 bu., of which 36% was exported, mainly to Papua and New Guinea, the Pacific islands and the United Kingdom. Rice is grown on irrigated pastures; it is a highly mechanized industry, with high yields by world standards. Rice acreage (averaging about 57 per holding) is controlled by the quantity of water made available to each grower. Attempts are being made to develop commercial rice production at Humpty Doo, Northern Territory, and in Western Australia.

Green Fodder and Hay.—The area devoted to green fodder crops includes more than 4,800,000 ac. (1,900,000 ha.) made up of oats, alfalfa, wheat, barley, sorghum, rye and others. The sowing of green fodder crops to supplement natural grazing is a growing practice in the dairying industry. The area cut for hay fluctuates according to climatic and economic conditions but averages about 2,500,000 ac. Wheat and oats are the main crops used for cereal hay although the acreage has dropped as mechanization has increased.

Industrial Crops.—The area planted to industrial crops, consisting of sugarcane, flax, peanuts, tobacco and cotton, averages more than 700,000 ac.

Sugarcane production is confined to the coastal fringe of Queensland and northern New South Wales (particularly the Richmond river district). As this area has high summer rainfall (at least 40 in. annually) and no frosts, it meets the climatic requirements of this crop. More than half the sugar acreage is north of Mackay, Queensland, and one-fifth of the acreage is irrigated. The average area cut for crushing (360,000 ac.) is about 76% of the total, the remainder being young and standover cane or required for plants. The industry is controlled by joint commonwealth and Queensland government legislation, production being limited to demand by restricting the area under cultivation. Sugarcane cultivation is mechanized, but only 3% is mechanically harvested. About 92% of the raw sugar in Australia is now handled in bulk without being bagged at any stage.

Production of raw sugar in the early 1960s totaled approximately 1,830,000 tons, of which 61% was exported (some in the form of manufactured products). The industry is protected by an embargo on imports of sugar and a two-price system under which the local price is adjusted to ensure a reasonable, equalized return to the producer.

Flax is grown for flax fibre and linseed oil. The acreage of flax for fibre averaged about 6,000 ac., but in 1961–62 it fell to 400 ac. as the commonwealth government, which had taken an active interest in this industry, decided to withdraw. Production of flax for linseed oil began in 1948–49 during a world shortage; about one-fifth of Australia's needs are now met from 95,000 ac., mainly on the Darling downs, Queensland. This crop competes with wheat in the better wheat-producing areas.

Peanut growing is mainly confined to the Kingaroy district in southern Queensland. Average production is about 14,000 tons from 35,000 ac.

Tobacco is grown chiefly at Mareeba-Dimbulah, Queensland;

at Texas (on Queensland-New South Wales border); near Myrtleford, Victoria; and at Manjimup, Western Australia. Total acreage under tobacco was about 27,000, and production totaled 20,000,000 lb. of dried leaf (about one-third of Australia's requirements).

Cotton growing used to be confined to Queensland, but is it now also being grown in New South Wales and, experimentally, in the Ord river area of Western Australia, in South Australia and Victoria. The commonwealth government pays a bounty to growers based on quality and related to 16.125*d.* per pound for middling one-inch white raw cotton.

Orchards and Fruit Crops.—The varieties of fruit grown in various parts of the continent range from pineapples, pawpaws and mangoes in the tropics to strawberries, raspberries and currants in the cooler parts of the temperate zone. The acreage under orchards and fruit gardens averaged 290,000 in the early 1960s.

Vineyards.—The acreage under vineyards in the early 1960s was about 130,000 (53,000 ha.), concentrated in the Murray valley areas of South Australia, Victoria and New South Wales, where the crop was grown under irrigation. About 49% of the acreage produces grapes for drying, and the production of raisins and sultanas totaled 88,000 tons (of which 66% was exported) and of currants 8,000 tons (of which 59% was exported). Wine grapes are produced in the Barossa valley, South Australia, and at other vineyards along the Murray and Hunter rivers, in the Murrumbidgee irrigation area and in the Swan river valley, Western Australia.

Vegetables for Human Consumption.—Of the 270,000 ac. (110,000 ha.) devoted to producing vegetables for human consumption, about 35% is used for potatoes, two-thirds of which are grown in Victoria, New South Wales and Tasmania. A substantial amount of the fresh vegetables is grown near the main urban markets, but distant specialist growing areas became increasingly important by the 1960s.

Agricultural Organization and Policy.—Agriculture and marketing of products within a state are functions of the state government, but the commonwealth government has powers over interstate and overseas marketing of rural produce. (Commonwealth and state powers are both limited by sec. 92 of the constitution, under which interstate trade must be absolutely free.) Each state has an agricultural research and extension service, although the intensity of extension activities is limited by the great distances to be covered. State research work is supplemented by investigations carried out by the Commonwealth Scientific and Industrial Research organization.

State marketing boards have been established for a variety of products; the most important exception is wool, which is sold at auction to buyers from all over the world. Exports of agricultural products are in most cases governed by a series of export control boards (wheat board, Australian meat board, Australian dairy produce board, etc.), on which producers have a majority representation. During and after World War II many rural exports (but not wool or wheat) were sold under intergovernmental contract on a bulk basis to the United Kingdom. Generally, policy has favoured stability in internal and overseas marketing of primary products because of the importance of agriculture and the inflationary effects of fluctuations in export income. Hence, Australia was a party to the International Wheat agreement and the Commonwealth Sugar agreement and introduced stabilization schemes for the wheat and dairy industries.

Internally, co-ordination of agricultural policy at the commonwealth level is achieved through the Australian Agricultural council (consisting of commonwealth ministers for primary industry and the territory and state ministers for agriculture) and its subsidiary, the standing committee on agriculture, on which administrative and technical officers of state and commonwealth are represented.

After World War II Australia suffered from a major drought (1944–46) and from grave shortages of materials, equipment and manpower. Thus, despite a stronger financial position than existed before the war, the rate of increase in farm productivity not only lagged behind need but also behind achievements in the United Kingdom and the U.S. A five-year agricultural expansion program began in 1952, which substantially assisted the industry; production in the early 1960s was 35%–40% above prewar, and 50% above immediate postwar, years.

Australia's agricultural problem at the beginning of the 1960s was not productivity but the steady deterioration in world commodity prices and hence declining export values, and the competition represented by high domestic subsidies in continental Europe and in the United Kingdom and the dumping of U.S. surpluses. Policies set forth in the General Agreement on Tariffs and Trade (G.A.T.T.) and elsewhere are concerned with minimizing restrictions on Australia's exports.

Forestry.—Most of the original forest cover was cleared to make way for crops, pastures and settlements, and to supply the timber needs of an expanding economy. It was estimated in the early 1960s that the total area of forest in Australia was 512,000,000 ac. (207,000,000 ha.), or about one-quarter of the total land area of the continent, but only 19,200,000 ac. consisted of residual prime native forest. Four-fifths of the total forested area carried only sparse, stunted tree growth. Of the accessible forest area (320,000,000 ac.), only 30,000,000 ac. were in productive use. Forests fit for commercial exploitation are mainly restricted to the wetter belts of the coastal areas and near-coastal highlands of the eastern states and to the extreme southwest of Western Australia.

About 94% of the indigenous forest area consists of hardwoods. The genus *Eucalyptus* (of which there are more than 500 species, most of them indigenous to Australia) grows under a wide range of climatic conditions, ranging from the cold, wet uplands of Tasmania to the hot, dry inland areas of Western Australia. The genus includes such species as the mountain ash (*E. regnans*) of Victoria and the karri (*E. diversicolor*) of Western Australia. In the drier areas, by contrast, there are thickets of small, multiple-stemmed eucalyptus trees collectively known as mallees.

Less than 100 eucalypts are used for sawmilling, and only about 40 are exploited intensively. Among the outstanding commercial species are jarrah (*E. marginata*), mountain ash, blackbutt *E. pilularis*), spotted gum (*E. maculata*), messmate (*E. obliqua* karri, alpine ash (*E. gigantea*), tallowwood (*E. microcorys*), Murray red gum (*E. camaldulensis*) and ironbark (*E. paniculata* and others).

Commercial hardwoods of other genera include numerous furniture, cabinet and veneer timber trees, well known among which are red cedar (*Cedrela toona*, variety *australis*), Queensland maple (*Flindersia brayleyana*), southern and northern silk oak (*Grevillea robusta* and *Cardwellia sublimis*), Queensland walnut (*Endiandra palmerstonii*), blackwood (*Acacia melanoxylon*) and rosewood (*Dysoxylum fraserianum*). Turpentine (*Syncarpia laurifolia*) ranks with the world's best for wharf piles.

The most important indigenous softwoods were the forests of hoop pine (*Araucaria cunninghamii*) of Queensland and New South Wales. Although the greater part of the original hoop pine forest has made way for intensive agriculture, some areas in Queensland and, to a lesser extent, in New South Wales have been replanted with this species. Other native softwoods that have played a useful but minor part in the Australian timber industry include the bunya pine (*Araucaria bidwillii*) and the kauri (*Agathis* species) of Queensland, and the Huon pine (*Dacrydium franklinii*), celery-topped pine (*Phyllocladus rhomboidalis*) and King William pine (*Athrotaxis selaginoides*) of Tasmania.

To help overcome the deficiency in softwoods, 580,000 ac. of softwood plantations (75% of this area government owned) have been established. The principal species is *Pinus radiata*, but in subtropical regions *P. caribaea* and *P. taeda* have proved more successful. There are 31,000 ac. of hardwood plantations (mainly *Eucalyptus* species), but of greater importance are the areas of controlled natural regeneration of native hardwoods.

Sawn timber production exceeds 1,350,000,000 super. ft. annually. Much of this total is hardwood. Other timber, *e.g.*, sleepers (railroad ties), piles, fencing material, timber for mining, fuel is also cut, and an increasing quantity of pulpwood is being made for paper and fibreboard manufacture.

Australia has always been an importer of timber, largely to

make up for its lack of softwoods. Exports consist mostly of hardwoods (logs and undressed timbers).

Mining.—Mineral deposits in Australia occur in a region of Pre-Cambrian rocks in the western and central part of the continent—the relatively stable shield area—and in the region of folded Paleozoic rocks of the Tasman geosyncline in the east.

Exposed Pre-Cambrian rocks include much of Western Australia, South Australia and the Northern Territory, as well as portions of western Queensland and western New South Wales. They contain deposits of lead-silver-zinc, gold, tin, tantalum, mica, beryllium, manganese, uranium, etc.

Paleozoic rocks fringe eastern Australia from northern Queensland southward to include much of Tasmania and are host rocks for deposits of gold, copper, lead-silver-zinc, tin, tungsten, molybdenum, bismuth, etc. The highest-quality coal is found in Permian strata (the youngest Paleozoic rocks) in New South Wales, Queensland and, to a lesser extent, in Tasmania and Western Australia. Triassic (the oldest Mesozoic) rocks contain the most important deposits of coal in Queensland, Tasmania and South Australia, and Tertiary deposits of lignite (brown coal) occur in Victoria.

The almost unfolded rocks of the great Jurassic-Cretaceous-Tertiary basin from the Gulf of Carpentaria to the lower Murray valley lack metallic ores. While it may be expected that the great mass of the Pre-Cambrian shield is as rich as its margins, vast areas are covered by thick desert sands. However, the sedimentary rocks were deeply weathered during the Tertiary period, and opals and bauxite were formed near the surface.

The development of the Australian mineral industry began with the discovery of copper in South Australia in 1842. It was followed by the discovery of gold in the eastern states in 1851; of copper, tin and lead-zinc in the eastern states and Tasmania (Mt. Bischoff, 1871; Broken Hill lode, 1883; Mt. Lyell, 1886); and of rich goldfields in Western Australia (Coolgardie, 1892; Kalgoorlie, 1893). Apart from their monetary value an important effect of these discoveries was the encouragement given to settlement inland.

Australia is deficient in a few vital minerals, including petroleum, rock phosphate, elemental sulfur and tin. New deposits of bauxite, iron ore, manganese, copper and uranium have been discovered, and new developments have occurred in some of the older mining areas, such as Broken Hill; Mount Isa, Queensland; and Mt. Lyell, Tasmania.

Of the total local value of Australian mineral output in 1961, metallic minerals made up 42% (copper ore 12%, lead and lead-silver ore 9%, gold ore 9%, iron ore 3% and zinc concentrate 3%); fuel mining made up 36%; and nonmetallic mineral mining 22%.

Each state administers its own mining industry, determines the

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FIG. 8.—MAJOR MINERAL RESOURCES IN AUSTRALIA

level of royalties, provides financial assistance and operates a geological department. The commonwealth government administers mining in the territories, controls the export of certain metals and minerals, operates the bureau of mineral resources, geology and geophysics and provides financial assistance.

Coal.—All the good-quality coal in Australia is Permian or later. Of the measured and indicated reserves of semianthracite (small amount only) and bituminous coal, 90% is in New South Wales; of subbituminous reserves 65% is in New South Wales, and smaller amounts are in Western Australia and in South Australia; practically all the brown coal reserves are in Victoria. Inferred reserves of all grades of coal are large except in South Australia.

Black coal production in Australia exceeded 24,850,000 tons in 1963, 90% being obtained by underground working. The exploited seams are rarely deeper than 1,500 ft., and, although they vary in thickness, the gradients are flat and few problems arise from water or gases. At Callide and Blair Athol, Queensland, the seams, being 50 ft. or more thick, are among the thickest suitable for opencut working in the southern hemisphere.

Most Australian black coal is obtained in New South Wales and comes almost entirely from Permian deposits in a basin extending along the coast from Newcastle to Ulladulla and inland to Dubbo and Gunnedah. The chief workings are in the Hunter valley, in the vicinity of Newcastle, Maitland, Cessnock and Muswellbrook, with others around Lithgow and Bulli-Wollongong. Most large coalfields are located in the coastal region in areas with good rainfall, ample water supply and well-developed transport systems, and, being near large urban centres, are conveniently placed to supply secondary industry.

Australia exported 3,175,000 tons in 1963, mainly to Japan. In the 1960s overseas interests exploited coal deposits, particularly those that could be worked by opencut methods in Queensland, for export. For instance, from Moura, coal is exported to Japan through Gladstone, 200 mi. (320 km.) E.

The chief deposit of brown coal in Australia is a faulted-down trough of Tertiary brown coal around Morwell, 80 mi. E. of Melbourne. This fuel is used for electricity generation (at Yallourn), for briquetting and for the production of town gas (at Morwell), which is piped to Melbourne.

Iron.—Iron ore is widely distributed throughout Australia. In recent years very large reserves have been discovered—those in Western Australia alone have been conservatively estimated at more than 8,000,000,000 tons. In 1938 the commonwealth government prohibited the export of iron ore but early in the 1960s relaxed this embargo and by the end of 1964 had given approval for the export of 500,000,000 tons (mainly from Western Australia) over a period of years. Output in the early 1960s came from the Iron Monarch and Iron Baron deposits (Middleback range, South Australia) and from Yampi sound (Western Australia). Although some ore is smelted at Whyalla, South Australia (30 mi. [48 km.] from Iron Baron), and ore from Koolyanobbing is smelted at Wundowie, Western Australia, all that from Yampi sound is shipped to Newcastle and Port Kembla on the coalfields of New South Wales.

Lead, Zinc and Silver.—Australia is also a major producer of lead, zinc and silver. Much of the output of these metals comes from Broken Hill; other sources include Mount Isa, and Read-Rosebery, Tasmania.

Ore is dressed to concentrates at the mines. The Broken Hill lead and silver are converted into metal at Port Pirie or exported as concentrates, and the Mount Isa lead is smelted at the mine and exported as bullion. About half the Broken Hill zinc concentrate is exported overseas from Port Pirie, and the remainder is electrolytically treated (together with the whole of the output from Rosebery) at Risdon, near Hobart, Tasmania. Mount Isa zinc concentrates are all exported. About 92% of the silver is a by-product of lead-zinc mining.

Tin.—The annual mine production of tin averaged about 2,700 tons, produced mainly in Queensland and Tasmania, with small quantities coming from the other states. Imports of refined tin exceeded 1,775 tons.

Copper.—The mine copper production increased considerably after World War II and by the mid-1960s averaged about 120,000 tons. Half the Australian total comes from the Mount Isa mine and lesser amounts from Mt. Lyell; Mount Morgan, Queensland; and the Peko mine at Tennant Creek, Northern Territory. Blister copper is produced at Mount Isa, Mount Morgan, Port Kembla and Mt. Lyell, and refined at Townsville, Port Kembla and Mt. Lyell.

Gold.—Gold produced since 1851 amounts to more than 181,000,000 fine ounces (gold content of minerals produced), most of which comes from Western Australia and Queensland. With an annual average production of 1,100,000 fine ounces, Australia ranks fifth in world output. Of the Australian output, Western Australia produces 81%, more than one-half from the Coolgardie fields and much of the remainder from the Murchison, Dundas and Yilgarn fields. Other producing areas are Broken Hill; Chewton, Victoria; Mount Morgan and Cracow, Queensland; Tennant Creek; and Rosebery.

Original diggings were in superficial alluvial deposits that contained several nuggets of more than 1,000 oz., including the "Welcome Stranger," which weighed 2,520 oz. The exhaustion of easily worked deposits and increased costs of deep mining caused gold production in Australia to decline after 1903.

Uranium.—Production of uranium oxide is now confined to treatment at the Rum Jungle (Northern Territory) plant of stockpiled ore, and at the current rate it would operate until 1971. Production of uranium oxide totaled 1,084 tons in 1963, but the Mary Kathleen plant ceased operations at the end of that year.

Oil.—Australia is deficient in oil; crude oil and petroleum products form the largest single import item. The 70-year search for oil was rewarded in 1961 when a field was discovered at Moonie, 190 mi. (306 km.) W. of Brisbane (Queensland). Since then new strikes or developments have been frequently announced. In March 1964 the Moonie field came into commercial operation, and crude oil was pumped along a new 200-mi., 10-in. pipeline (built at a cost of £A5,000,000) to Brisbane. More recently oil has been found at Alton, 55 mi. S.W. of Moonie, and the pipeline was to be extended there.

Natural gas prospects are also good. Since 1961 natural gas from Roma (280 mi. W.N.W. of Brisbane) has been used for electricity generation, and there are proposals for a pipeline to Brisbane. Four potentially important discoveries of natural gas have been made 280 mi. W. of Roma, 500 mi. N. of Adelaide, 120 mi. S.W. of Alice Springs and on Barrow Island, 900 mi. N. of Perth.

Total expenditure to 1962 on oil exploration in Australia and its territories exceeded £A100,100,000, 14% of which was contributed by government sources. During the years 1956–60 alone £A20,775,000 of overseas capital was invested in oil exploration, of which 60% was spent in Papua and New Guinea, 32% in Western Australia and 5% in Northern Territory. The commonwealth government encouraged the search for oil by tax concessions, subsidies and geological and geophysical investigations.

Bauxite.—Large deposits of bauxite at Weipa (north Queensland) and Darling range (Western Australia) were being developed in the 1960s. Weipa output grew from less than 20,000 tons in 1962 to 310,000 tons in 1963, of which two-thirds was exported to Japan and one-third smelted at Bell bay (Tasmania). A 200,000-ton capacity smelter was built at Kwinana (Western Australia), and one of 600,000-ton capacity was being built at Gladstone (Queensland) to begin operations in 1967.

Other Minerals.—Australia is the world's leading producer of rutile and zircon. Rutile (an oxide of titanium) is the main raw material for titanium metal and the principal mineral recovered from the eastern coast beach sands. Australian titanium production, stimulated by growing world demand, increased greatly. Opals are obtained mainly from the Coober Pedy and Andamooka fields, South Australia, and Lightning Ridge, New South Wales.

Adequate supplies are available of nearly all the raw materials required for the production of plaster, glass, earthenware, bricks, 'les and cement. Materials required in metal smelting, such as mite, fluorspar, magnesite and limestone, are also produced in Australia, and salt is obtained by evaporation of seawater and from inland salt lakes.

Fisheries.—Fish stocks in the southern hemisphere are small by comparison with those in the northern hemisphere, where most of the world's fish are obtained. The Australian catch is small, and sea food has to be imported.

Estuarine fishing takes place around the coast from Cairns, Queensland, to Ceduna, South Australia, and from Geraldton to Esperance, Western Australia. Mullet, Australian salmon and tuna make up about 40% of the Australian fish catch. Demersal fishing grounds consist of the reefs from which cod, snapper, etc., are taken, extending from northern Queensland around the southern part of the continent to Western Australia, and the continental shelf, from which flathead, morwong, etc., are taken off southeastern Australia and off the eastern Tasmanian coast. Demersal school shark grounds lie principally in Bass strait and off eastern South Australia. Snapper, flathead, morwong and shark make up 25% of the catch.

Pelagic or deep-sea fishing grounds include that for Spanish mackerel off the northeastern coast; that for barracuda in Bass strait and off eastern Tasmania; that for jack mackerel off southeastern New South Wales, eastern Tasmania and Western Australia; and that for tuna off New South Wales and Tasmania. Pilchards (sardines) are found from Moreton bay, Queensland around the southern coast of Australia to Western Australia, and anchovies are caught in Port Phillip bay and in Lakes Entrance, Victoria. Australian fisheries developed from onshore fishing to demersal reef fishing with long lines and, during World War I to trawling off the New South Wales coast; most vessels are Danish seiners. Tuna fishing increased considerably after the commonwealth government demonstrated in 1950 that this species could be caught in commercial quantities.

The annual average production of crustaceans totaled 39,000,000 lb. gross weight in 1961–62, of which crayfish represented 74% and prawns 20%. Crayfish production increased after 1945 to take advantage of the U.S. market for crayfish (lobster) tails.

Australia is the world's chief producer of pearl shell. Pearling is centred on Thursday Island, Torres strait, and at Broome, Western Australia and Darwin, Northern Territory. In 1956 a company began culturing pearls in Brecknock harbour, 270 mi. N of Broome.

In the early 1960s five coastal whaling stations operated, but by 1965 there was only one, at Cheyne Beach, Western Australia. The others had closed because of the shortage of whales.

Manufacturing.—Apart from the growing local market, events that fostered the growth of factory industry include: federation in 1901, with centralized customs and tariff control, a single tariff policy toward other countries and internal free trade; the extension of protection during the 1930s; and the stimulus of World Wars I and II. Spectacular growth took place during and after World War II. employment in manufacturing increased, and large amounts of capital were invested in both new and existing industries, including oil refining and the manufacture of motor vehicles, steel, chemicals and plastics. Although the United Kingdom has traditionally been the largest investor in Australian industry the United States provided about 30% during 1953–60. Net immigration from overseas (averaging about 90,000 persons a year since 1946) has greatly assisted in providing manpower for expansion and in stimulating local demand for manufactured products in the iron and steel industry, for example, about 25% of labour is supplied by immigrants.

The net value of production of Australian factories was about 60% of the total net value of recorded production. The chief groups were industrial metals, machines and conveyances; food drink and tobacco; clothing and textiles; chemicals, dyes and explosives; and paper, stationery and printing.

Manufacturing is concentrated in the state capitals, which have 73% of all factory workers as compared with 56% of the population. Each of the mainland capitals has attracted a dominant share of the state's industrial activities because of the availability of markets, labour, fuel, business and government contacts, and access to overseas and internal transport systems. Much of the

remaining industrial activity is located at a few large provincial centres on or near the coast, *e.g.*, Newcastle, Wollongong-Port Kembla, Geelong and Launceston, and at some inland urban areas; *e.g.*, Ballaarat and Bendigo. The leading industrial state is New South Wales followed by Victoria. The state governments compete with one another for industrial development and conduct separate promotion programs at home and overseas.

Industrial self-sufficiency has been pursued in Australia since the beginning of World War II, but the local market was not large enough to warrant the manufacture of some specialized machinery and apparatus. The metallurgical industry, by far the most important, does provide a measure of self-sufficiency in the basic requirements of manufacturing.

Basic Metal Industries.—The main centres of iron and steel production are the coastal cities of Newcastle, Wollongong-Port Kembla and Whyalla. There are completely integrated steelworks at Newcastle and Port Kembla, with a combined ingot steelmaking capacity in the early 1960s of 4,400,000 tons. These works draw ore from the Middleback range (South Australia) and from Yampi sound on the northwest coast. Limestone is obtained from Rapid bay, 60 mi. (97 km.) S. of Adelaide, and from Marulan, 75 mi. N.W. of Port Kembla. In May 1965 work was completed on a second blast furnace and other facilities that transformed Whyalla into Australia's third integrated iron and steel centre; it used coking coal from New South Wales and ore from the Middleback range. The rolling mill at Kwinana was being extended, and plans were in hand for a blast furnace and, later, for other facilities to make this the fourth steelworks in Australia; it would use iron ore from Koolyanobbing (360 mi. N.E. of Perth).

The Broken Hill Proprietary Company Ltd. (B.H.P.), by far the largest nongovernment enterprise in Australia, dominated the iron and steel industry both directly and through its subsidiaries and associates. In the mid-1960s this organization owned all the Australian blast furnaces and steelmaking capacity, except for a few electric and charcoal furnaces. Also within this combine are factories making pipes, wire and stainless steel products. In addition, B.H.P. operates the largest privately owned fleet in Australia, to carry ore, coking coal and finished products. Firms outside the group operate rolling mills and galvanizing works at Newcastle and Port Kembla, using feed from the steelworks, and have fabrication factories in most states.

Transport Equipment and Engineering.—World War II stimulated the Australian shipbuilding and repairing industry. There are five major shipyards, located at Sydney, Newcastle, Whyalla, Melbourne and Brisbane, and from 1942 to 1960, 75 merchant vessels, as well as naval and other craft, were launched.

Eight firms, all associated with overseas organizations, with a combined capacity of 330,000 units a year, assemble or manufacture locally about 95% of the passenger motor vehicles sold in Australia. In 1964 the commonwealth government compelled car manufacturers to increase the Australian component in their total costs to 95% within five years or suffer heavy tariff penalties. This stimulated still further investment in the industry. Exports total about 10,000 units annually. About 25,000 persons are engaged in the manufacture of vehicles, and 100,000 in their repair.

Australia produces much of its requirements of electric motors, as well as transformers, cables, electrical control gear, and radio and television equipment. Other products include railway equipment, machine tools, metal-working machinery, agricultural machinery, gasoline engines, pumps, builders' hardware and domestic appliances.

Oil Refining.—The eight main refineries in Australia are located on the coast at Kurnell (two), Matraville and Clyde (New South Wales); Geelong and Altona (Victoria); Kwinana; and Halletts Cove (South Australia). Only one of these was in operation before 1948. Two refineries under construction at Brisbane would receive part of their crude oil by pipe from the Moonie and Alton fields. Capacity increased from 800,000 tons in 1954 to 21,330,000 tons in 1965. A new oil refinery was being constructed near Melbourne.

Textiles.—The Australian wool textile industry consumes about 7% of the wool clip. There are about 135 woolen mills (mainly in Victoria and New South Wales) producing woolen and worsted cloth, blankets and rugs. Many mills are vertically integrated, undertaking all or most of the processes from wool scouring to weaving and finishing. Cotton-spinning and weaving mills use mainly imported raw cotton to produce an extensive range of goods, including duck and canvas, denims, drill, etc., and tire cord and fabric. Since 1961 three firms have started fine count spinning.

Power.—The total installed electric generating capacity was 7,220,000 kw.hr. in 1962. Steam plants generated power mainly from coal, of which nearly one-half was from the lignite deposits in southeastern Victoria. In addition small but increasing amounts of fuel oil were used. Improvements in high-voltage transmission and rising transport costs inspired the building of coal-fired steam plants near the coalfields, away from the main load centres.

Hydroelectric power plants are restricted to the elevated regions that receive adequate and reliable rainfall, such as the highlands of Tasmania and southeastern mainland Australia, as well as some minor schemes in Queensland. Most hydroelectric power projects have been built primarily for electricity generation, *e.g.*, the Tasmanian system and the Kiewa scheme in Victoria, or as ancillary to water storage for irrigation purposes; *e.g.*, Burrinjuck dam in New South Wales and Eildon dam in Victoria.

The Snowy Mountains hydroelectric scheme is a 30-year project being designed and constructed by the Snowy Mountains authority (a commonwealth instrumentality constituted in 1949), which will supply both electricity and irrigation water by diverting the waters of the Snowy river system to the inland, westward-flowing Murray and Murrumbidgee systems. The scheme is due to be completed in 1972 and is expected to cost about £A400,000,000.

In Tasmania hydroelectric power stations produce both the base and the peak load power, whereas in general the mainland stations are used to supplement the thermally produced base load at times of peak demand. (G. J. R. L.)

B. Trade and Finance

Foreign Trade.—Australia has always depended on foreign trade. During the 19th century the Australian colonies developed as suppliers of primary products to the British market and relied on British industry for most manufactured items. Domestic industrial development has not significantly diminished the importance of foreign trade to the Australian economy, although there have been great changes in the types of goods imported, and by mid-20th century there were the beginnings of an export trade in domestic manufactures. The average annual exports in the mid-1960s accounted for about 20% of the gross national product.

As an exporter of primary products whose prices have tended to fluctuate greatly in world markets and as a borrowing country dependent on fluctuating supplies of overseas capital, Australia has always been exposed to balance of payments difficulties. Between 1940 and 1960 it relied heavily on quantitative import controls to cushion the domestic economy against these disturbances, in addition to substantial international reserves.

Since the 1880s Australia has fostered domestic industrial development by protective tariffs, administered after the 1920s by a tariff board, which hears applications by industries seeking protection and makes recommendations to the government. In 1932 Australia subscribed to the Ottawa agreements, under which it granted preferential tariff treatment to British manufactures in exchange for preferences granted to its own exports in the British market under United Kingdom tariff and quota restrictions. After World War II the importance of these preferences diminished.

Imports.—Until the early 1950s industrialization had little effect on Australia's dependence on imports, measured by the ratio of imports to gross national product. But there has been a striking change in the types of goods imported. The share of finished consumer goods fell from 28% in 1913 to less than 17% in the 1960s; that of capital equipment rose from 17% to about 30%; that of producers' materials remained stable around 45%, but within this category there was a sharp shift from elaborately transformed to crude materials. There was some evidence of effective import replacement, real gross national product rising by 20% without any increase in imports. 1860s

The United Kingdom remained Australia's largest supplier. In the mid-1960s the United States and Japan came next, followed by the Federal Republic of Germany, Canada and the Arabian states (oil). Sterling area countries supplied two-fifths of the total.

Exports.—Primary products (including minerals) accounted for about 85% of the exports, and manufactures (including processed foodstuffs) for the remainder. Chief export items were wool, meat, wheat, dairy products, sugar, fruit and minerals (chiefly lead and zinc). By the mid-1960s the U.K. barely retained its lead as Australia's major market, taking only 19% of Australia's exports, just half of the total sterling area share. Both Japan and the European Economic community approached the British level, followed by the U.S. and the People's Republic of China.

Other Overseas Payments and Receipts.—Even in years of balanced merchandise trade, Australia had a regular deficit in its balance of payments on current account usually amounting to about £A200,000,000. This resulted from interest and profit due overseas on capital invested in Australia and from other invisible imports, especially freight, insurance, travel and immigrant remittances. Much of this deficit was offset by a substantial inflow of overseas capital. Whereas in the 19th century overseas investment in Australia mainly took the form of borrowing in London by Australian governments, the large inflow after World War II consisted mainly of direct investment and reinvestment by overseas (chiefly British and U.S.) companies in Australian industries. The only substantial net overseas borrowing on government account was from the International Bank for Reconstruction and Development.

Finance.—Since federation, the Australian system of public finance has undergone a drastic shift of financial power and responsibility from the states to the commonwealth. The main stages in this process, which accompanied the growth of governmental responsibility for economic policy and of the public sector in the economy, were: the commonwealth-state financial agreement (1928), under which the commonwealth assumed responsibility for state public debts and for all borrowing by the government; the introduction of uniform taxation (1942), under which the commonwealth assumed a monopoly of income taxation, coupled with reimbursement grants to the states; and the assumption of *de facto* control by the commonwealth over the total amounts available to the states for current and capital expenditure. The state governments remained responsible, under the constitution, for most functions of government involving expenditure (other than national debt interest, defense and social services), but their current expenditure was financed chiefly by commonwealth grants and to a lesser degree by their own tax revenue, while the larger share of their capital expenditure was financed by commonwealth taxation.

Total (commonwealth and state) taxation absorbed about 23% of the national income. Tax revenue of the commonwealth was derived mainly from personal income tax, company tax and indirect taxes (chiefly customs and excise, sales tax and payroll tax). State and local authorities relied for their tax revenue mainly on miscellaneous indirect taxes (rates and land taxes, stamp duties, etc.) and succession (inheritance) duties. The main items of public authority expenditure include cash social service benefits, national debt interest, public works, defense, education and health.

Australia's system of private finance was, until the 1950s, dominated by the large trading banks; there are seven private banks (two with head offices in London) and the government-owned Commonwealth Trading Bank of Australia. There are also some small state banks, the Reserve Bank of Australia (until 1959 called the Commonwealth Bank of Australia) and several savings banks. After the establishment in 1912 of the Commonwealth Bank of [illegible]stralia as a central bank with trading functions, banking [illegible] bject of political controversy. The Labor govern[illegible] ion in 1947 to nationalize the private banks was [illegible] tional by the courts. The reorganization of the [illegible] 1959 grouped the trading, development and sav[illegible] ies of the central bank into a separate Common[illegible] poration.

By the early 1960s the domestic Australian capital market had developed greatly. The main features were the rapid growth of hire-purchase (installment) finance, the new issue market (especially for fixed interest finance by companies), development banking and the establishment (1959) of an official short-term money market. The older financial institutions, the trading banks and life assurance companies reacted to this competition by themselves branching out into the new fields of finance.

In 1964 Australia announced the monetary system would be converted from the British system of pounds, shillings and pence to the decimal system of dollars and cents, effective in 1966.

(H. W. A.; A. J. Ro.)

C. Transport and Communications

Australia covers a large area, with a low density of population in its arid interior and a concentration of settlement in a comparatively narrow coastal belt. Long distances separate the main centres of population and industry. These factors explain the peripheral arrangement of the various transport systems that radiate from the state capitals. Much of the railway mileage, for example, lies within 200 mi. of the coast, with occasional lines penetrating inland to tap pastoral or mineral resources.

Until about the end of the 1930s roads and railways were essentially complementary, but since then they have become highly competitive as road haulage has proved more economical and flexible for nonbulky and specialized types of freight. State governments, having considerable sums of money invested in their state railway systems and being compelled for political or community reasons to keep many unprofitable lines open, attempt to control road and rail competition. New South Wales, for instance, makes a levy per ton-mile on intrastate (but not, by constitutional bar, on interstate) road journeys. Queensland forbids road haulers to charge less than the railway rate for a given journey. Even so, and despite road maintenance taxes imposed by state governments on freight-carrying road vehicles on both interstate and intrastate journeys, road transport can still compete effectively with railways. By offering freight concessions, state railway systems compete for the border trade of neighbouring systems, but occasionally they have taken joint action to prevent trade from falling into the hands of road haulers: thus concessions are offered by the New South Wales railways on wool dispatched from Riverina through Tocumwal, despite the fact that it then goes to Melbourne or Geelong on the Victorian system.

Roads.—There are about 61,000 mi. (98,000 km.) of proclaimed or declared main roads out of a total of 564,000 mi. (908,000 km.) of road, that are open for general traffic. World War II stimulated the construction of an all-weather bitumen road between Alice Springs and Darwin—the 950-mi. Stuart highway—and the reconditioning of others, such as that across the Nullarbor plain between Port Pirie and Norseman. After World War II road authorities faced great problems: maintenance had been neglected, and there was a greater volume of traffic traveling at faster speeds and carrying heavier loads.

Despite existing shortcomings, a tremendous effort has been put into road improvement since 1945. Motor transport is playing an increasing part in the development of the pastoral industry both in the movement of wool and stock and in the carriage of fodder during droughts. "Road trains," which consist of a diesel-engined prime mover and two or three trailers that can carry about 800 shorn sheep or 80 cattle at about 15–20 m.p.h., are used in remote parts of Australia. The commonwealth and state governments are financing a "beef roads" complex in northern areas designed to allow stock to be moved quickly in all seasons to the fattening country. The use of heavy road vehicles for long-distance haulage between capital cities has been a feature of postwar years.

Railways.—The railway systems, originating independently, were each centred on a state capital and used different gauges. Victoria adopted the broad gauge (5 ft. 3 in.), New South Wales the standard (4 ft. 8½ in.), Queensland, Western Australia and Tasmania the narrow (3 ft. 6 in.). South Australia built some lines linking with the Victorian broad-gauge system, and others on narrow gauge. The costs and delays at the breaks of gauge a

GODFREY LINGE

FIG. 9.—RAILWAYS IN AUSTRALIA

the state borders and elsewhere greatly affected Australian development. In 1930 the standard-gauge line from Sydney to Kyogle was extended to Brisbane, and in 1962 a standard-gauge line from Melbourne to Wodonga joined Sydney and Melbourne. Melbourne is linked to Adelaide by a broad-gauge line. A 380-mi. standard-gauge line from Kalgoorlie to Kwinana and Fremantle was due to be finished in 1967 at a cost of £A41,000,000.

The state systems are under the control of their respective governments, and, with the exception of Tasmania and Queensland, each radiates outward from the state capital—usually the chief port. Victoria has the densest railway network with 4,290 route miles. The Townsville to Mount Isa line has been modernized.

The commonwealth owns a short line linking the Australian Capital Territory with the New South Wales system, and three major lines, namely the Trans-Australian railway (standard) linking Kalgoorlie and Port Augusta with Port Pirie, the Central Australia railway (mostly narrow) linking Port Augusta with Alice Springs, and the North Australia railway (narrow) linking Darwin and Birdum.

Freight rates are calculated within each state on a tapering principle—a lower rate per ton-mile for longer hauls. Even though the states have reached some measure of agreement about goods traveling interstate, the rates charged are still higher than if the tapering principle were fully operative on such journeys. This is one of the main reasons why commodities tend to be sent to the capital of the state in which they are produced in spite of the fact that the capital of another state may be nearer. The processing of local products in country towns has been discouraged by the high rates charged on finished goods as against those on primary produce traveling to the seaboard. Freight handling at breaks of gauge is speeded by the use of bulk containers that are transferred bodily from one freight car to another, and some use is made of the "piggyback" system, whereby fully laden road trailers are transported on flat rail freight cars.

Some lines have been electrified, including that from Sydney to Lithgow, from Sydney to Gosford and from Dandenong to Gippsland. Several unprofitable lines have been closed, especially in Western Australia. The only underground railway is in Sydney.

Most of the several hundred miles of privately owned narrow-gauge railway serving mining, quarrying, forestry and sugar enterprises are not open for general use. However, part of the standard-gauge railway system around Newcastle is privately owned, although parts are operated by the New South Wales railways and some of it carries passengers.

Shipping.—Competition from commonwealth-owned shipping and from road and rail transport caused severe setbacks to private shipowners. Furthermore, lower productivity, partly brought about by the working conditions demanded by labour organizations, has slowed down the turn-round of vessels; in 1937, for instance, 2,500 tons of general cargo usually could be handled at the port of Melbourne in three and a half days whereas the time taken in 1956 was six and a half. The only prospering trade in post-war years has been the carrying of bulk cargoes, such as sugar, from Queensland to the southern ports, and iron ore from Yampi sound and Whyalla to the steel plants at Newcastle and Port Kembla. The Australian Coastal Shipping agreement (1956) has helped to minimize uneconomic competition.

Relatively long hauls along the coasts of Queensland and Western Australia allow the vessels engaged in intrastate trading to remain reasonably competitive for some types of cargo. However, coal shipped from Newcastle and Catherine Hill Bay to Sydney formed more than one-half the tonnage of intrastate cargo carried in 1957–58, and since then shipments of coal have decreased partly because of the increasing use of diesel locomotives, the construction of power stations at the coalfields and the substitution of by-product fuel oil from the Australian oil refineries. In the 1960s new passenger-vehicular vessels began operating between Tasmania and the mainland.

Ports.—About 100 commercial ports are situated along the coastline of Australia, together with many small seaports, jetties, landing stages and inland river ports at which trading vessels seldom call. Sydney, Melbourne, Fremantle (the port for Perth), Port Adelaide, Geelong, Port Kembla, Whyalla, Brisbane and Hobart handle (in that order) the greatest tonnages. Included are the ports of each of the capital cities, which contain a considerable proportion of the population of each state and much of their industrial and commercial activity. Some ports have highly specialized trades; for example Whyalla, Yampi sound, Rapid bay, Strahan and Catherine Hill bay, which are chiefly concerned with the handling of minerals.

Some ports, *e.g.*, Sydney, Hobart and Albany, are situated in natural deep harbours. Others lie behind artificial breakwaters, *e.g.*, Port Kembla, Burnie, Portland, Townsville and Mackay, or are located at river mouths, *e.g.*, Melbourne, Newcastle, Fremantle and Port Adelaide, or are a few miles upstream; *e.g.*, Brisbane, Launceston, Maryborough and Rockhampton.

Inland Waterways.—The river trade in Australia, particularly on the Murray and Darling rivers, reached its zenith in the 1860s

and 1870s. Being unable to compete against other forms of transport, it has now almost completely ceased. Some small craft operate on a few east coast rivers, such as the Hunter and Hawkesbury, but a revival of the river steamer and barge traffic on a large scale is unlikely.

Air Transport.—Regular air services operating throughout the continent link most major towns and many smaller centres. Frequent passenger and freight services operate between the capital cities. The volume of freight handled per head of population is greater than in any other country, and the passenger mileage per head is exceeded only by the U.S. Two airlines account for most of the passenger miles performed and the bulk of the ton-miles of freight carried within Australia. Six other companies operate regular services, some of which provide the only regular contact with many widely spaced cattle stations; and a number of firms undertake charter services or specialized work, such as spreading fertilizer and dusting crops.

The air ambulance and royal flying doctor services provide medical aid for the outback regions of Australia when called upon by a widespread system of local transmitters and radio bases. The commonwealth department of health operates the Northern Territory aerial medical service, and the royal flying doctor service, founded in 1928 by the Australian Inland mission, operates several bases in outback Northern Australia. The Bush Church Aid society for Australia and Tasmania (supported by Church of England funds) and the Federal Methodist Inland mission operate aircraft in the outback.

Overseas services go to the United Kingdom via North America, Mexico or the middle east, and to South Africa, Japan, New Zealand and other parts of the Pacific.

Postal Services and Telecommunications.—Letter sorting has been mechanized at the main offices, and distribution is carried out by road, rail, ship and air transport.

Communication facilities include a radiogram service to certain isolated places, a phototelegraph service for the reception and transmission of overseas photographic images and a teleprinter service. Transceivers bring remote stations and townships into the postmaster general's communication system. The Overseas Telecommunication commission operates overseas radio and cable services.

See also references under "Australia, Commonwealth of" in the Index. (G. J. R. L.)

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AUSTRALIAN ABORIGINES, the native race of Australia, have dark chocolate-brown skins. Their head hair, varying from slightly wavy to curly, is black, though children's hair in desert regions is frequently sandy, and facial and bodily hair is usually plentiful. The head is dolichocephalic or nearly so, with retreating forehead and deep excavation of the temporal region, deep-sunk eyes and the bridge of the nose receding beneath prominent eyebrow ridges. The lower part of the nose is splayed, the mouth wide, the lips usually thick, but not everted, and prognathism is common. Average male height is about 5 ft. 6 in., ranging from about 4 ft. 10 in. to a little over 6 ft., and the women's average is about 4 in. less. The build is linear.

Origin and Classification.—Three theories have been put forward.

Similarities of hair form and its distribution and certain features of the bony head structure suggested that the aborigines were archaic Caucasoids; *i.e.*, primitive Europeans. Further, the absence of definite evidence of throwbacks from consistent matings of descendants of European-aboriginal half-castes with Europeans was attributed to a common ancestral stock for both races; progressive dilution is the more likely and logical explanation. Blood-group analysis does not support the Caucasoid theory. Apart from Melanesian influence in the northeast, aborigines lack the B group, a regular European feature, and the S antigen, common in Europe (77%). Of the A group, there are 27%, western Europe's 45% and, of this 27%, all is A_1, whereas A_2, which is regular in Europe, is absent from Australia and, mostly, from the Pacific. Further, the aborigines' O-group frequency, 73% significantly exceeds that of western Europe which is under 50%. Finally, N is higher among them than elsewhere, whereas M and the Lutheran antigen are rare (*see* BLOOD GROUPS). If, the if aborigines and Europeans were archaically one stock, the

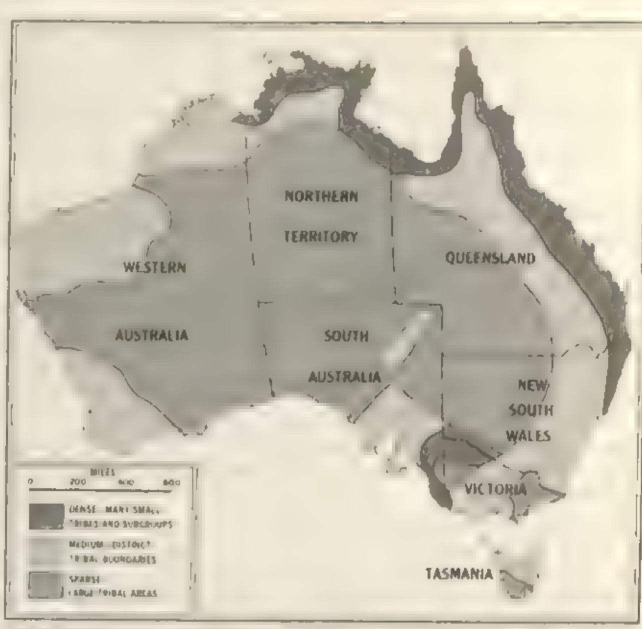
gence in blood has been remarkable. This is true also of the aborigines' fingerprint pattern, with its high frequency of whorls, differing completely from the Europeans'. Two other significant facts are: (1) the morphology of aboriginal facial musculature is highly undifferentiated; and (2) the external morphology of the aboriginal brain is marked by retention of very primitive forms (*e.g.*, of the intrastriate sulci) and by comparative underdevelopment of the new cortical areas.

J. B. Birdsell ascribed a trihybrid origin to the aborigines. The first occupants of the continent were Tasmanoids; *i.e.*, woolly haired, black Negritos. Next came stockily built, lighter-coloured Murrayians, with wavy to straight hair and with facial features "coarse and rough-hewn, but definitely Caucasoid in configuration." With their closest affinities to the Ainu, they were "related to some of the Upper Palaeolithic types of Europe." In Australia they remained in their least mixed form around the southeast and south. The third wave consisted of tall, linear and very dark Carpentarians whose general appearance was and is "extremely primitive, generalized and non-White." They are the true Australoid with closest affiliation to the Veddoids of Ceylon and southern India and are considered to be most clearly represented in northern and central Australia. All three stocks are said to have arrived in turn during the Fourth Glacial period by way of the Sahul shelf, which then joined New Guinea and northern Australia, and the aborigines are the result of their miscegenation in varying degrees. Thus, the archaic Caucasoids are only one element in the population and are distinguished from the later Australoids, while the crossing of the Negrito and archaic Caucasoid stocks accounts for the Tasmanians. These views have not been substantiated with sufficient data, and are not supported from blood analysis and fingerprinting. The differences in the aboriginal population can be explained by accepted biological processes without recourse to a triracial hypothesis, and the study of currents and winds shows that the Tasmanians could be the offspring of groups or a group drifting by canoe from Melanesia, probably the New Hebrides (a view with which physical anthropology can agree).

The third theory (held by E. Dubois, F. Weidenreich and A. Keith) is that the Australoids became differentiated in the Malaysian-Australian region, as indicated by the series *Pithecanthropus* (Java man), *Homo soloensis, Homo wadjakensis* and *Homo talgai* (southeast Queensland), all of which are fossils, and the Australian aborigines. They spread north and east to the Malay peninsula, southern India and Ceylon, and also east and south to New Guinea, Melanesia and Australia. Isolated in the latter, they retained their typical characteristics, whereas in New Guinea and Melanesia they were submerged by later waves of migrants with different blood group patterns.

Peopling of Australia.—The aborigines, whether in one or several periods, probably arrived either by way of the now submerged Sahul shelf or, where land connections were absent, by rafts and canoes. They brought with them the dingo, a species of dog. There are apparent surviving pockets of a common Australian language, not necessarily the original, in Cape York peninsula and northeast Arnhem Land. The aborigines were not gardeners and Australia provided no animals suitable for herding, so they lived by food-gathering and hunting, in which activities they were limited by distance from fresh water. With increase of numbers, subgroups set out to find other waters: "paths" of mythological heroes and "trade" routes indicate the directions of the migrations. The total population in 1788 was probably about 350,000, though some estimates have put the figure as low as 150,000, divided into about 500 tribes, each with its recognized territory and its distinct language or dialect, some of which developed marked differences. Archaeological research points to an occupation of probably 10,000 years or more.

Social Structure.—A tribe consists of several local groups which, food permitting, associate for most of the year. Each group, membership of which is in the male line, regards a particular part of the tribal territory as its country; *i.e.*, the country to which it belongs. Within it is a watering place where the group's ancestors originally settled and where the pre-existent spirits of



DISTRIBUTION OF ABORIGINES IN AUSTRALIA AND TASMANIA, 1788, YEAR OF THE FIRST EUROPEAN SETTLEMENT. TOTAL POPULATION OF ABORIGINES WAS ESTIMATED FROM 150,000 TO 350,000

its members are believed to have sojourned ever since, waiting for incarnation and reincarnation. Founders of secondary settlements and their descendants are forever kinsfolk of the primary group and its descendants, regardless of how far they are separated in space, time and customs. A system of classifying everyone as a relation codifies reciprocal behaviour based on recognized indirect kinship links (if any), on apparent generation level, on membership of clans or other social groupings and on ritual affiliation.

In much of Australia, relations are divided into two, four or eight groups (termed respectively moieties, sections and subsections), which are correlated with rules of marriage and descent and, like clans, are normally exogamous (*see* EXOGAMY). Such divisions serve to regulate kinship terms and behaviour especially in intertribal arrangements. Marriage is based on kinship. In a few tribes a man may marry his cross-cousin, *i.e.*, the daughter of his mother's brother or of his father's sister, but in most he may not marry anyone nearer than the daughter of his mother's or father's cross-cousin. The most widespread, preferred marriage is between persons classified as second-degree cross-cousins.

Adaptation.—The aborigines possess detailed knowledge of each tribal territory and when and where food can be obtained. This is summarized in the seasons, which vary from five to eight in different regions, each being marked by the normally expected climatic conditions and by the kinds of procurable foods.

Aborigines face the recurrence of droughts and food failures by regarding natural species and the rain as part of man's social and moral order and by entering into ritual relations with them. Each group within a tribe consists not only of men and women but also of several species, so that all are relations. The group (clan) bears the name of one of these, its totem (*see* TOTEMISM). The human members (totemites) do not injure or eat this totem or any other species of the group, unless in dire need and after due ceremony; on the other hand, the totem helps the totemites in waking life or in dreams by conveying information or by strengthening them when sick. Further, the men are divided into lodges, each of which is custodian of the mythology, ritual, sites and symbols associated with one or more natural species and with ancestral heroes. Through ritual re-enactment the creative past becomes operative in the present and the life of species and man is assured. The myths and ritual, usually called cult-totemism, are to the aborigines the "dreaming," signifying continuity of life unlimited by space and time. The initiation into cult-membership, which is open to men only, is a ritual form of death and rebirth or rising to life, an experience of passing from ignorance to a

conscious share in the "dreaming" and to an assurance of life. This is continued in the burial ritual, which varies in form in different regions and even in one region, but which always ensures the return of the spirit to its "dreaming," its spirit home, from which it will be reincarnated. Only the old men have full knowledge of the "dreaming" and therefore authority in ritual. This also gives them authority in matters of social behaviour, for the precedents are found in the behaviour and institutions of the ancestral heroes, but they actually apply the norms of customary behaviour, with which all are familiar.

Except in the case of infants and old persons, or when caused by a weapon, death is attributed to sorcery and only the medicine man, the "clever fellow," can extract the "badness" and restore confidence and the will to live. A psychic expert and a good psychologist, he comes in his "training" into association with the dead, with some totem spirits and with the sky-world. If he fails to cure, it is because he has been called too late, or the sorcery is too strong (as in fat and blood extraction), or the victim deserves his fate.

Culture.—Aboriginal myth and ritual are expressed in art, poetry, music and dance. The myths are preserved in chants which are poetic in expression, rhythmic in structure, linguistically interesting and musically significant. Sacred symbols and even weapons are painted and engraved to express myths, which are also chanted "into" them. The actors' bodies are painted in ritual, and mythological designs are engraved or painted on stone, painted on bark and even on the ground, the painting and engraving being themselves rites. Painting is also done for pleasure, just as singing and dancing take place at the camp-social corroboree as well as on the secret ground. There are regional schools of art and music and also regional differences in the form and decoration of implements and weapons. The content of some major religious cults also vary regionally.

See also AUSTRALIA, COMMONWEALTH OF: *The People*; AUSTRALIAN LANGUAGES; BOOMERANG; KARIERA; MURNGIN.

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(A. P. E.)

AUSTRALIAN ALPS, a term applied somewhat loosely to the mountain mass which occupies the southeasternmost corner of Australia (eastern Victoria and southeastern New South Wales). In a more local sense it denotes the ranges on the Victoria-New South Wales border forming the watershed between the Murray system and the Snowy and other rivers flowing directly to the Pacific. Strong vertical movements of the earth's crust have disrupted the original drainage to produce a pattern very complex in plan, well shown by the great fishhook bend of the upper Murrumbidgee. The term Alps as applied to these mountains denotes their general characteristics as massive and seasonally snow-clad highlands rather than their special structural features. In this latter sense they are not Alpine mountains but are a powerfully developed block massif composed of elevated areas and downfaulted areas. This Tertiary faulting affected a region of comparatively homogeneous topography and diversified it into a series of massive flattish uplands and comparatively roomy depressions. It was followed by a local glaciation (Pleistocene-Kosciusko Ice Age) which further emphasized the flatness of the summit topography. The result is an upper surface of broad undulating highlands upon which even the highest elevations (Kosciusko, 7,316 ft., the highest peak in Australia) are not distinctly remarkable. Because of the spasmodic nature of the uplifts the streams have worked out characteristic "valley-in-valley" forms. There are also evidences of extensive river capture.

The highlands are snow-clad in winter, though the timber line lies at 5,000 ft. and the area of alpine flora is small. The rocks of these highlands are extensively, if not richly, mineralized and a good deal of mining mainly in small and scattered workings (*e.g.*, Kiandra [altitude 4,640 ft.], the highest settlement in Australia) was once carried on. The valleys and basins and the lower uplands have been utilized mainly for pastoral purposes.

All development, however, is dominated by the Snowy hydroelectric project, a joint undertaking of the commonwealth and the two states. This scheme involves a complex system of dams and tunnels (one of them 35 mi. long) to divert water from the Snowy across the divide and so generate eventually at 16 power stations (the first of which was opened in 1955) about 3,000,000 kw. The project also adds considerably to the irrigation facilities of the Murray basin. New roads and construction camps have been built and the old rural service centre of Cooma, the main base, has been dwarfed by the boom town of its suburbs (pop. [1961] 8,716). In addition, this area was in 1960 becoming increasingly a national winter playground and health resort. *See* also AUSTRALIA, COMMONWEALTH OF.
(O. H. K. S.)

AUSTRALIAN CAPITAL TERRITORY, a separate political entity of the commonwealth of Australia, situated within the confines of the state of New South Wales and comprising the national capital of the commonwealth, Canberra, and some surrounding country. The site was selected in 1908–09 and the territory was turned over to the commonwealth by New South Wales in 1911. It lies on the Murrumbidgee river at the foot of the southern Alps and at an altitude of 1,900 ft. The population of the territory in 1954 was 30,315; its area is 939 sq.mi. Apart from the governmental, administrative, constructional and other activities of the capital city, there is some primary industry in the territory, mainly concentrated on wool and meat production, dairying and forestry. In 1915 the commonwealth also acquired from New South Wales sovereign rights over an area of 28 sq.mi. of land and water at Jervis bay for possible use as a port. *See* also CANBERRA.

AUSTRALIAN LANGUAGES, the languages spoken by the aboriginal inhabitants of the Australian mainland. The total number of aborigines in 1788 has been variously estimated from 150,000 to 350,000. N. B. Tindale's map locates almost 600 tribes. Geographical barriers and long isolation produced a great diversity of highly developed languages, the majority of which exist only in scanty vocabularies and grammars, often phonetically and grammatically inadequate, which were written largely by linguistically untrained missionaries, explorers and officials before 1930. By the 1930s, when trained linguistic research workers began their investigations, the native population was estimated to have decreased to somewhat less than 50,000 persons, and some languages and many dialects had become extinct.

No complete dictionary had been printed in any Australian language by mid-20th century; in only a few had adequate native texts been recorded.

The paucity and uncertainty of records of the Australian languages are such that statements concerning their characteristics and classification must be treated with reserve. There are two schools of thought: one sees grammatical features such as appear in inflected languages, and this seems to be the fact in some of the Australian languages; others deny this assertion, at least in the Aranda language and perhaps some others.

Phonetically, the Australian languages show great uniformity. Of the fricatives, only *v* and the velar fricative denoted by the phonetic symbol [γ] occur in isolated languages. The glottal stop is found in some northern languages. There is so little distinction between *p* and *b*, *t* and *d*, *k* and *g*, that some linguists assume the existence of only a single sound in each pair; viz., completely unvoiced *b*, *d* and *g*. Distinctions are made between dental, interdental and cerebral forms of *n* and *d* or *t*, also between dental and cerebral *r*, and several varieties of *l* sounds. A common sound is *ng*; it often begins Australian words. The *j*, which is pronounced as the "y" in "young," is frequently found in the combinations dj

or *tj*, *nj* and *lj;* and *w* is another common sound. The vowels *a, e, i, o, u* occur, but native speakers rarely preserve their exact shades.

Differing widely in grammatical structure, the Australian languages have certain features in common. There is great similarity in the word order. Two nominative case forms generally exist: first, the noun as the "name" (when followed by an intransitive verb), secondly the noun as the "agent" (when followed by a transitive verb). In many declension systems the cases are nominative, agentive, objective, possessive, ablative and locative, to which may sometimes be added a dative, instrumental and vocative. The adjective normally follows its noun. The personal pronouns, except in the Victorian languages, are built up out of different stems (as in the European languages). Numerals are always represented very poorly. In the verb, a reflexive voice, also a negative voice, may occur, but no passive. Postpositions replace the European prepositions. Some words are distributed over the whole continent; *e.g., mil* "eye," *kutara* "two," *mara* "hand."

These common phonetic and structural features suggest that the Australian languages may have developed from a common parent. No relationships between these languages and those of Papua, Melanesia, India or even Tasmania have been conclusively established on linguistic evidence. (*See* also PIDGIN; SLANG.)

MAIN LANGUAGE GROUPS

Prefixing Languages.—These stretch from near Broome along the Fitzroy river toward the Roper river and the Gulf of Carpentaria, covering the Kimberleys, Arnhem Land (except for its northeastern corner) and the top portion of the Northern Territory, also such northern islands as Groote, Bathurst and Melville. These languages stand out sharply because of their use of prefixes in the inflections of both nominal and verbal forms, whereas the remaining Australian languages use only suffixes for all flectional purposes. These prefixes are almost identical over the whole area, whereas the vocabularies of these languages show little resemblance. The agentive case is absent in the dual and multiple classifying languages. Some suffixing is found also in the prefixing languages. Incorporation of the pronoun objects into the verb is a second common characteristic. Some languages incorporate the noun object.

In most of the prefixing languages noun classification forms a further characteristic feature, permitting the following three divisions:

Multiple Classifying Languages.—These include Ungarinjin, Wunambal, Worora, Larakia, Kakadu, Anjula, Andiljaugwa. Here the noun classes vary from three to nine. The noun classes suggest the grammatical gender divisions of the European classical languages. This generally involves concord in the adjectives, numerals and pronouns.

One complex example is Andiljaugwa. This has nine noun classes; singular, dual, trial and plural are expressed by prefixes in its pronouns; transitive verbs incorporate the object pronouns; the verbs show many tenses and moods and also a separate negative conjugation.

Dual Classifying Languages.—Examples of this group are Gunavidji, Djerag, Worgaidj. Only two noun classes exist, corresponding roughly to a grammatical masculine-feminine division.

Nonclassifying Languages.—Examples include Iwaidja, Njulnjul and Rainbarngo. These conjugate the verb by prefixes and incorporate the pronoun objects, but lack noun classes.

Suffixing Languages.—These occupy the mainland south of the prefixing area; also Cape York peninsula and the northeastern corner of Arnhem Land with its adjoining lands. The following categories rest on the available printed material:

Western Desert Languages (Capell).—These are spoken over the huge arid area of central and western Australia, comprising probably one-third of the continent. The prefixing, southwestern peripheral and Aranda areas form the northern, western and eastern borders; and the Nullarbor plain marks the southern limit. Among the western desert languages are Garadjeri, Wolmeri, Julbre, Mudbura, Pitjantjara and Kukatja (better known as Loritja or Aluridja).

A practically uniform set of pronouns found throughout this area, and a distinctive verb conjugation are the characteristic features of these languages. In the Garadjeri group the root of the verb is either monosyllabic or a verbal noun conjugated by an auxiliary. Time, mood and person are indicated by the addition of suffixes to this root. A pronoun object may be added. In Pitjan(tja)tjara the suffixes indicating the personal pronouns may be appended to the first inflected word in the sentence, not merely to the verb root. Though allegedly one of the simplest Australian languages, Pitjan(tja)tjara has four declensions and four conjugations.

Southwestern Peripheral Languages.—These are the languages spoken in the peripheral coastal areas of southwestern Australia; *e.g.*, Pibelmen, Mineng, Whadjuk, Inggada. Many are extinct. Extant scraps of linguistic material indicate merely that these languages were distinct from those of the western desert tribes.

The Aranda Group.—The Aranda languages are found in the geographical centre of Australia, stretching from there northeastward across the Queensland border. Among them are the various Aranda dialects, Unmatjera, Kaititja, Iliaura, Jaroinga and others.

Aranda has case endings for five singular cases in the nominals (noun, adjective, pronoun). Dual and plural are normally expressed by the addition of *tara* "two" and *intjara* "many" respectively. When a noun is followed by the article, a pronoun, or an adjective, or a combination of several of these, such a group forms a nominal phrase, and the case endings are attached only to its last member. In the dual and plural forms of the first and second Aranda personal pronouns, distinctions are made linking them with the local sectional organization. In the verb a positive and a negative conjugation exist, each with an active and a reflexive voice. There are 4 tenses and 26 possible moods. Distinctions of singular, dual and plural are possible in each form. By means of reduplication and suffixes, up to 69 periphrastic verbs can be formed from the simple verbs, all capable of full conjugation. The sacred songs reveal the existence of a ceremonial language, characterized by many archaic words and a special poetic diction.

Victorian Languages.—This group includes most of the languages spoken in Victoria, also Jaralde (or Narrinyeri) in South Australia, and it stretches over into southern New South Wales. The area occupied reaches from the Murray valley to the southern coast. In these languages difficult and unusual consonant groups occur not only medially but also at the ends of words, and considerable use is made of suffixed pronouns. In their personal pronominal systems, person and number are normally expressed by pronominal suffixes attached to a common root, in sharp divergence from normal Australian practice. In the verb person and number are generally indicated.

Mixed Languages.—The mixed languages comprise the following:

The south-central group, which includes Pangkala, Dieri and the Darling river languages. The group stretches from the central portion of the south Australian coast into southwestern Queensland.

The north-central group, occupying most of southwestern and central Queensland. The north-central and south-central groups show evidence of a considerable mixture of the various Australian language types so far indicated. No real homogeneity is apparent.

New South Wales languages, which also form a very mixed group of languages. Among the best known are Kamilaroi, Wiradjuri and Gumbainggar. In Wiradjuri-Kamilaroi the dual and plural forms of the nouns are formed by adding the equivalents of "two" and "many" to the singular. In Wiradjuri, the possessive pronouns appear as suffixes attached to their appropriate nouns. In Gumbainggar the adjectives usually precede the noun and are inflected with it; prepositions precede the noun they govern.

Cape York and northeastern Arnhem Land group, among which

are the Wik- and Koko- languages of northern Queensland and the Murngin languages of northeastern Arnhem Land. In Wikmunkan there is incorporation of pronoun objects, and the adjective alone is declined when it qualifies a noun (as in Aranda). Wikmunkan and Kokoyimidir have no agentive case. The personal pronouns of Kokoyimidir and of the northern Murngin languages are similar to those of the western desert group. Murngin languages show agreement with the western desert languages in the objective and possessive case suffixes of their nouns.

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AUSTRALIAN LITERATURE. The history of Australian literature may be divided into four periods. Literature from 1788 to 1850 is mainly description by visitors, immigrants and native-born people of oddities produced by convict origins and the novel environment; the literature of the second period, from 1850 to 1910, is mainly an account of the way of life and values of the men and women in that pastoral and agricultural society; that of the third period, from 1910 to 1940, is the literature of the transition from rural to urban life; and in the fourth period, after 1940, literature reflected anxiety and doubt.

The Pre-Gold Period, 1788–1850.—The first period is much richer than the followers of a narrow nationalism admitted. The first fleet had men of literary talent among its officers. Two of them kept and published diaries of permanent value—D. Collins in *Account of the English Colony of New South Wales* (1798) and W. Tench in *A Narrative of the Expedition to Botany Bay* (1789) and *A Complete Account of the Settlement at Port Jackson in New South Wales* (1793). From 1788 to 1850 and even later the book of memoirs was the most usual form of literary expression. One of these was "A. Harris' " *Settlers and Convicts* (1847).

Another form in which men with literary gifts found expression was the political pamphlet. The distance from the seat of government, the contribution of the convicts to the wealth of the few and the morals of the many, the struggle for a secure title to the rich grazing lands of eastern Australia—all these provoked pamphlet wars, and some of these pamphlets are worthy of mention; *e.g.*, W. C. Wentworth's *A Statistical, Historical, and Political Description of the Colony of New South Wales and Van Diemen's Land* (1819), and J. Mudie's *The Felonry of New South Wales* (1837). Almost in the same category as the political pamphleteers are the early historians of the colonies of Tasmania and New South Wales. The two most important used history as political propaganda. J. West wrote his *History of Tasmania* (1852) as a supplement to his campaigns against the transportation system. J. D. Lang, an aggressive Presbyterian, published *An Historical and Statistical Account of New South Wales* (1834) as an apologia for his political campaigns against the British government, the squatters, the Irish and the pope.

Of poetry, novels and plays the first period was almost barren. Barron Field's *The First Fruits of Australian Poetry* (1819) is mentioned in histories of literature simply because it was the first. Charles Harpur (1813–68) used Australian themes, but he was a better writer of satirical prose than of poetry.

The Pastoral Period, 1850–1910.—The discovery of gold in 1851 had important effects on literature. Gold created a larger reading public; gold made Melbourne the economic and possibly the cultural centre of Australia; a generation after the discovery of gold, *i.e.*, by 1870, native-born Australians outnumbered the immigrants—the immediate occasion for the development of cultural chauvinism. Two poets of this period may be mentioned. Adam Lindsay Gordon (*q.v.*) used for his themes the everyday life of the Australian bushman. But although Gordon expressed the bushman's philosophy of resignation, he never became the bushman's poet. His contemporary, Henry Kendall (*q.v.*) also used material familiar to many—gum trees, the bush, the sea—but he wrote for the few.

Four prose writers made their mark at this time. The first was Henry Kingsley (*q.v.*), whose novel *The Recollections of Geoffrey Hamlyn* (1859) was an idyll of the squatter-gentleman from England who used Australia as a place to make money with which to return later to gracious living in England. The second was Marcus Clarke (*q.v.*), a gifted if wayward writer who poured forth a series of sketches, essays and short stories on the political and sectarian controversies of his day. By making extensive use of the material in the 1837–38 *Report of the Select Committee on Transportation*, and of the literary advice of Sir Charles Gavan Duffy, Clarke completed his indictment of the colonial system in his novel *For the Term of His Natural Life* (1874). Despite its wide popular appeal it is doubtful whether Clarke's work showed the understanding of the convict mind, or the literary ability of a less-known writer on the convicts, "Price Warung" (William Astley, 1854–1911) who published four collections of stories: *Tales of the Convict System* (1892), *Tales of the Early Days* (1894), *Tales of the Old Regime* (1897) and *Tales of the Isle of Death* (1898). The other prose writer of importance was "Rolf Boldrewood" (Thomas Alexander Browne, 1826–1915). He wrote one exciting story about bushranging, *Robbery Under Arms* (1888).

All these writers tended to accept the assumption that Australians as "colonials" were inferior to Englishmen. The federation movement was connected with the development of a nationalist literature in the last 20 years of the 19th century. The Sydney *Bulletin*, which began publication in 1880, provided a market for the nationalist writer. The result was a steady stream of distinctively Australian work, defiantly proud of the crudities, the coarseness, the vulgarity and the irreverence of Australians and confident in their doctrines of mateship and social equality for Australians and in their contempt for the rest of the world. The most important of these writers was Henry Lawson (1867–1922), author of *While the Billy Boils* (1896), *On the Track and Over the Sliprails* (1900) and *Joe Wilson and His Mates* (1901). Just as firm in his nationalism and belief in social equality but with a stronger intellectual content was "Tom Collins" (Joseph Furphy; *q.v.*). His three main works were: *Such Is Life* (1903), a rambling, discursive volume with a slender plot used as a peg for some brilliant discussions of the problems of Australia and of life; *Rigby's Romance* (published serially in 1905 and as a novel in 1921), a book with a slender plot, but valuable for its discussion of socialism and its knockabout humour; and *The Buln Buln and the Brolga* (first published in 1948), a nationalist allegory which contains some of the best slapstick comedy in Australian literature. The other aggressively Australian writer, "Steele Rudd" (Arthur Hoey Davis, 1868–1935), used comic relief as a poultice for the squalor of the lives of his characters—small farmers in Queensland. One writer who refused to use humour or idealism to relieve the gloom of her work was Barbara Baynton, whose important book was *Bush Studies* (1902).

By contrast with the skill and confidence of the prose, the poetry was disappointing. Lawson wrote from the heart, but rarely rose above the level of doggerel verse. Victor James Daley (1858–1905) had most success with his mordant political satires. Other poets were Dowell O'Reilly (1865–1923), Barcroft Henry Boake (1866–92) and Edward Dyson (1865–1931). During the same period, but quite unaffected by the noise and excitement of the nationalist movement, George William Rusden brought out his *History of Australia* (1883) and Gyles Turner published his *History of the Colony of Victoria* (1904).

The Urban Period, 1910–40.—In comparison with the optimism and the swagger of the works of the nationalist school, the

work of the third period seems pervaded by nostalgia, doubt and drabness. One reason for this was that economic changes had destroyed the unique conditions of bush life by 1910 and life in the big cities, which became the raw material for writers in the 20th century, was no different from life in industrial cities in Europe, the Americas or South Africa. The possible exception was the larrikin—the centre of Louis Stone's *Jonah* (1911) and Edward Dyson's *Fact'ry 'Ands* (1906). Different from other books of the period was a work whose main theme, the disintegration of a great character, could belong to any time or place—*The Fortunes of Richard Mahony* (1917–29), a trilogy by "Henry Handel Richardson" (*q.v.;* Ethel Lindesay Robertson). Her other works on Australian subjects were *The Getting of Wisdom* (1910) and *The End of a Childhood* (1934).

Two other women writers published important work during this period. One of them, Miles Franklin (1879–1954), did her best work by an imaginative, if nostalgic, recreation of the life of the pioneers of the Yass-Goulburn-Canberra-Brindabella districts; books of this class are *My Brilliant Career* (1901), *Old Blastus of Bandicoot* (1931), *All That Swagger* (1936) and *My Career Goes Bung* (1946). The other distinguished woman writer, Katharine Susannah Prichard (1883–   ), began her literary career as a warm-hearted, spirited teller of exciting stories, and moved slowly toward the social "message" of the spirit of the 1890s. Her books included *Working Bullocks* (1926), *Coonardoo* (1929), *The Roaring Nineties* (1946), *Golden Miles* (1948) and *Winged Seeds* (1950). "Brent of Bin-Bin" wrote a trilogy on the pioneers of the Canberra, Brindabella and Cooma districts.

Within this period the subjects and the methods of the novelists gradually widened. Mrs. Aeneas Gunn (1870–1961), published two moving accounts of the aborigines: *The Little Black Princess* (1905) and *We of the Never Never* (1908). Xavier Herbert published a brilliant though savage indictment of Australian behaviour to the half-caste in *Capricornia* (1938). Vance Palmer (1885–1959) wrote *The Swayne Family* (1934), a novel about the way of life and aspirations of a middle-class family in a Melbourne suburb. Eleanor Dark in *The Timeless Land* (1941) and *Storm of Time* (1948) used the historical setting of New South Wales from 1788 to 1808 as the medium for her sensitive conception of human relations and the relations between men and earth. Frank Dalby Davison wrote about animals in *Man-Shy* (1931) and *Dusty* (1946). Martin Boyd's witty and sophisticated books *The Montforts* (1928), *Lucinda Brayford* (1946), *The Cardboard Crown* (1952) and *A Difficult Young Man* (1955) discussed the great problem, for intellectuals and artists, of England versus Australia. Kylie Tennant (Mrs. L. C. Rodd; 1912–   ) published social satires. Gavin Casey (1907–   ), "Brian James" (1892–   ), Cecil Mann (1896–1967), Alan Marshall (1902–   ) and Dal Stivens (1911–   ) were the main writers of short stories.

Among poets Andrew Barton Paterson ("Banjo"; 1864–1941) won a wide audience with such ballads as "The Man From Snowy River" and "Waltzing Matilda"; C. J. Dennis (1876–1938) jerked many a tear with *Songs of a Sentimental Bloke* (1915). By contrast, men of talent received little attention from the public, though for the first time Australia had produced poets with technical equipment and maturity of outlook. These included Christopher Brennan (*q.v.*), Kenneth Slessor (1901–   ), R. D. FitzGerald (1902–   ), Frederick Macartney (1887–   ), Furnley Maurice (Frank Wilmot; 1881–1942), J. Shaw Neilson (1872–1942), Bernard O'Dowd (1866–1953) and William Blocksidge (William Baylebridge; 1887–1942).

The Period of Anxiety, After 1940.—The boundary between the third and the fourth periods is almost imperceptible. The expulsion of the European from south Asia and national and class wars stimulated, in some quarters, a reaction against the nationalism, the egalitarianism and the sentimentality to which the ideal of mateship frequently degenerated. This revolt was led by the poets and verse dramatists—a revolt which by the 1960s was still groping for a definition of values to substitute for the cheeky nationalism, the belief in material well-being for all, in equality and in "being mates." The most significant writers of this new age were the poets Douglas Stewart (1913–   ), Judith Wright (1915–   ), James McAuley (1917–   ) and A. D. Hope (1907–   ) and a novelist, Patrick White (1912–   ).

So the developments in literature corresponded roughly with the course of economic history. Like most new world literature, in the early period it was strong in narrative and humour, but rough in style and weak in intellectual content. Indeed, as late as 1960 the literature of ideas was still struggling for recognition in a society which seemed to be reluctant to drop the myth that the bush was the great creator in Australia.

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AUSTRALITE: *see* TEKTITE.

AUSTRALOPITHECINE, creatures which, when first discovered in South Africa, were regarded as apes with manlike features of skull, teeth and posture but were later recognized as representing collectively that crucial phase in human evolution when the body posture had become erect but the brain was no bigger than that of living apes.

History and Nature of Finds.—R. A. Dart (1924) first gave the name *Australopithecus africanus*, or South African ape, to the fossilized skull, with its internal cast, of a six-year-old child blasted from the Buxton lime cliff at Taungs, Bechuanaland.

R. Broom in 1936 discovered adults in dolomitic cavern deposits, called bone-breccias, in Sterkfontein valley, 30 mi. W. of Johannesburg. Three sites near Johannesburg, Sterkfontein, Kromdraai and Swartkrans, proved so rich in jaws, teeth, skulls and other skeletal remains that parts of approximately 100 specimens of representative ages were found before Broom's death (1951). Broom distinguished three different genera, *Plesianthropus*, *Paranthropus* and *Telanthropus;* but Ernst Mayr (1950) contended that generic distinction is unwarranted and that all australopithecines belong to one species of earliest man: *Homo transvaalensis.*

From 1945 onward, at Makapansgat, nearly 200 mi. N. of Johannesburg, Dart recovered over 100 tons of bone-breccia containing a rich fossil fauna accompanying another form of australopithecine, *A. prometheus.* The outstanding characteristic of all australopithecines (apart from their small brains and erect stature) is their human dentition—especially the small nibbling front teeth (incisors and canines) as contrasted with the large grinding back teeth (premolars and molars).

In 1959, in the bed of the Olduvai gorge, Tanganyika, L. S. B. Leakey and his wife found an almost complete adult skull of yet another form of australopithecine, *Zinjanthropus boisei.* The contrast between the front and back teeth was most exaggerated and the skull was accompanied by stone implements. Stone implements had been reported previously in the upper Makapansgat breccia by C. K. Brain and C. van Riet Lowe in 1955 and in the upper Sterkfontein breccia by J. T. Robinson and R. J. Mason in 1957. At both sites australopithecine teeth accompanied the tools.

Robinson showed in 1953 that an upper-jaw fragment found by L. Kohl-Larsen near Lake Eyasi, Tanganyika, and called *Meganthropus africanus* by H. Weinert (1950), fell within the australopithecine range. He also claimed as australopithecine two lower-jaw fragments found by G. H. R. von Koenigswald between 1939 and 1941 at Sangiran, Java (Indon.), and called *Meganthropus palaeojavanicus.*

The *Gigantopithecus blacki* of Von Koenigswald—known first from fossil teeth bought in Hong Kong drug stores in 1935 and 1939 and attributed then to a "giant orang"—was found by Pei Wen Chung and his helpers in 1956 to belong to another intermediate, cave-inhabiting, hunting type which the Chinese anthropologists still regard as anthropoid but which Broom (1939 and 1946) and Von Koenigswald (1952) have recognized to be hominid. The three lower jaws found came from two bone-bearing but geologically distinct Pleistocene faunal levels, the older one regarded by the Chinese scientists as being of Villafranchian antiquity, in a cave on Lêng-Chian-Shan, a mountain in Kwangsi province in southern China.

Apparently the old world from southern Africa to eastern Asia was inhabited by diversified australopithecine human types followed successively by pithecanthropine and neanderthaline types before *Homo sapiens* appeared.

Dating.—The fossil faunas accompanying australopithecine remains are classified as of the Villafranchian epoch. Until the International Geological congress of 1948, fauna of the Villafranchian type were associated with the late Pliocene epoch. By attaching Villafranchian deposits instead to the subsequent, early Pleistocene epoch, the congress probably trebled the length of the latter period. According to the recent potassium-argon isotope dating technique, the Pleistocene began 1,000,000 or more years ago.

Significance.—The australopithecines have afforded substantial support of Charles Darwin's theory that man evolved and that Africa was probably his cradle. From the vast areas of the African and Asiatic continents over which they ranged and the extensive time lapse they flourished, it is not surprising that the australopithecines diverged in dental and other characteristics so greatly, nor that discussion of their exact zoological relationships to one another and to other human beings, whether varieties, species or genera of mankind, continued. For example, it was being debated whether remains found in the 1960s at Olduvai were australopithecine, or represented a new species *Homo habilis*.

Their discoverers (*e.g.*, Dart at Taungs and Makapansgat, Broom at Sterkfontein, the Leakeys at Olduvai and Pei at Lêng-Chian-Shan) have agreed that these intermediate forms were hunters of animals upon which they mainly lived and with whose bones their own remains have been found. Some scientists, however, still retain the view originally promulgated by Dean Buckland (1822) that broken bones found in caves were all carried into them haphazardly by carnivorous beasts, especially hyenas.

Others following Dart believe that a great many of the bone, tooth and horn-core objects found on australopithecine sites were utilized as tools after being split and pounded in human fashion and even made into utensils by australopithecines. No admitted stone tool having been found hitherto in the lowest strata at Makapansgat, these observers believe man's earliest stone cultural phase was preceded by this kind of osteodontokeratic (bone, tooth and horn) cultural phase. *See* also Africa: *Archaeology: Fossil Hominid Remains;* Man, Evolution of: *Australopithecinae.*

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AUSTRASIA (sometimes also Austria), in the Merovingian period of French history, was the eastern Frankish kingdom as distinct from Neustria (*q.v.*), the western. The name, derived from a Germanic word meaning east, first occurs in the *Historia Francorum* of Gregory of Tours, in a passage dealing with the year 577. Austrasia then meant what had been the kingdom of Clotaire I's son Sigebert I (*q.v.*), covering the north and northeast of Gaul and spreading into Germany. Originally, however, the Romance areas of Aquitaine and Provence were also attached to the kingdom, so that the individuality of Austrasia, with its largely Germanic population, did not emerge clearly until the dukes of Aquitaine had made themselves virtually independent.

Clotaire II, king of the Franks, gave his son Dagobert to the Austrasians as their separate king in 623, and Dagobert, after succeeding to his father's kingdom, gave them likewise his own son Sigebert in 634. From then onward the kingdom had its capital at Metz and its own mayor of the palace, who after Dagobert's death in 639 became increasingly important (*see* Mayor of the Palace). The mayoralty of Austrasia was held by Pepin I and Grimoald, ancestors of the Carolingian dynasty, and after Pepin II had secured it for himself it remained in the family's possession, passing from father to son.

In the 7th century Neustria, in combination with Burgundy, was long successful in contesting Austrasian influence and was the dominant power until Pepin II's victory at Tertry in 687 assured the final ascendancy of the Austrasian mayors over the Frankish monarchy. In 751 Pepin III, the Short, deposed the last Merovingian king, Childeric III, and was himself elected king instead. Under the Carolingian dynasty royal authority was restored in France and an intellectual renaissance took place after the long decadence of the Merovingian period. *See* France: *History.*

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AUSTRIA (Bundesrepublik Österreich), for centuries the core of a multiethnical state of central Europe (*see* Austria, Empire of and *History* below), became a German-speaking state on its own on Oct. 30, 1918. From March 13, 1938, until the end of World War II it was incorporated by Adolf Hitler into his greater Germany. On April 27, 1945, a new provisional Austrian government was formed and, following a general election, it was, on Jan. 7, 1946, recognized by the four Allied powers, though Austria remained under military occupation, divided into four occupation zones. On May 15, 1955, the four powers signed at Vienna a state treaty with Austria which recognized and guaranteed the latter as "a sovereign independent and democratic state" and terminated its military occupation. By an act of parliament on Oct. 26, 1955, the day after the last foreign soldier had left Austrian soil, Austria declared itself a permanently neutral state. It did, however, join the United Nations (elected on Dec. 15, 1955).

Austria lies between latitude 46° 22′ and 49° 1′ N and longitude 9° 32′ and 17° 10′ E. Its area is 32,374 sq.mi. (83,849 sq.km.), its greatest extent (along 47° N) is 360 mi. (580 km.), its narrowest section is only 18½ mi. (30 km.). Its national boundary (total length 1,639 mi. or 2,637 km.) in the northeast toward Czechoslovakia largely follows the watershed between the Danube and the Vltava and then the March (Morava) River; in the east toward Hungary, it runs in the Hungarian plain and the Alpine foothills; in the southeast, toward Yugoslavia, it is formed by the Mur River, the watershed between the Mur and Drau (Drava) rivers, and then the crest of the Karawanken and Karnische Alpen. It continues westward toward Italy along the main crests of the Central Alps and toward Switzerland and Liechtenstein along the Silvretta Gruppe and Rhätikon mountains and then the Rhine. The boundary toward Germany follows the Northern Limestone Alps and the Salzach and Inn rivers.

This article contains the following sections and subsections:

I. PHYSICAL GEOGRAPHY

1. Geology and Geographical Regions.—While about two-thirds of Austria is formed by the Eastern Alps, it also includes part of the Bohemian massif, so that nearly three-quarters of its surface is mountainous. The hilly or lowland regions consist of the Northern Alpine foreland, the Vienna basin and Eastern lowland, and the Southeastern Hill country.

The Eastern Alps.—These stretch from a western boundary, running from Lake Constance via the Rhine and Splügen Pass to Lake Como, eastward to the Vienna woods (Wiener Wald) and the hills of eastern Austria which form a link with the Carpathians. They are lower in altitude than the Western Alps and gain in width but gradually decrease in altitude eastward, thus the easternmost parts were never subject to glaciation. In contrast to the Western Alps, faulting in addition to folding played a greater part in their formation and they have a more regular lithological arrangement. They can be divided into three principal parts: (1) the Central; (2) the Northern; and (3) the Southern Alps, separated from each other by structural longitudinal troughs (the line Arlberg Pass, Tirolese Inn Valley, upper Salzach, Enns, Mur, and Mürz valleys, Semmering Pass, dividing the Northern from the Central Alps, and, within Austria, the Drau [Drava] Valley separating the latter from the Southern Alps).

The Central Alps consist mainly of a granite or gneiss core with a mantle of Paleozoic crystalline schists. These rocks weather relatively easily and except at high altitudes or around the cirques of the Quaternary glaciers they give rise to gentle forms covered with a thick layer of debris and soil and support extensive summer pastures and forests. The chief mountain groups of the Central Alps are, from west to east: the Silvretta Gruppe, Ötztaler Alpen and Stubaier Alpen, and, after the much lower section containing the Brenner Pass, the Zillertaler Alpen and the Hohe Tauern with Austria's highest peak, the Grossglockner (12,457 ft.; 3,797 m.). These groups have extensive glaciers, the largest in Austria being the Pasterzen Kees (of the Grossglockner) which is 6 mi. (9 km.) in length. East of a line from the source of the Enns River to Spittal an der Drau the Central Alps split into two branches: the northern consisting of the Niedere (low) Tauern and some other groups (Gleinalpe, Fischbacher Alpen, Wechsel) stretching toward Wiener Neustadt and Bratislava in Czechoslovakia, and a southern group of the Gurktaler Alpen and Seetaler Alpen and Koralpe, ending at Maribor in Yugoslavia.

The Northern Alps border directly on the Central Alps only in the extreme west of Austria, otherwise they are separated from each other by a narrow zone of Paleozoic rocks, shales, porphyry, or graywacke of low altitude. This zone forms separate mountain groups only east of the Brenner Pass (the Tuxer Gebirge and Kitzbühler Alpen) and north of Leoben (the Eisenerzer Alpen).

The Northern Limestone Alps, which follow the northern graywacke zone, are in the western part shared between Germany and Austria, whereas the eastern part lies entirely within Austria. They consist of Mesozoic limestone, the highest mountain groups being formed of Triassic rocks. In the west, the Lechtaler Alpen and Tirol Limestone Alps are of chainlike character with numerous glacial cirques, while farther east in the Salzburg Alps, the Salzkammergut Mountains, and the Upper and Lower Austrian Limestone Alps, massiflike mountain groups with extensive plateau surfaces prevail. Where the surface is formed of pure limestone it is barren and riddled with karst (*q.v.*) features with underground drainage and numerous caves. The name Totes Gebirge ("Dead Mountains") in the Salzkammergut reflects their barren appearance. Where the surface is of dolomite, as in the Limestone Forealps, they are largely wooded or covered with summer pastures (*Almen*). Because of their lower altitude and ruggedness there are only a few glaciers. The Hochkönig, in the Salzburg Alps, is capped by a plateau glacier and there are valley glaciers on the Dachstein Gruppe in the Salzkammergut Alps.

To the north the Limestone Alps are fringed by a zone of late Cretaceous to early Tertiary sandstone, the so-called Flysch. Only in the extreme west and east does this give rise to mountain groups with names of their own, the Bregenzer Wald and the Wiener Wald respectively. North of the Tirol Alps this zone lies outside Austrian territory. The Flysch zone reaches its greatest altitudes (up to 5,500 ft.; 1,680 m.) in the Bregenzer Wald, the name Wald ("wood") being only applicable historically as most of its heights were cleared for meadows and pastures. (*See* ALPS.)

The Southern Alps.—The equivalent to the northern zone in the south is more limited in extent and is largely represented by the Karnische (Carnic) Alpen and by part of the Karawanken. The separation between the lithological zones is, however, less clear cut in the south and is further complicated by the interposition of the Klagenfurt basin, the largest of the interior basins within the Austrian Alps. In the south the graywacke zone is followed and intermixed with the Southern Limestone Alps.

The Bohemian Massif or Austrian Granite Plateau.—This is geologically the oldest part of Austria and belongs to the Hercynian mountain system. It rises steeply from the Alpine foreland and forms an undulating surface occasionally overtopped by rocky crags and covered by block fields with raised bogs in between. In its eastern part it is well wooded. Generally the Danube forms its southern boundary, but in a few cases it separates some outliers by gorges. Of these the Wachau, between Melk and Krems, is the most famous and with its vineyards and ruined castles rivals the Rhine gorge.

The Northern Alpine Foreland.—This stretches from the border along the Salzach and the Inn rivers. On the whole gently undulating, it rises only in the forested Hausruck to 2,500 ft. (760 m.). Otherwise the surface is largely made up of more recent material: ground moraines and terminal moraines giving rise to hills and enclosing lakes in the southwestern part as far east as the Enns River and, to the north and east of that, gravel sheets and terraces consisting of the glacial outwash partly covered by the valuable loess, deposited by the

FIG. 1.—RELIEF MAP OF AUSTRIA

wind in the last glacial period. The base rock, a fine-grain impermeable marl, comes to the surface only in the lowest parts, though it reaches a thickness of over 3,000 ft. (900 m.). It contains iodine and thermal wells, natural gas, and oil (discovered in 1959 near Ried). There are extensive lignite fields. The woodland which formerly covered the Alpine foreland is now limited to three forests on the poorest gravel soils.

The Vienna Basin and the Eastern Lowland.—These continue the Alpine foreland eastward and are similar in character. The northern part between the Granite plateau and the March (Morava) River is a hilly country of 650 to 1,300 ft. (200 to 400 m.) in height occasionally overtopped by Jurassic hills 300 to 650 ft. higher. Structurally it is divided by a fault (running southwest to northeast) and its eastern section is geologically part of the Vienna basin. There the base rock has been much fractured and downfaulted to great depths. The northern Vienna basin contains Austria's major oil and natural gas fields. The surface consists of gravels and sands widely covered by loess, the basis for arable cultivation and viticulture.

The southern part of the Vienna basin forms an embayment also in a morphological sense. It extends in a triangular shape toward the Semmering Pass and is bounded in the west by the steep edge of the Limestone Alps which end in a fault line. This is known as the thermal line because of the many spas which are located there. The eastern boundary of this so-called Vienna Bay is formed by the wooded Leitha Mountains, an uplifted horst. The downfaulting of the Vienna basin began in Miocene times. First a fresh-water lake, it later became part of the Miocene sea, and then land again during the Pliocene period. In this process brown coal was formed. More important economically is the Miocene Leitha limestone which is widely used as building material. During the Ice Age great amounts of gravels were deposited in the southern part, which now support only pinewoods and heath.

The lowland east of the Leitha Mountains has a character of its own. Dominated by the Neusiedler Lake (*q.v.*), with its grazing areas to the east and its wells, it resembles the Hungarian *puszta*. On the eastern slopes of the Leitha Mountains and the shores of the lake there are extensive vineyards.

The Southeastern Hill Country.—Like the northern part of the Vienna basin, a structural though not a morphological basin, the Southeastern Hill country is the last of the physical regions. Formed at the same time as the Vienna basin, the faulting there resulted in volcanic activity. There are also many warm and mineral springs. During Pliocene times the basin was filled with gravel, and brown coal also was formed. But, since there the uplift continued longer, the Pliocene gravel sheet became heavily dissected by the rivers which cross it in gorges up to 300 ft. (90 m.) deep.

2. Climate.—Austria's climate is determined by its location and by its relief. The Northern Alpine foreland and the Granite plateau, dominated by Atlantic influences, are characterized by a moderate mean annual range of temperature of 38° F (21° C) and precipitation in every month with a maximum in summer and a minimum in February and March. The amount of precipitation varies on an average between 24 and 60 in. a year, depending on the relief and nearness to the Alps. Eastern and southeastern Austria have a more continental climate characterized by a greater (mean) annual range of temperature, of up to 41° F (23° C) and a smaller amount of precipitation ranging between 18 and 40 in. (45 to 100 cm.) depending on relief. The rainfall maxima occur from May to August.

The climate of the Alps has some peculiar features of its own. Normally the temperature decreases for every 1,000 ft. (300 m.) rise in altitude by 3° F (1.7° C), but during the winter air drainage can cause a temperature inversion in the Alps. While deeply incised valleys and basins are in the grip of heavy frost the mountains above experience much higher temperatures, which in the sun may approach summer values. For that reason the mean annual range of temperature in the interior basins and valleys with their hot summers is greater than either in the north or the east, whereas that of the peaks is considerably smaller (Sonnblick, 10,187 ft. (3,105 m.), range 26° F (14.4° C). In addition on the peaks the maxima and minima occur later adding a further oceanic touch to their climate. There is no absolute parallel between altitude and amount of precipitation. The effect of the mountains in increasing precipitation is very pronounced in the marginal northern chains, but it is not continued by the further rise in altitude toward the Central Alps, and some sheltered interior basins and valleys have only 24 in. (61 cm.), thus necessitating irrigation. Maximum rainfall occurs during the summer months except in the Gail and upper Drau valleys where an autumn maximum betrays Mediterranean influences.

A further characteristic of the Alpine climate is its winds. During high-pressure weather winds that blow along the valleys are a regular feature. Of greater importance, however, is the föhn, a warm and extremely dry south wind. It is caused by a depression passing north of the Alps and is of great force, often causing damage, but it speeds the melting of the snow. It is particularly felt in the Tirolese Inn Valley, where it enables maize to be cultivated.

3. Vegetation and Animal Life.—The lower parts of the Alps, the Northern Alpine foreland, and the Granite plateau share the middle European (or Baltic) type of vegetation. These regions were formerly covered by continuous high forests: deciduous trees, especially beech at the lowest altitudes, followed by mixed forests and spruce woodland higher up, intermixed toward their upper limit with larch and stone pine. The lower slopes have been largely cleared for agriculture. Many of the native animals of this zone have either disappeared, such as the boar, bear, wolf, and lynx, or have become much rarer, as have red and roe deer. Hares, squirrels, and martens, and, among the larger birds, blackcocks, hazel hens, hawks, buzzards, sparrow hawks, and pheasants are still frequent.

The eastern parts of Austria also were originally largely forested, the prevailing trees being pubescent oak, hornbeam, and sweet chestnut. Fairly large areas of these, in the form of brush and scrubwood, still cover the eastern hills. Where they have been cleared arable cultivation, fruit growing, and viticulture have taken their place. Pine forests cover extensive areas on the poorer soils. In the Neusiedler Lake area and on dry soils near Vienna the natural vegetation cover is of a steppe type (*Steppenheide*). Characteristic animals are the hamster and, in the riverside woods of the Danube and the shores of the Neusiedler Lake, there are numerous water birds, storks, herons, wild geese and ducks, and many others.

The highest parts of the Alps have their own flora. Above the upper limit of forest dwarf pines certain willow species and various low shrubs like the alpine roses, cranberries, and bilberries are interspersed with natural meadows. At greater altitudes, where vegetation becomes intermittent, there are cushion plants and rare species like the edelweiss, while at the greatest altitudes only algae, lichens and mosses are found. Of the characteristic alpine animals the ibex has become very rare and is now only found in a few preserves but the chamois is still frequent. The marmot has to be protected to prevent its extinction. The ptarmigan is still common but the golden eagle is now rare.

The forests and their animals, most of whom enjoy a closed season to ensure their survival, are looked after by foresters. Many rare plants and animals, especially numerous bird species, are protected absolutely. There are also areas conserved for their outstanding beauty, and smaller areas, about 40 in all, have been designated nature preserves and may only be entered with special permission.

II. THE PEOPLE

1. Ethnology.—Austrians are on the whole a mixture of the Dinaric and Nordic and to a lesser extent east Baltic and Mediterranean types. Pure representatives of a single race, even in mere appearance, are rare. Ethnically about 98% of the Austrians are German, and the German language is understood even within the small non-German areas. Although the Austrian usage of German has a number of common characteristics, the differences between the dialects of one area and another are considerable. Most of these local dialects belong to the Bavarian group except for those spoken in the west which belong to the Alamannic group. Accord-

ing to the 1951 census, there were about 74,000 Austrians who habitually spoke Croatian, Slovene, Hungarian, or Czech either exclusively or together with German. The Croatian minority, which is the largest group (34,000), is almost exclusively located in the Burgenland; they do not form a compact group but live in a number of villages separated from each other by German-speaking areas. The Slovenes form the second largest group (24,000). They are concentrated in southern Carinthia (Kärnten), but nearly half their number give German as their first choice of language. The other groups are smaller. There are about 11,000 Hungarians, mostly in three districts in the Burgenland, and about 5,000 Czechs, largely in Vienna.

2. Religion.—In religious denomination the Austrian people are nearly as homogeneous as they are ethnically. According to the 1951 census 89% were Roman Catholic, 6.2% Protestant and 3.8% of no denomination. The Jewish element (200,000 in 1934 and 11,000 in 1951) is almost exclusively located in Vienna and the Protestant group also has its largest concentration there, though there are small Protestant communities in the Burgenland, Carinthia, Styria (Steiermark), and Upper Austria (Oberösterreich) which were established before the Counter-Reformation. The Roman Catholic Church divides Austria into two main parts under the archbishops of Vienna and Salzburg, and Roman Catholicism is still a potent political factor.

3. Settlement.—The type of settlement depends on the way in which individual farmsteads are associated with each other. In the Alps, except in the larger valleys and in the Northern Alpine foreland, farmsteads are irregularly scattered (*Einzelhöfe*) and are compact farms; *i.e.*, have all their land in one piece. As a result of division of holdings up to five farmsteads may form an irregular hamlet, a *Weiler;* this is the prevailing type in the Bregenzer Wald. In the larger valleys of the Alps and in eastern Austria the dominant type of settlement is the village. West of the Enns River they are generally very irregular in their ground plan; these are the *Haufendörfer*. East of the Enns River, in the formerly Slavic areas colonized since approximately 1000 A.D., the villages are much more regular. Street villages (*Strassendörfer*) of great length, or variants of these where the street widens to a central village green (*Angerdörfer*), are characteristic. Where farms are grouped together in villages the land is usually divided into many individual parcels. (K. A. S.)

III. HISTORY

For Austrian history prior to 1918 *see* AUSTRIA, EMPIRE OF.

1. Deutschösterreich.—On Oct. 21, 1918, the German members of the imperial parliament (*Reichsrat*) of Austria formed themselves into a national assembly for Deutschösterreich or German-Austria; and on Oct. 30 they proclaimed this an independent state under the direction of a state council (*Staatsrat*) composed of the leaders of the three main parties and other elected members. Revolutionary disturbances in Vienna and, more important, the news of the German revolution forced the state council on the republican path. On Nov. 12, the day after the emperor Charles's abdication, the national assembly resolved unanimously that "German-Austria is a democratic republic" and "German-Austria is a component part of the German republic." Karl Renner (*q.v.*), a leading Socialist, became head of a coalition government with Otto Bauer (*q.v.*), the acknowledged spokesman of the left wing of the Social Democrats, as foreign minister. On Nov. 22 a further law defined the territory of the republic. The national assembly claimed the provinces with a majority of Germans in their integrity; it also claimed the German areas of Bohemia and Moravia.

The greatest danger to the new republic seemed to be Bolshevism, especially when a Soviet republic was established in Hungary at the end of March 1919. The Austrian Social Democrats were determined to resist Bolshevism with their own forces, not to make an alliance (as the German Social Democrats did) with the old order. Julius Deutsch organized the *Volkswehr* ("People's Guard"), and this was twice effective (April 17 and June 15) against Communist attempts at a *Putsch*. Otto Bauer and Friedrich Adler staked their popularity on defeating the Communist agitation in the workers' and soldiers' councils, which had been set up on the Soviet model. By mid-1919 Communism had been defeated, and a Communist party never raised its head again in the days of the republic.

More dangerous was the tendency of the provinces, or states, to break away from Vienna or to claim almost complete independence. Though the principal motive of this was reluctance to send food supplies to Vienna, it represented also a genuine feeling that, with the fall of the Habsburg (*q.v.*) dynasty, nothing higher than the province remained. Vorarlberg voted for union with Switzerland in May 1919, and Tirol attempted to secede also. In February 1919 elections for a constitutional assembly were held, and when this assembly met (March 4), it had to make wide concessions to federalism in order to appease the provinces; in exchange Vienna (hitherto part of Lower Austria) was also elevated to the rank of a state, with the mayor as equivalent to state governor. This proviso subsequently enabled "red Vienna" to pursue an autonomous policy despite the existence of a non-Socialist government—a result not foreseen by the Socialists, who were the strongest supporters of unitary government on orthodox Marxist lines. The territory acquired from Hungary (*see* below) was also formed into a separate state, Burgenland, thus making nine states in all.

The constituent assembly also settled the constitution of the federal republic (Oct. 1, 1920). The state council was abolished and a bicameral chief legislative assembly, the *Bundesversammlung*, was established. The upper house or *Bundesrat* (federal diet) was to exercise only a suspensive veto and was to be elected roughly in proportion to the population in each state (this represented a defeat for the federal elements in the states, which had wanted the *Bundesrat* to exercise an absolute veto and to be composed of equal numbers of members from each state). The lower house or *Nationalrat* (national diet) was to be elected by universal suffrage on a basis of proportional representation. The *Bundesversammlung* in full session elected the president of the republic for a four-year term, but the federal government, with the chancellor at its head, was elected in the *Nationalrat* on a motion submitted by its principal committee, this committee being itself representative of the proportions of the parties in the house.

2. Republic of Austria.—The programs of the major political parties and, especially, the foreign policy of Otto Bauer insisted firmly on *Anschluss* ("union with Germany"), but article 88 of the peace treaty of St. Germain (*q.v.*), signed on Sept. 10, 1919, forbade *Anschluss* without the consent of the League of Nations and also stipulated that the republic should cease to call itself Deutschösterreich (German-Austria). The republic was, however, treated as the heir of the Habsburgs and saddled with payments of reparations (which were never paid). The German-speaking areas of Bohemia and Moravia had to be ceded to Czechoslovakia. The southern frontier with Yugoslavia was threatened by Yugoslav armed invasion. As the population of the disputed area put up a stiff resistance despite opposition by the central government in Vienna, it was finally decided that the question should be settled by a plebiscite; this, when held (Oct. 10, 1920), returned a majority of 59% in favour of Austria. The German-speaking districts of western Hungary were to be ceded to Austria outright; but Austria was obliged to hold a plebiscite in the face of Hungarian resistance, and Sopron was finally restored to Hungary.

In the elections of February 1919 for the constituent assembly the Social Democrats, under Karl Renner, had been returned as the largest single party, with 69 seats against 63 won by the Social Christians and 26 won by the German Nationalists. Renner had then formed another coalition government, but he was obliged to resign in June 1920. A new cabinet was formed in July under the premiership of Michael Mayr, a Social Christian, with Renner as foreign minister. In the elections of Oct. 17, 1920, the Social Christians gained 82 seats, the Social Democrats 66 and the German Nationalists 20. Mayr remained premier and also took the portfolio for foreign affairs. In December 1920 Michael Hainisch became the first president of the republic. The political composition of Austria was now stabilized and no decisive change took place during the following years. Moreover, the accurate system of proportional representation, though it did not (as in other countries) encourage a multiplicity of parties, combined with the ideo-

logical background of Austrian parties to lessen oscillations of membership in the assembly. Of the two mass parties which the republic had inherited from the Habsburg monarchy, the Social Democrats had an unshakable majority in Vienna (in which about a third of all the inhabitants of the republic lived), while the Social Christians had an equally unshakable majority among the conservative-Catholic peasants. The former "imperial" classes (army officers and landowners) usually became Social Christians, though the program of the party was as demagogic as that of any party of the masses. The urban middle classes, hostile to both workers and peasants, became German Nationalists. But German nationalism was not limited to the middle classes. The workers and even the peasants felt themselves to be Germans and would also respond to the national appeal—as a series of unauthorized plebiscites held in the western provinces in 1920–21 clearly demonstrated by their overwhelming majorities in favour of an *Anschluss*.

The main task of the non-Socialist governments in power in Austria from autumn 1920 was to restore financial and economic stability. Between 1919 and 1921 the urban population of Austria lived largely on relief from the United States and Great Britain, and, though production improved, distress was heightened by inflation which culminated in financial collapse in 1922. In October 1922 the chancellor, Ignaz Seipel (*q.v.*), negotiated the Geneva protocols, securing a large loan through the instrumentality of the League of Nations, which enabled Austrian finances to be stabilized. In return Austria had to undertake to remain independent for at least 20 years. The controller general appointed by the League of Nations reported in December 1925 that the Austrian budget had been balanced satisfactorily, and in March 1926 the international financial control was withdrawn.

Seipel's success in October 1922 gave Austria some years of stability and made economic reconstruction and relative prosperity possible. In Socialist-controlled Vienna, during the years that followed, an ambitious program of working-class housing, health schemes and adult education was carried out, giving "red Vienna" a unique reputation in Europe. These schemes were financed principally by heavy taxes on property in Vienna, which virtually eliminated private income from house rents.

In 1920 all three major parties spoke in democratic terms. Despite democratic phrases, however, preparations for civil war had never been abandoned. The Social Christians, led by Seipel, who believed in strong government, were convinced that they had to protect the existing social order against a Marxist revolution. The Social Democrats felt their social reform program endangered by reactionary tendencies. The Social Democrats, moreover, had their own armed force, the *Schutzbund*, descended from the People's Guard of 1918. In the provinces reactionary forces, originally formed for defense against the Yugoslavs or merely against internal disorder, gradually took on the general description of the *Heimwehr* ("home defense force"). The Social Democrats and the reactionary forces regularly demonstrated against each other, and these demonstrations sometimes led to conflict. In 1927, in the course of a clash between *Schutzbund* and "front fighters" at Schattendorf, an old man and a child were accidentally shot by the "front fighters." When the "front fighters" were acquitted by a Vienna jury on July 14, the Social Democrats called for a mass demonstration. This took place on July 15, but got out of hand and ended in the burning down of the ministry of justice. In street fighting between the police and the demonstrators almost 100 persons were killed. The Social Democrats then launched a general strike, but this had to be called off after four days. Seipel had used the opportunity for a violent assertion of authority. The balance between Socialist and non-Socialist forces in Austria was never secure after this decisive date.

The Social Christians, increasingly pressed by the *Heimwehr*, now began to take the offensive against the Social Democrats. Wilhelm Miklas, a leading Social Christian, was elected president as successor to the nonparty Michael Hainisch. There were repeated attempts to revise the constitution, principally with the object of strengthening the power of the executive. After protracted negotiations, in view of the worsening economic situation, a compromise was reached late in 1929. On Dec. 7, 1929, a series of constitutional amendments gave increased powers to the president, especially that of appointing ministers and of issuing emergency decrees; on the other hand Vienna preserved its autonomy, and the democratic principle was preserved against the far-reaching authoritarian demands of the *Heimwehr*. In the elections of November 1930 the Social Democrats were returned as the largest single party with 72 seats, the Social Christians held 66, the German Nationalists 19 and the *Heimwehr* (now posing as a fascist party on the Italian model) 8.

These political events were overshadowed by the great economic crisis. Though the Social Democratic leaders believed that the crisis should be met by the orthodox means of deflation and economy, they were resolved not to be compromised by supporting these measures and refused to enter a coalition government. On the other hand, in October 1931 they acquiesced in suspending the election of the president by direct popular vote, as had been provided by the constitution of 1929, and agreed to the re-election of Miklas by parliament for a further four years. Meanwhile the government, led by Otto Ender and Johann Schober (*q.v.*), was driven to desperate devices in order to stave off collapse. Schober, leader of the middle-class German Nationalists, launched the project for a customs union with Germany in March 1931; this provoked violent opposition from France and the Little Entente (Czechoslovakia, Yugoslavia, and Rumania) and was subsequently condemned by a majority of The Hague court. The bankruptcy of the Creditanstalt, the most influential banking house in Austria, in May 1931, brought Austria close to financial and economic disaster. This, together with the rise of the National Socialists in Germany, brought considerable support to the Nazis in Austria, and the provincial elections in 1932 showed that they had now a considerable mass following. The Nationalists began to demand a general election, and this demand was taken up by the Social Democrats in their anxiety not to be associated with the Social Christian government.

3. Dollfuss and Schuschnigg.—As a result when Engelbert Dollfuss (*q.v.*) formed a Social Christian government on May 20, 1932, he could count on a majority of only one vote. Dollfuss belonged to a new generation which had been educated in the conservative conviction that the western form of parliamentarian government had been forced upon the central Europeans as a result of military defeat and socialist revolution, and that the political and social order could be restored only by the establishment of some kind of strong authority. The leaders of the Social Christian Party found themselves under attack from two ideological enemies, the Marxists and the Nazis, who apparently threatened the very basis of the conservative order. The weak position of the Social Christian government made it imperative for Dollfuss to replace the democratic government by an authoritarian one. The opportunity to do this came in March 1933 when, during the debate on a minor bill, an argument arose over alleged irregularities in the voting procedure. Renner, the president of the *Nationalrat*, resigned; the two vice-presidents followed his example and Dollfuss declared that parliament had proved unworkable. It never met again with full membership and Dollfuss governed henceforth by emergency decree.

By this time (spring 1933) Hitler was in power in Germany, and Nazi propaganda for the incorporation of Austria was vastly increased. In this situation Dollfuss turned to Italy for help, being convinced that British and French aid would be ineffective. This shift in foreign policy can also be attributed to the fact that Dollfuss had to rely on the help of the *Heimwehr* to stay in power. The anti-Marxist *Heimwehr* had been in close contact with the Italian Fascist Party for a number of years already, and when Dollfuss visited Mussolini at Riccione in August 1933 he secured Mussolini's promise to protect Austria's independence only on the condition that he would give the *Heimwehr* a free hand in the destruction of the Social Democratic Party in Austria.

The Social Democrats were subjected to increasing provocation and on Feb. 12, 1934, took to arms. Civil war followed. Though the workers operated a general strike, the armed resistance was limited to the members of the *Schutzbund*, now a small force. After four days fighting Dollfuss and the *Heimwehr* were victori-

ous. The Social Democratic Party was declared illegal and driven underground. In the course of the same year, all political parties were abolished except the *Vaterländische Front* ("Patriotic Front"), which Dollfuss had founded in 1933 to unite all conservative groups. In April the rump of the parliament was brought together and accepted an authoritarian constitution. The new constitution had its spiritual basis in the social teaching of the Roman Catholic Church as expressed in the papal encyclical *Quadragesimo anno*. The framework of organization was to be a system of occupational estates, and the executive was given complete control over the legislative branch of government. The elected assemblies disappeared and were replaced by advisory bodies, appointed in complicated and futile fashion. The rights of man guaranteed under the democratic constitution were also swept away. "Republic" was removed from the official name of the state which was now merely "the Federal State of Austria."

On July 25, 1934, a group of Nazis seized the chancellery and attempted to proclaim a Nazi government. Dollfuss, whom they had taken prisoner, was murdered. The plan, however, miscarried: the Nazi party in the chancellery was compelled to surrender, and its leaders were executed; a Nazi rising in Styria was suppressed; and, faced with the mobilization of an Italian army on the Brenner Pass, Hitler repudiated his Austrian followers. Franz von Papen was sent as German ambassador to reduce Austria by other means.

Kurt von Schuschnigg, who became chancellor on the death of Dollfuss, was a man of gentler personality and of less violent political passions. The administration of the authoritarian constitution became, in the easygoing Austrian fashion, less oppressive than its Italian and German counterparts. In a vague way Schuschnigg would have liked to restore the Habsburgs, but he shrank from the international complications that this would involve. Therefore the regime drifted on without popular favour, weakened by the personal rivalries and ambitions of its leaders and sustained only by a guarantee from Italy. The temporary accord of Great Britain, France, and Italy in the "Stresa front" (April 1935) seemed to promise new security, but the Ethiopian crisis soon destroyed the unity of the western powers, and Austria's isolation was complete when Hitler and Mussolini allied themselves in 1936. On the other hand, Hitler was not yet ready for any great stroke. Schuschnigg was therefore able to negotiate a compromise with Germany on July 11, 1936: Germany promised to respect Austrian sovereignty; in return Austria acknowledged itself "a German state." Schuschnigg promised amnesty to the Nazis and held out a prospect of including some "nationally minded" Austrian in his ministry in the future. The agreement of July 1936 did not bring any serious change but left Austria open to Nazi infiltration. The Austrian Nazis continued to conspire. In January 1938 the Austrian police discovered that a new Nazi *Putsch* was in the offing. Schuschnigg thought to defeat this conspiracy by a meeting with Hitler, where he would confront him with the evidence, but Hitler, though he had not ordered the plot, came down on the side of the conspirators. At Berchtesgaden on Feb. 12 terms of surrender were dictated to Schuschnigg. He had to agree to give a general amnesty to the Austrian Nazis, to suppress the evidence of the plot and to include some leading Nazis in his cabinet. Mussolini had by then abandoned hope or intention of protecting Austria. Nevertheless Schuschnigg resolved to challenge Hitler alone. On March 9 he announced that a plebiscite would be held on March 13 to decide in favour of Austrian independence.

4. Anschluss.—Hitler could not allow Schuschnigg's plebiscite to be held: having himself much experience with plebiscites, he knew it would go in favour of whoever was running it. Though the Austrian crisis had taken him unawares, he acted with energy and speed. Mussolini's neutrality was assured, there was a ministerial crisis in France and Neville Chamberlain in Great Britain was in the first flush of appeasement. On March 11, 1938, two peremptory demands were made for postponing the plebiscite and for the resignation of Schuschnigg. Schuschnigg gave way. German troops, accompanied by Hitler himself, entered Austria on March 12.

It seems to have been Hitler's original intention merely to establish a Nazi government in Austria, headed by Arthur Seyss-Inquart, but once on Austrian soil Hitler was intoxicated by the general enthusiasm and proclaimed the union of Austria with Germany on March 13. A plebiscite on April 10, held throughout greater Germany, recorded a vote of more than 99% in favour of Hitler.

Austria became the Ostmark (east mark) and was absorbed into Germany for all purposes. There was at first some friction between local Nazis and those brought in from the old *Reich;* but this ceased as the local Nazis were given positions elsewhere. There was, on the other hand, an Austrian movement of resistance against Hitler, but this was naturally obliged to operate in secrecy.

5. Second Republic.—Nevertheless a myth of Austrian independence persisted, and the Allies in World War II committed themselves to this at the meeting of foreign ministers in Moscow on Oct. 30, 1943. This was subsequently confirmed at the meeting at Teheran, though Winston Churchill made various proposals for a unification of Austria and Bavaria or other neighbouring countries as late as spring 1945. As a result, when the Soviet troops captured Vienna on April 13, 1945, they at once set up a government under Renner, based on a coalition of Social Democrats, Social Christians, and Communists. The Allies agreed in July on the division of Austria, including Vienna, into zones of occupation, in which the respective Allied military commanders had supreme political powers. In October 1945 the Renner government was finally recognized by all four occupation powers as an all-Austrian government. A general election held in November 1945, in which former Nazis were excluded from voting, returned 85 members of the Austrian People's Party (corresponding to the Social Christians of the prewar period), 76 Socialists (corresponding to the Social Democrats), and 4 Communists. Renner resigned and was elected president of the republic; Leopold Figl, leader of the Austrian People's Party, became chancellor, though still with a coalition ministry. The occupying powers called on the assembly to draw up a new constitution; it replied on April 13, 1946, that the constitution of 1929 should be restored. In June 1946 the control agreement of July 1945 regulating the machinery of Allied political supervision was modified by restricting Allied interference essentially to constitutional matters.

In November 1947 the only Communist minister, K. Altmann, resigned from the government in protest against the monetary reform bill. The Austrian People's Party and the Socialists were thenceforth to be for years the sole partners in a coalition government which was formed in proportion to the parties' strength in parliament. This principle of proportional representation, originally introduced into Austrian politics for election purposes in 1919, was to be the main factor of Austrian public life from 1945.

From 1945 to 1952 Austria had to struggle for survival. After liberation from the Nazi rule the country faced complete economic chaos. Aid provided by the United Nations Relief and Rehabilitation Administration (UNRRA) and, from 1948, support given by the United States under the Marshall Plan made survival possible. Heavy industry was nationalized in 1946, and by a series of wage-price agreements the government tried to control inflation. Reconstruction was especially difficult in the Soviet zone of occupation, where the military commanders continuously interfered in political and economic affairs. The result was a migration of capital and industry from Vienna and Lower Austria to the formerly purely agricultural western provinces. This brought about a far-reaching transformation of the economic structure of the country.

Austria long remained occupied by U.S., British, French, and Soviet forces. A treaty had been expected early and the western allies were anxious to conclude one, but the Soviet government frustrated them. In 1947, however, at the time of the Italian peace treaty, the British government declared that it regarded the state of war as ended. In 1953, moreover, a heavy burden was removed from the Austrian economy when the Soviet government declared that it would pay its own occupation costs (as the U.S. had done since 1947). Thereupon the British and the French followed suit.

When, in 1949, the former Nazis were allowed to participate in

the general election, the third group in Austria's prewar party life was restored. The Union of Independents (later renamed as the Freedom Party), corresponding to the former German Nationalist group but free now from ideological ties, won 16 seats in parliament. In the subsequent elections (1953, 1956, 1959) the relationship of the three parties remained stable (1959: Austrian People's Party, 79 seats; Socialists, 78; Freedom Party 8).

When Renner died (Dec. 31, 1950), Theodor Körner, the Socialist mayor of Vienna, was elected president of the republic by direct popular vote. On his death (Jan. 4, 1957) the leader of the Socialist Party, Adolf Schärf, was elected president.

The influence of the Socialists in the coalition government, which had been relatively strong under Leopold Figl's chancellorship, was reduced when the Austrian People's Party replaced Figl with Julius Raab in spring 1953 and had Reinhard Kamitz appointed minister of finances. The subsequent economic reconstruction and the advance to a prosperity unknown to Austrians since the years before World War I is generally identified with the so-called Raab-Kamitz course, based on a modified free market economy. The nationalized steel industry (VÖEST [Vereinigte österreichische Eisen und Stahlwerke] at Linz), electrical power plants (notably Kaprun in the Tauern) and oil fields (in Lower Austria), together with the privately owned lumber and textile industries and the tourist traffic, were the major economic assets.

6. Austria Free and Neutral.—The Berlin conference of the foreign ministers of the Big Four (January 1954) raised Austrian hopes for the conclusion of a peace or state treaty. There for the first time Austria was admitted as an equal conference partner, but the failure of the foreign ministers to agree on the future of Germany again prejudiced Austria's chances. It appeared that the Soviet government was not prepared to forego its strategic advantages in Austria so long as Germany was not "neutralized."

Early in 1955 the Soviet government suddenly reversed its ten-year-old Austrian policy, probably in the hope that the Austrian example would induce the Federal Republic of Germany also to follow the road of neutrality. The Soviet government was now ready to sign the Austrian state treaty and, on its entering into force, to evacuate the occupation troops.

The treaty was signed in Vienna on May 15, 1955, by the representatives of the four powers and Austria. It formally reestablished the Austrian republic in its pre-1938 frontiers as a "sovereign, independent, and democratic state," but did not include a guarantee of neutrality. It prohibited *Anschluss* or union between Austria and Germany as well as the restoration of the Habsburgs. It guaranteed the rights of the Slovene and Croatian minorities in Carinthia, Styria, and Burgenland. The United Kingdom, the United States, and France relinquished to Austria all property, rights, and interests held or claimed by or on behalf of any of them in Austria as former German assets or war booty; but the U.S.S.R., in addition to about $1,250,000,000 taken during the occupation, obtained tangible payment for the restoration of Austrian freedom. This included $150,000,000 for the confiscated former German enterprises that Austria had to buy back from the Administration of Soviet Property in Austria, together with $20,000,000 allegedly advanced to these enterprises by that administration; $2,000,000 for the confiscated German assets of the First Danube Steamshipping Company; and 10,000,000 metric tons of crude oil as the price of Austrian oil fields and refineries that had been Soviet war booty.

The state treaty came into force on July 27, 1955. By Oct. 25 all occupation forces were withdrawn and Austria recovered its full sovereignty. On Nov. 5, duly approved by both houses of the parliament, a constitutional law of perpetual Austrian neutrality was promulgated. (F. F)

In April 1961 Raab resigned and was succeeded as chancellor by a fellow member of the People's Party, Alfons Gorbach. In the election of November 1962 the People's Party won 81 seats, the Socialists 76, and the right-wing Freedom Party 8. The government coalition was patched together with difficulty, the Socialists opposing return of the archduke Otto of Habsburg, eldest son of the last emperor. In February 1964 Gorbach resigned and Josef Klaus (chairman of the People's Party) became chancellor. On the demand of the Socialists, he published a statement excluding the archduke from Austria. President Schärf, who died on Feb. 28, 1965, was succeeded by Franz Jonas.

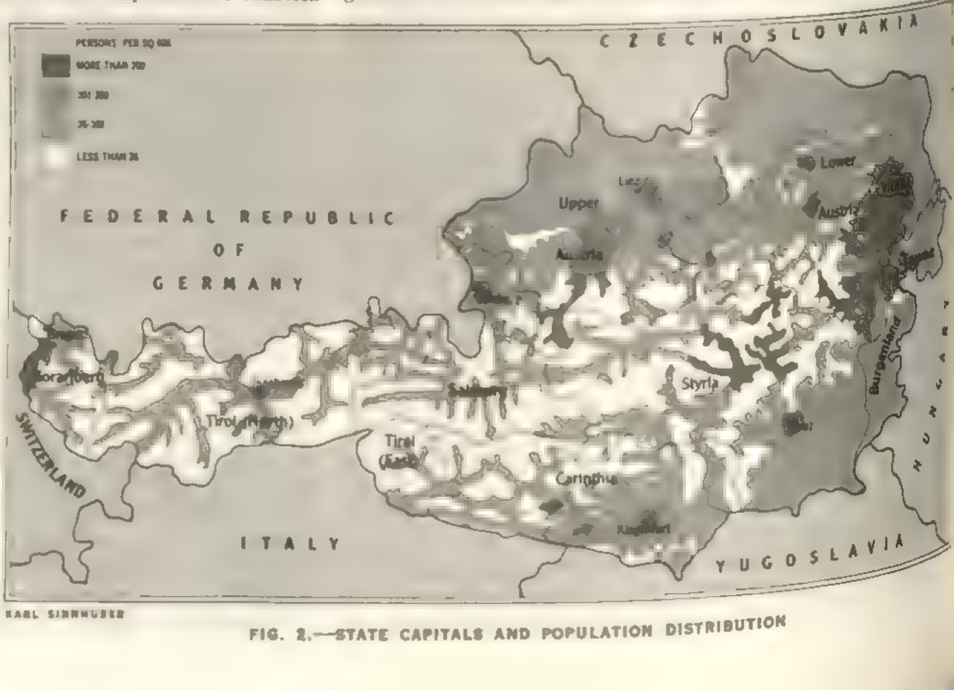
In the seventh general election (March 6, 1966) since World War II, the People's Party took 85 seats (of 165 in the *Nationalrat*); the Socialists dropped to 74 seats, and the Freedom Party to 6. A new era in Austria's political history began on Apri. 19 when Klaus and his People's Party formed the first noncoalition government of the postwar period. In June the archduke Otto was granted a visa to return.

After recovery of national independence, Austria's principal difficulty in foreign affairs was with Italy on the old question of Alto Adige (*see* TIROL). Agitation against Italian rule by some of the Germans there, who occasionally resorted to terrorism continued in the 1960s and provoked diplomatic protests from Rome against the toleration allegedly accorded by Austria to refugee terrorists. (X.)

IV. POPULATION

The total population at the 1961 census was 7,073,807. (In 1951 it was 6,933,905.) This figure included about 350,000 former refugees, most of them naturalized. The disparity between areas, and especially the great concentration in and around Vienna is due to historical reasons as well as to the physical nature of the country. (Distribution by *Bundesländer* [states] is shown in the table.) The principal centres of population outside Vienna are Graz, Linz, Innsbruck, Salzburg, and Klagenfurt (*qq.v.*).

Of the 3,370,000 persons gainfully employed in 1961, 47% were engaged in industry and trade and 23% in agriculture and forestry; more than a reversal of the 1910 percentages of 27.5 and 33. The birth rate increased from 14.8 per 1,000 in 1951 to 18.6 per 1,000 in 1961. The death rate declined from 12.7 to 12.1 in the same period. Despite the absence of official family-planning facilities, birth rates are lowest in the larger cities; these owe their growth—or in the case of Vienna the arrest of its decline—to the



KARL SINNHUBER

FIG. 2.—STATE CAPITALS AND POPULATION DISTRIBUTION

PHOTOGRAPHS, (TOP LEFT) HERBERT LOEBEL—PIX FROM PUBLIX; (TOP RIGHT) JAMES SAWDERS—COMBINE; (CENTRE LEFT) CAMERA PRESS LTD., LONDON; (CENTRE RIGHT) ERNEST RATHENAU—PIX FROM PUBLIX; (BOTTOM) TET BORSIG—PIX FROM PUBLIX

AUSTRIAN CITIES

Top left: Innsbruck with the Nordkette, Tirolean Alps, in the background
Top right: Landeck, on the Inn river, Tirol
Centre left: Vienna, St. Peter's church dome (left) and steeple of St. Stephen's cathedral
Centre right: Graz, on the Mur river. The Schlossberg is shown on the left in the background
Bottom: The old part of Salzburg with (centre) St. Francis' church. In the background on its dolomite crag is the Hohensalzburg fortress

AUSTRIA

BY COURTESY OF (TOP RIGHT, BOTTOM RIGHT) AUSTRIAN STATE TOURIST DEPARTMEN[illegible] (CENTRE RIGHT) [illegible] HAUSSMANN—PIX FROM PUBLIX; BOTTOM LEFT, TRAVEL—PIX FROM PUBLIX

VIEWS OF THE AUSTRIAN COUNTRYSIDE

Top left: Farm land near Salzburg
Top right: Cable railway on the Schmittenhöhe, Zell am See, Salzburg
Centre right: Chapel in the Tirol mountains near Innsbruck
Bottom left: Sheep moving into the Ötz valley after wintering in South Tirol, It.
Bottom right: Mountain climbers on the Gross Glockner (12,461 ft.)

trend of urbanization; *i.e.*, migration from rural areas to towns. Thus the countryside, despite its surplus of births over deaths, has experienced a slight but steady decline in population, especially in the eastern parts of Austria that formed the Soviet zone of occupation. Also characteristic of the rural areas is a high rate of illegitimate births, generally around 25%. This is largely due to the custom whereby a farmer's son does not marry before taking possession of the farm. Another population movement that has been going on for some time has been from higher to lower altitudes, although the growth of tourism has in some valleys reversed this trend.

V. ADMINISTRATION AND SOCIAL CONDITIONS

1. Constitution and Government.—The constitution in force in the early 1960s was a slightly modified version of that of 1929 which itself incorporated certain amendments, principally in a centralist direction, of the original constitution that had established Austria as a democratic republic and a federal state in 1920. There is a sharp separation between legislative, executive, and judiciary powers, and adequate guarantees of human rights and liberties are included, many of them originating in laws dating as far back as 1862 and 1867. The constitution also embodies a section of the Treaty of St. Germain (1919) guaranteeing the rights of minorities. It may be summed up as a parliamentary-presidential type of federal constitution with a strong bias toward centralism.

The federal nature of the state is expressed both in the division of administrative powers between the central government and the *Bundesländer*, and in the composition of the central legislative body. A fairly comprehensive list of powers is allocated to the central government for both legislation and administration. There is a further mixed sphere of government where the centre legislates, either in detail or in principle, and the *Bundesländer* carry out the administration. All further residual powers remain with the *Bundesländer*.

The legislature consists of a lower house (*Nationalrat*) elected directly by the nation on the basis of equal, direct, secret, and personal suffrage of all persons over the age of 20, under a modified system of proportional representation, and an upper house (*Bundesrat*) drawn from representatives of the *Bundesländer*, whose influence on national legislation is restricted to the exercise of a suspensory veto. Each *Bundesland* has its own assembly (*Landtag*) and elected governor (*Landeshauptmann*), the latter acting in a dual capacity as chief provincial official for the central administration and premier for the *Bundesland*. An independent constitutional court acts as guardian over the constitutional rights of the citizen and mediates in constitutional disputes between the *Bundesländer* and the central government, and a similar administrative court deals with violations of administrative powers.

2. Political Parties.—The second republic is characterized by the small number of parties and the dominance of the two main parties, the Austrian People's Party (Ö.V.P.) and the Austrian Socialist Party (S.P.Ö.) which since 1945 have formed coalition governments. The People's Party in all general elections gained the majority of seats in parliament and provided the chancellor. It is progressively conservative and believes in free enterprise, although it has carried through measures of nationalization. Its largest following is among farmers, the middle classes, and active Roman Catholics of the intelligentsia. It enjoys the unofficial support of the church and is colloquially referred to as "the black party" (from the priests' cassocks). The Socialist Party would like to see the economy nationalized in all its branches, but it stands much nearer the centre than its predecessor the Social Democratic Party, though still popularly known as the "red party." Its principal following is in the industrial areas, especially Vienna, where since 1918 all elected mayors have been Socialists. In all presidential elections after 1945 they gained the majority. The Austrian Communist Party (K.P.Ö.) gained its maximum of five seats in 1949, but lost its three remaining seats in 1959. The other party of any significance, and since 1959 the only opposition party in parliament, is the Austrian Freedom Party (F.P.Ö.). It was started in 1949 as the Union of Independents, and tends to the right wing; its backing (16 seats in 1949; 8 in 1959) comes mainly from former "nationalists" and also from liberals. The composition of the *Nationalrat* after the election of 1962 was: Ö.V.P., 81 seats; S.P.Ö., 76 seats; F.P.Ö., 8 seats.

3. Taxation.—Austrians are among the most heavily taxed people in Europe. In the early 1960s national taxes amounted to over one-fifth of the gross national product, and local taxes and national insurance contributions tended to raise the proportion. National taxation includes: (1) income tax, payable by all individuals on the amount by which the joint household income exceeds 9,500 schillings a year, subject to the graded tax-free allowance and allowances for dependents; standard rate varies according to the level of income up to an absolute maximum of 52% of total income for an unmarried person under 40, and allowances are similarly graded. (2) Corporation tax, paid by companies and other legal persons in lieu of income tax and assessed on total profits before payment of dividends. (3) Turnover tax, payable on all sales and services except exports, public utilities, public undertakings, and postal services, which is of the "cascade" type levied at each transfer of ownership. (4) Transport tax levied on the gross receipts for conveyance of persons or commodities. (5) Equalization of burdens tax, at 18% of income or corporation tax, which is a kind of surtax designed to even out family burdens and promote housing. (6) Property tax assessed at 0.5% of the value of all assets owned inside and outside Austria, subject to an allowance for Austrian residents against the first 40,000 schillings. (7) Acquisition of rights tax payable on share issues and contribution of capital to a partnership or by a foreign company to an Austrian branch. (8) Estate transfer tax payable on purchase or acquisition of real estate. (9) Insurance tax on insurance premiums. Indirect taxation affects goods such as tobacco, beer, wines, spirits, and petroleum products, and there are taxes on motor vehicles, casinos, and lotteries, stamp taxes on bills, petitions, etc., and customs duties. Local taxes include those on industry and trade and on real estate, though nearly one-third of the latter goes to the federal authorities, and taxes for fire protection, housing construction, etc. Taxes for specific purposes may be levied nationally or locally. The two principal religious denominations are legally entitled to collect from their members a tax assessed on income.

4. Employment.—Recovery after World War II was substantial. Full employment was achieved by 1960 and real wages on an average were about 45% higher than in the immediate prewar years, and in no case had they lagged behind increases in the cost of living. There is no state control of wages (except for a statutory minimum), which are fixed by collective bargaining, agreements being legally binding for all employees, both union and nonunion. Wages were improved by holidays and bonuses. Many classes of salaried employees received a double monthly salary twice yearly.

The rights of employees are safeguarded by a closely knit system of laws and regulations. They can receive free advice and representation from the Chamber of Workers and Employees of the *Bundesland*. In every factory with more than five employees a workers' delegate, and in one with more than 20 employees

Austria: Population Distribution, 1961 Census

Bundesländer	Area sq.mi.	Area sq.km.	Population	Density per sq.mi.	Density per sq km.	Capital or administrative seat
Vienna (Wien)	160	414	1,627,566	10,172	3,931	
Lower Austria (Niederösterreich)	7,402	19,170	1,374,012	186	72	Vienna
Styria (Steiermark)	6,326	16,304	1,137,865	180	70	Graz
Upper Austria (Oberösterreich)	4,625	11,978	1,131,623	245	94	Linz
Carinthia (Kärnten)	3,681	9,534	495,226	135	52	Klagenfurt
Tirol	4,883	12,647	462,899	95	37	Innsbruck
Salzburg	2,762	7,155	347,292	126	49	Salzburg
Burgenland	1,531	3,965	271,001	177	68	Eisenstadt
Vorarlberg	1,004	2,602	226,323	225	87	Bregenz
Austria	32,374	83,849	7,073,807	218.5	84	Vienna

a works council, must be elected by secret ballot. The 16 unions of the Austrian Federation of Trade Unions are not linked to any political party. By the early 1960s trade union membership, which is not compulsory, was about 1,500,000 or about two-thirds of all employed.

5. Housing and Welfare.—In the early 1960s rents were low, on average 5.2% of income of a working class family. There was an almost absolute rent control by the state except for nonsubsidized houses built privately after World War II. Few improvements could be made by landlords of older property.

The first laws regulating sickness and accident insurance were passed toward the end of the 19th century, and under the first republic a ministry of social welfare was established. A new beginning was made in 1945, and the basis of the present system is the General Social Insurance act of Jan. 1, 1956. All employees and most self-employed are obliged to belong to a comprehensive social insurance plan. In the early 1960s there were about 300 hospitals and nursing homes and the over-all ratio of doctors and dentists to inhabitants was 1 for 560, the lowest in Europe. Other public expenditure for welfare purposes included child allowances to wage earners and salaried employees, school meals and holidays for children, special training of physically handicapped persons, and scholarships for university students.

6. Justice.—According to the constitution justice is a federal matter. All courts (except those of arbitration) are state courts and all judges are appointed by the federal president or on his behalf by the minister of justice. Once appointed, judges have complete independence and can neither be dismissed nor transferred. They give judgment according to the law but have the right to interpret it according to the circumstances. In addition to the professional judges there are also *Schöffen* ("lay magistrates"), who in certain cases sit on the bench with professional judges. Juries are only called upon for the most serious crimes. In case of conviction they determine the sentence jointly with the judges.

The lowest courts are the 231 *Bezirksgerichte* ("district courts"), which are only competent to deal with minor misdemeanours and minor civil cases. Linked with these courts administratively but not functionally are the *Arbeitsgerichte* ("industrial courts"). The next higher level consists of the 20 provincial courts, *Kreis- und Landesgerichte*. These, besides being courts of appeal against judgments of the lower courts, may try all civil cases and criminal cases liable to penal servitude of up to the limit of ten years. More serious cases, which include political crimes such as high treason, are tried by a *Geschworenengericht* ("jury") of three judges and eight jurors. The *Oberlandesgerichte* ("high courts") at Vienna, Graz, Linz, and Innsbruck, presided over by three professional judges, are courts of appeal in criminal and civil cases. The *Oberster Gerichtshof* ("supreme court") of five judges is the final court of review in civil cases and court of appeal in criminal cases. It is also the final appeal court for cases previously heard before the *Handelsgericht* ("commercial court") or the *Jugendgericht* ("juvenile court"), both at Vienna. The *Verfassungsgericht* ("constitutional court"), also at Vienna, is responsible for cases involving interpretation of the constitution. The police are empowered to collect fines on the spot for certain minor offenses (especially traffic offenses). The accused, however, has the right of trial by a regular court.

The basis of the civil law is the general civil code of 1812 with additions, including those after World War II. The criminal code, dating from 1852 and since frequently amended, imposes sentences of fine, imprisonment, penal servitude, and loss of civil rights. Corporal punishment was abolished in 1867 and capital punishment (except under martial law) first in 1919 and, after reintroduction in the early 1930s, again in 1950. Commercial law is largely based on the German commercial code of 1897; additions were made after 1950. Industrial law includes clauses applicable to all types of employment (*e.g.*, the protection of children and juveniles and employee representations) and to various groups of employees. Normally the only permissible language at court is German, but exceptions are made for Austrian citizens of a different mother tongue. Court cases, even while still *sub judice*, may be the subject of free comment in the press.

7. Education.—The standard of education in Austria is high, and the modern methods of teaching associated with the reforms of Otto Glöckel (1874–1935) in the 1920s won general recognition abroad. A new education act was introduced in 1962 concerned with reorganization in secondary schools. Compulsory school attendance between the ages of 6 and 14 was introduced in 1869. The basic school is the eight-year elementary school (*Volksschule*) but there is in most of the larger places a four-year advanced school (*Hauptschule*) which replaces the last four years of the elementary school and provides a somewhat higher level of general education. In the early 1960s there were more than 4,500 elementary schools (with about 570,000 pupils) and 866 public advanced schools (with 187,000 pupils). Education in the first four years of the *Volksschule* is universal, after which the pupil may continue either in the *Volksschule* or the *Hauptschule*, or upon passing an entrance examination may attend a secondary school from the age of 10 to 19. The secondary schools, which numbered about 200 with an attendance of 82,000, are of three main types: the classical *Gymnasium*, teaching Latin and Greek and one modern language; the *Realgymnasium*, teaching Latin and two modern languages; and the *Realschule*, which emphasizes mathematics and science, with two modern languages. Obtaining the leaving certificate confers the constitutional right to a place at an institution of higher education. In addition to the secondary schools there are various vocational, technical, commercial, and agricultural schools, which the pupil may enter at the age of 14; there are also about 30 teacher training colleges with about 8,000 students. Adult education of every type is also highly developed, particularly in Vienna, where it is largely associated with the Socialist Party. Austria has four universities—at Vienna, Graz, Innsbruck, and Salzburg. The last, refounded in 1963, offers only a limited range of subjects. There are also nine colleges of university rank and academies of fine arts and music. The total number of students exceeded 50,000 in 1964.

8. Defense.—The state treaty of May 15, 1955, authorized Austria to restore its national armed forces and fixed no limitation of their size. However, the treaty prohibited the service in the Austrian armed forces (1) of persons not of Austrian nationality (2) of Austrian nationals who had been German nationals before March 13, 1938; (3) of Austrian nationals who served with the rank of colonel or higher in the German armed forces between March 13, 1938 and May 8, 1945; and (4) of Austrian nationals who had been members of the National Socialist (Nazi) Party or its subsidiary organizations, except those who were exonerated by the appropriate body in accordance with Austrian law.

On Sept. 7, 1955, a defense act establishing Austrian armed forces was promulgated. It introduced compulsory military service for all fit males between the ages of 18 and 51. The peacetime army consists of recruits serving nine months, of volunteers for longer service and of professional officers. Special technical units are recruited from volunteers serving 15 months. In 1960 the Austrian forces consisted of 245 units with about 50,000 men. The supreme command is vested in the federal president. The *Militärakademie* (officers' training school) at Wiener Neustadt, originally founded in 1752, was reopened on Dec. 14, 1958. In September 1961 it was decided to set up an organized militia of 20–25 units for frontier guard service in the border zone.

VI. THE ECONOMY

When the new Austrian republic came into being in 1918, it was economically unbalanced. Cut off by customs barriers from the areas which had supplied coal and much of its food, and which had been its major markets, it seemed to have little chance of survival. In the early years of the republic, banks and many other enterprises failed, inflation set in and there was widespread unemployment.

Recovery did not begin until the mid-1920s and was largely initiated by international loans (see *Finance* below). Much progress was made during the next few years toward an adjustment to the new conditions which necessitated the development of water-power resources, agriculture, and manufacturing industries. The developing tourist trade and earnings from international transit

traffic also helped toward stabilization. This stage came to an abrupt halt after the world economic crisis of 1929, and the resulting unemployment and decline of living standards gave rise to a political restlessness which led to civil unrest. Politics dominated Austria's economy until the *Anschluss* with Germany in March 1938. Thenceforward Austria's economy became geared to the requirements of German rearmament and war. This resulted in expansion and modernization in all heavy industries, the establishment of large plants, like the iron and steel works at Linz, erection of industrial plants in some Alpine valleys for strategic reasons, the building of hydroelectric power stations, and a great increase in the exploitation of the oil fields northeast of Vienna where production rose from under 33,000 tons in 1937 to almost 1,250,000 tons in 1944.

After World War II Austria once more became a separate state, and again faced vast economic problems. There had been considerable damage to housing, industries, and communications, and in the Soviet occupation zone there was much interference with the economic life. The basis for this was a clause in the Potsdam Agreement of August 1945 which gave each occupation power title to the German assets in its zone. While the western Allies transferred their German assets in 1946 to the trusteeship of the Austrian government and in 1949 relinquished their claims altogether, the Soviet authorities took over every enterprise which they considered had been under German control. These numbered about 250, the largest being part of the First Danube Steamshipping company and the entire oil industry. After initially removing machinery and equipment, they changed their policy and appointed an Administration of Soviet Property in Austria (USIA) which had also its own retail organization. Thus until the conclusion of the state treaty in 1955, when Austria agreed to buy these enterprises back in cash and goods to the total value of $332,000,000 (£110,-650,000), this large section of Austrian industry was exploited without reference to the requirements of Austrian economy.

Although the annexation by Germany was the cause of these difficulties, Austria economically experienced a net gain, notably in iron and steel, nitrogenous fertilizer and aluminum industries, staple fibre manufacture, hydroelectric power stations, and communications. The *Anschluss* period had also increased the industrialization of the western *Bundesländer* and thus evened out the unequal distribution of industry of the time before 1938.

As after World War I, the economic recovery of Austria after World War II was largely made possible by foreign aid. Until late 1947 even a bare survival would have been impossible without this aid, given largely by UNRRA, the United States, the United Kingdom, and private bodies (the value of goods received was approximately $500,000,000 or more than £165,000,000). Similarly, the long-term reconstruction plan was only made possible by the inclusion of Austria in the European Recovery Program (Marshall Plan aid), under which it received altogether $962,000,000 (£320,-650,000). Of this, the bulk was used for investment in the following (in order of magnitude): industry, hydroelectric power plants, agriculture and forestry, and public communications. Internal measures contributing to the success of the recovery program included currency reforms and price and wage agreements. In 1954 the budget was balanced for the first time, and the financial year closed with a surplus of 500,000,000 schillings (about $19,600,000). Progress continued into the 1960s. In May 1960 Austria formally became a member of the European Free Trade Association. Since, however, more than 50% of her exports go to the Common Market she applied in 1964 for associate membership of the EEC.

A. Production

1. Agriculture.—Because of its mountainous character barely half of the surface is suitable for agricultural use, more than one-third is under forest, and about 13% is unproductive. Although mixed farming prevails there is a principal subdivision of live-stock or arable farms, but statistics distinguish nine different types of farm, depending on the different proportions of land use. For instance, three different types of wine-producing farms are noted, devoting a varying proportion of their land to the production of wine; such are frequently found in the *Weinviertel* ("wine quarter") of Lower Austria, the Neusiedler Lake region, and southeastern Styria. The total area under vineyards is about 98,850 ac. (40,000 ha.) and in 1961 production was approximately 1,195,000 hl. (about 26,300,000 imperial gallons).

Fruit cultivation is widespread but subsidiary to other farming. Apples take first place, especially in Styria. In Upper and Lower Austria much of the apple crop is made into *Most* ("cider"), largely for farm consumption. Two-thirds of the pear harvest also is of cider quality. Stone fruits (plums, apricots, and peaches) are also grown. Walnuts are grown chiefly in the Burgenland.

Of the agricultural land (9,416,000 ac. or 3,851,000 ha. in 1960), arable accounts for about 40%, followed by meadows and pastures, and alpine grassland with approximately 38% and 22% respectively. The bulk of arable land is in the Alpine foreland and the Eastern lowland; these regions account between them for more than 90% of the total, 40% being in Lower Austria. Most of the meadows and pastures are in the southern part of the Alpine foreland and the Flysch zone, the Granite plateau, and the lower Mur Basin in Upper Austria, Styria, and Lower Austria. More than one-third of the alpine grassland is in the western Central Alps.

Grain, which takes half of the plowland, is the most important crop. In the early 1950s rye was overtaken by wheat, a reflection of changing consumption habits. Various measures have resulted in increased yields per hectare and since 1961/62 self-sufficiency in bread. While self-sufficiency in potatoes was maintained it dropped in sugar to around four-fifths. In the mountainous areas, where most farm land is for hay and grazing, cattle are the mainstay of the economy; during the summer months most of them graze on the mountain pastures, a practice which makes for a healthy stock besides bringing the high areas into use. The number of horses has declined though horse breeding in the Alpine area remains important. The raising of goats and sheep, which in the Alps use the poorest and highest pastures, is insignificant.

The Alpine areas cannot compete in stock numbers with the arable areas of the Alpine foreland and the Eastern lowland, where fodder crops occupy much of the farm land. As in arable farming, there has been a steady improvement in stockbreeding, reflected by the increase of milk yields. Difficulties are that the principal breeds are not specifically dairy cattle, and that on small farms about one-quarter of Austria's cows are used also as draft animals. However, the country did become self-supporting in dairy products after 1956. Most farms have a few pigs which have increased in quality through improved breeding methods. Hens are raised everywhere.

To be fully competitive within a free European market, a great deal more has still to be done. Since 1961 a "green plan" has been in operation to improve the agricultural structure. The most urgent task is reallocation of farm land of which in the 1960s more than 2,500,000 ac. (approximately 1,000,000 ha.) still needed attention. Equally serious is the prevalence of small farms: 23% of the total of about 400,000 farms and holdings are under 5 ac. (2 ha.) and another 24% under 12½ ac. (5 ha.). About 90% of Austrian farmers own all or most of the land they farm and only 5% of holdings are pure tenant farms.

2. Forestry.—Forests cover more than 7,500,000 ac. (3,000,-000 ha.), about 37% of Austria's surface. In percentage of the productive area Austria takes fourth place among European states. The forests yield approximately 9% of the national income and in the early 1960s timber, timber products, and paper accounted for almost one-fifth of the total exports.

Conifers, mainly spruce, form about 84% of the forest area; the rest is deciduous in which beech predominates. Here, as in farming, the major handicap to efficiency is the property structure, as a result of which more than half of the total forest area is privately owned and consists of lots smaller than 123½ ac. (50 ha.). Lack of capital and training makes for inefficiency and about one-quarter of the total yield is consumed by the producers. State forests (15% of the total) and large private forests are the best kept. Owners of the small forests are encouraged to combine into forest utilization co-operatives. Overcutting took place during and after World War II, and the state has subsidized reforesta-

tion schemes and the building of access roads.

3. Mining.—Mining of salt, copper, and iron in Austria is of prehistoric standing and attracted people into areas otherwise hostile to settlement, like the Hallstatt region, where the wealth of the salt mines made it an important cultural centre, giving its name to the Early Iron Age period. The mining of these products continued during the Middle Ages and gold, silver, and precious stones in the Central Alps, and lead in Carinthia were also won. By mid-20th century the mining of precious metals had ceased, but other minerals such as coal, magnesite, kaolin, petroleum, and natural gas were extracted. By the early 1960s the total number of employees in the extractive industries averaged 30,000, nearly half in coal mining. While hard coal resources are small, the only economical mines being at Grünbach in Lower Austria, there are many brown-coal fields. The total coal reserves are estimated at 300,000,000 tons and production has much increased since 1937. There are, however, marketing difficulties, and competition from imported coal or oil. Calculated on the basis of the calorific value of hard coal, home coal production can satisfy only about one-third of Austria's needs.

Oil was discovered in 1932 near Zistersdorf, north of Vienna. Production rose slowly until 1937 (33,000 metric tons), and reached a peak of nearly 3,700,000 tons in 1955, after which it declined by more than 1,000,000 tons. Associated with oil is the production of natural gas, which increased from 285,000 cu.m. (1 cu.m = 35.314 cu.ft.) in 1937 to 1,699,000,000 cu.m. in 1963, making Austria third producer in western Europe after Italy and France. Proved reserves were estimated at 58,500,000 tons of oil and 30,000,000,000 cu.m. of gas. A modern oil refinery at Schwechat (Vienna) began operating in 1960. Home production satisfied 60% of needs in the early 1960s.

Iron ore is the most important metal. About three-quarters of it comes from the Erzberg in Styria where it is quarried rather than mined and production costs are low. It is also mined at Hüttenberg in Carinthia. Although annual production normally exceeds 3,700,000 tons (iron content about 1,200,000 tons), this is insufficient and a considerable amount of ore, pig iron, and scrap has to be imported. The total reserves are estimated at 330,000,000 tons. Next in importance are lead-zinc-molybdenum and copper ores. The former occur in Triassic rocks at a number of places in the southern Limestone Alps and mining is centred in Bleiberg ob Villach. Annual production exceeds 190,000 tons; the lead from these ores amounts to about 5,000 tons or half the requirements and the zinc is of similar tonnage. Copper ore occurs in the northern Shale Alps but the copper content is low (2.2%) and only the largest deposits near Bischofshofen (Salzburg) and near Schwaz (Tirol) are used. (At the latter place the ore contains small amounts of mercury and silver.) Annual production averages 140,000 tons. The copper smelting is done at Brixlegg (Tirol); production averages 10,000 tons, of which about one-fifth comes from home produced ores.

The mining of magnesite, for which Austria once possessed a world monopoly, is important to the Austrian economy. Deposits occur in the Central Alps and the Shale Alps. The most valuable mines are at Radenthein (Carinthia), Veitsch, and Breitenau in Styria. Annual production, which exceeded 1,500,000 tons in 1960, has since declined. Raw magnesite and magnesite products are exported.

Important saline deposits occur in the lowest Triassic strata in the northern Limestone Alps. The salt is generally mixed with clay so that most is extracted by filling underground cavities with water and subsequently pumping out and evaporating the brine. The total production of salt in the early 1960s was about 170,000 tons. Brine is also used in the chemical industry and for medicinal purposes at the spas. Salt has been a state monopoly since the Middle Ages.

Other minerals mined include: antimonial ore, bauxite, graphite (much increased in the 1960s by use in iron ore smelting), gypsum and anhydrite, manganese ore, oil shales, quartz and quartz sand, talcum, and wolframite ore. A great deal of stone is quarried, mostly for public buildings.

4. Power.—Relief and climate combine to give Austria a water-power potential of about 5,000,000 kw., the greatest in central Europe. The largest hydroelectric power stations utilize the Danube. Total annual production by 1963 reached 18,444,000,000 kw-hr. (*c.* 85% hydroelectric). Most of the thermoelectric stations use Austrian brown coal except those at Vienna and Linz where Austrian oil and natural gas provide much of the fuel.

5. Industries and Crafts.—Trades and crafts occupy a leading position and form the most numerous occupation group. Apprenticeships of three to four years assure high quality and competition with industry. Most of the trades supply internal consumption, but those that produce for export contribute between them about 15% in value of Austrian exports—these are bone china, ceramics, high-quality glass goods, glass costume jewelry, petit point work from Vienna, lacework, and wood carvings.

Manufacturing industries, which employ nearly as many people as the crafts, range from heavy industries to optical or radio manufacture. In Austria the tendency is toward a large number of small specialized industries. By two acts in 1946 and 1947 a high proportion of industries were nationalized. This was in part due to complications arising from formerly German-owned plants. The controlling body for these industries, which include petroleum, coal, electricity, metal ore mining, iron and steel, and part of the chemical, electrical, machine, and vehicle industries, is a holding company set up in 1956, the Österreichische Industrie und Bergbau-Verwaltungsgesellschaft (Austrian Board of Industry and Mining). Heavy iron and steel industry is concentrated in two places: an old centre in Styria near the iron ore deposits and a newer one at Linz. Annual pig iron production, 390,000 tons in 1937, exceeded 2,000,000 tons in 1963, and production of crude steel increased from 650,000 tons to nearly 3,000,000 tons, in spite of the lack of coking coal. An important Austrian contribution to metallurgy was the development of the LD (Linz-Donawitz) oxygen converter process. Production of aluminum, the greater part for export, rose from 4,400 tons in 1937 to more than 90,000 tons in the early 1960s.

Austria's extensive timber resources have created an important paper industry, including wood pulp, cellulose, and cardboard, with 80 paper mills in the major valleys on the margins of the northern Limestone Alps and the Vienna and Klagenfurt basins. By 1963 annual production of paper exceeded 520,000 tons; more than half was exported, and was a leading foreign currency earner. The textile industry greatly expanded after World War II and synthetic fibre, yarn, cloth, and clothing made a valuable contribution to exports. Because of postwar difficulties (*e.g.*, reduction of livestock, shortage of foreign currency for import of tanning materials and leather) the leather industry was slow to recover.

The chemical industry occupies third place by value of production. Many basic chemicals are produced, especially nitrogen fertilizer, and there are rubber and plastic industries. The machine and vehicle industries are mainly concentrated at and near Vienna, Graz, and Linz; an isolated centre is at Steyr. They produce heavy machinery for metal works and rolling mills, drilling and mining equipment, agricultural machinery, lathes, pumps, looms, and many other items. There is shipbuilding near Vienna and at Linz, and locomotive and rolling stock construction at Vienna and Graz. The motor industry ranges from production of autocycles to trucks and buses, but after a peak in the late 1950s production declined in all branches.

The tobacco industry is a state monopoly. Imports come largely from Greece and the United States. Annual excise duty paid on tobacco amounts to more than 2,000,000,000 schillings, nearly one-tenth of all indirect taxes collected.

B. Trade and Finance

1. Foreign Trade.—Imports in the immediate post-World War II years consisted largely of foreign relief consignments which in 1945–46 amounted to 88% of the total. As the Austrian economy recovered these fell off and by 1954 were as low as 3[illegible] of imports.

Foodstuffs accounted for more than one-third of imports in 1937 but by the early 1960s they had dropped to about one-eighth. Machines and vehicles were the chief articles imported. Exports, in order of value, were finished and semifinished goods, raw mate-

rials, including electrical energy, and foodstuffs. The value of imports always exceeded that of exports, but earnings from services (freight charges, tourism) more than filled this gap. By 1953, for the first time in the history of the republic, Austria had a surplus (more than $70,000,000 or £25,000,000) in its balance of payments.

Since the 1950s the Federal Republic of Germany has become Austria's principal trade partner. Of exports in 1963, 49.1% went to EEC and only 15% to EFTA states, while east European countries took 18.4% and overseas countries 13.3%. Entrepôt trade is carried on at the three customs-free zones at Linz, Graz, and Innsbruck, established after World War II.

Tourist Trade.—Spas of international repute like Badgastein (*see* GASTEIN) and Baden, cities like Vienna, Salzburg (with its music festivals), and Innsbruck (*qq.v.*), the lakes of the Salzkammergut and the Austrian Alps have for long attracted tourists. This trade first reached its peak during the 1930s when most of the foreign visitors came from Germany and southeastern Europe. After World War II its recovery was slow and it was not until the mid-1950s that it became reestablished as a significant industry.

2. Finance.—After the collapse of Austria-Hungary, Austria experienced several years of inflation and financial chaos, ending only when financial help came from abroad, in particular the International Reconstruction loan of 1923, floated under the auspices of the League of Nations. From 1924 until 1930 current revenue covered current expenditure and at least a large part of state investments. In 1931, however, the world depression precipitated a financial crisis; the League of Nations was again called in to assist, and a further international loan was raised.

After World War II the Austrian government encountered serious problems. While production was at a very low level, there was a large volume of currency in circulation. Heavy budgetary expenditure was necessary both for normal purposes and for the support of the occupying forces and displaced persons, and the collection of revenue was difficult because of the disorganization of the fiscal apparatus and the division of the country into zones of occupation between which communication was at first restricted.

From 1946 onward there was a surplus on the ordinary budget, but total state expenditure was greatly in excess of revenue. This was due partly to heavy investment expenditure in the extraordinary budget, but also to extrabudgetary expenditure on occupation costs (which were optimistically regarded as a temporary item and financed by inflationary borrowing) and subsidies (which were partly paid out of funds accumulated from the sale of goods supplied to Austria for relief and rehabilitation). The over-all position was therefore inflationary. The first attempts to deal with the situation were the wage and price agreements of August 1947 and September 1948, the general aim of which was to reduce subsidies and offset the consequent price increases by wage increases, but from the state's point of view the saving on subsidies was largely cancelled out by the extra payments for wages, social welfare, etc. An acute budgetary crisis arose in May 1949, when it became clear that the original budget was quite unrealistic. A revised version was produced which increased tax rates, imposed a special tax to cover occupation costs and reduced certain subsidies; and a third wage and price agreement partially alleviated the extra burden thus imposed on wage earners. In September 1950 a fourth wage and price agreement further cut subsidies and gave consequential wage increases.

Further steps to deal with inflation were taken after 1951; credit was restricted and the bank rate was raised from 3.5% to 5% and later to 6%. These measures, together with a voluntary "standstill agreement" on prices and wages in the autumn of 1951, served to stabilize the financial situation to some extent during the following year. There was a surplus in the balance of payments in 1953, and the position had improved to such an extent that investment and social expenditure was increased in 1954, while at the same time income tax and the tax on business capital were reduced. The bank rate was reduced to 4½% in 1959.

The basic unit of the Austrian currency is the schilling, divided into 100 groschen. The schilling was first introduced in Austria in 1924 when it replaced the Austro-Hungarian krone (crown). This currency collapsed after 1918 and the schilling was at first equal to 10,000 kronen. In March 1938, after the *Anschluss*, it was replaced by the reichsmark at the rate of 1 reichsmark to 1.5 schillings. When the schilling was reintroduced after World War II a limit of 150 reichsmarks per person were exchanged on a 1 to 1 basis, additional money was valueless and banking accounts were blocked (subject to certain exceptions). Since these measures proved insufficient to prevent inflation, the currency protection bill of December 1947 provided for the issue of schillings at a rate of 1 new schilling to 3 old. From October 1946 the official exchange rate was 10.14 schillings to 1 U.S. dollar. On May 4, 1953, the schilling was devalued to 26.00 to 1 U.S. dollar.

C. Transport and Communications

The pattern of communications has been dominated by Austria's central location in Europe, in particular its position between the Mediterranean, the North, and Baltic seas, and across the Danube gap between the central uplands of middle Europe, the Carpathians, and the Alps. Early routeways which crossed the territory of present Austria were the amber road from the Baltic to the Adriatic and the salt road from the Salzkammergut into Bohemia. While the Roman Empire extended as far north as the Danube, roads across the Brenner and other Alpine passes and others following the valleys of the major rivers gained importance, which increased during the later Middle Ages and, with the formation of the Austro-Hungarian Empire, Vienna became the hub of the communication lines. Despite the breakup of the empire in 1918, Vienna retained much of its former role during the interwar period, but the division of Europe into west and east that followed World War II had a much more pronounced effect and resulted in considerable reorientation of the transit traffic, emphasizing the north-south at the expense of west-east lines.

1. Roads.—Only the federal roads, including motorways, are of international importance. The Salzburg-Vienna, Brenner Pass, and Vienna-Semmering motorways were under construction in the 1960s. Peculiarities of the Austrian road system are that the principal (No. 1) road from Bregenz to Vienna is in two sections separated from each other by German territory, that the alpine crossing at Badgastein is facilitated by taking road vehicles through the Tauern Tunnel by train, and that a similar service exists through the Arlberg Tunnel during the winter and has to be used during temporary snow blockages of the Arlberg Pass. The Grossglockner Road, which goes up to nearly 10,000 ft. and is a toll road, largely serves tourist traffic and is only open during the summer and early autumn. Licensing laws restrict competition by regular private bus services on routes served by the railways. Bus lines, largely operated by the Federal Railways and Postal Administration, provide regular services to outlying places.

2. Railways.—The earliest railways were built to link the major population centres of the Austro-Hungarian Empire. The first line ran from Prague and Cracow to Vienna and on to Graz and the then Austrian port Trieste. The first sections of this line were opened in 1839 and the stretch across the Semmering (1854) was the first alpine railway. A second tunnel under the Semmering was opened in March 1952. The main line of Austria, the Westbahn, from Vienna to Lake Constance, was not completed until 1885 with the construction of the Arlberg Tunnel. The last major railway construction was the Tauernbahn (1900), the fourth line on Austrian territory to cross the Alps from north to south. The state-owned Austrian Federal Railways (Österreichische Bundesbahnen) operate about 90% of the railway routes in Austria. Private railway construction began about 1880 and was restricted to branch lines often built in narrow gauge.

Electrification.—The end of World War I brought changes and difficulties to the Austrian railways; a number of junctions around the borders were lost and the traffic pattern changed radically. These difficulties were added to the permanent problem of the relief, with its inclined and curved sections increasing the running costs. The loss of the coalfields, the greater efficiency of electric locomotives for climbing, and the hydroelectric power potential of the country were stimuli toward electrification, which was decided on by parliament in 1920. The section Innsbruck-Landeck was

completed in 1923 and by 1938 most of the lines of the western *Bundesländer*, Vorarlberg, Tirol, and Salzburg had been electrified. By 1952 the entire Westbahn had been electrified.

Mountain and Cable Railways.—These types of "railway" are of great importance for the Austrian tourist trade. The first mountain railway operated by cogwheels was opened in 1893 (Schafberg, Salzkammergut). The first funicular cable line (*Seilschwebebahn*) for passengers began operation in 1927 to the Rax (Lower Austria). The highest, the Vallugabahn near Sankt Anton am Arlberg, goes up to 9,220 ft. Many chair lifts, operating in summer and winter, and ski tows have also been built.

3. Shipping.—Shipping in Austria is found on the larger lakes where it serves local transport and the tourist trade but commercially by far the most important is the Danube shipping. The First Danube Steamshipping Company (E.D.D.S.G.), now a state enterprise, began operating in 1830. The main commodities transported on the upstream traffic were grain, pulses, eggs, and mineral oil, and downstream timber, iron and metal goods, building material, and paper. After World War II, because of Soviet occupation of eastern Austria, shipping (except that operated by the Soviets) was at first confined to the section from Linz upstream. The U.S.S.R. had furthermore seized all ships and installations of the E.D.D.S.G. as German assets, since during the *Anschluss* it had passed to the German government. In the state treaty of 1955 Austria agreed to buy back all the assets for $2,000,000 (£714,000) and the company was by August 1955 again in Austrian hands.

By 1960 the total annual goods traffic on the Austrian section of the Danube was about 5,500,000 tons. Of the imported goods about 50% were coal and coke (mostly coming from or via Germany), 15% mineral oil and 15% iron ore. Exports included crude oil and gas oil (over 50%, three-quarters of which went to eastern bloc countries and included Austrian compensatory deliveries to the U.S.S.R.), iron and steel (23%) and fertilizers (11%). The leading Danube ports in Austria are Linz (with a customs-free zone) and Vienna. Austria was admitted to full membership of the Danube Commission, established under Soviet control in 1948.

4. Civil Aviation.—Vienna developed during the interwar years as an important junction of European air routes. Immediately after World War II, aviation was forbidden to Austria. With the signing of the state treaty Austria regained its air sovereignty and Austrian Airlines (AUA) was founded toward the end of 1957. It began operations on April 1, 1958, and in 1960, operating with Super Viscounts, covered a network connecting 22 cities in 16 countries. This service was made possible by pooling agreements with British European Airways, Deutsche Lufthansa, Swissair, and Aeroflot. The most important airport is at Vienna (Schwechat). The other commercial airports of Austria in order of importance are Innsbruck, Klagenfurt, Salzburg, Linz (Hörsching), and Graz. Austria has developed an air mountain rescue service and there are a number of glider and sailplane schools.

5. Postal Service and Telecommunications.—The Austrian postal service is the heir of the Austrian imperial mail which was established in the early 16th century as one of the first postal institutions. The telegraph service in Austria showed recessive tendencies in the early 1960s, while the teleprinter service, in which Austria possesses a dense network, was expanding. Direct-dial telephone services were introduced. All telecommunications, including radio and television, come under the jurisdiction of the postal authorities. The Österreichischer Rundfunk G.m.b.H. operates 17 television and about 100 radio stations. Television in Austria began experimentally in 1955 and regular programming started in 1957. Austria is linked with the Eurovision network.

See also references under "Austria" in the Index.

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AUSTRIA, EMPIRE OF. The connotation of the name Austria has varied with the phases in the political relationships of various territories under the Babenberg and Habsburg dynasties and has found its final expression in the Austrian republic (see AUSTRIA). The Bavarian settlements in the region now known as Lower Austria were the nucleus, and were first recorded under the designation Ostarichi ("eastern region") in the year 996. This name would seem to have been already current during the Carolingian period, whereas the German term *Ostmark* was introduced by modern historians. The lands governed by the Babenbergs and Habsburgs retained their own names, privileges and cultural individuality, but the name Österreich (the Latin form 'Austria' came into use in the 12th century) was used as the first and oldest feudal title both for the dukes and for the totality of their lands (in the later middle ages *domus Austriae* and *dominium Austriae*). After the end of the Thirty Years' War the lands under the immediate rule of the Habsburgs came to be called the Austrian lands though this name never had any constitutional significance. Constitutional unity was not achieved until the creation of the Austrian empire in 1804. From 1867 to 1918 the Hungarian territories of the Austro-Hungarian dual monarchy were no longer considered as part of Austria. The Austrian republic of the 20th century is roughly equivalent in extent to the Habsburg Austria of the later middle ages.

HISTORY

In the territories of the Austrian republic are found traces of human settlements dating back to the early Paleolithic period, and from subsequent periods several cultures are found coexisting. The entire Illyrian culture of the Early Iron Age (*c.* 800–450 B.C.) takes its archaeological name from that of Hallstatt, the principal Austrian site. Celtic tribes invaded the eastern Alps *c.* 400 B.C. and eventually founded the kingdom of Noricum (*q.v.*), while in the west (Vorarlberg and Tirol) the ancient race of Raetians was able to maintain itself. After an initially peaceful penetration during the last two centuries B.C., Roman troops finally occupied the country in 15 B.C., and the lands as far as the Danube became part of the Roman empire. South of the Danube lay the Roman provinces of Raetia, Noricum and Pannonia. Among the towns, Carnuntum (near Hainburg on the Danube) at first took precedence over the *municipium* Vindobona (Vienna). Further large settlements grew up at Brigantium (Bregenz), Juvavum (Salzburg), Ovilava (Wels), Lauriacum (Lorch, near the Enns), Virunum (near Klagenfurt), Teurnia and Flavia Solva. The peaceful development of these provinces was arrested by the invasions of Germanic tribes of Marcomanni and Quadi from the north (A.D. 166–180), and even after the repulse of these tribes by the emperor Marcus Aurelius these lands could not regain their former prosperity.

Already in the 3rd century the Roman frontier defenses were hard pressed by invasions from the Alamanni, and finally heavy attacks by the Huns and East Germans in the 5th century put an end to the Roman provinces on the Danube. There is archaeological evidence of Christian settlements in this area from the 4th century, and the biography of St. Severinus by Eugippius constitutes a unique literary source for the dramatic events of the second half of the 5th century. At that time a large number of German tribes (Rugians, Goths, Heruli and later Langobards (*see* LOMBARDS) settled on Austrian territory. In the year 488 Odoacer, ruler of Italy, brought about the emigration of part of the Roman population from these provinces.

After the departure of the Langobards (568) further development was determined by the Bavarians in their struggles with the Slavs who were invading from the east, while Alamanni settled in what is now Vorarlberg. The Bavarians were under Frankish influence, while the Slavs had Avar rulers. By the end of the 6th century the Slavs had penetrated as far as Carinthia and eastern Tirol, and after 624 a pact between the Slav tribes against the Avars led to the short-lived rule of the Frankish merchant Samo, which may also have extended over the territories of the Eastern Alps. About 700 the Enns river was the frontier between the Avars and the Bavarians, whose dukes from the house of Agilolf were, after 639, virtually independent rulers.

No doubt they, as well as the remainder of the Roman population, provided support for the Christian mission which is known to have existed *c.* 620. Among the missionaries active *c.* 700 the most important for Austria was Rupert, who founded the church of Salzburg. After the duke of the Slavs in Carinthia had placed himself under the protection of the Bavarians (before 750), the latter began to penetrate into the valleys of Carinthia and Styria, founding settlements and missions.

After defeating the Bavarian duke Tassilo III (787–788), Charlemagne led a number of attacks against the Avars (790–*c.* 796) and destroyed their khanate; the survivors settled in the eastern part of Lower Austria and soon disappeared from history. The newly created Frankish provinces on the Danube were at first administered as part of Bavaria, but only up to 799. In the regained eastern territories (the Austrian mark or march, Pannonia and Karantania or Carinthia) frequent disagreements arose in the subsequent years among the princes and between them and the royal house. The situation grew serious when to this unrest was added the threat of the kingdom of greater Moravia. Nevertheless the process of civilization was considerably advanced in Austria during the Carolingian period (790–907). Missionary activity was directed from Salzburg (from 797 an archbishopric) and Passau, while concurrently the settlement of the new lands by Bavarian and Frankish farmers went forward under both ecclesiastical and secular rulers. In 881, near Vienna, came the first clash with the Magyars, who after the destruction of the greater Moravian empire (906) became a mortal danger for the Carolingian marches. The counterattack by a large Bavarian army ended in catastrophic defeat at Pressburg (Bratislava) in 907, when the archbishop of Salzburg and Luitpold of Bavaria (the father of the duke Arnulf and the holder of great lands in the marches) were among those killed. The territories as far as the Enns river fell under Magyar domination, but in Lower Austria a certain continuity of settlement was maintained from which, after the victory at Lechfeld (955) and the further repulse of the Hungarians in the 960s, a fresh start could be made.

The Babenbergs.—In the regained territories east of the Enns, the first margrave to be mentioned is Burkhard, who lost his office as a result of his championship of Henry the Quarrelsome, duke of Bavaria. In 976 the office fell to Leopold I, of the house of Babenberg (*q.v.*), under whose rule the eastern frontier was extended to the Vienna woods. About 1002 Vienna must already have been in German hands. Between 970 and 980 new marks were created in what was later known as Carniola (or Krain) and in Styria. For a short time (*c.* 1043–63), in the east of the Austrian mark, the so-called new mark (Neumark) enjoyed an independent existence. The position of the Babenbergs was at that time still humble; their territorial rights were no greater than those of other leading noble families, and ecclesiastical immunities (those of Passau, in particular, but also Salzburg, Regensburg and Freising, as well as numerous monasteries) diminished their power within their official sphere. The bishops of Passau exercised diocesan powers in Austria and owned some important trading centres which later developed into towns.

Austria was repeatedly drawn into the disputes of the Investiture controversy (*see* GERMANY: *History;* PAPACY). In 1075 the margrave Ernest was killed fighting the rebellious Saxons. His successor Leopold II abandoned the cause of Henry IV, who raised the Bohemians against him and bestowed the mark on their duke Vratislav. In spite of their defeat at Mailberg (1082), however, the Babenbergs were able to survive. Meanwhile the cause of the so-called reform movement in the church gained ground, particularly through the influence of Altmann, bishop of Passau. Its centres were the newly founded monasteries of Göttweig, Lambach and Admont (the last named still outside the Babenberg lands, in Styria).

The reign of Leopold III (1095–1136) is particularly important in the history of Austria. In the struggle between the emperor Henry IV and his son Henry V, Leopold sided with the young king in 1106 and was rewarded with the hand of his sister Agnes; this intermarriage with the reigning dynasty not only increased Leopold's reputation but no doubt also brought him additional means of power. He was able notably to improve his position with regard to the Austrian nobility and to be the first to describe himself as the holder of a territorial principality (*principatus terrae:* Ger. *Landesfürstentum*). He strengthened his reputation with the clergy by means of generous endowments of religious communities (the foundation or restoration of Klosterneuburg and the establishment of the Cistercians at Heiligenkreuz). Toward the end of his life he obtained the rights of civic ruler of Vienna, though his residence remained at Klosterneuburg. Leopold III's achievements would have been impossible without the unremitting labour of several generations of the farming population. During the 11th and 12th centuries additional forest lands were cleared, settlements sprang up in the mountains and the demands of an increasing population caused villages to grow into towns. The fact that Austria possessed a larger number of public markets than Bavaria and also a more flourishing urban life was due to the greater productivity of the country and to its favourable situation at the intersection of major trade routes.

Formally Austria continued to be part of Bavaria, but in fact from the 11th century the rule of the Bavarian dukes no longer extended over it. In the gradual process of the dissolution of the great duchies, it was inevitable that the Babenberg territories should become a separate entity. They had enjoyed a continuity of rulers of the same house for six generations, whereas Bavaria

had changed its duke 15 times. The occasion was provided by the conflict of the German king Conrad III with the Welfs, from whom he wrested Bavaria in 1138. He bestowed the land on his half brother Leopold IV of Babenberg in 1139 and after the latter's death on Henry II Jasomirgott.

The emperor Frederick I Barbarossa put an end to the struggle for Bavaria by making Austria over to Henry Jasomirgott and his wife Theodora as a duchy, together with three countships, the actual location of which is disputed. By a document known as the *privilegium minus* (Sept. 17, 1156), Frederick reduced the obligations of the dukes toward the monarchy (attendance at royal court days only obligatory in Bavaria, provision of troops only required for campaigns against Austria's neighbours). For themselves Henry and Theodora were granted succession through the female line and the right, in the event of the premature death of their children, to appoint a candidate for the succession. To this was added the right of approving the exercise of authority by other powers within the confines of the new duchy. Against such other powers and, in particular, against the immunity of the clergy, Henry Jasomirgott was now able to exert some pressure. Yet throughout the middle ages there remained territorial dominions in Austria that were not subject to the duke. It also proved impossible to create in Vienna, now the capital city, a separate Austrian bishopric, though the two last Babenbergs made many efforts to bring this about.

Henry's son, Leopold V, was able to conclude a treaty of inheritance (1186) with Otakar IV of Styria, who had in 1180 been raised from the rank of margrave to that of duke. Through this treaty Styria came under Babenberg rule as early as 1192, as well as the Traungau (now Upper Austria), the province of Pitten (now in Lower Austria) and smaller estates in Carinthia and Carniola (Krain). With the exception of a short intermission (1194–98) the reigning Babenberg henceforth bore the title duke of Austria and Styria. During the reign of the emperor Frederick II this title was further extended by the addition of "lord of Krain" through the acquisition of fiefs of the margrave Henry of Istria, who died in 1228. The attempt to raise Austria and Styria to the status of kingdom and to place Krain as a dukedom under the rule of the new king miscarried in 1245.

During the 12th century Vienna grew into a centre for foreign trade, and the newly opened route across the Semmering pass also made access to the Adriatic easier for Austrian merchants. But the main reason for the prosperity of the two dukedoms was the completion of the colonization of the land, which was principally carried out in Austria by the religious settlements, by the great houses of the aristocracy and by the *ministeriales* and in Styria also by the house of Traungau, whose rule lasted until 1192. The house of Babenberg played only a modest part in this colonizing movement, but supported it by keeping the peace and by a policy of moderation which sought to keep Austria from involvements in imperial politics. A change came about under the last representative of the dynasty, Frederick the Warlike, whose harsh internal policy and military excursions against neighbouring lands, together with his opposition to the emperor Frederick II, led in 1237 to the temporary loss of both Austria and Styria. The crisis, however, was overcome and fresh opportunities were about to open for the duke when, on June 15, 1246, he was killed in battle against the Hungarians on the Leitha river. With him the male line of the family came to an end.

The Interregnum.—The emperor Frederick II took over the Babenberg lands and attempted to rule them by placing them in the charge of captains general. Pope Innocent IV meanwhile pressed the claim of a niece of the last of the Babenbergs, Gertrude, who in 1247 had married Hermann, margrave of Baden, a supporter of the papacy. Hermann managed to assert himself to some degree against the imperial troops but died in 1250. Hungarian and Bavarian invasions persuaded the Austrian nobility to recognize the margrave Premysl Otakar II of Moravia as duke. He entered Vienna in 1251 and in the following year married Margaret, a sister of Frederick the Warlike. King Béla IV of Hungary failed in an attempt to occupy both Austria and Styria but, through papal intervention, obtained territories in Styria at the peace of Buda (1254). In 1260 Premysl Otakar, now king of Bohemia, was able, with the support of the nobility, to take over Styria entirely; and in 1262 he was granted both Austria and Styria in fief from Richard of Cornwall, the titular German king (though admittedly only by writ). In 1270, moreover, he extended his rule over Carinthia and Carniola. At first Premysl Otakar's reign was generally popular, but later he began to encounter opposition from the Austrian nobility, probably caused in part by the dissolution of his marriage with Margaret (1260) but principally by his policy of reclaiming estates and privileges which the nobility had held since 1246. (HE. FI.; E. ZO.)

The Accession of the Habsburgs.—On the death of Richard of Cornwall the electors chose as German king the Swabian count Rudolf IV of Habsburg, who was crowned as Rudolf I on Oct. 24, 1273 (*see* RUDOLF: *German kings*). Because his personal dominions, in Switzerland and in Alsace, were comparatively small (*see* HABSBURG) and because his duty as German king in any case required that the excessive power of Premysl Otakar should be broken, Rudolf seems from the first to have wanted to secure the former Babenberg lands for his own house. He went about this purpose cautiously. First, in 1274 he questioned Premysl Otakar's right to the three duchies (Austria, Styria and Carinthia). Then, in 1276, having twice summoned Premysl Otakar to appear before the imperial diet, he placed him under the ban of the empire, led an army into Austria and defeated him. Premysl Otakar renounced his claim to the duchies and did homage to Rudolf for Bohemia and Moravia. Two years later, trying to recover what he had lost, he was defeated and killed.

In 1281 Rudolf made his eldest son Albert governor of Austria and Styria, retaining Carinthia under his own rule. Then, on Dec. 27, 1282 he raised his two sons Albert and Rudolf to the rank of princes of the empire and invested them jointly with Austria, Styria, Carinthia, the Windisch Mark and Carniola. The next year, however, this dual sovereignty was abolished, Albert receiving the territories as a hereditary possession, his brother being compensated with a sum of money. Finally, in 1286, Carinthia was detached from Albert's dominion and bestowed on Meinhard, count of Tirol.

As ruler of Austria, Albert (*see* ALBERT I, German king) had to contend with the discontent of the towns and nobles. In 1288 a rising in Vienna compelled him to flee the city, and in 1296 he granted it many of its lost municipal privileges. The Styrian nobles revolted in 1292, the Austrian nobles in 1295. There was also perennial discontent in the Habsburgs' Swiss lands, so that when his father died in 1291 Albert was unable to contend the election of Adolf of Nassau as German king. In 1298, however, Albert gained the deposition of Adolf and, defeating him at Gollheim, was himself crowned king as Albert I. In 1306, moreover, he set his eldest son Rudolf on the Bohemian throne, but Rudolf died next year and Albert was himself murdered in 1308.

Albert was succeeded as duke by his second son, Frederick (*see* FREDERICK III, German king; in Habsburg-Austrian history reckoned as Frederick I, being the first Habsburg to bear the name since the family's accession to the duchy). This Frederick in 1314 stood for election as German king, and for the next eight years Austria had to support the cost of his war with his rival Louis IV the Bavarian. In 1322, however, at the decisive battle of Muhldorf, Frederick was defeated and taken prisoner. More important for the Habsburg house, meanwhile, was the defeat of Frederick's brother Leopold I (1293–1326) by the men of Uri and Schwyz at Morgarten in 1315: henceforth, throughout the 14th and 15th centuries the Habsburg position in the Swiss cantons was to become less and less secure, until their attempt to establish their authority there had to be given up altogether.

On Frederick's death (1330) his brothers Albert II (1298–1358) and Otto (1301–39) succeeded jointly to the duchy, which under them received its first important accession of territory. In 1335 Henry, duke of Carinthia and count of Tirol, died. The emperor Louis IV enfeoffed Albert and Otto with Carinthia and the southern Tirol ignoring the claims of John of Bohemia's son John Henry, who had married Henry's daughter and heiress Margaret (*q.v.*) of Carinthia. As a result, in 1336, John of Bohemia ravaged

Austria, but he was persuaded to recognize the Habsburg succession in return for the grant of northern Tirol to John Henry.

By denying the clergy's immunity from taxation and by restricting the rights of bequest to religious bodies, Albert II tried to save from the "dead hand" of the church resources urgently needed to meet domestic and external problems. The Swiss cantons were further asserting themselves against the Habsburg power, while in Austria itself his brother Otto rose in rebellion and bad harvests and the ravages of the Black Death increased the misery of the population. In 1355 Albert tried to settle the problem of government within the duchy by a family ordinance which admitted the right of all male members of the family to rule.

Albert's eldest son Rudolf IV (1339–65) succeeded to the duchy in 1358. It was he who founded the new cathedral of St. Stephen's in Vienna (1359) and the university there (1365). He also compelled the most powerful family of the Austrian nobility, the Schaumberger, to recognize his overlordship; and in 1363 he persuaded Margaret Maultasch, whose third husband Meinhard III had died in that year, to make over the Tirol to him and his brothers. In 1359 Rudolf's forged charter, the *privilegium majus*, whereby he claimed for himself the title of archduke (*q.v.*), had caused a breach between him and the emperor Charles IV, of the house of Luxembourg, who was also king of Bohemia; but in 1364 he and Charles signed the treaty of Brno (Ger. Brünn), which provided that on the extinction of either family its lands should be inherited by the other.

The Habsburg Lands Divided.—Rudolf was in 1365 succeeded by his two brothers Albert III (1349 or 1350–95) and Leopold III (1351–86). These two, by the treaty of Neuberg (1379), partitioned the family lands, which were to remain divided between the Albertine line (Upper and Lower Austria) and the Leopoldine (Styria, Tirol, Carinthia and Carniola) until 1457. Leopold had already secured the Windisch Mark (1374) and parts of Vorarlberg (1375), and in 1382 Trieste submitted voluntarily to him to escape the encroachments of Venice. His defeat and death at Sempach in 1386 presaged the final loss of the Habsburg dominions in Switzerland.

The division of the family lands caused serious internal troubles on the death of Albert IV (1377–1404), who had succeeded his father Albert III in 1395. His son and heir, Albert V (*see* ALBERT II, German king), was only seven years old, and members of the Leopoldine line contended with one another for the rich wardship. Though in 1406 the united estates of the territories achieved a temporary reconciliation between their rulers, a vicious civil war broke out soon after. This divided Austrian society so deeply as to produce separate citizen factions in Vienna. In 1409 the emperor Sigismund mediated peace, ruling that the brothers Leopold IV (1371–1411) and Ernest (1377–1424) should share the wardship. In April 1411, however, the estates of Austria declared Albert V to have come of age and did homage to him; in June Leopold died, and Ernest, unable to resist the united loyalty of the estates, had to give up the wardship.

Albert V consolidated his position as duke by appointing advisers favoured by the estates and by securing the goodwill of the emperor Sigismund, whose daughter, the heiress to Bohemia and Hungary, he married in 1422. During his minority the duchy had been prey to civil disorder, but Albert now stamped out banditry and re-established law and order. By organizing an effective militia he checked the incursions of the Hussites who in 1428 reached the gates of Vienna. In 1438 he was crowned king of Hungary, German king and king of Bohemia in succession to Sigismund, but in 1439 he died on a campaign against the Turks—the new and growing threat to Austria.

The part played by the estates during the minority of Albert V foreshadowed their increasing influence in Austrian affairs throughout the 15th century. In the face of weakening noble authority the estates in some cases began to organize themselves for the maintenance of peace. Their assent to taxation was vital and their importance was enhanced as the merchant classes grew richer.

The Reunion of the Habsburg Lands.—Albert's successor as German king was his second cousin (Frederick V in the Habsburg-Austrian reckoning; *see* FREDERICK III, emperor), who was already duke of Styria and guardian of his own first cousin Sigismund of Tirol. Then, on Feb. 22, 1440, 20 days after Frederick's election as king, Albert's widow gave birth to a son and heir, Ladislas Posthumus (Lászlo V of Hungary), for whom Frederick likewise became guardian. Frederick's reign, however, was to be one of almost ceaseless strife with the estates, his neighbours and his jealous family. After a revolt of the nobles of the Tirol had forced him to release Sigismund from tutelage in 1446, a more serious movement broke out in Ladislas' domains in 1451, headed by the rich adventurer Ulrich Eitzing and Ladislas' uncle, Ulrich, count of Cilli, and supported by strong parties among the estates of Austria, Bohemia and Hungary. On his return from Rome, where he was crowned emperor in March 1452, Frederick was besieged in Wiener Neustadt by this league and forced to release Ladislas from his guardianship. Ladislas now became nominal ruler over his wide domains, while the actual power was wielded in Austria by Ulrich of Cilli and in Bohemia and Hungary by national regents in the persons of George of Podebrady and János Hunyadi respectively. When Ulrich was killed in 1456 the emperor succeeded to the wide estates of his house, but the death of Ladislas in 1457 opened up a period of strife and civil war between Frederick and his brother Albert VI, which was ended only by Albert's death in 1463. The Styrian and Austrian possessions were now at last reunited under Frederick, but Hungary and Bohemia, on the death of Ladislas, had broken away and had elected national kings: George of Podebrady in Bohemia and Matthias Corvinus, the son of Hunyadi, in Hungary. In 1414, moreover, the Swiss possessions of the Habsburgs finally gained their independence.

In 1485 Matthias Corvinus actually drove Frederick from Vienna, established his own residence there and incorporated large parts of Austria, Styria and Carinthia in the kingdom of Hungary. Reduced now to impotence, Frederick was forced to agree to the election of his son, Maximilian (*see* MAXIMILIAN I, emperor) as German king in Feb. 1486. Through the excesses of Sigismund, duke of Tirol, it seemed possible that the Habsburgs would lose the territory, but in March 1490 Maximilian was able to persuade Sigismund to surrender his duchy in return for an annual income. In April 1490, moreover, Matthias Corvinus died, whereupon Hungary was plunged into civil war which enabled Maximilian to regain the lost Habsburg territories with ease. For a year (1492–93) the allegiance of the Austrian lands was restored to the aging Frederick. (A. LH.)

Maximilian I (From 1493).—On Frederick's death (1493), Maximilian became the ruler of the whole Habsburg dominion. Under him it was notably consolidated by the acquisition of lands adjacent to its nucleus (Austria, Styria, Carinthia and Carniola) or to its two other major components (the countship of Tirol and the lands west of Lake Constance). In 1500, by virtue of an inheritance treaty that Rudolf IV had concluded in the 14th century, Maximilian acquired the countship of Görz (Gorizia) which opened up the Isonzo plain to the Habsburgs and brought them to the frontier of the mainland core of the Venetian republic's territory. In 1505 his help in the disputes of the Wittelsbachs of Bavaria and of the Palatinate was rewarded with the possession of new districts in the northern Tirol and the districts of Hagenau and Ortenau on the upper Rhine. In 1516, moreover, he gained towns and territories from Venice in Friuli and in the southern Tirol. He failed, however, to establish himself in the territory of the Grisons (Graubünden), which the Habsburgs had long coveted but which went over to the Swiss confederation in 1497–98.

The central area of the Habsburg dominion was in fact not Austria but the Tirol, rich in silver and copper mines and, as the bridge between Germany and Italy, the focus of a flourishing trade. Maximilian, an enthusiast for the new arts of the Renaissance, preferred the Tirol to all his territories, though he had no fixed residence there.

The constituent members of the Habsburg dominion still had no consciousness of political unity. The estates of each territory strove to maintain their traditional privileges and would not willingly renounce any of them without receiving some compensatory share in the central administration. Thus all Maximilian's at-

tempts to reform the administrative, fiscal and legal structure of his lands met with stubborn resistance from the estates. Through the Innsbruck *Generallandtag* ("general assembly of the lands") in 1518, he took the first step toward developing some common interest among the various estates in respect to their common lord, but this soon came to nothing. His attempts to raise the Habsburg dominion to a hereditary kingdom failed, while his many ventures in imperial foreign policy produced financial embarrassments which he never overcame. As the grants of money from the estates were inadequate he had to borrow heavily from the banking houses of Fugger and Welser, to whom he was obliged to pledge many lands and privileges—most notably his mining interests in the Tirol. Assistance from the princes and the estates of the empire was also meagre, as he could not overcome their suspicion that his imperial policy was a cover for the dynastic advancement of his house. His wars with France (over the Franche Comté and Milan), with Hungary and with Venice brought no lasting success, and his highest ambition, that of leading Christendom against the Turks, the enemies of his dynasty and of the empire, was never realized.

Under Maximilian, nevertheless, the future greatness of his house was founded. The marriage of his son Philip the Fair to Joan of Castile and Aragon in 1496 led to the inheritance of Spain and the Spanish territories in Europe and America by the Habsburgs. Likewise the betrothal treaties that he concluded at Vienna in 1515 were to bring Hungary and Bohemia to the Habsburgs through the marriages (1521 and 1522) of his grandchildren Maria and Ferdinand to the eventual heirs to these kingdoms, Louis and Anna, children of Vladislav of Bohemia (Ulaszlo II of Hungary).

Ferdinand I (1521–64).—On the death of Maximilian in 1519 his grandson Charles, already ruler of Spain and the Netherlands, inherited the family lands in Austria. After his election as emperor, Charles V by the partition of Worms in 1521 delegated the government of Austria, Styria, Carinthia and Carniola to his brother Ferdinand I and also by the partition of Brussels in 1522 nominated him ruler of the Tirol and the Vorlande and Statthalter in the recently acquired Württemberg. This was the origin of the division of the house of Habsburg into two great branches, the Austrian and the Spanish (*see* HABSBURG; also SPAIN, *History*).

When Louis II, king of Bohemia and Hungary, was killed at the battle of Mohács in 1526, Ferdinand took up his rights to both kingdoms under the treaty of 1515. By wise concessions to the Bohemian estates, he was able to secure their support against a rival claimant from Bavaria, and with the resources thus acquired he compelled the submission of Hungary. Together with Hungary, however, there fell to him the duty of defending Europe against the Turks, and this he was scarcely in a position to discharge. Repeated Turkish attacks, culminating in the siege of Vienna in 1529, collapsed not so much because of the resistance that they encountered as because the Turks themselves failed to support them properly, but Buda fell in 1541 and the peace of 1547 obliged Ferdinand to pay an annual tribute of 30,000 ducats to the sultan. The fertile plains of the Tisa (Theiss) and the Danube fell under Turkish rule and were to be exploited by the Turks for the next century and a half (though no attempt was made to convert the population to Islam). The Hungarian magnates, particularly John Zápolya, were meanwhile able to maintain their independence to a large degree by playing emperor and sultan off against one another. Raids by Turkish pashas, however, kept the Habsburg frontier districts in a state of permanent warfare. Ferdinand by himself could not afford to raise a sufficient force against the Turks; Charles V's other European problems prevented him from joining his brother to form a united Habsburg army; and the princes of the empire, hostile to the idea of a universal Habsburg monarchy, would not support an offensive against the Turks since the reconquest of the lost lands would have favoured Habsburg dynastic interests rather than those of the empire.

From this time on the necessity of establishing a firm frontier against the Turks determined the policy of the Habsburgs. To coordinate the resources of his territories, Ferdinand set up three central offices: the privy council (*geheimer Rat*) for foreign affairs (1527); the *Hofkammer* for financial administration (1527); and in 1556 the *Hofkriegsrat* was set up for military affairs.

These offices established themselves only slowly against the opposition of the estates, but their development strengthened the Germanization of the various nationalities under Habsburg rule. Having been constantly loyal to his brother Charles V, Ferdinand was elected king of the Romans in 1531, and after Charles's abdication (1556) he became emperor.

The Reformation raised serious problems for Austria, as conditions there were no less favourable to the spread of Lutheranism than elsewhere in the empire. The close connection between the religious upheaval and the economic and social conditions was demonstrated by the Peasants' War, which, in 1525, spread to Austria from southern and middle Germany. A typical manifestation of this conflict was the *Landesordnung* promulgated in the Tirol by Michael Gaismair as the basis for a utopian Christian republic. The initially amicable negotiations opened by Ferdinand with the Tirolese representatives, mostly peasants, came to nothing when the defeat of the peasants in Germany destroyed the movement in Austria also. While the Anabaptists were especially strong in Moravia, the Lutherans found powerful support among the Austrian nobility, which with their reciprocal support was able to strengthen its position in the estates as against the ruler. Thus, since Ferdinand wanted the nobility to back him against the Turks, he was obliged to permit the new teachings, though he refused to secularize or hand over the monasteries. Moreover, though he was a true son of the old church, Ferdinand thought that the schism resulting from the Augsburg Confession might well be healed if both sides were to show good will. Since communion in both kinds and clerical marriage were widespread in Austria and in southern Germany, he tried to persuade the pope to allow the practices. In the event, however, by summoning the Jesuits to Vienna (1551) and to Prague (1556) he in fact introduced the Counter-Reformation.

His efforts to simplify and to consolidate the central organs of administration in his dominions did not prevent Ferdinand from regarding his territories as the patrimony of his house or indeed from dividing them among his sons in his will. Ferdinand, the second son, received Oberösterreich (that is, Tirol and the Vorlande); Charles, the third son, received Innerösterreich (Carinthia, Styria, Carniola and Gorz); and Maximilian, the eldest, received all the remaining lands together with right of representing the house as a whole. This division inevitably strengthened separatist tendencies and weakened the solidarity of the estates.

Maximilian II (1564–76).—The new emperor (*see* MAXIMILIAN II), as ready for compromise as his father, was personally inclined to the humanist type of Christianity represented by Erasmus, though his office and his circumstances required a militantly Catholic attitude. To win the nobility's support in the war against the Turks, which in 1567 had suddenly flared up again, he and his brother Charles had to make notable concessions to the Protestants in the exercise of their religion, which was certainly that of the majority of the people. Moreover, in the Tirol and in the Danubian lands, where it was protected by the nobility in the estates, Protestantism began to organize itself as a church. The consent of the secular princes to this development was not necessary, since in the Roman Catholic Church in Austria the highest diocesan powers and, with them, the right of supervising the lower clergy belonged to non-Austrian ecclesiastical princes, the archbishop of Salzburg and the bishop of Regensburg. The measures prompted by the state for the reform of Catholicism by means of visitations and general ordinances on monasteries, chapters and congregations had no effect for the time being—not least because Maximilian himself still considered a compromise between the two denominations possible. He got the help of the Bohemians against the Turks by further religious concessions but his hopes of succeeding to the Polish crown on the extinction of the Jagiello dynasty in 1571 were disappointed, as it passed instead to the Turkish nominee Stephen Báthory of Transylvania.

Rudolf II and Matthias.—The shy and eccentric Rudolf II, who succeeded his father in 1576, was likewise unable to conclude any religious compromise and indeed let all control of affairs slip from his hands. Since Maximilian had not altered the partition

of the Habsburg lands made by Ferdinand I, Rudolf took over the headship of the house as well as his father's territories. As Austrian Protestantism produced no outstanding leaders at this time, the forces eager for reform were increasingly attracted to the Catholicism of the Council of Trent, and Rudolf encouraged this movement (in particular by founding new houses of the reforming orders, the Jesuits and the Capuchins). Maintaining that the religious concessions heretofore made had been granted during the prince's pleasure and so could be withdrawn, the sovereign government, with the help of the reform commission, moved against those Protestant cities which were not under the protection of the nobility in the estates. Their ministers were expelled and the citizens examined on their beliefs, those who did not freely submit themselves being driven out. The remaining inhabitants were obliged to elect Catholics to all municipal appointments, to install Catholic priests and to restore to the Catholics all the churches that they had alienated. The religious conflict became more and more a struggle for power between the estates and the absolutist sovereign. In 1594–97 the Protestant peasantry of Upper Austria rose in rebellion, their motives partly religious partly economic, and the suppression of the rising resulted in the complete restoration of Catholicism: communion in both kinds was forbidden, Lutheran books burned and hundreds of persistent Lutherans driven out without regard to the harm that this expulsion would do to the region's economy. In the Tirol also the archduke Ferdinand was able, with help from Bavaria, to suppress risings against the religious absolutism of the regime.

The first real relief for the estates and for Protestantism came with the renewal of the Turkish danger. The conclusion of peace with Persia left the Turks free to direct their energies westward again, and from 1593 to 1606 an indecisive frontier war went on between them and the Habsburgs whose forces received occasional help from Spain, from the other German princes, from the Italian states or from the pope. On taking Transylvania (*q.v.*), where the mixed Lutheran and Calvinist population had known no religious restrictions under the Turks, the Austrians began to enforce Catholicism there also. This provoked a rebellion, and in 1605 the Transylvanians elected István Bocskay as their prince instead of Rudolf. Then the Hungarians, who had always been freer from sovereign control than the Habsburgs' other subjects and were also alarmed at the progress of absolutism and the return of Catholicism, elected Bocskay likewise as their king. Bocskay invaded Moravia and threatened to spread the rising to Bohemia and to Austria. In the face of this danger a Habsburg family council, on the ground of Rudolf's incapacity, recognized his brother Matthias, the eldest of the archdukes, as head of the house and authorized him to make terms with the Turks and with the rebellious Hungarians. By the treaty of Vienna (1606) Bocskay received part of eastern Hungary and was recognized as prince of Transylvania, while Hungary itself was granted religious freedom and a constitution of its own independent of Austria, together with a specific guarantee of these freedoms from the estates of Bohemia, Moravia and the Austrian lands. These estates, united, represented a significant power as against the sovereign. The peace of Zsitvatörök (1606) with the Turks cost the emperor little, as Turkey was again threatened by Persia in the east. Besides a single payment of 200,000 ducats as compensation for the annual tribute of 30,000, only a few border fortresses and about 200 villages had to be ceded, and the major consequence of the settlement was that for the next 75 years the Habsburgs were free from worry in this quarter. This and this alone enabled the dynasty to survive the severe external and domestic crises from which it suffered in the following decades.

To compel Rudolf to a lasting recognition of these treaties, Matthias concluded an armed alliance with the Austrian, Hungarian and Moravian estates and, when Rudolf declared this confederation illegal, marched on Prague to depose him. Rudolf then allied himself with the Bohemian estates (to whom he accorded far-reaching freedoms) and finally persuaded Matthias to accept a compromise. This left Bohemia in Rudolf's hands but gave Hungary, Moravia and Austria to Matthias, together with the succession to Rudolf in Bohemia. In fact it was the estates on both sides who gained most from these transactions. In the *Majestätsbrief* of Prague (1609), Rudolf conceded freedom of conscience to all subjects in Bohemia and furthermore granted to the Protestants there the right to form themselves into a special committee, which was to be convened by their own "defensors." The privileges granted to Moravia and to Hungary amounted practically to independence. In the Alpine and Danubian lands the Catholic nobles and prelates were strong enough to limit the extent of concessions in the matter of religion, but in general the estates, who were the protectors of Protestantism, won a significant victory over the sovereign, who was protecting Catholicism.

Rudolf was far from satisfied with the compromise. At his invitation his cousin the archduke Leopold, bishop of Passau, sent a plundering army across Austria to Prague (1611). Thereupon the Bohemian estates transferred their allegiance to Matthias and compelled Rudolf to abdicate the Bohemian kingdom. Rudolf was thus left powerless, with nothing but the title of emperor. With his death in 1612 the "Habsburg Brothers war" came to an end.

Matthias, having now achieved his ambitious plans, set vigorously about the restoration of Catholicism in Austria. In this he had the assistance of the Jesuit-educated cardinal, Melchior Klesl, who had already become bishop of Vienna under Rudolf. To secure the Habsburg succession, as Rudolf had left no children and as Matthias and his brothers had none, it was agreed that the archduke Ferdinand, a son of Maximilian II's brother Charles, should be Matthias' heir, despite the strong claims made by the Spanish Habsburgs. By skilful tactics Ferdinand obtained recognition as heir from the Bohemian and Hungarian estates—even though he was known to be a convinced Catholic with tendencies to absolutism. Matthias died in 1619.

Ferdinand II (1619–37).—Before Matthias died, conflicts between Catholics and Protestants had broken out in Bohemia. In May 1618 the Protestant assembly, summoned by the defensors, had thrown the emperor's regents from the windows of the Hradcany palace and by this act, the so-called Defenestration of Prague, had given the signal for a general rising. On the death of Matthias the estates of the hereditary lands withheld their homage from Ferdinand. Their speaker, Georg Erasmus von Tschernembl, described the *Landtag* as an organ of popular sovereignty and called on the estates to take independent action. A provisional administration set up by the Bohemians sent an army against Vienna, but this was driven back by the emperor's troops. In no way discouraged, the Bohemians then proceeded, in the presence of envoys from the Austrian estates, to give themselves a constitution, to summon the other estates to send delegates to a general assembly like those of the Netherlands and of Switzerland and to proclaim the deposition of Ferdinand as king of Bohemia. Instead they elected Frederick V the elector palatine as king (Aug. 1619), the magnates putting such restrictions on his power as to render it ineffectual. Ferdinand, however, having been unanimously elected as emperor by the German princes, then discarded his predecessors' policies of compromise. In 1620, Maximilian of Bavaria, now allied with the emperor, led the army of the Catholic league through Upper Austria unopposed and, in the battle of the White Mountain, near Prague, crushingly defeated the Bohemians, who received no help from the Protestant princes of the empire. This battle is commonly regarded as the first action in the Thirty Years' War (*q.v.*). King Frederick fled, and the way was now open to radical social, political and religious changes in Bohemia. The leaders of the rising were executed and their followers exiled, while the lands of the condemned were for the most part divided among foreign nobles, who came to form a new upper class more dependent on the Habsburg dynasty and so loyal to it. The forcible re-establishment of Catholicism led to the mass emigration of the Protestants. With its legislation, judiciary and administration all controlled by the crown and the ascendancy of the Czech language broken, the kingdom of Bohemia lost its relative individuality and became simply a component unit of an integrated Habsburg monarchy.

After the reduction of Bohemia the Austrian estates could expect no gentler treatment; for Ferdinand the struggle toward religious unity meant the struggle for the true maintenance of his

lands. In a very short time the reformed faith was driven from Upper Austria, which hitherto had been the stronghold of Protestantism but which had been pledged to Bavaria as security for Maximilian's services against the Bohemians. The rising of the Upper Austrian peasantry in 1625–26 was stamped out by military force and altered nothing. The same policy was enforced throughout the rest of the hereditary lands. In Hungary, which had at first sided with the Bohemians, the emperor's son was crowned as king in 1625 but here, in view of the perpetual threat from Transylvania and the Turks, the emperor's policy could not be pursued so forcefully as in the other lands. Yet even in Hungary those magnates who went over to Catholicism soon began to enforce their new religion on their Protestant subjects.

The Habsburg house paid dearly to restore political and spiritual unity to its empire and to rebuild the basis of imperial and princely authority. It was the achievement of Ferdinand II that after long years of turmoil Austria came to be the major Catholic power in southern Germany. But his attempt to establish religious unity by force throughout the empire not only provoked the opposition of the Protestant princes but also alarmed secular and ecclesiastical princes of all denominations in the face of the Habsburg "universal monarchy" and dismayed the powers of Europe.

Ferdinand's ordinance of 1621 established primogeniture in the Habsburg family for the hereditary lands and also for Bohemia.

(W. P. F.)

Ferdinand III and the Peace of Westphalia.—When Ferdinand II was succeeded in 1637 by his son Ferdinand III the Thirty Years' War was still raging. The peace of Westphalia which brought that war to an end, was the major event of the reign. The consequence of this settlement was that the modern sovereign state in Germany developed, not on the level of the Holy Roman empire, but on that of the major territories (Bavaria, Brandenburg-Prussia, Saxony, etc.) within its boundaries. Thus it was that the Counter-Reformation and Habsburg absolutism, triumphant though they were in the Habsburg hereditary lands (including Bohemia), were prevented from taking hold on the other parts of the empire.

Leopold I, Joseph I and Charles VI.—In foreign affairs the reigns of Ferdinand III's son Leopold I (1658–1705) and of the latter's two sons Joseph I (1705–11) and Charles VI (1711–40) were dominated by recurrent wars against France and against Turkey. Within the Habsburg lands, meanwhile, these reigns saw a social and political transformation resulting from the victory of absolutism, a cultural flowering in the spirit of the Counter-Reformation and an economic development in accordance with the changed situation in Europe.

The Turkish Wars, 1663–1739.—The consolidation of the Habsburgs' rule in their own dominions was greatly promoted by successes against the Turks. The war of 1663–64 won little for the Habsburgs, but the long war that had begun with the Turkish advance to Vienna in 1683 ended in a series of victories for them. The relief of besieged Vienna (1683) was followed by the recapture of Buda (1686) and the progressive recovery of Hungary, until finally under the peace of Karlowitz (1699) the Turks surrendered all Hungary except the Banat to Leopold I. In the enthusiasm of liberation, the Hungarians at the diet of Pressburg (Bratislava; Hung. Pozsony) in 1687 renounced their right to elect their king and recognized the Habsburgs as the hereditary successors of St. Stephen. Even so the house of Austria proved unable to establish complete absolutism in Hungary, so that there remained an essential difference between the eastern and western constituents of the developing Danubian monarchy.

A further Austro-Turkish War (1716–18) ended with the peace of Passarowitz in 1718, whereby the Banat, Belgrade with part of northern Serbia and half of Walachia were ceded to Charles VI. In both these last two wars, as in the intervening war with France (*see* below), the Habsburgs had had the services of Prince Eugène (*q.v.*) of Savoy, but he was dead when Charles VI's last Turkish war was fought in alliance with Russia (1736–39). This ended disastrously, and under the peace of Belgrade (1739) all that had been gained by the peace of Passarowitz, except the Banat, had to be restored to Turkey.

The Habsburg-Bourbon Conflict, to 1740.—In their wars against the Turks the Habsburgs could rely on the support of the great princes of the empire (Charles V, duke of Lorraine, commanded the emperor's army in the relief of Vienna in 1683 and Bavarian, Saxon and Brandenburg troops fought beside them in Hungary), but some of the imperial forces had still to remain tied down in the west to guard the frontiers of Germany against aggression by Louis XIV of France (*see* DUTCH WARS; GRAND ALLIANCE, WAR OF THE). The treaty of Westphalia had already transferred some of the outlying Habsburg possessions (notably those in Alsace) to France, and subsequent French encroachments were at first successful. The balance was however restored with the Grand Alliance of 1689, concerted by William of Orange, king of England as William III, against the French supremacy. This alliance between the Catholic Leopold I and the Protestant maritime powers (England and the Netherlands) remained, with few alterations or interruptions, a basic feature of Austrian foreign policy into the middle of the 18th century. The treaty of Rijswijk (1697) at the end of the War of the Grand Alliance was the first setback for Louis XIV and a triumph for the concept of a balance of power in Europe, although the skill of French diplomacy was able to separate the allies. The peace negotiations were in any case overshadowed by the question of the Spanish succession, since Charles II the last of the Spanish Habsburgs was childless and in very ill-health. On Charles's death in 1700, Louis XIV claimed the whole of the Spanish inheritance for his grandson the duc d'Anjou (Philip V of Spain), while the powers of the Grand Alliance recognized instead the emperor Leopold I's younger son Charles, king of Spain. War broke out again and spread over Italy, western Germany and the Netherlands (*see* SPANISH SUCCESSION, WAR OF THE). The allies at first won a series of brilliant victories under the generalship of the duke of Marlborough and Prince Eugène of Savoy, but this encouraged them to make excessive claims against France. Then in 1711, the emperor Joseph I died leaving only daughters (his son Leopold, born in 1700, had died in 1701) so that his younger brother, the allies' candidate for the Spanish succession, became emperor as Charles VI. This made the English and the Dutch more disposed to negotiate with France, since the accession of Charles VI to Spain would have reconstituted the Habsburg empire of his ancestor Charles V and utterly destroyed the balance of power. Under the treaties of Utrecht, Rastatt and Baden (1713–14) the Austrian Habsburgs acquired the Spanish Netherlands (the modern Belgium), Milan, the kingdom of Naples (without Sicily, of which the duke of Savoy became king), Sardinia and the Spanish bases on the Tuscan coast, but neither Spain itself nor Spanish America, which passed to the house of Bourbon. After a subsequent Spanish attempt to regain Sicily and Sardinia had been thwarted by the quadruple alliance of England, France, Austria and the Netherlands, the duke of Savoy in 1720 surrendered Sicily to Austria, which in exchange transferred Sardinia to him. In the War of the Polish Succession (1733–35) Austria fought unsuccessfully against France, Spain and Sardinia, and was obliged by the peace of Vienna (1735–38) to surrender Naples and Sicily to Don Carlos, the future Charles III (*q.v.*) of Spain, in exchange for Parma and Piacenza.

Internal Affairs.—The period between the end of the Thirty Years' War and the death of Charles VI (1740) was the high period of Austrian baroque. The triumph of the dynasty and of the Counter-Reformation over the Protestant estates in Bohemia and in Austria, the subsequent victories over the Turks and finally the reconquest of Hungary all found expression in the magnificent palaces, churches and monasteries of the time; *e.g.*, the Belvedere and the Karlskirche in Vienna, Klosterneuburg and the Vienna palaces. The old-established noble families of the various territories, no longer able to assert themselves by independent political action, took service at court, in the army and in the administration. There they came into contact not only with members of foreign nobilities (Italians, Spaniards, Frenchmen, Walloons and Irish Jacobites) who had entered the same service, but also with members of the *bourgeoisie* who through long service as officials had acquired noble status. The mingling of these various elements resulted in a new nobility loyal to the dynasty. Likewise the

Habsburgs could rely on the support of the Catholic Church, which owed its ascendancy in their lands mainly to them (it was the church's loyalty that was later to make Joseph II's policy feasible). On the other hand the dynasty needed the good will of the estates and the church to finance its frequent and lengthy wars. For this reason and also because the sovereign, head of the Holy Roman empire and guardian of its constitution, dared not give a bad example to the other princes of the empire for their conduct toward their estates, the estates of the Habsburg lands were able to take up a stronger position against centralizing tendencies, especially in matters of taxation, minor jurisdictions and local administration, than were, for example, their counterparts in France or in Prussia.

In the industrial and commercial field the Vienna administration, already in Leopold I's time pursued a mercantilist policy like that of France, Austria's enemy and competitor. Charles VI, who had learned the importance of sea trade during his years in Spain, promoted the development of Trieste as the major port of the empire, and founded companies in Vienna and Ostend for trade with the near east and with India. The Ostend company (*q.v.*), however, provided unwelcome competition to England and the Netherlands and in 1727 Charles agreed to suspend its charter in return for the concurrence of the maritime powers in the succession law of the pragmatic sanction (*see* below). The most important economic and colonial achievement of the period was the cultivation and settlement of the territories reconquered from the Turks (for Hungary settlers were brought in from the overpopulated Rhenish districts). The Vienna city bank had been founded by Joseph I in 1706, and under Charles VI a supreme banking office (the Universal-Bankalität) was instituted. Nevertheless it was impossible even during the long periods of peace to bring order into the state finances.

The Pragmatic Sanction.—The problem of the succession overshadowed the reign of Charles VI. In 1713 Charles had determined that all his kingdoms and lands should descend as an integral whole without partition (*indivisibiliter et inseparabiliter*) to his eldest son, should he have one, or, failing a son, to his eldest daughter and then, if she should die without issue, to Joseph I's daughters and their descendants. A son was born to Charles in 1716 but died in the same year, and Charles's following children were both daughters (Maria Theresa, born in 1717, and Maria Anna, born in 1718). Accordingly, in 1720, the pragmatic sanction (*q.v.*) was published, embodying Charles's decision. On its publication the pragmatic sanction received the assent of the individual estates of the Habsburg dominions, so that it came to be a constitutional law of the developing Habsburg monarchy and a bond between the lands belonging to the Holy Roman empire (the Austrian lands and the lands of the Bohemian crown) and the lands outside the empire (those under the crown of Hungary). As the last child of Charles VI was also a daughter (Maria Amalia, born in 1724), Austrian diplomacy in the last decades of his reign was directed toward securing acceptance of the pragmatic sanction from all the European powers. Joseph I's daughters and their husbands (the electors of Saxony and Bavaria), the diet of the empire, Russia, Spain, Great Britain, France, Prussia, the Netherlands, Denmark and Sardinia did in fact recognize the pragmatic sanction. (AD. WA.)

Maria Theresa and the Wars of 1740–79.—On the death of Charles VI (Oct. 1740) the pragmatic sanction was promptly contested by two of the powers that had guaranteed it. Charles Albert of Bavaria (*see* CHARLES VII, Holy Roman emperor), raised claims on Maria Theresa's inheritance, while Frederick II of Prussia claimed most of Silesia (*q.v.*) and took actual possession of it. Frederick's victory over the Austrians at Mollwitz (April 1741) encouraged Charles Albert to insist on his own claims. The French supported him and finally Bavaria, France, Saxony and Spain joined in the attempt to partition the Habsburg lands. The War of the Austrian Succession (*q.v.*) ensued. Maria Theresa had to concede the loss of most of Silesia to Prussia but succeeded in dividing the hostile coalition and in winning the imperial crown for her husband, Francis of Lorraine, in 1745. Even though France continued the war, Austria was able, in alliance with the maritime powers, to regain the southern Netherlands and the larger part of the Italian possessions by the peace of Aix-la-Chapelle (Oct. 1748).

Alliances with the maritime powers, however, had in the past proved to be completely unsatisfactory to the Austrians, who had been disappointed both by the settlement at the end of the War of the Spanish Succession and by the maritime powers' attitude toward the Ostend company; and this disappointment had already led Charles VI to ally himself with Spain (1725) and also to attempt a *rapprochement* with France. Under the new chancellor W. A. von Kaunitz (*q.v.*) this *rapprochement* was achieved with the treaty of Versailles (May 1, 1756). Maria Theresa's consent to this alliance with Austria's previous rival was given in the expectation that France would now help her to recover Silesia. In consequence of this treaty and of the preceding convention of Westminster between Great Britain and Prussia by the so-called "diplomatic revolution," the previous system of European alliances was completely reversed. In the Seven Years' War (*q.v.*), which broke out between the realigned powers in 1756 and in which Russia also joined the Austrian side, the Prussians sustained frequent defeats but even so by the peace of Hubertusburg (Feb. 1763) Maria Theresa was compelled definitively to renounce her claims on Silesia.

The basis of the future struggle between Prussia and Austria for hegemony in Germany was thus laid. Frederick of Prussia was now determined that Austria should gain nothing in Germany that might balance the loss of Silesia. Joseph II, however, who had succeeded his father Francis as Holy Roman emperor in 1765 and was coregent with Maria Theresa of the Habsburg dominions, took advantage of the situation caused by the extinction of the Bavarian electoral line (Dec. 1777) to make a treaty in 1778 with Charles Theodore, elector palatine and heir to Bavaria, whereby Lower Bavaria and Mindelheim were to be ceded to Austria. Frederick thereupon invaded Bohemia and began the War of the Bavarian Succession (*q.v.*). Maria Theresa, without Joseph's consent, then made overtures to Prussia. Finally, with France and Russia mediating as guarantors of "the two-power system" in Germany, the peace of Teschen was signed in May 1779. By this only the easternmost corner of Lower Bavaria, the Innviertel, was conceded to Austria.

The First Partition of Poland (1772).—The alliance with Russia during the Seven Years' War had inhibited Maria Theresa from resisting Russian designs on Poland and on Turkey, though it was in Austria's interest that the integrity of both these states should be maintained. In July 1771, however, Austria had made a treaty with Turkey. Nevertheless, since Great Britain and France would take no action and as Prussia was temporarily acquiescent, the Russian empress Catherine II was able to bring her first Turkish war (1768–74) to a conclusion that established Russian influence on the northern shore of the Black sea (peace of Kuchuk Kainarji). During the Russo-Turkish war, however, Prussia, to forestall unilateral Russian action in Poland, proposed the partition of that country. Austria had already occupied the Zips (Pol., Spisz) territory in the Carpathians in 1769, and Maria Theresa, against her will, now participated in the partition treaty of Aug. 1772 (*see* POLAND: *History*). By it Austria received Galicia and Lodomeria. In 1775, moreover, to counterbalance Russia's territorial gains from Turkey and as a reward for Austria's pro-Turkish attitude Bukovina was detached from Moldavia by the Turks and ceded to Austria.

The Internal Reforms of Maria Theresa.—Beginning with Austria and Bohemia, Maria Theresa aimed to convert the Habsburg lands, still organized on a feudal basis, into a centralized state. In 1749, under the Haugwitz system (so-called after its inaugurator, the chancellor Friedrich Wilhelm Haugwitz), the central political and financial administrations were amalgamated into a *Directorium in publicis et cameralibus*, while the judiciary —formerly a department of the court chancellery—was put under an *Oberste Justizstelle*. At the instance of Kaunitz, however, the *Directorium* was dissolved in 1761, and the *Staatsrat* was established to advise the ruler on matters submitted by the high offices of the state. In the provinces the administrative functions of the

estates were absorbed in the central administration, the head of the provincial government being at the same time president of the estates. The officials of the circles (*Kreisämter*) were to implement the central policies through the provincial courts and the village authorities. The court council of trade (*Kommerzhofrat*), set up in 1762, diminished the restrictive practices of the guilds and encouraged large-scale commerce and exports (especially to the southeast). In education, the *Studienhofkommission* was set up in 1760 and a system of elementary secular education, based on enlightened Catholic principles, built up; the dissolution of the Society of Jesus in 1773 facilitated the liberation of secondary and advanced education from ecclesiastical control and the reorganization of the curriculums (the faculties of medicine receiving special attention). Although herself a strict Catholic, Maria Theresa, advised by Kaunitz and other ministers, brought the church more and more under the control of the state, government approval being required for the publication of papal bulls and for the occupation of benefices, taxes being levied on the clergy and the religious orders being subjected to supervision. In 1748 the upper estates lost the right to administer and levy taxes, and later even domain lands, hitherto exempt, became liable. Moreover, between 1771 and 1778 a series of *Robot* or work patents were introduced which regulated and restricted peasant labour services in the German and Bohemian lands. Commissions were also appointed to devise, on the basis of customary law and of common sense, a unified system of civil and criminal law and in 1768 the *Nemesis Theresiana*, regulating penal procedure, was sanctioned. Caused at least in part by the Prussian example, a great deal of the reforms aimed at the strengthening of the political and military power of the monarchy. Increased state revenues made possible the reorganization of the standing army and the building up of a reserve army; conscription was introduced and armaments were improved (under L. J. von Daun, president of the war council).

Joseph II (1780–90).—Joseph II, sole ruler of the Habsburg lands after Maria Theresa's death, made a considerable effort to restore the position in Germany to what it had been before the War of the Austrian Succession. By a close understanding with Russia, he hoped to keep Prussia's attention fixed on the east and so to hinder Frederick II from interfering in a renewed Austrian attempt to acquire Bavaria in exchange for the Netherlands. In the event, however, this attempt to augment the German element in the Habsburg dominion had to be abandoned in 1785, not so much because of the confederation of northern and middle German states that Frederick formed against it as because of French opposition, France being always interested to maintain inter-German rivalries.

Catherine of Russia, requiring Austrian support for her designs against Turkey, proposed that Russia and Austria should reach an understanding and, at a meeting at Kherson in 1787, succeeded in gaining a defensive alliance from Joseph, though he refused to commit himself further. When war had actually broken out between Russia and Turkey, however, he joined in on the Russian side (1788) and in 1789 his field marshal, E. G. von Laudon, took Belgrade ("the gate to the Balkans"). Then Prussia, as Turkey's ally, began preparations against Austria, and this threat, combined with internal troubles (*see* below), compelled Joseph's successor Leopold II to agree to terms with Turkey. An agreement reached through British mediation at Reichenbach (1790) was followed by the peace of Sistova (Aug. 1791), whereby Austria had to renounce the new conquests. Russia, however, by the peace of Jassy (Jan. 1792), won more territory on the coast of the Black sea.

The internal troubles mentioned above sprang from Joseph's precipitate reforms. In his role of "people's emperor" and "enlightened despot," he sought to integrate all his diverse lands (including Hungary) as a unitary state, to mobilize all their resources of manpower for that state's purposes and, by general social legislation, to promote the welfare of all his subjects. Local traditions and sentiments were ignored especially when they stood in the way of practical policy. If the estates were convened only to grant taxes or even not convened at all, that meant that they could no longer obstruct the progress of autocracy, while at the same time the rivalries between the component parts of the Habsburg dominion and the opposition to the process of unification were overcome. To further the new policies a carefully controlled and centrally co-ordinated bureaucracy was put in charge of all branches of the administration, and a police force with extensive powers developed. Moreover, in 1784, German was introduced as the administrative language throughout the Habsburg dominions, not with a view to germanization but in order to bind the multinational empire more closely together and to facilitate the work of the central authority, which was now represented by one vast organ, the *Vereinigte Hofstellen*. The *Toleranzpatent* of 1781, which made concessions to non-Catholics, was issued in the belief the state would benefit by securing the loyalty of all its subjects and similar motives of practical utility were behind the dissolution of the contemplative orders in 1782, their confiscated assets being used for the endowment of new pastoral institutions and bishoprics and for poor relief. The priesthood was to be transformed through the *Generalseminare* into a civil service, while marriage was declared to be a civil contract. In most cases the universities were converted into *lycées* and their curriculums adapted to the training of civil servants. On the dismantling of the feudal jurisdictions a new hierarchy of law courts (provincial courts, appeal courts and a supreme court) was established; in 1781 a general ordinance on jurisdictions was promulgated; in 1787 the first volume (*Privatrecht*) of a new code of civil law, covering Bohemia, Austria and Galicia, was issued; and in 1788 new regulations on civil and criminal procedure were introduced. As the population was still preponderantly agricultural, the emancipation of the peasantry was of major importance. Decrees of 1781–82 abolished personal serfdom and guaranteed the peasants' freedom of movement and their rights to marry without their master's authorization and to acquire land. Finally, a patent of 1789 not only regulated the peasants' obligations in money dues but also distributed taxation equitably among all landholders.

Leopold II (1790–92).—Joseph's younger brother Leopold, who succeeded him in 1790, had already, as grand duke of Tuscany, proved himself an enlightened absolutist, though not so stubborn or thoroughgoing as Joseph. Even Joseph had had to give ground in the Netherlands and in Hungary and the new emperor, confronted by general unrest and the changed European situation (*see* FRENCH REVOLUTION), had to pursue a more moderate policy throughout his dominions. He summoned the estates, quashed the *Generalseminare*, restored the universities, repealed the patent of 1789 and loosened the structure of centralization. Nevertheless the *Toleranzpatent*, the emancipation of the peasantry and the dissolution of the monasteries remained in force though the activities of the police were increased after the outbreak of revolution in France. In Hungary, the centralizing policies of Joseph II, who had refused the Hungarian coronation ceremony and had had St. Stephen's crown brought to Vienna, had caused extreme discontent. In spite, however, of strong anti-Habsburg movements there, the dynasty maintained its position in that country, and, by the federalization of the administration Leopold II was able to play off the Vlachs of Transylvania and the Slavs of Croatia against the efforts at domination made by the Magyar ruling race.

In 1789 the Austrian Netherlands had declared their independence (*see* BELGIUM: *History*). Prussia, the United Provinces of the Netherlands and Great Britain had at first recognized the new state, but the agreement reached at Reichenbach (*see* above) and the fear that revolutionary France might conquer Belgium led them to reconsider their position, particularly as Leopold acceded to the Belgian requests for the removal of foreign officials and for the participation of the estates in legislation. Then Leopold's circular of Padua (July 1791), calling on the European powers to assist the French king, clearly indicated that Austria was prepared to take the lead in Europe against the danger of republicanism. The same danger also prompted a temporary *rapprochement* between Austria and Prussia, when the two powers issued the joint declaration at Pillnitz (Aug. 1791), calling for the maintenance of the monarchical regime in France and for collective action by the European powers if the French king and his

subjects should fail to reach agreement. This declaration, however, despite Leopold's conciliatory tone, strengthened the hand of the war party in Paris, and in Jan. 1792 the French sent a note so provocative as to be an ultimatum to Austria. Austria and Prussia thereupon contracted a defensive alliance (Feb. 1792). Leopold then offered the protection of the powers to all right-minded Frenchmen against the Republican party. His death (March 1, 1792) was followed by a further French ultimatum (March 27) and then by the French declaration of war (April 20).

The Revolutionary Wars (1792–1801).—The period of the French Revolutionary Wars (*q.v.*) was one of strain, sacrifice and effort for Austria. In 1793 Russia, Great Britain, the Netherlands, Spain and Sardinia joined Austria and Prussia in the first coalition against France. Co-operation between Prussia and Austria, the two countries which were to bear the brunt of the war, was prejudiced, however, from the outset by longstanding mistrust: for example, in 1793, Prussia and Russia made a further partition of Polish territory without allocating any share of it to Austria; then in 1795 Austria and Russia decided between themselves how the rest of Poland was to be divided, without consulting Prussia beforehand on the share that Prussia was to receive. After a temporary success at the battle of Neerwinden in March 1793, by which Belgium (occupied by the French in 1792), was recovered by the allies, the military situation soon deteriorated, as the French overran the palatinate and, in the spring of 1794, Belgium again. When Prussia had signed the separate peace of Basel with France (April 1795), Austria, though assured of help from Great Britain and Russia by the triple alliance of Sept. 1795, had to sustain alone the struggle on the German front. Great efforts were required to prevent other member states of the empire from concluding separate treaties with France and to check the French drive across the Rhine in 1795. The French had, indeed, penetrated into Bavaria before the archduke Charles's victory at Würzburg (Sept. 1796) drove them back across the Rhine. The decisive blow against Austria, however, was delivered in Italy. The important fortress of Mantua, after repelling three French assaults, was forced, through starvation, to surrender, and Napoleon's lightning thrust over the Carinthian Alps compelled Austria to accept an armistice at Leoben in April. By the peace of Campoformio (Oct. 1797) Austria lost the Netherlands and Lombardy but received instead the Venetian territories, including Istria and Dalmatia. Furthermore, at the congress of Rastatt, which opened in Dec. 1797, Francis II, who had been crowned emperor in succession to his father Leopold in July 1792, had to agree to the surrender of the left bank of the Rhine to France and to accept a scheme whereby the German ecclesiastical princes were deprived of their secular authority.

Great Britain and Russia, taking advantage of Bonaparte's absence in Egypt, formed the second coalition in Dec. 1798 to crush the new France, and Russian troops were allowed to cross Austrian territory. France therefore again declared war on Austria in Feb. 1799. Prussia remained aloof from the coalition. Successes against the French in southern Germany, in Switzerland and in northern Italy, however, were followed by discord between the allies so that the planned onslaught on France came to nothing and Russia left the coalition (Oct. 1799). The Austrians were then decisively defeated by Bonaparte, back from Egypt, at Marengo in Italy (June 1800) and by Moreau at Hohenlinden in southern Germany (December). By the peace of Lunéville (Feb. 1801) France was again able to impose terms on the emperor. The approaching zenith of Napoleon's career corresponded with the nadir of Austrian fortunes. (Fr. Hu.)

THE AUSTRIAN EMPIRE

The Napoleonic Wars, 1804–1813.—When Napoleon assumed the title of emperor of the French (1804), the end of the Holy Roman empire was clearly approaching. On Aug. 10, 1804, Francis therefore assumed a new dignity as emperor of Austria—a title based on the family lands, not on tradition; and for the first time the Habsburg monarchy received formal expression. Then in 1805 Francis was drawn into the third coalition with England and Russia against Napoleon: one Austrian army was surrounded and compelled to surrender at Ulm; and the main Austrian army, together with the Russians, was defeated in the battle of Austerlitz (*q.v.*) on Dec. 2. By the treaty of Pressburg (Dec. 26, 1805) Francis not only lost all his lands in Italy, including the recently acquired Venetia, but also recognized the full sovereignty of Bavaria, Baden and Württemberg, thus virtually abdicating the last tatters of imperial dignity in Germany. The formal end came on Aug. 6, 1806, immediately after the founding of the Confederation of the Rhine; Francis renounced his title as Holy Roman emperor and was henceforth only Francis I, emperor of Austria.

Austria was still, however, regarded as the leading German state; and German patriots looked to the Habsburgs for leadership against Napoleon. The foreign minister, Johann Philipp Karl Joseph von Stadion, hoped to restore Austrian independence by an appeal to German sentiment, not by playing France off against Russia. The archduke Charles (*q.v.*), the only Austrian general of ability, reorganized the army and improved its methods of fighting; he anticipated the vaunted Prussian reform of strengthening the regular army with a militia. Stadion hoped to build up a new coalition against Napoleon and attack him in the rear while engaged in Spain. In 1809, however, Napoleon struck first. But though the Austrian armies were driven out of Bavaria, Napoleon was himself defeated when he attempted to cross the Danube at Aspern (May 21 and 22)—his first defeat. After elaborate preparations he had his revenge at the battle of Wagram (July 6), although with heavy losses. Francis feared that further war would lead to the dissolution of his empire, especially as Napoleon was promising the independence of Hungary. He therefore agreed to the peace of Schönbrunn (Oct. 14, 1809). Austria had its army restricted to 150,000 men; surrendered Salzburg and the Innviertel to Bavaria; lost part of Galicia to the grand duchy of Warsaw and part to Russia; and saw its South Slav lands annexed to the French empire as the "Illyrian provinces." Francis would never again pose as a German national leader.

Metternich (*q.v.*), the new foreign minister, personified the policy of caution and delay; he put his faith in the balance of power, not in national enthusiasm, and intended to win Napoleon's favour until such time as he should overreach himself. Thus he promoted the marriage of Marie Louise, Francis' daughter, to Napoleon in 1810. The helplessness of the monarchy was further emphasized by the financial crisis of Jan.–March 1811, when the state went bankrupt. When Napoleon planned his campaign against Russia, Metternich accepted the position of a subordinate ally (March 14, 1812). The Austrian army under Karl Philipp, prince zu Schwarzenberg (*q.v.*), was, however, a nominally independent force and avoided taking any serious part in the Russian campaign. After Napoleon's disaster in Russia, Metternich presented himself as armed mediator between Russia and Prussia on the one side and France on the other. He feared Russian predominance probably even more than French and might well have supported France if Napoleon had shown any sign of moderation. In June 1813 Napoleon agreed to an armistice, and the combatants were invited by Metternich to a peace conference at Prague. But at a preliminary meeting with Metternich in Dresden Napoleon rejected all compromise, refusing to surrender any of his hegemony in central Europe. Metternich, on leaving, said to a bystander, "Your emperor is a doomed man." Austria now entered the struggle against Napoleon (Aug. 12, 1813), and Schwarzenberg became allied commander in chief. Under him the allies defeated Napoleon decisively at Leipzig (Oct. 16–18, 1813). Metternich tried for compromise with Napoleon, or at least to salvage a regency under Marie Louise. These attempts broke against Napoleon's intransigence, and Metternich had to acquiesce in the restoration of the Bourbons.

The Vienna Settlement.—The first treaty of Paris (May 30, 1814) laid down new frontiers for Austria in Italy, and these lands were incorporated in the Habsburg monarchy as the kingdom of Lombardy-Venetia. They were given a façade of representative institutions and an appearance of autonomy under a Habsburg viceroy. Bavaria paid the price of being accepted as an ally by surrendering Tirol, Vorarlberg, Salzburg and the Innviertel to Austria. At the congress of Vienna Austria recovered the "Illyrian

provinces" which it had lost in 1805 and 1809; and, when the Polish question was settled, it recovered most of Galicia. Further, Tuscany and Modena went to Habsburg archdukes. Francis did not, however, reassert his claims to Belgium and rejected the invitation from a number of German princes to reassume the title of Holy Roman emperor. Instead Austria became a member of the German confederation, with the position of presiding power. Metternich projected a similar confederation for Italy, but this was never achieved and he had to be content with treaties of alliance, especially with Naples. In Metternich's view Austria was a "saturated power," without further territorial ambitions; and its predominance in Germany and Italy was therefore a guarantee of peace and conservatism. In reality Metternich had saddled the Habsburgs with the task of resisting the two most formidable national movements of the 19th century, yet made it impossible to ally with one against the other.

Metternich's Foreign Policy.—Though Metternich became chancellor and therefore theoretically senior minister in 1821, his influence on home policy was sporadic and for the most part ineffective. His "system" was nothing more than a grandiose name for a pacific foreign policy. Austria had nothing to gain from war and least of all, as Metternich was the first Austrian statesman to realize, from a crumbling of the Turkish empire (*see* EASTERN QUESTION). The basic object of his foreign policy was therefore to put a brake on Russia's advance in the near east; this was best achieved by talk of monarchical solidarity against the radical peril. Moreover Austrian greatness rested on treaty rights rather than on natural strength, and it was therefore Metternich's aim to keep international relations on a basis of legal principles and away from a conflict of power. Though he was doubtless genuinely afraid of a new revolutionary outburst, he exaggerated this danger in order to distract the Russians from their historical field of ambition in the Balkans. For this reason he even acquiesced in Alexander I's idealistic project of a Holy alliance (*q.v.*).

In the early days after 1815 Metternich tried to establish the congress system, a directorate of the great powers over all European affairs. Though this system brought France back to European co-operation in 1818, it broke down at the congress of Verona (1822) when Great Britain refused to join conservative intervention in Spain. Even so, Metternich succeeded in turning Russia's attention away from the Greek revolt and in giving the Ottoman empire a breathing space. There was a new alarm in 1829 when Russian armies reached the gates of Constantinople, and Metternich reluctantly planned an anti-Russian coalition. The revolutions of 1830 brought Russia back to a conservative course, and Turkey was saved by the Polish revolt. In Oct. 1833 Russia and Austria made the conservative pact of Münchengrätz (Mnichovo Hradiste): Russia got security against a new Polish rising and, in return, promised not to tamper with Turkey; and both powers agreed to co-operate against radicalism. The later eastern crisis of 1839–41 seemed less dangerous, in that Great Britain and Russia worked with Austria against a pseudorevolutionary France. Nevertheless Russian ambitions were again aroused, and Metternich, in his last years of power, was preparing the way for an Austro-French coalition against Russia. The essential condition for this was the French renunciation of ambitions in Italy, and in 1847 François Guizot gave a half-hearted impression that he would pay this price. At all events Metternich had sustained European stability for 33 years against the two dangers of a new French upheaval in the west and a Russian advance in the Balkans. His system had this flaw: he believed that Austria would collapse only if attacked from without. The revolution of March 13, 1848, was to prove him wrong.

Internal History.—The character of Austrian rule between 1815 and 1848 was determined by the bureaucratic conservatism of Francis I. He had taken fright at the failure of Joseph II and was now resolved to change nothing. His empire rested on the two pillars of bureaucracy and police. Francis dabbled in the trivial details of administration and could never be brought to have a policy. Above all he disliked any form of collective advice and preferred to play his ministers off against each other. He had in 1801 abolished the council of state created by Maria Theresa; and after experiment with less formal bodies restored it in 1808 with more limited powers. Indeed after 1815, though the highest title was "conference minister," there was no conference of ministers. Each department was rigorously restricted to its own affairs and the emperor was the only agent of co-ordination between them. Hence the stagnation of the imperial rule, which justified the verdict, "administration has taken the place of government." Francis reserved his greatest interest for the work of the police, which improved on the model of Joseph II and Napoleon. The letters even of members of the imperial family were opened; all literature was censored; and higher education was kept futile and formal. Yet the tyranny was blundering and ineffective, and the educated classes knew what was astir in the world long before 1848.

Metternich, with others, made many proposals for reforming the bureaucratic system. His panacea was a council of empire (*Reichsrat*) which, while ostensibly advisory, would check the emperor's arbitrary rule. He even proposed to give this sham parliament a pseudorepresentative character by inviting selected delegates from the provincial diets. Though Francis often promised to consider this scheme, it remained unachieved at his death in 1835. Metternich had more success in reviving provincial sentiment and in keeping the diets alive. Just as his mechanistic political philosophy preached the balance of power in international affairs, so he sought to promote "the strength that comes of diversity" within the empire. In practice this meant little more than the hope that provincial loyalties would prevent a united demand for liberal concessions. Where previous rulers—Maria Theresa, Joseph II and even Francis in his early reign—had been reformers or at least enemies of historical rights and privileges Metternich tried to restore traditions even when they were decaying. On his advice the Hungarian diet was summoned in 1825 after 12 years of absolutist rule; but he was not a success as a parliamentary statesman, and the Hungarian diet soon proved intractable In 1830 he had to call for mobilization in view of the supposed danger from France, and this increased Austria's financial difficulties Metternich's hold on the emperor was weakened and Franz Anton, Graf Kolowrat, Metternich's chief rival, won imperial favour when in 1831 he produced a balanced budget, the only one in the reign Though the conservative alliance with Russia in 1833 did something to restore Metternich's prestige, his influence on home affairs was still at a low ebb when Francis died in 1835.

Ferdinand I.—The new emperor, Francis' son Ferdinand, was feeble-minded; yet no provision had been made for a regency. Metternich planned to make himself supreme under cover of the archduke Louis, the most insignificant of Francis' brothers who was to be nominal regent. Louis was even persuaded to acquiesce in Metternich's schemes for a sort of states-general and an imperial cabinet, both under the chairmanship of the chancellor. Metternich was, however, opposed by the other members of the imperial family and by Kolowrat, who remained in control of finance. The crisis came in 1836 when Metternich tried to reduce some of the Austrian tariffs so as to enter the German Zollverein. Kolowrat threatened to resign, and the archduke John, the only liberal Habsburg, came to court to voice the opposition. Louis withdrew his support from Metternich, who lacked the resolution to force a decisive struggle. The administrative reforms were scrapped and the direction of affairs was put in the hands of a "preconference," consisting of Louis, Kolowrat and Metternich. These three were resolute only in negation; and for 13 years the destinies of the Austrian empire rested with three men whose principal motive was mutual jealousy.

The revival of provincial sentiment was, however, accelerated. The more enlightened members of the nobility had come to realize that the system of *Robot* was uneconomical even for the landowner; and many diets passed resolutions in favour of agrarian reform. Moreover, in promoting "the strength that comes of diversity" Metternich encouraged national sentiment as well as provincial, though he assumed that it would always be content with purely cultural expression. Most important was the revival of Czech literary culture in Bohemia: inspired by the romantic illusions of Johann Gottfried von Herder, this consciously elevated

Slav virtues and first challenged German cultural supremacy in the Austrian empire. The Czech national leaders, with Frantisek Palacky at their head, claimed Bohemia as their historic state and tried to turn the feudal Bohemian diet into an expression of Czech nationalism. The Bohemian nobility, though rarely of Czech origin, accepted this curious role; and in 1846 the Bohemian diet demanded the restoration of its rights as they had existed before the battle of the White Mountain. There was a similar, though less defined, revival of South Slav culture, led by the Croat poet L. Gaj and also patronized by Metternich. Here too the Croat diet gradually took on a national character, though its struggle was against Hungarian nationalism, not against German. The Croat demands for autonomy were directed to Pressburg, not to Vienna.

Hungary, which had been the real problem even in the reign of Francis, was moving steadily toward revolution. Count István Széchényi (*q.v.*), the first national leader, a great noble and conservative in social outlook, wished the aristocracy to put themselves at the head of the national movement and thus to keep it in safe channels. The symbol of this policy was the bridge across the Danube at Budapest, built with the first taxes levied on noble land. Even in this stagnant period the empire favoured economic reform; and Metternich welcomed Széchényi's program. It was, however, soon eclipsed by the extreme national agitation of Lajos Kossuth (*q.v.*), who appealed to the lesser gentry, not to the great aristocracy. Kossuth aimed to make Hungary a Magyar national state, complete with parliamentary institutions; nationalism and radicalism went hand in hand. The Hungarian diet of 1844 broke completely from governmental control; Magyar became the official language of state, with some temporary exceptions. This law created the "national problem" in Hungary and, since Croatia was subordinate to Hungary, it created the Croat problem as well.

Discontent is usually confined to a single revolutionary class; in Austria it was then universal. The aristocracy resented bureaucratic control and favoured a provincial autonomy which they supposed would be under their own control. The middle classes, capitalist or professional, desired a liberal parliamentary state, centralized and German in character. The peasants wished to end the *Robot* and to win freedom of movement. The industrial workers, concentrated in Vienna, turned against their factory conditions and, though few in numbers, could supply a violent fighting force. Perhaps most influential, the university students, in their inflated number, dreamed of a Utopian radical future. The first open revolt was in Galicia in 1846, beginning as an abortive Polish national rising. The Austrian authorities, lacking regular forces, appealed to the peasants to rise against their masters, and the result was a *Jacquerie*. The peasants, who had saved the empire with scythe and flail, were promised abolition of the *Robot;* thus the first revolutionary act came from the government itself. In Italy, too, the upper and middle classes grew out-of-hand, and the Hungarian diet of 1847, firmly under Kossuth's influence, announced a revolutionary program. Finally the diet of Lower Austria, which met in Vienna, though composed largely of bureaucrats, prepared to act as a channel of protest against Metternich, who had undeservedly become the symbol of the decaying order.

The Revolutions of 1848.—The Hungarian revolution proceeded by legal means. In Budapest a group of students announced the full radical program at the end of February. Kossuth persuaded the diet, which still met at Pressburg, to silence this radical movement by carrying its program in more regular form. The "March laws" made Hungary a Magyar liberal state, connected with the rest of the empire only by a personal union; they departed from the radical demands only in substituting a restricted property franchise for universal suffrage and thus kept the Hungarian parliament in the hands of the landed gentry.

In Bohemia a radical program was formulated on March 11. The diet of Lower Austria gave the signal for revolution in Vienna on March 13. The rising grew too formidable to be repressed; and members of the imperial family insisted that Metternich should sacrifice himself. He resigned and escaped from Vienna the following day. Kolowrat became for a few days "responsible prime minister"; when this proved too absurd he was succeeded by C. L. Ficquelmont, long designated by Metternich as his successor at the foreign ministry. Ficquelmont was in turn driven from office by student demonstrations (May 3); and the titular head then became Franz Xavier von Pillersdorff, an elderly bureaucrat with an unmerited reputation as a liberal. On March 18 Lombardy revolted against Austrian rule, and the military forces of the empire were thereafter concentrated on the war in northern Italy. Elsewhere imperial policy was confined to concessions and surrender.

Vienna was granted liberal freedoms on the morrow of the revolution; press censorship was abolished and a national guard created. On March 15 a states-general was promised at some undefined future. A fresh revolt on April 25 led to the publication of a centralized parliamentary constitution, modeled on that of Belgium. This, with its restricted suffrage and two-chamber parliament, failed to satisfy radical opinion. Pillersdorf challenged this opinion by dissolving the national guard on May 13. This provoked a further rising (May 15), and a constituent assembly, elected by universal suffrage, was promised. On May 17 Ferdinand and the imperial court fled to Innsbruck, and a committee of public safety was set up in Vienna on May 26. Hungary met with less resistance; the "March laws" were constitutionally confirmed by Ferdinand on April 11, and the Hungarian revolution was thus fully legalized. Bohemian demands did not receive full satisfaction; though Czech and German were given equality as official languages and a responsible Bohemian government promised, the union of Bohemia, Moravia and Silesia (the historic lands of the Bohemian crown) was left open (April 8). Nevertheless the imperial court at Innsbruck seemed to be planning to play Bohemia off against Vienna, as later it played Croatia against Hungary. But on June 12 the imperial commander in Prague, Alfred, first prince von Windischgrätz, seized the excuse of a radical demonstration to restore authority by force. Though the military had already won a victory at Cracow on April 25, the conquest of Prague by Windischgrätz was the first substantial success of reaction; yet national passions were so great that the defeat of the radicals, supposedly Czech, was welcomed even by radical Germans.

Imperial authority seemed to be recovering on a liberal basis. At Innsbruck a more resolute government was set up. Nominally under Anton von Doblhoff, its real leader was Johann Philipp, Freiherr von Wessenberg, an elderly diplomat of ability and genuine liberalism; it also included the Vienna radical, Alexander, Freiherr von Bach, as minister of justice. The constituent assembly met on July 22, 1848, with representatives from all parts of the empire except Lombardy-Venetia and Hungary. On the motion of Hans Kudlich, a radical student though representing a peasant district, the assembly at once considered the agrarian question and on Sept. 7 passed the Act of Emancipation, which ended the feudal system of land tenure. *Robot* was abolished, and the peasant holder was given security; the landowner received compensation partly at the expense of the state, partly at that of the tenant. The work of Joseph II was thus completed.

On July 25 Josef Radetzky's army in Italy defeated the Italians at Custoza; and on Aug. 5 Charles Albert evacuated Milan. (*See* ITALY: *History*.) An armistice was concluded, though the Austrian government was still vaguely committed to granting Lombardy-Venetia liberal conditions. On Aug. 12 Ferdinand and the imperial family returned to Vienna. The problem of Hungary was now outstanding. Wessenberg and Bach were determined to enforce a revision of the "March laws" in order to make Hungary an integral part of the empire again, especially for fiscal purposes. When the Hungarians, under Kossuth's leadership, refused this demand, the imperial court, without informing its ministers, restored to favour Josip Jelalic as *ban* of Croatia (Sept. 4). Jelalic had earlier been dismissed on Hungarian prompting; his restoration was thus a defiance of Hungary and on Sept. 11 he invaded Hungary at the head of his Croat troops.

Kossuth appealed to the constituent assembly to mediate between Hungary and the dynasty. The imperial government insisted that Hungary must first accept the unity of the empire. After a three-day debate (Sept. 17–19) the assembly refused to re-

ceive the Hungarian delegation. The government now believed that it had a free hand, and imperial troops were sent from Vienna to help Jelalic. This provoked a radical revolt in Vienna on Oct. 6. Theodor, Graf Baillet von Latour, the minister of war, was murdered and the court fled to Olmütz (Olomouc) in Moravia, followed by the majority of members of the assembly. A parliamentary rump of German radicals and Poles conducted the defense of Vienna against the forces of Windischgrätz and Jelalic. A Hungarian army failed to relieve Vienna, the provinces did not respond to Kudlich's appeal for support, and Vienna surrendered to Windischgrätz on Oct. 31. Some radical deputies and Cäsar Wenzel Messenhauser, the military commander, were shot, together with Robert Blum, a delegate from the German parliament at Frankfurt.

Schwarzenberg as Prime Minister.—On Nov. 21 a new government of forceful men was appointed, with Prince Felix Schwarzenberg, brother-in-law of Windischgrätz and former adviser to Radetzky, as prime minister. Graf Franz Seraphin von Stadion, formerly governor of Galicia, was minister of the interior. Karl Ludwig, Freiherr von Bruck, a German trader from Trieste with grandiose economic vision, was minister of commerce, and the energetic Bach remained minister of justice. The ministers were determined to assert the power of the Austrian empire against radicalism, but also against the traditional elements of weakness; their policy was reaction, not restoration. A new emperor was needed for this new policy of force. On Dec. 2 Ferdinand abdicated in favour of his nephew Francis Joseph (*q.v.*). Since there was no time to consult precedents, he became emperor in a hole-and-corner way in the castle at Olmütz; moreover, since Francis Joseph and his ministers rejected all traditional liberties and customs, this great European "crowned head" was never given a coronation until he was crowned king of Hungary after the compromise of 1867. The empire of Austria had been invented by Francis I in 1804, and no imperial coronation was ever devised. Further, Francis Joseph, being hostile to Czech and Italian claims, was never (unlike his predecessor) crowned king of Bohemia or with the iron crown of Lombardy.

Since Vienna was in a state of siege, the assembly was convened to meet at Kremsier (Kromeriz) in Moravia on Nov. 15. There the deputies drafted a constitution, which was almost completed when Schwarzenberg dissolved the assembly on March 7, 1849. The Kremsier constitution was unique among Austrian constitutional experiments in having been devised after free discussion among political leaders. Its framework was a centralized imperial authority, working with due regard for popular rights. To preserve national rights, much of the administration was left to the provinces; for the national minorities within the provinces, there were to be subordinate "circles." The Kremsier constitution showed how autonomy of national cultures could be secured under the rule of a liberal dynasty; it did not show how the dynasty could be made liberal. It was in fact the work of politicians whose revolution had already been defeated. The Kremsier constitution omitted Hungary; it was therefore useless to Schwarzenberg as a propaganda weapon. To prevent the ill effects of a constitution actually agreed upon by subjects, the assembly was dissolved on March 7. Stadion hastily drafted a constitution which treated the entire empire, including Hungary and Lombardy-Venetia, as a unitary state. This constitution was itself declared suspended until the "provisional emergency" was over.

The war with Sardinia was renewed in March 1849, and the Italian army was defeated at Novara (March 23). On April 5 the Austrian deputies were ordered to withdraw from the German national assembly. Hungary, however, was still unsubdued; and on April 14 the Hungarian parliament meeting at Debrecen deposed the Habsburgs and elected Kossuth governor. Schwarzenberg was compelled to ask for Russian help, and Russian forces entered Hungary in May. On Aug. 13 Arthur Görgey, the Hungarian commander in chief, surrendered to the Russians at Világos. Imperial rule in Hungary was asserted with great cruelty by Gen. Julius Haynau. The Hungarian constitution was abolished, and Hungary was incorporated into the unitary empire. In Nov. 1850 an emergency decree casually abolished the Hungarian tariff frontier which had been the essential mark of Hungarian separatism. Croatia, which had supported the imperial cause loyally, fared no differently; its constitution and autonomy were also abolished. "What Hungary got as punishment, Croatia received as reward."

Schwarzenberg's constructive aim in foreign policy, inspired by Bruck, was to force the entire Habsburg empire into a revived German confederation and thus to establish an "empire of 70 millions" under Habsburg leadership. He secured Russian backing against Prussian plans to create a new North German federation under Prussian leadership, and in Nov. 1850 Prussia had to agree to return to the old federal diet. But when Schwarzenberg attempted to execute his own plans at a conference at Dresden (Feb. 1851), he met with united opposition from the German princes; and this opposition was supported by Russia. The only relic of the empire of 70,000,000 was a Prussian promise that the inclusion of Austria in the Zollverein should be considered on some future occasion.

On Dec. 31, 1851, the Stadion constitution, which had remained in theoretical existence, was formally abolished, together with the provisions for individual liberty which had remained equally theoretical. An imperial council (*Reichsrat*) or sham parliament, on the lines formerly advocated by Metternich, had already been set up to advise the emperor on legislation, but it never functioned to any serious purpose. Since absolutism was the keynote of the new system, Francis Joseph (like Francis before him) would not have his absolutism curtailed even by an advisory council. Karl Friedrich, Freiherr Kübeck von Kübau, a former liberal, on whose advice the patent of Dec. 31, 1851, had been made, hoped himself to supplant the all-powerful ministers who had governed the empire since the defeat of the revolution. But though ministerial power was certainly weakened, Kubeck did not benefit. Once more, as in the reign of Francis, the emperor became the sole instrument of co-ordination between ministers strictly confined to their own departments.

The Bach System.—The evil effects of Kübeck's patent were not apparent so long as Schwarzenberg's strong personality maintained his position as prime minister. But when he died in April 1852, no new prime minister was appointed, Francis Joseph himself attempting to act as such. The outstanding minister who remained from Schwarzenberg's powerful team was Bach, now minister of the interior. He carried the authority of centralized administration to the most extreme parts of the empire, which was ruled as a unit for the first time in its history. Though originally radical in outlook, Bach accepted an alliance with the clergy to maintain his position at court. Education was put back under clerical influence; and a concordat (Aug. 18, 1855) gave the Roman Catholic Church a highly privileged position. Civil marriage was abolished, and the concordat even contained a promise that no confessional laws would be altered without the consent of the Vatican. The Bach system was administered by German bureaucrats and aimed to make the Austrian empire a centralized German state. It was, however, disliked by the German middle classes because of the lack of liberal institutions and still more because of the unstable finances caused by the great burden of armaments. The greatest hostility to the system was in Hungary where the German administrators were known as "Bach hussars." Hungary remained under martial law as did Lombardy-Venetia, until 1857.

Buol's Foreign Policy.—A forceful foreign policy had been an essential part of Schwarzenberg's outlook. This had restored Austria's position in Italy and Germany, but had not freed from dependence on Russia. Karl Ferdinand, Graf von Buol-Schauenstein, Schwarzenberg's successor as foreign minister, ignored this dependence. In 1853, when the eastern crisis opened which led to the Crimean War (*q.v.*), he refused to allow Russia a free hand or even to partition the Turkish empire with it. On the other hand he hoped to acquire the Danubian principalities (the later Rumania) for Austria; and Austrian forces occupied them in July 1854. Just when Buol's course seemed set for war with Russia the Austrian generals intervened and insisted that the army was not strong enough to fight Russia in Galicia. Buol

therefore had to try to retain the friendship of the western allies, Great Britain and France, by promises that were always empty. On Dec. 2, 1854, he signed a treaty of alliance with them and received in return a French guarantee of tranquility in Italy for the duration of the war. But when the ensuing conference at Vienna between the belligerents (Feb.–April 1855) proved abortive, Buol evaded action, leaving the field free for Austria's opponent, Sardinia, to win the allies' good will by supporting them. Both sides blamed Austria for its inactivity, and at the congress of Paris (Feb.–March 1856) Austria was isolated: the Austrian troops had to withdraw from the principalities, and Buol had to hear Austrian rule in Italy denounced in full congress by the Sardinian delegate, Cavour.

The estrangement from Russia shattered the keystone of Metternich's foreign policy which had given the Habsburg monarchy 40 years of security in Europe. Russia was bent on disrupting the coalition of Great Britain, France and Austria; and, in its resentment against Austria, gave cautious approval to the revolutionary projects of Napoleon III to remodel the map of Europe. Napoleon and Cavour were therefore free to provoke Austria into war, and Buol did nothing to prevent them. He rejected the congress proposed by Russia (March 1859), failed to secure the alliance of Prussia, and finally launched an ultimatum to Sardinia demanding that it should disarm (April 19, 1859). The statement that the ultimatum was sent by the generals or the court without Buol's knowledge is a legend, invented to conceal the incompetence of Austrian diplomacy. The Austrian army in Italy was defeated at Magenta (June 4) and at Solferino (June 24). Francis Joseph then made the armistice of Villafranca (July 12) with Napoleon, by which he surrendered Lombardy, retaining Venetia. This was confirmed by the treaty of Zürich, signed on Nov. 10, 1859.

The October Diploma.—Defeat in war discredited the absolutist system. Johann Bernhard, Graf Rechberg-Rothenlöwen, a disciple of Metternich, succeeded Buol, and Agenor Goluchowski, a Polish aristocrat, succeeded Bach (Aug. 1859). The intention was to return to the historic conservatism of the era before March 1848, when the aristocracy co-operated in theory with the crown. Symbol of this revived aristocracy was the "reinforced *Reichsrat*" (May–Sept. 1860); the intention was to increase the *Reichsrat* by members from the provincial diets, but since these had also been abolished in 1849, the additional 38 members (2 for each province) were nominated by the emperor. In July 1860 the reinforced *Reichsrat* submitted a report advocating the reconstruction of the empire on a basis of aristocratic federalism. Though Francis Joseph was now much under the influence of the Old Conservatives (spokesmen of the Bohemian and Hungarian aristocracy), he paid no serious attention to this report. But, anxious to create a good impression before meeting the Russian emperor and the king of Prussia at Warsaw (Oct. 21, 1860), he had an aristocratic constitution hastily drafted and formally published as the "October diploma" (Oct. 20). This diploma revived the provincial diets, under aristocratic control; these diets were to advise on all legislation except in a few matters which were reserved for the central *Reichsrat*. The *Reichsrat* was itself to be mainly drawn from the diets, and it too was to have only advisory powers. The Hungarian diet was to proceed "according to its former constitution"; regulations for the other diets were to be issued later. Finally, matters concerning the provinces other than Hungary were to be discussed in common without the Hungarians. This was the first premonition of dualism.

The October diploma did nothing to satisfy the Hungarian demand for the constitution of 1848, as formally acknowledged by Ferdinand I. It was equally rejected by the Germans who disliked both its federal and its aristocratic character. Saddled with debt and with war expenses, the empire was especially vulnerable to the opinion of the German capitalists in Vienna, who were now more hostile than they had been to the Bach system. The Hungarian Old Conservatives persuaded Francis Joseph that the Hungarians would accept the October diploma if they could have proof of his liberal intentions in the rest of the empire. In Dec. 1860 Goluchowski was dismissed and his place taken by Anton, Ritter von Schmerling, whose task it was to give the non-Hungarian lands a stronger dose of liberalism.

The February Patent.—Schmerling was a bureaucrat with some liberal leanings and strong centralist convictions. He had defended the unity of the Habsburg lands against the German radicals at Frankfurt in 1848 and was now determined to defend this unity against the Hungarians. On Feb. 26, 1861, he produced a patent which, ostensibly a gloss on the October diploma, in reality reversed it. The diets lost most of their powers; the *Reichsrat*, though still elected by the diets, became a parliament with two houses (*Herrenhaus* and *Abgeordnetenhaus*), legislating for the entire empire. Yet a "narrow *Reichsrat*" was also defined to deal with non-Hungarian affairs.

The franchise had previously been designed to benefit the great landowners; now both it and the constituencies were rigged to benefit the German middle classes. This was the system of "electoral geometry," by which the Germans became predominant in the *Reichsrat*. The February patent lacked many essential constitutional securities; it did not even provide for parliamentary control over finance or legislation. Still it was accepted by most German liberals as an excuse for making their peace with the dynasty.

The Hungarians, however, refused to be satisfied with anything less than the restoration of the laws of 1848. When the Hungarian diet met in April 1861 it refused to elect representatives to the *Reichsrat;* and it was dissolved in August after presenting an address of protest to Francis Joseph. Schmerling announced: "We can wait"; and Hungary was once more brought under martial law. This policy continued to receive the support of the German liberals. Other nationalities were less subservient: the Croat diet was also dissolved in 1861 when it too demanded the restoration of its ancient privileges; the Czech deputies withdrew from the *Reichsrat* in 1863. Only representatives of the Saxons in Transylvania maintained the illusion that the *Reichsrat* was the parliament of a united empire.

In order to win the support of the German liberals, Schmerling advocated a forward policy in Germany, putting Austria at the head of the movement for German unification. Rechberg, still foreign minister, would have preferred a conservative co-operation with Prussia, but he was overborne by Schmerling. In 1863 Francis Joseph attempted to inaugurate German reforms by summoning a meeting of German princes at Frankfurt; this attempt broke against Prussia's refusal to attend. In 1864 Austria was drawn into the war against Denmark for Schleswig and Holstein; the peace of Vienna (Oct. 1864) ceded the duchies to Prussia and Austria jointly. Rechberg tried once more to make a real alliance with Prussia; when he failed his usefulness was over, and he resigned in Oct. 1864. Francis Joseph was equally weary of Schmerling's liberalism, which had failed to conciliate or to subdue the Hungarians. When Ferencz Deák (*q.v.*) the Hungarian leader, put forward proposals which held out hopes of a successful compromise, Francis Joseph dismissed Schmerling and replaced him with a conservative "ministry of counts," headed by Richard, Graf Belcredi (*q.v.*).

Belcredi's Ministry, 1865–67.—Belcredi and his fellow counts swung back, with more sincerity, to the aristocratic conservatism of the October diploma. The *Reichsrat* was dismissed, the February patent "suspended," and the provincial diets were once more packed in favour of the great landowners. Belcredi hoped that, if he increased the powers of the provincial diets, the Hungarians would be satisfied with the same rights as the others; but the essence of the Hungarian claim, founded in history as well as in law, was that Hungary was unique. Thus Belcredi had nothing better to offer than Schmerling's policy of waiting; yet this policy had caused Schmerling's dismissal. Belcredi had been appointed to settle with Hungary in view of the approaching war with Prussia; instead he welcomed war with Prussia as an excuse for not settling with Hungary. The ostensible ground for war with Prussia was a dispute over Holstein, but the real cause lay in the struggle for mastery in Germany. The Austrian government might have had Italian neutrality in exchange for surrendering Venetia. It was too proud to make this sacrifice, yet signed a

treaty with Napoleon III (June 12, 1866) by which it promised to surrender Venetia after the war. Austria had therefore to fight a war on two fronts (*see* SEVEN WEEKS' WAR). Though the archduke Albert (*q.v.*) won a barren victory over the Italians at Custoza, the main Austrian army was routed by the Prussians at Sadowa (Königgrätz) on July 3. By the peace of Prague (Aug. 23) Austria surrendered Venetia and was excluded from Germany. It was only due to the grace of Bismarck that it remained a great power. As a result of the war of 1866 Austria became the second "Sick Man" of Europe.

Immediately after Sadowa, negotiations were renewed with Deák and with his chief supporter, the elder Gyula Andrássy (*q.v.*), who desired a partnership between Germans and Magyars to hold down all other nationalities of the empire. Belcredi would not accept this program; he still hoped to balance the other provinces against Hungary and therefore urged them to formulate demands. These delaying tactics no longer satisfied Francis Joseph, who was eager for revenge on Prussia. In Oct. 1866 Friedrich Ferdinand, Graf von Beust (*q.v.*), formerly prime minister of Saxony, became foreign minister; and his concern too was to settle with Hungary as quickly as possible. He persuaded Francis Joseph that a settlement was possible if negotiations were limited to Hungary (Feb. 3, 1867). Belcredi resigned, and Beust was left alone with a few officials to wind up old Austria.

The Compromise of 1867.—The agreement reached between Beust and Andrássy was a compromise between the emperor and Hungary, not between Hungary and the rest of the empire. Indeed the peoples of the empire were not consulted, despite Francis Joseph's promise at the time of the October diploma not to make further constitutional changes without the advice of the *Reichsrat*. Hungary received full internal autonomy, together with a responsible ministry, according to the "March laws" of 1848. In return Hungary agreed that the empire should still be a single great state for purposes of war and foreign affairs. Francis Joseph thus surrendered his domestic prerogatives in Hungary, including his protection of the non-Magyar peoples, in exchange for the maintenance of dynastic prestige abroad. The "common monarchy" consisted of the emperor and his court, the minister for foreign affairs and the minister of war. There was no common prime minister (other than Francis Joseph himself) and no common cabinet. The common affairs were to be considered at the delegations, composed of representatives from the two parliaments. There was to be a customs union and a sharing of accounts, which was to be revised every ten years. This decennial revision gave the Hungarians recurring opportunity to levy blackmail on the rest of the empire.

The Compromise (*Ausgleich*) came into force when passed as a constitutional law by the Hungarian parliament in March 1867. Francis Joseph would not have troubled to get the consent of the rest of the empire. Andrássy, however, insisted that there should be a formal approval; and the "narrower *Reichsrat*" of the February patent was therefore summoned by Beust in May 1867. The *Reichsrat* was only permitted to confirm the compromise without amending it. In return for this the German liberals who composed its majority received certain concessions, which were added to the February patent as "constitutional laws." The rights of the individual were secured and a genuinely impartial judiciary was created. Freedom of belief and of education were guaranteed—a breach of the concordat of 1855 with Rome, which now remained an empty form. Nothing, however, was done to modify the system of electoral geometry. In the contemporary phrase the German liberals were so eager "to climb on to the driver's seat of the state coach" that it escaped their attention that they were not allowed to hold the reins. The ministers were still responsible to the emperor, not to a majority of the *Reichsrat*.

The official name of the state shaped by the Compromise was Austria-Hungary. The kingdom of Hungary had a name, a king, a history of its own. The rest of the empire was a casual agglomeration without even a clear description. Technically it was known as "the kingdoms and lands represented in the *Reichsrat*" or, more shortly, as "the other Imperial half." The mistaken practice soon grew of describing this nameless unit as "Austria" or "Austria proper" or "the lesser Austria"—names all strictly incorrect until the title "empire of Austria" was restricted to "the other Imperial half" in 1915. These confusions had a simple cause: the empire of Austria with its various fragments was the dynastic possession of the house of Habsburg, not a state with any common consciousness or purpose.

AUSTRIA-HUNGARY

The Bourgeois Ministry.—In Dec. 1867, when the constitutional laws had been passed, Beust received the empty title of imperial chancellor, though in reality no more than foreign minister. On his advice Francis Joseph appointed a "bourgeois ministry" or "ministry of citizens" (in contrast to Belcredi's "ministry of counts"), drawn from the German liberals of the *Reichsrat* and with Karl Wilhelm (Carlos), prince von Auersperg as minister-president. This bourgeois ministry continued the work of liberal reform. It restored civil marriage (March 1868), regulated secular education and instituted universal military service. But Austria could not be governed solely for the benefit of the German middle class. The Czechs were indignant at the revival of electoral geometry and at their exclusion from all share in political life. Their deputies had boycotted the *Reichsrat* when it was renewed. On Aug. 23, 1868, they issued a declaration of their aims. They asked for equal national rights for the Czechs in Bohemia and for electoral reform—demands that could have been met within the framework of the existing unitary system. But, inspired by the Hungarian model and envious of Hungarian success, they also demanded the unification of "the lands of St. Wenceslas" (Bohemia, Moravia and Silesia) and the same independence for this "Great Bohemia" as Hungary possessed. This would have ended German predominance in Austria and destroyed Hungary's position as Austria's only partner. The ensuing 50 years of imperial history were determined by the choice of the emperor and of the Germans to surrender to Hungarian dictation rather than call in the Czechs as associates.

The bourgeois ministry was divided in its attitude to the Czech demands. The middle-class Germans, who were in the majority wished to give the Czechs an intransigent answer and to break their boycott of the *Reichsrat* by holding direct elections in the constituencies without the intervention of the Bohemian diet. The minority, led by Eduard, Graf von Taaffe (*q.v.*), a boyhood friend of the emperor's, and by the Polish Count Alfred Potocki, wished to offer the Czechs local concessions in Bohemia in exchange for their recognition of the central state and their attendance at the *Reichsrat*. Policy swung to and fro. In Sept. 1868 Taaffe became prime minister without having the support of the majority in the ministry. In Dec. 1869 the German ministers again urged direct elections to the *Reichsrat*. Taaffe appealed to the emperor who refused to support him; whereupon Taaffe and Potocki resigned. A purely German ministry was then formed under Leopold Hasner. The *Reichsrat*, however, failed to carry direct elections by the necessary two-thirds majority, and the Poles, Rumanians, Slovenes and Italians withdrew from it. The German ministers wished to engage in a general struggle with the other nationalities and asked the emperor to dissolve all the diets whose members had withdrawn (April 1870). This was too much for Francis Joseph and the German ministers resigned in their turn. Potocki now formed a cabinet chiefly of imperial officials and tried to arrive at a compromise which should satisfy both Czechs and Germans. He dissolved all the diets and also the *Reichsrat*, but new elections did not produce any more favourable result. The Czechs thought they were in sight of complete victory and would be satisfied with nothing less than the kingdom of St. Wenceslas; the Germans refused to weaken the centralized state or even to grant national concessions to the Czechs in Bohemia. When the *Reichsrat* met in Oct. 1870 Potocki was censured both for negotiating with the Czechs and for failing to reach an agreement with them. Potocki resigned (Nov. 24), but since no new ministry could be found he remained in office until Feb. 1871. His only memorable act was the formal denunciation of the concordat with Rome in July 1870.

The Franco-German War.—Beust had been made foreign minister in 1866 and had himself pushed through the Hungarian

Compromise in 1867 in order to prepare for a war of revenge against Prussia. For this an alliance with France was essential, and negotiations were conducted from 1867 until 1870. In 1867 Napoleon III and Francis Joseph met at Salzburg; later the archduke Albert, the Austrian commander in chief, visited Paris and a French general came to Vienna for military conversations. Agreement was never reached. Beust wanted a general alliance which would give Austria-Hungary security against Russia as well as against Prussia. Napoleon wished to keep his hands free in order to make concessions to Russia in the near east at the decisive moment. His eyes were turned solely against Prussia. Beust, on the other hand, could not openly take a line involving the loss of German territory to France if he wanted Austria to recover its position as a German power. Most of all, the negotiations broke down on the question of Rome (*see* ITALY: *History*): the Austrian generals would not face a new war with Prussia unless secure from an Italian attack; the Italians would not enter the alliance unless French troops were withdrawn from Rome; and Napoleon could not give up the pope because of clericalist opinion in France. When the crisis broke in July 1870 France and Austria-Hungary were not allies. Beust knew that this was his last chance against Bismarck and advocated war or at least armed neutrality. He was opposed by the Austrian generals who insisted that the army was not ready; also, the Germans in Austria now regarded Bismarck as their national hero. The final push came from Andrássy, now Hungarian prime minister, who, realizing that Austro-Hungarian dualism, with all its advantages for Hungary, was due solely to Prussia's victory in 1866, was determined that this victory should not be reversed. Austria-Hungary remained neutral, at first provisionally, then without reserve. By a fine irony dualism, Beust's sole success as a statesman, was the decisive barrier against the success of his foreign policy.

The Czech Crisis of 1871.—Once the policy of revenge was abandoned there was no purpose in trying to present Austria as a German state, and the Compromise with Hungary also lost its justification. For a moment Francis Joseph considered a return to thoroughgoing centralism under Schmerling; this would have provoked an immediate Hungarian resistance and, besides, the Germans would no longer support Schmerling. Francis Joseph therefore turned to the federalist alternative and aimed at a settlement with the Czechs. On Feb. 5, 1871, Karl Siegmund, Graf von Hohenwart, a leading German clerical, became prime minister, with Albert Schäffle as minister of commerce and the real inspirer of policy. Schäffle, a radical from Baden, was one of the few Germans who had retained the genuine idealism of 1848. He wished to transform the Habsburg monarchy into a federation of equal peoples and to extend the suffrage in order to lessen national passions which were, he believed, predominantly middle class. Hohenwart and Schäffle at first attempted to proceed by slow stages. In April 1871 bills were introduced into the *Reichsrat* increasing the autonomy of the provinces; these bills were rejected by the German majority. Hohenwart and Schäffle then decided to face a full settlement with the Czechs. After some months of negotiations an imperial rescript (Sept. 12) proposed to revive the historic rights of Bohemia, together with full national equality for Czechs and Germans in Bohemia. When this compromise was accepted, Francis Joseph would be crowned king of Bohemia in Prague. The Czech leaders thought that this was the beginning of a bargaining such as had preceded the Hungarian Compromise and therefore answered (Oct. 10) with 18 "fundamental articles," which insisted on the unity of "the lands of St. Wenceslas." Moreover the Czech leaders knew that their national movement had as yet little real strength; they doubted whether Bohemia could really hold its own against Hungary and the nameless "imperial third." They therefore demanded a federal system for all the imperial lands except Hungary, with the *Reichsrat* reduced to a congress of delegates. Yet this federal system would not have solved the national question: the provinces were historical, not national, units, and the national struggle would simply have been fought in each province as it was already being fought between Czechs and Germans in Bohemia. Now as always the Czechs would not contemplate a redivision of the Habsburg lands on national lines, for they would have then lost their "historic" Bohemia. The Germans would have gained, as a nation, from such a national redivision; but they in their turn would not dismember the unitary state centred on Vienna, which they regarded as historically theirs.

The Hohenwart-Schäffle bargaining with the Czechs provoked open German opposition, and there were riots in the streets of Vienna. Hohenwart and Schäffle were men of the study, not practical politicians, and they were nonplused by this appeal for force. Andrássy had throughout observed their policy with hostility; if the Czechs achieved their aim Hungarian predominance would be at an end. When Francis Joseph asked for his advice he came to Vienna with simulated reluctance. He challenged Hohenwart whether he was prepared to break the German opposition by force: "If not, do not begin this policy." The Czech fundamental articles were abruptly rejected; and the Hohenwart ministry was dismissed (Oct. 27, 1871). Andrássy's triumph was complete when on Nov. 14 he took Beust's place as foreign minister.

Andrássy.—A new version of the "bourgeois ministry," composed of German middle-class liberals, was restored with Prince Adolf Auersperg as prime minister. These Germans were in office by favour of Andrássy, not from their own strength or merits. Indeed Hungary, by perpetuating the national disputes within Austria, was sole gainer from the crisis of 1871. The German ministers were themselves disillusioned, barren and often corrupt. Their only achievement (Feb. 1873) was that they at last managed to institute direct elections for the *Reichsrat*, though of course retaining the complicated franchise with its four *curiae* or categories of constituency. This change defeated the Czech policy of abstention; but the German liberals made no effort to make their return to the *Reichsrat* easy and continued to treat Bohemia as Hungary had been treated in the days of the "Bach hussars." The German ministers, closely linked with Viennese capitalists, were greatly weakened by the financial crisis of May 1873, especially as some ministers were involved in the attendant scandals.

The great issue of these years, however, was in foreign affairs. Now that Hungary was secure, Andrássy, once a revolutionary, had become conservative and wished to preserve the Compromise of 1867 indefinitely. This involved friendship with the new Germany and the maintenance, at the opposite end of the frontier, of the Ottoman empire—for which a pacific Russian policy was essential. The League of the Three Emperors (*Dreikaiserbund*) of 1872, by which Francis Joseph and the German and Russian emperors agreed to work together for peace, gave expression to this policy, but in 1875 upheavals in the Balkans threatened to change Russia's course. (*See* EASTERN QUESTION.) The Andrássy note (presented on Jan. 31, 1876) proposed reforms which the Porte might adopt; when this failed, Andrássy was faced with the inevitable outcome that Russia would attempt to impose reforms on Turkey by force. Like Metternich before him, though for very different reasons, Andrássy was convinced that Austria-Hungary was a "saturated state"; the Russian offers of partition therefore did not attract him. Since Russia could not be restrained altogether, Andrássy's object was to keep its aims within modest limits; this seemed to be achieved by the two secret agreements of Reichstadt (Zákupy) in July 1876 and Budapest in Jan. 1877, agreements more important for what they excluded than for what they contained. Russia, renouncing "the great partition," agreed to be content with Bessarabia and in return gladly acquiesced in Austria-Hungary's acquiring Bosnia and Hercegovina. Andrássy therefore watched in neutrality the Russo-Turkish war of 1877–78, despite the fire-eating protests of Francis Joseph and the Austrian generals who were eager for war. In Feb. 1878, with the war won, Russia forgot its promised restraint and imposed on Turkey the treaty of San Stefano, which created a Great Bulgaria. Andrássy protested against the treaty, but he was still set against going to war and evaded an alliance with Great Britain until it was clear that the Russians had given way. At the congress of Berlin (*q.v.*) Bulgaria was dismembered, and Russia accepted its earlier program. Turkey was given another generation of existence, and Austria-Hungary along with

it. Neither empire owed this breathing-space to its own strength; they had been saved by British resolution, by Russian weakness and most of all by Bismarck's opposition to a general war.

The problem of Bosnia and Hercegovina remained. Turkish rule could not be restored, and Austria-Hungary could not allow the aggrandizement of Serbia, already a dangerous example of a South Slav national state. Andrássy had to acquiesce, with extreme reluctance, in the occupation of Bosnia and Hercegovina by Austria-Hungary; he genuinely hoped that within 30 years the Ottoman empire might be reformed and that then the provinces might be restored to Turkish rule. Since the provinces were occupied, not annexed, they could not be included in either Austria or Hungary; they therefore became the only territorial expression of "the common monarchy" and provided a substitute for the colonial outlet by which in the later 19th century the great powers displayed their civilizing energy. The German ministers objected strongly to this addition of new Slav populations to an empire in which Germans were already outnumbered, and voted against Andrássy's policy in the delegations. This was a breach of the implied bargain with Francis Joseph, by which the Germans had been allowed to preserve their dominant position at home in compensation for leaving foreign policy as an imperial prerogative. In Aug. 1878 he broke with the bourgeois ministry, though they remained in office until suitable successors could be found.

Francis Joseph was also dissatisfied with Andrássy, since his foreign policy seemed always to be determined by Hungarian and not by dynastic interests. Francis Joseph had forgotten the lessons of caution taught by the defeats of 1859 and 1866; he began again to imagine himself the ruler of a great state. Andrássy managed, however, to impose an effective barrier against any Habsburg expansion in the Balkans before he resigned. This was the Austro-German alliance of Oct. 1879, also more important for its omissions than for its contents. Certainly Germany promised to support Austria-Hungary in case of a direct Russian attack; this was a commonplace long accepted even by Russia. But Germany did not promise to support Austro-Hungarian plans in the Balkans. Indeed a conservative Austro-Hungarian foreign policy was the essential condition of the alliance. The alliance had an important domestic consequence: since Germany guaranteed the dual system, Hungary no longer needed the friendship of the Germans in Austria and could allow an attempt to conciliate the Czechs and other Slavs, such as Andrássy had forbidden in 1871. Thus the alliance with Germany ended German predominance in Austria.

Taaffe as Prime Minister.—In Aug. 1879 Taaffe took office as prime minister above the parties, an imperial minister (*Kaiserminister*) as he called himself. His object was to persuade the Czechs to attend the *Reichsrat* in return for concessions in the national question. This object was achieved in April 1880 when Czech and German became the languages of "the outer service" in Bohemia. The Czechs returned to the *Reichsrat* and, though their spokesman made a formal statement at the beginning of each session disputing the competence of the *Reichsrat* to legislate for Bohemia, they in reality displaced the Germans as the party "loyal to the constitution." The Czechs were further rewarded in 1882 by a lowering of the franchise to include all who paid five florins in direct taxation. This enfranchised the more prosperous Czech peasants and so weakened the hold of the German middle class. An even more striking Czech gain was the division of Prague university into separate Czech and German establishments. Taaffe did not imagine that he had solved the national question; in his own words, he aimed "to keep all the nationalities in a balanced state of mild dissatisfaction." This cynical lack of system gave Austria about 12 years of political calm such as it had not known since Metternich's days.

In the Taaffe era Austria-Hungary seemed to recover independence as a great power. Gustav Siegmund, Graf Kálnoky (*q.v.*), foreign minister from 1881 to 1895, had no faith in Russian pacific intentions. Though drawn by Bismarck into a renewed League of the Three Emperors (June 1881), he also made secret treaties with Serbia (1881) and with Rumania (1883) which were designed to exclude Russia from the Balkans. Further, the triple alliance with Germany and Italy of May 20, 1882 was incipiently an anti-Russian coalition and was turned to good use by Kalnoky when the Eastern question was reopened in 1885. He refused to accept Bismarck's advice to partition the Balkans with Russia. Instead he promoted the two Mediterranean agreements with Italy and Great Britain (March and December 1887) which set up an effective barrier against Russia and assisted a peaceful outcome of the confused Bulgarian crisis. Still Kálnoky's pertinacity had an unexpected influence on home affairs. Bismarck was unshakably resolved not to be drawn into war with Russia for the sake of Austro-Hungarian interests in the Balkans; and, to emphasize his resolve, asserted his indifference also concerning the fate of the Germans in Austria and actually encouraged Taaffe's concessions to the Czechs.

The more extreme German nationalists, feeling themselves abandoned both by the emperor and by Germany, redoubled their extremism. In 1882 their "Linz program" proposed that Galicia and Dalmatia should be made autonomous and that the rest of constitutional Austria should become exclusively German in character with the backing of the German *Reich*. German nationalism also took on, for the first time, an anti-Semitic form, inspired by Georg, Ritter von Schönerer, its most violent exponent. On the Czech side, too, extremism developed. The Young Czechs disliked the squalid bargaining in the *Reichsrat* and wished to revive the program of state rights by which all Bohemia should become a Czech preserve. The rise of these extreme parties drove Taaffe to seek a compromise with the more moderate national leaders in the *Reichsrat*. In 1890 a committee of Czech and German deputies produced a practical agreement by which provinces with more than one nationality should be divided for administrative and judicial purposes. The struggle for jobs in the bureaucracy, which was the core of the national struggle, was to be settled by creating enough jobs to satisfy all competitors. This settlement, however, was rejected by both Young Czechs and nationalist Germans. The Germans would not surrender Prague, despite their own claim for an exclusively German area, and the Young Czechs would not surrender the unity of Bohemia. In 1891 both Czech and German moderates were routed at the elections for the *Reichsrat*, and in 1893 attempts to divide the judicial system in Bohemia led to Czech riots in Prague and to the proclamation of a state of siege.

Taaffe decided to break the opposition of the middle-class parties by calling in the lower classes. His era had seen the foundation of mass parties. In 1887 Karl Lueger (*q.v.*) had founded the Christian Socialist league, which appealed to the small shopkeepers and clerical peasants; though anti-Semitic and anticapitalist it was loyal to the dynasty and strongly opposed to national disruption. In 1889 Viktor Adler (*q.v.*) had united the scattered Marxists of Austria in the Social Democratic party at the party conference at Hainfeld. Though the Social Democrats used revolutionary phraseology, they too were opposed to national disruption; besides they were mainly concerned, in practice, with improving the conditions of the industrial workers. Their Marxist philosophy made them depreciate the importance of national emancipation, though their own movement was soon divided on national lines. Thus the trade union organizer claimed and secured for himself the national freedom which he denied to his followers.

Taaffe was won for the idea of appealing to the workers and lower middle class by Emil Steinbach, who had become minister of finance in 1889. Francis Joseph acquiesced in the hope (afterward justified) that universal suffrage would make the Social Democrats less revolutionary. On Oct. 10, 1893, a bill was introduced abolishing the complications of electoral law and giving the vote to all adult males. The parties, even the national demagogues, saw their ruin and formed a coalition against it. Moreover Kálnoky also intervened on grounds of foreign policy. Since the fall of Bismarck in 1890 the German government had dropped its restraint in the Balkans and was giving Austria-Hungary firm backing against Russia; Kálnoky could not therefore allow anything which seemed to weaken the Germans in Austria or lessened the impression that the Habsburg monarchy was a German national state. Francis Joseph feared that the *Reichsrat* coalition might

impose upon him a parliamentary ministry. He therefore proposed that if the parliamentary leaders would become ministers on his terms, universal suffrage should be dropped. The terms were accepted, and on Nov. 11, 1893, Taaffe left office.

Badeni.—The new ministry, under Alfred, third prince von Windischgrätz, was ostensibly formed by a coalition of the leading parliamentary parties—the German liberals, the clericalist great landowners and the Poles. They were united only in opposition to universal suffrage. The national struggle had merely been transferred from the *Reichsrat* to the ministry, and each minister defended his national cause. As in the days of Metternich, administration took the place of government. The ministry was torn by ceaseless conflict. The end came in June 1895, when the government fulfilled an old promise of Taaffe and introduced Slovene classes into the grammar school at Cilli (Celje) in Styria. Since the school hitherto had been exclusively German this was regarded as a grave blow at the German cause, and the German liberals resigned. A temporary ministry under Erich, Graf Kielmansegg, lasted till the end of September. Then, on Oct. 2, Kasimir Felix, Graf Badeni (*q.v.*), former governor of Galicia, took office.

Badeni's answer to the franchise question (1896) was to add a fifth layer of constituencies to the curial system, returning 72 members by qualified universal suffrage. Like many others before and after, Badeni was confident that he could settle the conflict between Czechs and Germans. His hands were freed by developments in foreign affairs; the Balkan crisis had died away; and with the fall of Caprivi German policy had again taken on a friendly attitude toward Russia. Moreover in 1895 Kálnoky had overreached himself; to improve his relations with the Vatican, he had tried to interfere with the anticlerical trend in Hungarian legislation and at once had been forced from office by Hungarian protests (May 1895). His successor, the younger Agenor Goluchowski, was a Pole and therefore by no means friendly to Russia by inclination. But since he could not count on either German or British support he was driven to make an agreement with Russia (April 1897) which put the near east "on ice" for an indefinite period. Thus Badeni was free to conciliate the Czechs without fearing the effect on opinion in Germany.

His great stroke was the ordinance of April 5, 1897, which put Czech and German on an equality in Bohemia even for "the inner service"; *i.e.*, for communications within and between government departments. Since the Germans refused to learn Czech (were indeed forbidden to do so by a diet decree of 1868) Badeni's ordinance would give the Czechs a monopoly on government employment. Schönerer thought that his chance had come to disrupt the Habsburg monarchy. His followers obstructed the proceedings of the *Reichsrat*, as the Irish had obstructed those of the British house of commons. Karl Hermann Wolf distinguished himself by throwing an inkpot at the speaker and was removed by the police. German demonstrations followed in Vienna, Salzburg and Graz. Francis Joseph feared that the days of 1848 had come again; on Nov. 28, 1897, Badeni was dismissed.

Körber.—There followed three years of interregnum, when a bewildering succession of ministers attempted to piece together the fragments broken by Badeni. Paul von Gautsch von Frankenthurn (Nov. 1897–March 1898) proposed that Czech and German should be used only in the "mixed" districts of Bohemia; this was rejected by both nationalities. Franz, Graf von Thun-Hohenstein (March 1898–Oct. 1899) tried to force the economic agreement with Hungary over the *Reichsrat* by "emergency decree" (paragraph 14 of the constitutional laws of 1867). A challenge from the Germans brought his resignation. Graf Manfred von Clary-Aldringen (Oct.–Dec. 1899) restored pre-Badeni requirements in Bohemia and so at once provoked Czech rioting and obstruction. Finally Ernst von Körber became prime minister in Jan. 1900. Francis Joseph had long abandoned hope of settling the national question or even of constructing a ministry which should be supported by a majority of the *Reichsrat*; it was enough that there should not be a compact majority against it. The ministers were henceforth bureaucrats, not politicians; and the leading bureaucrat, or prime minister, merely added a certain contact with the *Reichsrat* to his other office duties.

Körber perfected the system by which all necessary legislation was promoted as emergency decree and the *Reichsrat* then kept in a state of division so as not to reject it. The parties were "kept sweet" by local concessions; in return they left government to Körber and his fellow bureaucrats. Körber actually carried the budget of 1902 and the customs agreement with Hungary (Dec. 31, 1902) in a regular parliamentary manner, but he could not repeat his success. The politicians would vote neither for nor against the budget. Körber also introduced old-age and sickness insurance into Austria. In Dec. 1904 his bargainings miscarried and he was driven from office by a combination of parties.

Universal Suffrage.—Gautsch, who took office again in succession to Körber, intended to follow the same cynical path, but events were too much for him. This was the period of the conflict in Hungary between Francis Joseph and the party of independence, which was attacking the common army. To defeat these attacks Francis Joseph appointed a nonparliamentary ministry in Hungary under Géza Fejérváry (June 1905) and then, closing the Hungarian parliament, threatened to introduce universal suffrage (Feb. 1906). Almost simultaneously occurred the first Russian revolution, which for a short time achieved universal suffrage in Russia. Widespread demand for universal suffrage followed in Austria, and Francis Joseph was suddenly converted by the arguments that had been put before him by Taaffe and Steinbach in 1893: universal suffrage would weaken the middle-class nationalist parties, therefore he must have it without delay.

The first bill, produced by Gautsch on Feb. 23, 1906, roused general opposition from the parliamentary politicians, and Gautsch resigned. But imperial and popular pressure combined to beat down parliamentary opposition. After a short ministry under Prince Conrad von Hohenlohe-Schillingsfürst (March–June 1906), Max Wladimir, Freiherr von Beck, another official, became prime minister. He succeeded in carrying the suffrage bill in Dec. 1906. The vote was given to every male of 24, the complicated constituencies were abolished, and instead constituencies were devised so as to give accurate representation to each nationality. The only injustice was in Galicia where the Poles received 20 seats more than their number deserved at the expense of the Ruthenes (Ukrainians). The total membership of the house of representatives was increased from 425 to 516, the Germans now inescapably in a minority with 233 members. The general election of 1907 seemed to confirm the hope that universal suffrage would eclipse the nationalist parties and would substitute a game of *rouge et noir* played on the imperial table. The Christian Socialists were returned as the largest party with 94 members, and the Social Democrats followed close on their heels with 87. Both parties were loyal (*kaisertreu*) despite their supposedly subversive social doctrines. It was a curious irony that the Habsburg monarchy now rested on a Marxist-clericalist coalition.

Beck made the most of his success. He passed the budget in the regular way (for the last time); the backing of the *Reichsrat* enabled him to strike a favourable tariff bargain with Hungary, and he even included parliamentary leaders in his ministry. New difficulties soon arose, and Francis Joseph was impatient for quick results. The Ruthenes agitated with justification against the Poles, and Count Adam Potocki, the governor of Galicia, was assassinated. The Germans obstructed the Bohemian diet, and the Czechs in retaliation obstructed the *Reichsrat*. Beck might have survived these difficulties had he been secure elsewhere; but he was disliked by court circles for his advocacy of "revolution from above," and in 1908 ruined himself by opposing Aehrenthal's foreign policy. He was forced out of office as a result of the Bosnian crisis in Nov. 1908.

The Bosnian Crisis.—Austria-Hungary had enjoyed a breathing space in foreign affairs while Russia was engaged in the far east. This ended when Russia was defeated in the Russo-Japanese War (1904–05). Aloys Lexa von Aehrenthal (*q.v.*), who became foreign minister in Oct. 1906, planned to revive Metternich's conservative partnership with Russia and thus to free Austria-Hungary from German tutelage. He was ignorant of domestic affairs and did not understand that a partition of the Balkans with Russia was barred both by Austria-Hungary's national con-

flicts and by its economic interests which extended into Russia's projected sphere. On the other hand Aehrenthal was pressed from the first to do something to silence the supposed challenge from Serbia, which had broken away from Habsburg hegemony in 1903 and could not be brought to heel either by coercion or conciliation. When a tariff war failed (1906), Aehrenthal offered the Serbs a favourable commercial agreement only to have it rejected both by the *Reichsrat* and by the Hungarian parliament. The situation was made graver by events in Hungary which seemed to be turning Serbia into "the Piedmont of the South Slavs." During the Hungarian constitutional crisis of 1905–06 the Croats, instead of repeating the hostility of 1848, offered to co-operate with the Hungarian party of independence if Croatia in its turn could be freed from Hungarian control. To strengthen their hands the Croat leaders joined with Serb representatives from Dalmatia and parts of Croatia to form the Serbo-Croat coalition. Though this group used South Slav phrases, it was far from being disloyal or disruptive in origin; its only purpose was to ensure that Serbs and Croats within the monarchy were not played off against each other either by the emperor or by the Hungarians. But in the course of 1906 the Hungarian party of independence made up its quarrel with Francis Joseph. It dropped its attacks on the common army and received a free hand to renew its policy of Magyarization against the Slavs and Rumanians in Hungary.

Thus the Serbo-Croat coalition was driven into the arms of independent Serbia by Hungarian intransigence and imperial weakness. Since Francis Joseph would not challenge the privileged Magyar nation, he and his ministers had to pretend that South Slav discontent was caused solely by agitation from Serbia. Aehrenthal proposed to humiliate Serbia by annexing Bosnia and Hercegovina, the Turkish provinces occupied by Austria-Hungary in 1878; the annexation would show that Austria-Hungary was a great power and that Serbia could not hope to liberate South Slav territory. In Sept. 1908 he secured, as he thought, the approval of Count A. P. Izvolski, Russian foreign minister, at a meeting at Buchlau (Buchlov), in exchange for his agreeing to the opening of the straits to Russian ships of war. The two provinces were declared annexed by autograph letters of Oct. 5 and an imperial rescript of Oct. 7. This exploded "the Bosnian crisis." Great Britain and France objected to the opening of the straits and prevented Izvolski from collecting his promised reward. Moreover, Russian opinion cared nothing for the straits and much for the South Slavs; Izvolski therefore had to protest and still more to encourage Serb protests. Thus Russia's backing of Serbia and Serb patronage of the South Slavs within the Habsburg monarchy were both Aehrenthal's doing. Far from solving the South Slav question, Aehrenthal had created it in earnest.

War seemed imminent. Russia was unprepared, however, and France reluctant to support Russia. In March 1909 a German ultimatum compelled Izvolski to abandon his support of Serbia. Aehrenthal could now have had the war against an isolated Serbia which he had originally planned. But even before the German ultimatum he lost his nerve; he at last appreciated the problem which had baffled abler men—what would be achieved by war against Serbia, even if successful? The Habsburg monarchy could not afford to annex more South Slavs; it had too many already. Aehrenthal's turn against war was supported by Francis Joseph, skeptical of the strength of his army, and even by Francis Ferdinand, the heir to the throne, who opposed anything which might benefit the Magyars. Franz Conrad von Hötzendorf, chief of the general staff, remained alone in his advocacy of war. On March 25 Aehrenthal tamely accepted a Serb promise not to protest further. Nothing, however, was done either to conciliate Serbia or to satisfy the South Slavs. Serbian feelers for appeasement (the last in 1913) were rejected. Serbo-Croat coalition within the monarchy was treated as a treasonable conspiracy. Its leaders were sentenced for treason at Zagreb, after a trial so farcical and corrupt that they were at once pardoned by Francis Joseph. Moreover, during the Bosnian crisis, Aehrenthal supplied "proofs" of Serbo-Croat treason to the historian Heinrich Friedjung, who thereupon used them in newspaper articles. The Serbo-Croat leaders took legal action against Friedjung, and in the trial it was shown beyond dispute that the proofs supplied by Aehrenthal were forged. At the meeting of the delegations, T. G. Masaryk (*q.v.*) explicitly accused Aehrenthal of having had them forged in the Austro-Hungarian legation in Belgrade, and Aehrenthal did not attempt to answer the accusation. (It is more than probable, however, that Aehrenthal himself and even Masaryk were victims of an ingenious forger.)

Bienerth and Stürgkh.—The Bosnian crisis exhausted all initiative in the Habsburg monarchy. Beck had advocated "revolution from above" and had been turned out in Nov. 1908; Aehrenthal had aimed at a solution by violence and missed his aim. Henceforth affairs drifted. Richard Bienerth, who succeeded Beck as Austrian prime minister, offered to include Czech and German ministers without portfolio in his cabinet as watchdogs of their respective national interests; the Germans scented in this an admission that Bohemia was Czech and refused to co-operate. Gautsch (prime minister, June–Nov. 1911) also fell foul of the Germans. Karl, Graf von Stürgkh, who succeeded him, played for safety by doing nothing. Even this did not work. In 1913 German obstruction brought the Bohemian diet to a standstill, and Stürgkh suspended the provincial constitution. In March 1914 Ruthene obstruction wrecked the *Reichsrat*, and it too was suspended. Thus the reign of Francis Joseph ended in the "provisional absolutism" with which it had begun. Nor was this all. Since the Hungarians insisted on treating all South Slavs as traitors, the constitution of Croatia was also suspended in 1912 and the Hungarian governor ruled Croatia as dictator. Only the Hungarian parliament remained in existence, and even there István Tisza was engaged in a policy of negation. Recognizing that Hungary could never secure a more favourable settlement than dualism, he was opposed to any change in Hungarian conditions at home or abroad.

Austria-Hungary was equally ineffective in foreign affairs. Every Habsburg statesman had insisted that Austria-Hungary could not allow the dismemberment of the Turkish empire. Yet when the Balkan War broke out in Oct. 1912, Aehrenthal's successor Leopold, Graf Berchtold, did nothing. The conservative alliance with Russia made a ghostly appearance when the Balkan states were warned by the two great empires that they would not be allowed to acquire Turkish territory. The Balkan states ignored the warning, annexed Turkish territory and kept it. In the course of the Balkan Wars (*q.v.*) Austria-Hungary mobilized once and sent an ultimatum to Serbia twice, but was prevented from war by the German refusal to support it. All that Austria-Hungary salvaged from the wreck was Albania, precariously created by the great powers. Despite Albania, the Turkish empire in Europe had vanished. The national principle had triumphed in every frontier of the Habsburg monarchy. To keep going at all, Berchtold had to become a Balkan politician and to boast of his alliance with Bulgaria. Serbia, aggrandized with Ottoman territory, now began to take its role as the Piedmont of the South Slavs more seriously. It was even graver for the Habsburg monarchy that Rumania turned against its alliance with the central powers and went over to friendship with Russia (June 1914). Every neighbour coveted Habsburg territory with national justification. Even Germany tolerated the Habsburg monarchy only so long as it acted as Germany's agent in southeastern Europe. Thus, in view of the deadlock in home affairs Austria-Hungary could arrest national disruption only by a war against the national states, which would in fact make it the dependent and prisoner of Germany, greatest of the national states.

World War I.—Nevertheless Austria-Hungary might have dragged out a long state of suspended animation. It was characteristic, for instance, that the Habsburg monarchy, once the prototype of military empires, now spent less on armaments than any other great power, less even than Italy. By 1914 the real great powers had almost forgotten Austria-Hungary; their conflict of interests had shifted to Turkey in Asia.

On June 28, 1914, Francis Ferdinand (*q.v.*), nephew of Francis Joseph and heir presumptive, was assassinated at Sarajevo. Francis Ferdinand had acquired an inflated reputation as a potential re-

former or even saviour of the monarchy; he was assassinated simply as an alien and unwelcome ruler by a Bosnian Serb. The Austro-Hungarian government possessed no evidence that the Serb government was implicated in the murder, and none was ever found. Still it was hastily decided to force war on the Serbs. Conrad, the chief of staff, had always desired war against somebody; Berchtold's reputation could not stand another ultimatum without a war to follow it; Francis Joseph wished to vindicate the honour of the dynasty, though he had disliked his nephew; even Tisza acquiesced in war against Serbia, after imposing the nonsensical condition that Austria-Hungary should not acquire any Serb territory. Berchtold and his associates did not plan a world war but were resolved on war with Serbia, even if it brought a world war in its train. The ultimatum to Serbia, drafted so as to provoke war, was dispatched on July 23; the Serbian answer was rejected as inadequate, and war was declared on July 28. (*See* WORLD WAR I.)

The Serbs drove back the invading armies and in the autumn of 1914 themselves invaded southern Hungary, while the bulk of the Austro-Hungarian army was engaged against the Russians in Galicia. The Habsburgs were "saved" by German power. Early in 1915 German armies drove the Russians out of Galicia; later in that year German generals conducted a campaign which overran Serbia. For all practical purposes Austria-Hungary had ceased to exist as an independent power and was merely a German satellite, no more independent than Bavaria. This was shown early in 1915 when the Germans sought to buy Italy from entering the war on the entente's side by offers of Austrian territory: the Austrian foreign ministry was not consulted or even informed. Italy declared war on Austria-Hungary on May 23, 1915.

The war had an equally decisive effect on home affairs. Once Austria-Hungary became a military appendage of Germany, the Germans in Austria became again "the people of state." All German parties except the Social Democrats united in the "Easter manifesto" of 1915, which simply restated the Linz program of 1882: Dalmatia should be surrendered to the Italians, Galicia to the Poles, the rest of Austria was to become a German unitary state. Thus the German Austrians had returned to the program of Schmerling; they even dreamed of restoring German supremacy over Hungary. The reverse happened. Hungary controlled the food supply of the monarchy and could dictate terms. In Jan. 1915 Berchtold was dismissed on Tisza's orders; his successor, Baron Stephan Burián von Rajecz, was the first Magyar to become foreign minister since Andrássy and took his orders from Tisza, not from Francis Joseph. The power of Hungary was shown when Germany attempted to repeat with Rumania the maneuver which had failed with Italy and to buy Rumania off with part of Transylvania. Tisza at once imposed a decisive veto; and in 1916 Rumania entered the war on the Allied side (Aug. 27, 1916). The subsequent defeat of Rumania was achieved entirely by German armies.

Yet it would be wrong to suppose that all the nationalities except the Germans and Magyars were actively disloyal. Many Poles hoped for a restored Poland under a Habsburg archduke, and Jozef Pilsudski, the Polish leader, co-operated with the Austro-Hungarian forces. The Croats, Slovenes and Slovaks, once allies of the dynasty in 1848, vied with each other in loyalty and still hoped for an empire "above the nationalities." The Croats fought willingly against the Serbs and enthusiastically against the Italians. The only nationality which recognized that it had everything to lose by a German victory was the Czech; and even Czech opposition was negative. In Dec. 1914 Masaryk left Bohemia for western Europe in order to win the Allies for his program of Czechoslovak independence; but he knew that he could succeed only in the event of a long war.

Francis Joseph sustained the fabric of administration until his death (Nov. 21, 1916). Even the assassination of Sturgkh (Oct 1916) by Friedrich Adler, a pacifist Socialist, only led to the recall of Körber to the prime ministry. Charles I (*q.v.*) grandnephew of Francis Joseph, succeeded to the throne and tried to break the deadlock at home and abroad. Convinced that the war was lost, he opened secret negotiations with the entente powers in the spring of 1917; but, though he was ready enough to consent to the acquisition of Alsace-Lorraine by France, he refused to surrender any territory to Italy and even insisted on Habsburg hegemony over Serbia. Charles tried to avoid being crowned king of Hungary, so as to be able to impose changes in favour of the national minorities. Tisza brought him to heel by threatening to stop the food supplies of Vienna. Tisza was driven to resign by Charles's insistence on suffrage reform in Hungary, but his resignation produced no change. After a brief interval Tisza was succeeded by Alexander Wekerle, a Magyarized German who was equally opposed to an extension of the franchise.

In Dec. 1916 Charles got rid of Körber as Austrian prime minister and replaced him by a Bohemian noble, Graf Heinrich Clam-Martinic. Czech leaders, sentenced for treason in 1915, were amnestied, and the *Reichsrat* was summoned for May 30, 1917. The Czechs now demanded the union of all Czechs and Slovaks "in a single Bohemian state." The South Slav deputies (principally Slovenes with a few Croats from Dalmatia) demanded a union of all South Slavs within the monarchy. These demands, though theoretically compatible with the survival of the Habsburg monarchy, challenged German supremacy in Austria and, still graver, the integrity of Great Hungary. Since Germans and Magyars held all the real power, Charles could make no concessions until Germany had been defeated in war; and then it would be too late. Charles could only offer a "ministry of the nationalities" under Joseph Redlich; its only function would have been to deceive the nationalities, and the offer was refused. Clam-Martinic threw up his post in despair, and administration passed to Ernst von Seidler (June 1917), a bureaucratic prime minister of the old type.

Austria-Hungary was now more than ever dependent on Germany. Ottokar, Graf Czernin (foreign minister, Dec. 1916–April 1918), continued secret negotiations with the Allies but could never offer the separate peace which was all that they wanted. The defeat of the Italians at Caporetto (Oct. 1917) failed to knock Italy out of the war. Czernin attended the peace negotiations with Russia at Brest-Litovsk and signed the treaty (March 3, 1918); his only concern was to secure Ukrainian wheat and even in this he was not successful. In April 1918 Clemenceau revealed the secret negotiations with Charles in the previous year, and Czernin was dismissed as a scapegoat on German orders. Charles himself had to visit German headquarters at Spa and surrender all independent initiative. Burián was restored as foreign minister on German and Hungarian instructions. He too made gestures toward peace but trembled before the German veto even when the German armies were defeated in Aug. 1918.

Meanwhile the Czech deputies to the *Reichsrat* and in the three "Bohemian" diets issued a manifesto on Jan. 6, 1918, demanding a sovereign state "within the historic boundaries of the Bohemian lands and of Slovakia" (at this revolutionary moment it did not matter that Slovakia had never existed and had no historic boundaries). In Aug. 1918 the Allies recognized the Czechoslovaks as "an allied nation," with Masaryk and his national council "as present trustee of the future Czechoslovak government." On the military side Conrad launched an offensive on the Piave (June 15, 1918) which altogether miscarried; and he was dismissed. A new prime minister, Max, Freiherr Hussarek (July 17, 1918), abandoned even words of conciliation for the Czechs and instead offered the Germans the administrative partition of Bohemia.

Disaster came swiftly in September when the Bulgarian front collapsed. On Oct. 4, Burián dispatched a peace note to U.S. Pres. Woodrow Wilson, accepting his Fourteen Points; Wilson replied on Oct. 21 that he could no longer accept "autonomy" as the basis of peace. On Oct. 16 Charles issued a manifesto promising to transform Austria into a federal state; even this scheme was made worthless by the proviso that it would not infringe the territorial integrity of "Great Hungary." Then the new foreign minister, Gyula Andrássy, son of the founder of dualism, in an effort to secure recognition of some dynastic fragment, agreed (Oct. 27) to accept the independence of Czechoslovakia and of the new South Slav state. This note never received a reply. On Oct. 27 also Heinrich Lammasch, a reputed expert in

national problems, was appointed prime minister to preside over the dissolution of the Habsburg state; no one would negotiate with him even for this purpose.

The Poles had already declared their independence at Warsaw on Oct. 7. On Oct. 28 the Czechoslovak republic was proclaimed in Prague. The Slovaks had only reached the point of demanding "autonomy" within Hungary; though still negotiating with Budapest, they accepted the new Czechoslovak state on Oct. 29. The Slovenes and Croats found themselves defenseless against the Italians and became South Slavs as the lesser evil: the Yugoslav state was proclaimed in Zagreb on Oct. 29. The master nations also abandoned the dynasty. On Oct. 31 a democratic government under Mihály, Count Károlyi, was formed in Budapest; and three days later Károlyi announced the end of dualism and the establishment of Hungary as an independent state. The German Austrians had opposed the program of national self-determination so long as it operated against them; they now tried to invoke it against the Czechs for the sake of the Germans in Bohemia. On Oct. 30 the German members of the *Reichsrat* turned themselves into a German national assembly and proclaimed the state of "German-Austria," a state without boundaries or definition but with a government composed of Socialists, whereby the Germans too hoped to transform themselves into an "oppressed people."

Imperial authority had collapsed. On Nov. 1 Károlyi ordered all Hungarian troops to return home; the troops of other nationalities needed no orders. On Nov. 3 the Austro-Hungarian high command, negotiating on behalf of an empire which no longer existed, concluded an armistice with the Italians. The army thereupon disintegrated. The Lammasch government made some attempt to secure the emperor's personal safety but failed to accomplish even this and vanished. Charles renounced all share in the government of German-Austria on Nov. 11, in that of Hungary on Nov. 13. He refused to abdicate and carried his empty titles into exile. A republic of German-Austria was proclaimed on Nov. 12 and a republic of Hungary on Nov. 16. For the history of the Austrian republic *see* AUSTRIA: *History*. (A. J. P. T.)

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AUSTRIA, LOWER (NIEDERÖSTERREICH), a *Bundesland* (federal state) of the Republic of Austria. Area 7,402 sq.mi. (19,170 sq.km.).

Physical Geography.—Lying astride the Danube from the mouth of the Enns to that of the March and to the Leitha mountains, it shares in four of Austria's physical regions: the Granite plateau, the Alps, the northern Alpine foreland and the Eastern lowland.

The Lower Austrian part of the Granite plateau, the Waldviertel ("forest quarter"), extends to the Manhartsberg range and across the Danube and is a dissected or undulating plateau with deeply incised rivers. In the west the climate is cold and damp while farther east mean annual temperatures rise and rainfall decreases to as little as 24 in. The soils follow a similar pattern, forest covers up to 60% in the west while in the east there is extensive arable land. Its share of the Eastern lowland, popularly known as the Weinviertel ("wine quarter"), is hilly country with extensive loess cover and favourable climate. Wheat, maize (corn) and sugar beet fields are interspersed with market gardens, orchards and vineyards. The southern Vienna basin south of the Danube (the Vienna bay) structurally belongs to the Alps. Bordered by the easternmost ranges (*e.g.*, the Leitha mountains) of the Central Alps to the east and the fault scarp of the limestone mountains to the west, its landscape and climate resemble that of the northern Vienna basin though its gravels support only pinewoods and heaths. Along the southwest-northeast faultline thermal springs have given rise to spas (*e.g.*, Baden).

The Alpine area includes parts of the Central Alps to the south and Limestone and Flysch Alps to the north of the Semmering (*q.v.*) pass. The Central Alps reach 5,702 ft. in the wooded Wechsel mountains. The Bucklige Welt to the east is considerably lower, and forests alternate with grassland and some fields. The Limestone Alps rise to more than 6,500 ft. On their highest levels are barren karst (*q.v.*) surfaces, and the karst springs at the foot of Raxalpe and Schneeberg supply Vienna with part of its water. Woodland predominates at lower altitudes and farther north as in the sandstone Flysch Alps which reach their greatest extent and terminate in the Vienna woods. There beech replaces the conifers of the Limestone Alps. The climate of the Alpine part varies greatly, depending on altitude and exposure. The importance of the Alpine foreland region is far greater than its size would indicate. A hilly, well-watered area 650 to 1,330 ft. in altitude, it is widely covered by loess, supporting predominantly arable cultivation.

History.—Human settlement began in the Paleolithic period

The areas which attracted prehistoric man were the Wachau (Danube gorge), the area around Horn, the Alpine foreland and the Vienna bay along the thermal line.

The name Austria Inferior was coined when King Otakar of Bohemia, who had taken possession of Austria in 1251, divided the duchy for administrative purposes along the river Enns. Although the official name of this part remained until 1918 Österreich unter der Enns, it was popularly called Niederösterreich. (The latter title was used by the emperor Maximilian, and subsequently, to denote Upper and Lower Austria, Styria, Carinthia, Carniola and the adjoining coastland.) The definite administrative division between Upper and Lower Austria took place about 1450. There were no permanent changes in the boundaries of Lower Austria until after World War I when an area near Gmünd was ceded to Czechoslovakia. Lower Austria became a *Bundesland* in 1918 and in 1920 lost Vienna except as the seat of its administration. During the *Anschluss* period (1938–45) it was the *Reichsgau Niederdonau* of greater Germany, extending farther north and east and with Krems as its capital, but losing land to Vienna. It was again a *Bundesland* in 1945 with its former boundaries and in 1954 under the district reorganization law recovered most of the area (309 sq.mi.) which had gone to Vienna. (*See* also AUSTRIA: *History;* AUSTRIA, EMPIRE OF.)

Population.—The population in 1961 was 1,374,012, a decrease since 1934 in common with all *Bundesländer* which formed part of the Soviet zone of occupation. The density was 185.6 to the sq.mi. Ethnically, Lower Austria is purely German, the dialect spoken belonging to the Bavarian group. Most of the people are Roman Catholic (included in the dioceses of St. Pölten and Vienna), but there are small Protestant communities. About half of all Austrian towns are in Lower Austria. The principal (pop. 1961) are: St. Pölten (40,112), Wiener Neustadt (*q.v.;* 33,845), Baden (*q.v.;* 22,484), Krems an der Donau (21,046), Amstetten (12,086), Stockerau (11,853), Neunkirchen (10,027). One-fifth of the people live in places of more than 5,000 inhabitants. The number of old townships with few inhabitants include the famous Dürnstein in the Wachau (where Richard Coeur de Lion was imprisoned) with 600 and Hardegg on the Thaya with 300. Rural settlement is characterized mainly by villages of the regular "colonial" types except for the Alpine foreland and Alps where dispersed hamlets and isolated farms prevail. Characteristic houses are the square farmstead in the western Alpine foreland, multiple farmsteads in the southern Alpine part and single file farmsteads in the east.

Administration and Social Conditions.—Matters not reserved by the constitution for the federal government are dealt with by the *Bundesland* government, consisting of the governor and six other members elected by and responsible to the provincial diet (*Landtag*), which has 56 members elected for five years by popular vote. The *Landtag* is a legislative body but the acts it passes must be approved by the federal government. In the *Bundesrat* (upper house of the federal diet) Lower Austria has ten votes. After 1954 it was divided into 21 administrative districts. Local government is in the hands of burgomasters and commune councils elected by popular vote.

The prevalence of small farms of less than 5 ha. (12 ac.) (only 13% are larger than 20 ha.), with extreme fragmentation of holdings, has a great bearing on social conditions, causing the excessive use of family labour and comparatively low living standards. The conditions of the urban and industrial population are also inferior to those of the western *Bundesländer*, attributed partly to earlier industrialization but more to war damage, dismantling and slow recovery after Soviet occupation.

The Economy.—Agriculture and forestry supported (in 1951) about 47% of the working population. Nearly 60% of the land is used for agriculture (almost three-quarters is arable) and more than one-third is forested. The main farming areas are the Eastern lowland and the Alpine foreland. Grain (wheat, rye, maize, barley for brewing) takes first place but root crops (potatoes, sugar beet and fodder beet) follow closely. Viticulture in the Weinviertel, the Wachau, the southern bank of the Danube east of Vienna and the slopes of the Vienna bay, both in area and production, amounts to more than 60% of the Austrian total. Fruit, associated with mixed farming, is grown mostly in those areas and in the Alpine foreland, especially plums, cherries and apricots. There is market gardening around Vienna. Lower Austria also leads in livestock. Except in the higher parts cattle are stall-fed. Large tracts of forest, especially in the Alps, are state owned and highly productive in timber (nearly 2,000,000 cu.m. annually).

Oil and natural gas production in the northern Vienna basin is the chief extractive industry, with a pipeline to Vienna and a refinery of 1,600,000 tons capacity at Schwechat. There is the important Ybbs-Persenbeug hydroelectric power station on the Danube. Mesozoic coal is mined in the Limestone Alps and Tertiary brown coal near Wiener Neustadt and St. Pölten; gypsum near Grünbach and graphite in the Wachau. There are brick and ceramics industries, and limestone quarrying for the largest Austrian cement plant at Mannersdorf. The deposits of siliceous earth northeast of Krems are unique.

Industries include food processing, sugar refining and brewing, timber (about 1,000 sawmills) paper and cellulose, and the heavy metal industry, mainly in the Alpine valleys, fed by Styrian iron ore. Textiles are concentrated around Baden, at St. Pölten and in the northern Waldviertel, which also has an old-established glass industry, and chemicals at St. Pölten, Korneuburg and south of Vienna; the Semperit rubber plants at Traiskirchen and Wimpassing are the *Bundesland's* largest industrial concern. Wiener Neustadt has a small aircraft factory.

Communications.—Trade routes have crossed this region since earliest times, for Vienna is the meeting point of many natural routeways: from the North sea, the north, and the northeast, via the Moravian gate; from the Adriatic by the Semmering pass. The prehistoric "amber" route crossed the Danube east of Vienna and a Roman road along the Danube was met at Vindobona (Vienna) and Carnuntum (Petronell) by one from the south. These routes were used by the first railways: the Nordbahn (to Cracow, 1837–39); the Südbahn, which crossed the Semmering (1848–54) and was the first mountain railway in the world; the Westbahn along the Danube valley. Roads also centre on the Vienna area, including the motorway from Salzburg and the planned Vienna-Graz motorway. Two-thirds of the Danube in Austria lies in Lower Austria, including the beautiful Wachau, providing goods and passenger transport. There is a cog railway to the Schneeberg and a funicular cable line to the Raxalpe. Vienna's airport of Schwechat is the largest and most important in Austria. *See* also AUSTRIA.

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AUSTRIA, UPPER (OBERÖSTERREICH), a *Bundesland* (federal state) of the Republic of Austria. Area 4,625 sq.mi. (11,978 sq.km.).

Physical Geography.—Lying astride the Danube from the Inn to the Enns rivers, Upper Austria includes part of three of Austria's physical regions: the Granite plateau, the Alps and the northern Alpine foreland. Its Granite plateau area roughly ends at the Danube and is called Mühlviertel ("Muhl district") after its main river. Its surface is undulating and slopes gently from northwest to southeast. Because of altitude and exposure to the westerlies its climate is raw and damp except for the sheltered and fertile valley of Freistadt. The soil is generally thin and poor and there is extensive forest with grassland at lower altitudes. The Alpine area, comprising limestone mountains and the Flysch (sandstone) foothills includes most of the Salzkammergut (*q.v.*) with its many lakes (Hallstatt-, Wolfgang-, Mond-, Atter- and Traunsee). At heights of 2,000 m. (6,600 ft.) the surfaces

are barren; below are extensive forests, and in the valleys meadow and some arable land. Although long settled because of salt resources there are only three towns of any size, Gmunden, Ebensee and Bad Ischl. Economically the most important part of Upper Austria is its share of the Alpine foreland. Loess cover at the higher terraces yields a fertile soil, but on the gravel sheets there is much woodland (*e.g., Weilhartforst*). In the centre are the forested hills of the Hausruck and Kobernauser Wald with deposits of brown coal (lignite). Climatically this is the most favoured region.

History.—The most important prehistoric sites were the late Neolithic pile dwellings of the Mondsee and the settlement at Hallstatt (*q.v.*), which owed its importance to the presence of salt. In 1192 the Traungau (the nucleus of present Upper Austria) became an appendix to the duchy of Austria, and as a result the 10th-century name Ostarichi ("eastern region") was applied also to areas west of the Enns. The name Austria Superior was coined when King Otakar of Bohemia, who had taken possession of Austria in 1251, divided the duchy for administrative purposes along the river Enns. Although the official name of this part remained until 1918 Österreich ober der Enns, it was popularly called Oberösterreich. The definite division of Upper from Lower Austria took place around 1450, and in 1490 Linz became its capital (following Enns, Steyr and Wels). During the *Anschluss* (1938–45) Upper Austria became the larger *Reichsgau Oberdonau*, afterward reverting to a *Bundesland*. (*See* AUSTRIA, EMPIRE OF.)

Population.—The population in 1961 was 1,131,623, and the density 244.6 per sq.mi., the highest for all *Bundesländer* except Vienna. The increase was due to industrialization and the influx of more than 100,000 refugees. Ethnically the people are German, a Bavarian dialect being spoken, and mostly Roman Catholic (the Linz diocese is virtually coincident with Upper Austria). A small number (less than 7%) are Protestants.

The principal towns (pop. 1961) of Upper Austria are: Linz (195,978), Wels (41,060), Steyr (38,306), Bad Ischl (12,703), Gmunden (12,518), Braunau am Inn (14,449), Ebensee (9,602), Ried im Innkreis (9,471), Vöcklabruck (9,353), Enns (8,919). Rural settlement, apart from the few large villages, consists of hamlets and isolated farms. Traditional farmhouse types are the single unit farmstead to the west and the multiple farmstead to the east of the Traun river. The most impressive, the *Vierkanter* ("square farmstead"), is found mainly in the Alpine foreland east of the Traun.

Administration and Social Conditions.—Matters not reserved by the constitution for the federal government are dealt with by the *Bundesland* government, consisting of the governor and eight ministers elected by and responsible to the *Landtag* (diet) which is elected for six years by popular vote and has 48 members. The *Landtag* is a legislative body but its acts must receive the approval of the federal government. In the *Bundesrat* (upper house of the federal diet) Upper Austria has seven votes. There are 17 administrative districts (*Bezirke*) of which two, Linz and Steyr, are cities. Local government is the responsibility of burgomasters and town and commune councils elected by popular vote.

The farmers, especially in the Alpine foreland, are more prosperous than those elsewhere in Austria since more than 50% of all farms are of medium size, from 5 to 100 ha. (12 to 250 ac.). Industrialization has not caused serious overcrowding and refugees have been absorbed steadily.

The Economy.—Farming uses 56% of the land and forestry one-third. Most of the grain (wheat and rye) is grown in the Alpine foreland, also sugar beet, especially in the east. More than half of the agricultural land is grass, mainly in the higher regions, though the most intensive stock farming is in the Alpine foreland, based on fodder crops. Fruit cultivation is associated with mixed farming and the bulk of apples and pears are turned into cider on the farms. Large tracts of forest, especially in the Alps, are state owned and production of timber exceeds 1,000,000 cu.m. annually.

Hunting is strictly controlled and licences provide considerable income. The game consists of hares, roe and red deer and chamois. Fishing comprises nearly two-thirds of all Austrian fishing rights and nearly half the breeding stations, mostly trout.

There is salt mining at Bad Ischl and Hallstatt, and a large evaporation plant at Ebensee, combined with a chemical industry; granite quarrying on the lower Inn and the Danube; limestone quarries for cement and brickworks; the important Eternit (asbestos-cement) plant at Vöcklabruck; and brown coal mines in the Hausruck and farther west (a by-product is china clay). Upper Austria leads in major electric power stations. After 1959 oil wells near Ried were in production. Industries include dairying, food processing, sugar refining, brewing, the making of agricultural machinery, tanning (large works at Mattighofen) and sawmilling (with a timber industry and paper and cellulose plants). Dating from the *Anschluss* period are the artificial fibre yarn plant at Lenzing; the aluminum plant at Ranshofen; and the iron and steel works and nitrogen (chemical) plant at Linz, which rely on Styrian ore and imported coal. Linz has become Austria's foremost industrial town; Steyr is an industrial centre with bicycle and vehicle manufacture. The making of glass costume jewelry, introduced after 1945 from Czechoslovakia, centres on Steyr.

Trade and communications have been important since the salt trade of the Early Iron Age. Ovilava (Wels) was the junction of two Roman roads. During the middle ages the rivers were used for the transport of timber, salt and iron ore, but only the Danube has retained this role, Linz being the largest Austrian river port, with a customs-free zone. The first railway in middle Europe (opened in 1832 and horse-drawn) linked Linz with Budejovice in Bohemia. Now Austria's chief line, the Westbahn, is joined at Wels by the line from Ostend and at Linz meets the Pyhrnbahn from the south and the line from Berlin and Prague. The Salzburg-Vienna motorway passes south of Linz. Air traffic at Linz airport is of minor importance. *See* also AUSTRIA.

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AUSTRIAN LITERATURE.

AUSTRIAN LITERATURE. The literature of Austria is beyond a certain point inseparable from German literature as a whole. A common language has led to interaction and to a degree of common development; and the article on GERMAN LITERATURE therefore will be found to cover much ground where Austrian writers played an important part. The work of individual writers is also considered more fully in articles under their names. The scope of the present article, therefore, is limited to showing the particular development and special characteristics of Austrian literature—characteristics which grew up through such factors as the country's outlying position, the special place which the Habsburg provinces occupied in the empire, and the success in Austria of the Counter-Reformation which, from the end of the 16th century, divided the country from much of Germany, making it the centre of a baroque culture peculiar to itself. The various territorial and local characters and traditions, notably the temperament and mentality of the Viennese, have also played their part in creating an Austrian literature.

The literature of Austria came into existence at the point where Celtic, Roman and Germanic civilizations met. under the duchy it followed the changes of the Habsburg fortunes, returning under the republic to the country's original boundaries without ever losing entirely the stamp of the regions which contributed to it.

The Duchy.—The country grew out of a little march county on the Danube and first became spiritually aware of itself in a monastic literature belonging to the lands of the Eastern Alps. Biblical material was generally chosen and adapted to the style of the minstrels. In the Danube valley, at least around Melk, this literature had apparently a real public. This is shown by the first individually distinct poets we know of: *c.* 1120 the anchoress Frau Ava, with her deeply personal presentation of the Redemption story; *c.* 1130 Adelbracht with his *Johann Baptista*; *c.* 1150 Priest Arnold with his poem on the Holy Spirit; *c.* 1160 the lay brother Heinrich von Melk with his satirical lays.

After 1156 the duke was a sovereign prince and the first independent ruler in the Holy Roman empire. The new court at Vienna was artistically ambitious. The poem of chivalry was in Austria a native growth with roots among the people; it dates from *c.* 1150 with Dietmar von Aist and the Kürenberger. About 1190 Reinmar von Hagenau (*q.v.*) became court poet to the dukes of Austria, taking the popular songs of chivalry that belonged to the country and building from them his splendid flowing rhythms and his complaints of unhappy love. Walther von der Vogelweide (*q.v.*) was Reinmar's pupil in Vienna *c.* 1185. He ennobled Austrian popular poetry by grafting on to it Reinmar's new style. The most beautiful of his love poems form a cycle of their own, apparently inspired by a simple girl, who, if we understand Walther correctly, brought him a late happiness. It is the finest lyric collection of medieval Germany. But Walther was also the literary "great power" of the Hohenstaufen empire. He exerted this power through his political comment and as traveling minstrel. He had to a remarkable degree the gift of the right word at the right moment. His followers in Austria and also in Tirol formed a whole school of their own. The poetical diaries of Ulrich von Lichtenstein, the country dance songs of Neidhart von Reuental, the poems of Tannhäuser (*q.v.*), with their licence all alike lay their stress on lyricism.

Austrian poetry reached equal stature in the epic, especially in the *Nibelungenlied* (*q.v.*) which reached its final perfection at the hands of an Austrian minstrel. An abundance of related works grouped themselves in the Alpine lands around this wonderful poem: *Ortnit*, *Wolfdietrich*, the *Gudrun* (*qq.v.*), *Laurin*, *Alpharts Tod*, *Dietrichs Flucht*, *Rabenschlacht*, *Biterolf* and *Rosengarten*.

This was the flowering under the Babenberg dukes. At the coming of the Habsburgs there remained, with the declining middle ages, only a barren harvest: jest books, *Novellen*, rhymed commentaries on affairs of the time, the rough humour of the *Neidhartspiel*, written around the poet and folk hero Neidhart von Reuental. In Tirol alone at the turn of the period, Oswald von Wolkenstein (1367–1445) achieved distinction, returning to his Eisack valley after adventurous wanderings and dying there in 1445, the first modern to express himself in lyric.

The Habsburg Empire.—By marriage, inheritance and diplomacy the house of Habsburg was able, after the setbacks of the middle of the 15th century, to acquire first the German imperial throne, then the Burgundian inheritance, then the Spanish lands—the old world and the new, and finally—the dream of centuries—the territories that touched their own, the kingdoms of Bohemia and Hungary. In this wide empire with its vibrating frontiers the duchy, and with it Vienna, was the point of rest. The imperial chancellery migrated in 1438 from the Prague of the Luxembourg dynasty to the Vienna of the Habsburgs, bringing with it a double heritage: the German literary language, which was built up in Prague largely from middle German components; and the humanist disposition and care for style. Through the literary models it provided and the work of its officials, the chancellery became the nursery of early Viennese humanism. The written language which was now developing took on in Vienna Austrian colouring, while humanism gained a recognized leader in Aeneas Silvius Piccolomini, later Pope Pius II (*q.v.*). The emperor Maximilian I, himself a writer (*Weisskunig*, *c.* 1514, publ. 1775; *Teuerdank*, 1517), made Vienna, through chancellery and university, the leading humanist city in Germany. He was the creator of European Austria in both its material extent and its mental attitude. He was helped by Conradus Celtis (*q.v.*), Johannes Spiessheimer (1443–1529) and Joachim von Watt (1484–1551).

Vienna only acquired a theatre after the Renaissance with the *Kaiserspiele*, or court plays, of Conradus Celtis and the *Klosterspiele*, or monastery plays, of the abbot of the *Schottenkloster* Benedictus Chelidonicus (*c.* 1500). The German plays of the schoolmaster Wolfgang Schmeltzl (*c.* 1500–*c.* 1557) were also first performed in the *Schottenkloster*. The coming of the Jesuits gave a new turn to Austrian ideas. From 1554 onward they created out of the dynastic alliance of Austria and Spain a community of religious conviction and mental inclination. They immediately began to perform plays in their school: first Terence, Plautus, the usual school plays and finally their own considerable repertoire. Side by side with this the Italian opera developed, spacious, colourful and especially patronized by the emperors. The Austrian theatre took its baroque stamp from Jesuit Vienna and from the then independent archbishopric of Salzburg; and the Viennese baroque theatre was one of the artistic triumphs of Europe. Not one of the great cities had ever striven to create, as did Vienna, the art of a whole people for the people in their spiritual and physical entirety, though not in the vernacular but in Latin and Italian.

The individual regions flourished too, each in its own way. Tirol had its own courts from time to time. From 1430 there was an abundance of sacred and secular drama, especially in Stezing at the foot of the Brenner where Vigil Raber (d. 1552) was collecting and rewriting the plays of the people. About 1570 Archduke Ferdinand of Tirol led a real poets' court. His court preacher was the spellbinding Johannes Nas; the Jesuits performed plays, while the Capuchin Laurentius von Schnüffis, from being theatrical producer to a duke, became the mystical lyricist of the soul (*Philotheus*, 1678). Salzburg had a life of its own, shining through the humanist Paul von Hofhaimer (1459–1537), who set its tone, through the theatre of the archbishop's court and through the Benedictine university founded in 1620. In Upper Austria the burgess in the little town, the monk in his monastery and the nobleman on his estate were all writing. Styria had the flourishing *Meistergesang* and a wide range of artistic interest in the great monasteries such as Kremsmünster where for example Simon Rettenbacher (1634–1706) was writing religious plays. Christoph von Schallenberg (1561–97), Wolfgang Helmhard von Hohberg (1612–88) and Katharina von Greiffenberg (1633–94), poets who belonged to the nobility, were Protestants. So was the prolific storyteller Johann Beer (1655–1700). The Protestant nobility of Lower Austria occupied itself with the translation of Romance poetry. It was the emperor Ferdinand II, sometime ruler of Styria, who had English actors at his Graz court, who decided the battle against the Reformation, first in Styria and then in all his other lands. The voice of the triumphing church was uplifted in Vienna by Abraham a Sancta Clara (1644–1709), the Habsburg court preacher and master of baroque German prose.

The Austrian Empire From 1740 to 1918.—The last empress of Habsburg blood, Maria Theresa, turned decisively toward the German problems of her lands in order to assert her position in the empire. Her reforms and those of her son Joseph II served the revival of Austria's German language and culture. This is true particularly of the theatre. From 1709 there was a settled theatre at the Kärntnertor for the traveling players. In 1741 the empress added to it the tennis court near the *Burg*, or castle. Joseph II issued a new edict in 1776 after which the Burgtheater began its rise, while alongside it the popular stage or *Volksbühnen* developed. At this time the poet's play took precedence over the actor's play, Vienna becoming once more the first city in the kingdom for drama. The Burgtheater had its heyday under Josef Schreyvogel (1768–1832) and Heinrich Laube (*q.v.*), receiving in the middle of the 19th century its fitting poets in Eduard von Bauernfeld (*q.v.*) for comedy and Franz Grillparzer (*q.v.*) for tragedy. At the same time the popular stage achieved stature through the fairy tale plays of Ferdinand Raimund (1790–1836), the popular pieces of Johann Nestroy (*q.v.*) and the peasant drama of Ludwig Anzengruber (*q.v.*). During the first half of the century Austrian literature extended its influence to parts of the world where the empire had a stake. Joseph von Hammer-Purgstall (*q.v.*), a great interpreter, made the east fashionable in literature. Jakob Philipp Fallmerayer (*q.v.*) turned the eyes of the west toward Byzantium and its heir, Russia. Anton Prokesch (1795–1876), an influential diplomat in Turkey, fascinated through his descriptions of the near east. Charles Sealsfield (pseudonym of Karl Postl; 1793–1864) caught the imagination of the United States with novels in English and German. At the same period, in a great series of poets, the empire displayed itself in all its fullness: as seen by the soldier, with Friedrich von Schwarzenberg (1800–70); through the painter's eye with Adalbert Stifter (*q.v.*); through the strange and bizarre with Ferdinand von Saar (1833–1906); through the heart of the mistress of an estate with Marie Ebner von Eschen-

bach (*q.v.*). Here too is the Austrian countryside clear as on the day of its creation: Upper Austria in the deeply felt dialect of Franz Stelzhamer (1802–74); Tirol in Hermann von Gilm (1812–64) and Adolf Pichler (1819–1900) as well as in the ancient and indestructible Tirolean peasant play, found again with Franz Kranewitter (1860–1938) and Karl Schonherr (*q.v.*); Styria at the same period in its inimitable storyteller Peter Rosegger (*q.v.*).

Vienna itself was more than ever the leader at the turn of the century. The chief development was the entry of the working class into intellectual life and the creation of a working-class poetry. Alfons Petzold (1882–1923) found a modern and more elevated style for this poetry. Siegfried Lipiner (1856–1911), Richard von Kralik (1852–1934) and Hermann Bahr (1863–1934) were the three most stimulating forces in the city, united in the determination to make Austria the cynosure of Europe. The city's richly varied flow of creation developed, presenting the tragic transformation of men through machines with Emil Ertl (1860–1935); the sacrifice of faith and country with Enrica Handel-Mazzetti (*q.v.*); the Vienna of the elegant idler with Arthur Schnitzler (*q.v.*); a stylish recreation of creative people with Stefan Zweig (*q.v.*); quiet happiness of heart in the verses of Franz Karl Ginzkey (1871–1963); and the elevated style of nearly every form with Richard von Schaukal (1874–1942). The crown of the epoch was the librettos of Hugo von Hofmannsthal (*q.v.*) which recaptured the spirit of baroque Austria. Many of these poets, among them Rainer Maria Rilke, Franz Werfel (*qq.v.*), Georg Trakl (1887–1914) and Rudolf Kassner (1873–1959) were of Sudeten German origin and had behind them more than five centuries of a shared tradition.

The Republic After World War II.—The common life of the empire was broken not in 1918 but in 1945 when Hungary and Bohemia finally broke away from their historic bond. It was only then that Austria really found itself once more within its original boundaries. But Austria had to begin life anew, and it was not possible to predict whether its literature would develop as it promised to do. It is an advantage that the characters of the various regions are well-recognized. After World War II Hans Sterneder, Maria Grengg, Rudolf Henz, Friedrich Sacher and August Stöger were writing in the Danube valley. Salzburg was represented by Karl Heinrich Waggerl and Georg Rendl. In Carinthia were Johannes Lindner, Josef Friedrich Perkonig and Wilhelmine Wieser, as well as Robert Musil (*q.v.*) with his novel of Austria, *Der Mann ohne Eigenschaften*. Tirol displayed its multicoloured facets in the work of Josef Weingartner, Josef Leitgeb, Maria Rubatscher, Kurt Ziesel, Franz Tumler and Alma Holgersen. The Voralberg expressed itself in dialogue through Armin Diem and in powerful epic through Gertrud Fussenegger-Dorn. Hans Kloepfer, Julius Zerzer, Bruno Ertler and Paula Grogger spoke for Styria.

Viennese poetry achieved style after 1918 with Otto Stoessl, Alexander Lernet-Holenia and Josef Weinheber. Austrian drama held its direction without losing touch with the movements of the time. Its playwrights were Anton Wildgans (*q.v.*), Felix Braun, Franz Theodor Csokor, Richard Billinger, Josef Wenter, Friedrich Schreyvogl and the indisputable master Max Mell. Prominent voices in Austria after World War II were Heimito von Doderer, Fritz Habeck, Rudolf Bayr, Fritz Hochwälder and Christine Busta. The widest in range among them was Erich Landgrebe.

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AUSTRIAN SUCCESSION, WAR OF THE (1740–1748). In 18th-century Europe the failure of the male line in a ruling dynasty was always apt to lead to war, and it did so in 1740 when the head of the house of Habsburg (*q.v.*), who was also the Holy Roman emperor Charles VI, died without leaving a son. In 1713, before any children had been born to him, Charles had issued a pragmatic sanction (*q.v.*), or fundamental law, regulating the succession in the Habsburg dominions. These, by 1740, consisted of the so-called hereditary lands of Austria, Hungary and Bohemia and of various provinces (the southern Netherlands, the grand duchy of Tuscany, the duchy of Milan and other territories in the plain of Lombardy) which had been more recently acquired and were treated as colonies or dependencies. Between 1720 and 1723 Charles had prevailed on the estates, or representative assemblies, in the hereditary lands to agree to the pragmatic sanction. Later (when it had become clear that his inheritance would descend to his daughter Maria Theresa) he had been at great pains to get his provision accepted by the various principalities in the empire and by the interested powers of Europe. All in the end had accepted them apart from the elector of Bavaria, Charles Albert, who disputed Maria Theresa's claim but lacked the power to oppose it unaided.

Charles VI, however, had made no provision for the succession to the imperial dignity which, though elective, had been held by the head of the house of Habsburg since the 15th century. It carried no powers of coercion, but it was a source of considerable prestige and moral authority, particularly among the small and middling states, which saw in the emperor the defender of Christendom against the Turks and of Germany against France, and where men looked to Vienna for the careers and honours unattainable at home. The imperial dignity was therefore an attractive prize, and for some time before Charles VI died it was clear that it would be a cause of strife, since many rulers had an interest in seeing that it did not go to Maria Theresa's husband Francis, who as the former ruler of a small duchy within the French orbit (Lorraine, which he had exchanged for Tuscany on his marriage in 1736) could plausibly be held to be unsuitable. If, however, Francis were not elected emperor, the successful candidate would have to be endowed with territories appropriate to the dignity, a task which was seen to be incompatible with leaving the Habsburg inheritance intact.

Frederick the Great's Invasion of Silesia, 1740–41.—The war which everyone expected was begun by Frederick II, later known as the Great, who had acceded to the throne of Prussia in May 1740. Charles VI died on Oct. 20, 1740. On Dec. 16 Frederick invaded Silesia, which formed part of the Bohemian lands and was one of the richest of the Habsburg territories, with a population of just over 1,000,000, or nearly 50% of that in Frederick's own territories at his accession. Since Frederick had given his formal consent to the pragmatic sanction he broke his word when he invaded Silesia and was also guilty of an act of unprovoked aggression. In consequence he incurred much odium at the time and later. Among his contemporaries, however, the reasons for this seem to have been the unusual degree of success that he achieved, his cynical indifference to standards of international behaviour which everyone professed but no one followed and, in general his having thrust himself into the circle of the great powers while going out of his way to express his contempt for their rulers and ruling classes. To invade, on the other hand, as he had done, a defenseless neighbour in violation of a treaty and without a declaration of war, was perfectly in accordance with 18th-century practice.

Frederick overran Silesia in a matter of weeks, for the province was wholly unprepared for attack, and since he had timed his invasion for the end of the campaigning season, the Austrians were unable to bring up reinforcements until the spring. Apart from his openly confessed desire to distinguish himself, his action had only one purpose: to acquire the resources necessary if he were, as he said, to raise Prussia "out of the dust." In return for Silesia he offered Maria Theresa a large sum of money and the promise to support her husband at the forthcoming imperial election. Maria Theresa, however, against the advice of most of her ministers, turned these proposals down, and since Frederick was still without allies, the success of his gamble was put in jeopardy.

Before 1740 Prussia had never felt strong enough to pursue an independent policy. Not only was its population very small (about 2,250,000); its territories were among the poorest in Europe west of the Vistula and scattered over a large area without defensible frontiers. That so inconspicuous a state, apparently so ill-provided with the sinews of war, should challenge a major power was generally seen as the height of rashness. When Louis XV of France heard the news he described Frederick as a madman. There

was, however, more in Frederick's favour than at first sight appeared. By virtue of an economy and a social structure organized primarily with a view to military needs, Frederick possessed an army of more than 80,000 men—a number about four times as large, by 18th-century standards, as a state of average wealth and with Prussia's population could be expected to maintain. In equipment and discipline this army had no equal in Europe. It had moreover the unique advantage of being commanded by an autocrat of exceptional talents who had the power to order personally every aspect of military affairs, as well as every aspect of civil affairs as far as 18th-century conditions permitted.

By comparison the Habsburgs were poorly prepared for war. On the one hand, they had just been defeated by the Turks, with whom they had concluded a disadvantageous peace in 1739, so that their treasury was empty and their army, normally 160,000 strong, had been reduced to less than half this number; on the other hand, they lacked the means to mobilize their still considerable resources. For in the hereditary lands, the centre then and later of Habsburg power, the authority of the central government was negligible, depending on the good will of a large number of estates. Even when these estates could be prevailed on to grant taxes and to release men for military service, they never fulfilled their promises, and against this recalcitrance the crown had no remedy. In no other dominions of comparable standing was there so glaring a contrast between the wealth and power of individual subjects and the poverty and weakness of the crown. Thus, when the first battle of the Silesian campaign was fought at Mollwitz on April 10, 1741, 16,000 ill-trained and ill-equipped Austrians faced 24,000 Prussians and were defeated.

French and British Involvement.—The Prussian victory at Mollwitz made certain that the quarrel over Silesia would expand into a European war, since it confirmed the suspicion that the Habsburg dominions were incapable of self-defense and thus ripe for partition. The state that principally desired to exploit these possibilities was France. The French had a long tradition of hostility to the Habsburgs dating from the 16th century, when the emperor Charles V had threatened them with encirclement. Since the Thirty Years' War this danger had, admittedly, ceased to exist. Indeed from that time onward it was France that was the menace, not only to the Habsburgs but also, under Louis XIV, to the balance of power throughout the world. Louis XIV's defeats, moreover, had been principally engineered not by Austria but by Great Britain and the United Provinces of the Netherlands. Notwithstanding these facts, however, the old anti-Habsburg tradition lived on in France, as did the newer tradition, sanctified by Louis XIV's victories, though temporarily discredited by his defeat, of French hegemony in Europe.

When Charles VI died there had been two schools of thought in France on the subject of foreign policy, of which one held that the French ought not to take any steps which would lead to war in Europe. This point of view had at first commended itself to Louis XV and to his chief minister, Cardinal Fleury, who knew that French finances could not stand the strain of a continental war as well as of the war at sea with Great Britain that was imminent. It was, however, the other view that prevailed, sponsored by the comte (later Marshal and duc) de Belle-Isle (*q.v.*), who represented the opinions of the army and the nobility at court. Belle-Isle, as Fleury once put it, became the "inventor and architect of that glorious scene"—a Europe united against Maria Theresa. At his instigation the French concluded a treaty with Prussia (the treaty of Breslau, June 5, 1741) in which they recognized Prussia's right to the bulk of Silesia. While not themselves declaring war against Austria, they provided Charles Albert of Bavaria with troops, money and instructors to train his army, in order that he might conquer territories in the hereditary lands to sustain the imperial dignity to which they proposed to raise him; by a mixture of bribery and coercion they induced the ecclesiastical electors on the Rhine to support his cause; by similar means they won over the Saxons, whose natural inclination was to fear Prussia and support Austria; they spurred on the Swedes to attack Russia so that the Prussians might be freed from the fear of a Russian invasion (a project which achieved its purpose even though the Swedes were defeated); finally they facilitated a Spanish attack on the Habsburg territories in Italy.

When Philip V, grandson of Louis XIV, was established by the treaty of Utrecht on the throne of Spain, the Spaniards were deprived of their Italian possessions because Great Britain feared the Bourbon interest in this strategically vital area. Since then they had been struggling to get them back. Don Carlos, the eldest son of Philip V by Isabella Farnese (and afterward Charles III of Spain), had succeeded in acquiring Parma in 1731 and the kingdom of Naples in 1734. Now Isabella planned to secure an appanage in Lombardy for her second son, Philip, and to turn the Habsburgs out of Italy. When she embarked on these projects in the autumn of 1741 she had French permission to move her armies through France, and French naval escorts protected the troops that went by sea.

Thus the vultures gathered around the prey and organizing them into an alliance had been an easy task for the richest and, militarily, the strongest power in Europe. The French themselves engaged in the undertaking not on behalf of any national or even dynastic interests, but in the belief that as the greatest nation in the world, in the arts of peace as well as war, it was their due and destiny not indeed to conquer Europe as Louis XIV had tried to do, but to dominate it by means of client states.

As was natural in these circumstances, Great Britain saw France from 1741 onward (as between 1689 and 1714) as the principal disturber of the peace of Europe. The British feared a French hegemony for many reasons, but essentially because the French, like themselves, were a great maritime and colonial power and, as it seemed clear to many, the fate of colonies and commerce would be settled on the battlefields of Europe. A state that dominated the continent could close the continental ports to British exports, deny access to the indispensable sources of naval stores in the Baltic, secure the ships and crews of the smaller maritime powers and so in the long run control the seas, oceans and colonies of the world. Admittedly this argument was always rejected in many circles in England and by every parliamentary opposition. These people maintained that Great Britain should fight only at sea and leave the quarrels on the continent alone. Their point of view was, however, so plainly untenable that the maritime or "blue water" school found no adherents among people in authority. When French armies were on the march in Europe no British government ever failed to intervene.

Throughout the long duel between France and Great Britain which lasted from 1689 to 1815, war on the continent was always accompanied by war in the colonies. Apart from the Netherlands East Indies, which were not involved in the 18th-century wars, the principal colonial areas of the world—the Caribbean, North America, India and the slave stations on the coast of West Africa—were a scene of continuous strife between the colonial powers, of which by 1740 much the strongest were the British and the French. The conflicts originally arose out of local circumstances, for the European trading stations and settlements were everywhere contiguous and in competition. The stock of national animosity, however, to which these various disputes contributed, was powerfully increased by current views on the purpose and functions of colonies and trade. With their ambitions or fears centred on Europe, governments generally and, in the existing circumstances, justifiably believed that their revenues and thus their power turned largely on the volume of their foreign trade and on a favourable balance of trade. They saw trade as a means of economic warfare to be waged by tariffs and navigation acts backed by naval force.

In 1739 the conflicts endemic in all the colonial areas had exploded into war in the Caribbean. The Spanish government claimed a monopoly of the trade with its colonies in America, but was unable to exploit it since Spain could not produce sufficient commodities to satisfy the colonists' needs. This state of affairs provided the more highly developed nations with an irresistible temptation and the British in particular perennially succumbed to it in violation of the Asiento (*q.v.*) treaty. As a result the so-called War of Jenkins' Ear (*see* JENKINS, ROBERT) broke out between Great Britain and Spain in Oct. 1739. The French could

not remain indifferent, since a British victory would jeopardize their vital interests in the western hemisphere. The fear of a British hegemony there, and also in the Indian ocean, dominated French thinking to the same extent as the fear of a French hegemony in Europe dominated British thinking—and with as much justice; for although France was an overwhelmingly agricultural nation, the French capacity to make war depended heavily on the revenues derived, directly or indirectly, from their colonial trade. At the end of Aug. 1740 Fleury had sent two powerful battle squadrons to the French West Indies, and France had become Spain's auxiliary, though without declaring war on Great Britain.

As a consequence the war in Europe expanded into a world war. As Frederick the Great once put it: ". . . thanks to the politics of our century no dispute, however small, can arise anywhere that may not spread to, and set by the ears, the whole of Christendom." He saw this as the work of Great Britain and France. They, he said, had "a preponderance over all the other powers. They look on themselves as the leaders of two rival gangs to which all kings and princes must attach themselves."

From the start the British thus had an interest in supporting Maria Theresa, and parliament voted her £300,000 in the session of 1741. Throughout that year, however, and for a part of 1742, they could provide no physical help. Apart from any other reason, they lacked a base in Europe, since Hanover, which should have served this purpose, succumbed to enemy pressure in Sept. 1741. With a French army on his western frontiers and a Prussian army to the south, George II, to the rage and fury of his British subjects, felt himself obliged to declare Hanover neutral.

The Situation in Central Europe, 1741–45.—Maria Theresa was thus left to face alone the formidable forces of Belle-Isle's coalition. French and Bavarian troops overran Upper Austria in the summer of 1741 and pushed north into Bohemia. In November they captured Prague. For a number of months after the French plans went into operation it did indeed seem that the Habsburgs were doomed. Maria Theresa's chancellor, Count Philipp Ludwig von Sinzendorff, compared their position to that of a drowning man: "The water," he said, "is up to our necks."

Maria Theresa, however, though only 24 and wholly without experience, never lost her courage. Against the advice of most of her ministers, of her husband and of the British government, she refused to negotiate with the enemy, pointing out that if she were to make concessions these would only lead to further demands. Forced to flee from Vienna before the advancing French and Bavarians she went to Pressburg (Bratislava in Slovakia). There, again contrary to the advice of her ministers, who were familiar with the Hungarian tradition of exploiting Habsburg difficulties, she addressed the Hungarian parliament. Speaking without notes (though not without tears) she besought the Hungarian magnates and gentry for help. Overcome by emotion at the sight of their young and beautiful queen in distress, they responded to the appeal. They promised 100,000 men. This famous episode, however, turned out to be of more sentimental than practical significance. Of the promised 100,000 only 20,000 materialized and they were without discipline, training or equipment. It was in fact not so much the Hungarian contingents that saved the Habsburgs, at this juncture, as Maria Theresa's determination not to give in and the difficulties that beset the allies.

The French and Bavarians fought in enemy territory at a considerable distance from home while the Austrians fought on their own soil. This was a great advantage in an age when bad communications usually prevented large-scale movements in winter and at all times set narrow limits to the numbers of men and the quantities of supplies that could be moved. Since the system of promiscuous plunder in vogue during the Thirty Years' War had by now been prohibited in the interests of discipline, and since the system of organized plunder, or requisitioning from conquered territories, had not yet been adequately developed, food for the troops and, particularly, fodder for the animals, were apt to be the Achilles' heel of every commander. To these and other obstacles placed by contemporary practices and conditions in the way of overwhelming an enemy by weight of numbers were added the obstacles created by the French and Spanish courts, where incompetent people were often appointed to command and where the plans of the competent were disrupted by ignorant and ill-advised interference. Finally there was the difficulty of keeping the alliance together.

In central Europe the Prussians, the French and their satellites had no interest in common apart from the desire for plunder. Each was therefore suspicious of the others and afraid of being sacrificed to their ill will or inefficiency. Frederick, in the autumn of 1741, had wanted the French and Bavarians to capture Vienna in order to bring Maria Theresa quickly to terms, as he lacked the resources for a long war, but the French and Bavarians had preferred to go to Bohemia—among other reasons, in order to crown Charles Albert king there and secure the Bohemian vote in the imperial election. In Bohemia, however, particularly in view of their projects to conquer territories in this region for Saxony, they were uncomfortably close to Silesia. Frederick had no wish to become the pawn of his more powerful allies. He also urgently needed winter quarters for his troops. Thus in contravention of the treaty of Breslau, he concluded the convention of Kleinschnellendorf with Austria on Oct. 9, 1741, by which the Austrians surrendered to him the key fortress of Neisse and thus left him in undisturbed possession of upper Silesia. Freed from the need to fight the Prussians, the Austrians then drove the French and Bavarians out of Upper Austria, invaded Bavaria, and on Jan. 24, 1742—the very day on which Charles Albert was elected Holy Roman emperor as Charles VII—captured Munich.

It was understood that the convention of Kleinschnellendorf should be confirmed by a definitive treaty in the following December. This treaty, however, was never signed. Exclusively preoccupied with the conquest of Silesia, Frederick realized that the attainment of his object depended on a balance of power between France and Austria. After Kleinschnellendorf he moved in and out of the war as this principle dictated. He attacked Maria Theresa at the beginning of 1742, and his victory at Chotusitz on May 17 forced her to cede Silesia to him by the treaty of Berlin in the following July. He came into the war again in alliance with France at the beginning of 1744 because of the British and Austrian successes at the end of the previous year. Hampered by inadequate resources and transportation difficulties, and jeopardized by a mistaken strategy in the invasion of Bohemia in the autumn of 1744, his army was nearly destroyed. Frederick was, however, saved by his indomitable will and by his skill in battle. A series of remarkable victories (Hohenfriedeberg on June 4, 1745, Soor on Sept. 30, Kesselsdorf on Dec. 14) established his reputation as one of the great generals of the age and earned him the title of "the Great." They enabled the British, concerned that Austria's war effort should be concentrated against France, to induce Maria Theresa to accept Frederick's terms. She ceded the greater part of Silesia to him by the treaty of Dresden (Dec. 25 1745). The stalemate that developed between the other belligerents after this permitted him to feel secure until 1748.

The War in Western Europe.—The British between 1739 and 1748 were in no position to repeat what they had done in the War of the Spanish Succession or to forestall what they were to do between 1759 and 1762, for their political system was functioning according to its usual form and not as it could sometimes function in an emergency. Power was divided between the king and his ministers and ministers were divided among themselves. In order to stay in power they needed on the one hand the royal favour, which always made them objects of suspicion, on the other hand a majority in the house of commons, where there were no organized parties and opposition was always irresponsible. The disharmony which this state of affairs produced was now greatly aggravated by the belief that George II intended to sacrifice British interests to the interests of Hanover. Not surprisingly in these circumstances it proved impossible to formulate coherent plans, to correlate political and military strategy or to inspire that confidence in British leadership which was essential to co-operation among the allies.

In May 1742 the British had succeeded in procuring a base at Ostend (in the Austrian Netherlands) which the United Provinces had the right to garrison. The reluctant Dutch, Great Britain's

principal allies during Louis XIV's reign, were induced to enter the war in the following year. At Ostend was assembled the so-called pragmatic army of British troops and German mercenaries which by the middle of 1743 was about 30,000 strong. During 1742 and 1743 its commander, Lord Stair, formed plans for invading France in conjunction with the Austrians (during one of the interludes when they were freed from the Prussian menace) and for marching on Paris. He was, however, never allowed to put these plans into operation. George II, of unimpeachable physical courage but otherwise wholly unfitted for military command, insisted on exercising his rights as commander in chief. Although, because of the mistakes of the French, he managed on June 27, 1743, to extricate himself from an impossible position and to win the battle of Dettingen, he ruined the chances of what might have been a decisive campaign. Nevertheless the pragmatic army in 1743 fulfilled one of its main purposes, for it prevented the dispatch of French reinforcements to the Danube and Bohemia and by the end of the year the French had been expelled from Germany.

Louis XV now concluded that he could serve his interests best by dropping the pretense that he was acting only as an auxiliary in the succession dispute. He decided to attack England directly by means of a surprise invasion on behalf of the Jacobites. When news of this project leaked out, so that it had to be abandoned, he changed his objective to the conquest of the Austrian Netherlands, an area vital to the security of Great Britain. He declared war on Great Britain in March 1744 and on Austria in the following April. Maurice de Saxe (*q.v.*) was put in command of the French army in the spring of 1745, when—for the first time in this war and the last time before 1789—intrigues at court and the other vices of a corrupt political system failed to obstruct the rise of a great soldier to a position of undisputed control. Saxe defeated the British and their unco-operative allies, the Austrians and the Dutch, under the command of the duke of Cumberland, at the decisive battle of Fontenoy on May 11, 1745. As a result, and because the British had to withdraw a large part of their forces for use against the Jacobite rebellion that year, the French had the allies at their mercy. They conquered the whole of the Austrian Netherlands by the end of 1746 and invaded the United Provinces in 1747. They would have conquered that country also if Louis XV had not come to the conclusion that he could not continue the war.

Louis felt himself forced to this decision through lack of money and the apparent impossibility of raising further taxes or loans. Waste, extravagance and the absence of any rational system of priorities had distinguished French policy and practice since the beginning of the war, and British successes at sea had disrupted the French economy and reduced the government's revenues.

The War at Sea.—Success at sea came slowly to the British. Admittedly even in 1739 Great Britain was the strongest naval power in the world. The two-power standard which prescribed that the Royal Navy should be equal in strength to the combined navies of France and Spain was achieved on paper and was probably exceeded in fact. A strong naval tradition and a general awareness of the navy's vital importance increasingly insulated the navy against political intrigue and royal interference. Nevertheless at the beginning of the war it had far too few ships for its needs, and the war at sea suffered from the same lack of direction as did diplomacy and military strategy.

During the period (1739–44) when Great Britain was at war with Spain, but only with France as Spain's auxiliary, British efforts had first been directed toward destroying Spain's warmaking capacity by capturing the focal points of the trade with America on which the Spanish government depended for its revenues. These projects came to a dismal end with the disastrously mismanaged expedition against Cartagena in 1741. From the beginning of 1742 the navy was able to prevent the movement of French and Spanish troops to Italy by sea, but it had not established supremacy in the Mediterranean by the time France declared war. From 1739 it had been burdened, as always, with a huge number of defensive duties and these became vastly more onerous in 1744 when British ships everywhere became legitimate objects of French attack, when hordes of privateers were let loose on British merchantmen and when Great Britain itself was menaced (though imminently only in the spring of 1744) by invasion. For a number of years British naval forces were dissipated without adequate plan between their many tasks.

The French, however, were unable to profit from the period of weakness and divided councils in Great Britain. The British government had to render account of its actions to parliament and so was under some compulsion to cut its coat according to its cloth. The French government was not. When it had embarked on its continental ventures in 1741 its navy and its naval expenditure were inferior to the British and its mounting military commitments increased the gap. Money was the crucial shortage, and it gave rise to other shortages not always obviously attributable to it, particularly shortages of crews and timber. Ships and crews, therefore, became increasingly precious and one hesitated to risk them in battle if this could be avoided. Thus in 1744, after the invasion project and the attempt in the battle of Toulon (February) to destroy British power in the Mediterranean had failed, the French ceased to challenge the British battle fleets, but employed their warships principally to harass British trade and to protect their own. The nemesis that attends this way of proceeding descended on them in 1747. In that year Adm. George Anson solved the problem of naval priorities by means of the "golden rule" which was established as the pivot of British naval strategy. This prescribed a strong western squadron, large enough to spare detachments when required for other areas, whose principal purpose was to protect British and attack French merchant ships as they left or approached their home ports. Armed with this weapon the British moved over to the offensive in 1747. The western squadron fought a number of engagements with the heavily protected French convoys sailing to and from India and the West Indies. The French lost a great many escorts (as well as merchant ships) which they were unable to replace. Thus they began the descent that led inevitably to defeat; for with inadequate escort (and finally with none at all, as the escorts came to seem only a provocation to attack) the French merchant ships were an easy prey. In the end, since no one would insure them, they ceased on many routes to sail at all. Consequently in most of the principal towns of France bankruptcies and unemployment spread as merchants, shipowners and shipbuilders lost their livelihood. Meanwhile, in coastal districts suffering from poor harvests to which the British blockade made it impossible to bring grain by sea, the result was famine. In these ways the French economy was threatened with collapse. The controller general of the finances, J. B. de Machault d'Arnouville, said in 1748 that he saw all hell opening before him if the war at sea went on.

These disasters were of a kind which a country largely self-sufficient in foodstuffs and raw materials should have been able to overcome. Saxe pointed out that France had many resources left and that it was these resources, not the amount of money available to the crown, that counted. Louis XV's government, however, reacted after the fashion of 18th-century governments. It lacked the authority, the resolution and above all the desire to follow Saxe's advice, which would have involved drastic changes in the system of taxation and interference with the rights of property. Therefore, in order to restore their trade and to preserve their colonies, all of which for lack of naval ships to reinforce and defend them must sooner or later have fallen to British attack, the French were prepared to surrender their conquests. The British, who had achieved the objects for which they had entered the war and who disliked its expense, were prepared to do the same. In point of fact they had only one conquest to surrender—the fortress of Louisburg, on Cape Breton Island—but as the indispensable base for the conquest of Canada it was of great strategic value. It had been captured in 1745 through the initiative of the Bostonians.

The War in Italy.—The decision to make peace brought to an end the war in Italy where the Spaniards had failed to achieve their aims. By the treaty of Fontainebleau (Oct. 1743) Louis XV had agreed to enter the Italian war as a principal on the Spanish side. British naval power in the Mediterranean, however, had

virtually prevented the movement of enemy troops to Italy by sea since the end of 1741, so that the only way of invading Lombardy was overland through Savoy and Piedmont. The attitude of Charles Emmanuel III of Sardinia, who owned these territories, consequently became of cardinal importance. He himself wanted the duchy of Milan and saw that his interest lay in preserving a balance of power between the Habsburgs and the Bourbons. He sat on the fence, inclining to the side of the Habsburgs as the weaker party, until Sept. 1743. Then by the treaty of Worms he agreed to put 40,000 men into the field in support of Maria Theresa. The price of his alliance was £200,000 a year from Great Britain and various territories in Lombardy, which the British forced Maria Theresa to cede to him under threat of stopping their subsidies to her. In spite of the difficulties of conquering Piedmont by invasion through the mountains from the west, the French general Jean Maillebois nearly achieved the feat in the autumn of 1745. This was the one occasion when either side came within reach of decisive victory. Maillebois, however, failed to achieve it because the Spaniards would not agree to his plans and were supported by Louis XV.

The Peace of Aix-la-Chapelle.—The general peace treaty of Aix-la-Chapelle was signed on Oct. 18, 1748. Though Frederick the Great had taken no part in the negotiations the treaty guaranteed his possession of Silesia. It also guaranteed to Charles Emmanuel all the territories which Maria Theresa had ceded to him by the treaty of Worms, apart from Piacenza which was given to Don Philip together with Parma. With these exceptions the *status quo ante bellum* was restored. Louisburg was handed back to the French, and Madras, which the French had captured in 1746, to the British. The Austrian Netherlands, in accordance with Great Britain's vital interests, were returned to the Habsburgs. In general, in fact, the treaty of Aix-la-Chapelle, insofar as it was concerned with western Europe and the world overseas, put the clock back to 1739. The war had settled nothing. Indeed it had exacerbated existing rivalries, and the next war was to start in America in 1754 because of disputes that the peacemakers in 1748 had made no attempt to solve.

In central Europe, on the other hand, the war settled a good deal. Admittedly the Habsburgs retained the bulk of their inheritance intact. They also got back the imperial dignity, for the emperor Charles VII (Charles Albert of Bavaria) had died in Jan. 1745, and in the following September Maria Theresa's husband was elected to succeed him as Francis I. The Habsburgs, moreover, had learned a lesson. They could not have survived without the sea power, subsidies and military intervention of their British allies, but it seemed to them that their losses were due to the selfishness of, and their financial dependence on, Great Britain, and they were determined that next time they would stand on their own feet. After 1748 Maria Theresa embarked on her great reforms, with the result that by 1756, when the Seven Years' War broke out, the Habsburgs' warmaking capacity was stronger, relatively as well as absolutely, than it had been in 1740. All the same the Habsburgs never permanently regained the hegemony which they had exercised in Germany between 1648 and 1740. Though they did not recognize the loss of Silesia as final, or Prussia's position as a great power, and engineered the next war on the continent to get back the first and destroy the second, they failed in their endeavours—albeit by a narrow margin. Prussia had come to stay.

Even at the time the rise of Prussia was a fact of great significance, synchronizing as it did with the decline of the United Provinces, which the War of the Austrian Succession made plain, and accompanied as it was soon to be by the rise of Russia, whose intervention in world events was foreshadowed when in 1748, though too late to take part in the fighting, a Russian army of 30,000 men, for which the British paid, was sent to the Netherlands. These changes destroyed the equilibrium established at Utrecht after Louis XIV's wars and set up in its place one of another kind; one, moreover, that was to endure, apart from the interlude of the French Revolutionary and Napoleonic Wars, substantially unchanged until 1914. As William Pitt the elder put it in 1762: "Such are the great events by which the balance of power in Europe has been entirely altered since the time of the grand alliance" against Louis XIV.

See also references under "Austrian Succession, War of The" in the Index.

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(C. B. A. B.)

AUSTRIC LANGUAGES are a proposed family of languages that are spoken from the island of Madagascar to the Himalaya mountains, and from New Zealand to Easter Island. The Austric language family, proposed by Wilhelm Schmidt in 1906, connects the Malayo-Polynesian languages and the Austroasiatic languages (*qq.v.*) by presumed similarities in vocabulary, word formation and basic sounds. This grouping inspired other scholars to reach further and suggest links with Japanese, Indochinese American Indian, Australian and Sumerian. In 1942 Thomas Sebeok noted the need for caution, demonstrating that reliable conclusions could not be drawn without good descriptive grammars, reconstructed proto vocabularies and adequate comparison of protoforms to establish systematic correspondences. Concurrently Paul Benedict indicated the utility of Schmidt's hypothesis for interpretation and analysis.

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(D. S. Ml.)

AUSTROASIATIC LANGUAGES. According to a hypothesis promulgated especially by Wilhelm Schmidt, there exists a family of Austric languages (*q.v.*), with two major branches: the Malayo-Polynesian languages (*q.v.*) (including most languages of Malaysia, Polynesia, and Melanesia); and the Austroasiatic The numerous tongues involved in the Austroasiatic branch extend over a vast area, the limits of which are: Kūrkū, of the Chota-Nagpur group, in India, to the west; Bahnar, belonging to Mon-Khmer proper, to the east; the Semang and Sakai languages of the Malay peninsula, to the south; and Palaung of the Salween basin, with Khasi, defining the northern boundary.

Three subfamilies are said to comprise Austroasiatic by those who accept the hypothesis in its fullest form: (1) Mon-Khmer, further subdivided into (*a*) Mon-Khmer proper, (*b*) Cham, Jarai Radé and Sedang (more likely Indonesian languages), (*c*) the languages of the Malay peninsula, (*d*) Nicobarese, (*e*) the languages of the Salowen basin, and (*f*) Khasi; (2) the Munda languages (*q.v.*) of the Himalayas and Chota Nagpur; and (3) Annam-Muong (attached, however, by Henri Maspero, who rejects the Austroasiatic alignment, to the Thai family).

Insofar as the proponents of the Austroasiatic hypothesis claim that the relationship among the groups in question is a genetic one, that is, that they are descendants of a common ancestor, they have failed to support their notions with the authority of comparative linguistics. The nature of the data adduced would seem, however, to justify serious attempts to reconstruct parent forms.

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(T. A. Sb.)

AUSTRONESIAN LANGUAGES: *see* Malayo-Polynesian Languages.

AUTHORITARIANISM: *see* Absolutism, Political.

AUTOBIOGRAPHY, the account of an individual human life, written by the subject himself. In the broadest sense any self-written account of one's life and times may be thought of as autobiographical, but autobiography as a literary genre stands apart from certain related forms—notably the personal essay, the diary, the travel journal and the autobiographical novel. It must, obviously, be composed by the subject himself, not ghost written by a professional biographer; yet it may be dictated to an

amanuensis, and it may be written—though this is seldom the case—in the third person. It must attempt to survey, in retrospective mood, a considerable portion of life, if not an entire life; and it must take the form of an ordered narrative, with deliberate selection and shaping of material (though not constructed as fiction) to compose an artistic whole. Above all, its underlying principle must be scrutiny of the self, with outside happenings, persons encountered, and observations admitted primarily as they impinge on the consciousness of the person on whose character and actions the writing is focused. These restrictions, it will be seen, rule out such works as Montaigne's *Essays*, Pepys's *Diary*, Coleridge's *Biographia Literaria*, Wordsworth's *Prelude*, and Joyce's *Portrait of the Artist as a Young Man*. All of these are autobiographical in a broad sense, but to consider them as autobiographies would bring into this genre a very large part of the world's literature, since it is rare indeed to find a work of imagination which contains no element of self-revelation.

The one related form which it is difficult, if not impossible, to separate logically from autobiography is the *memoir*. The writer of memoirs is usually a person who has played a distinguished role in history, or who has had the opportunity to observe, at close range, history in the making. The Civil Wars in England in the 17th century produced a flood of such reminiscences, of which the *Memoirs* of Sir Edmund Ludlow (1617?–1692) and Sir John Reresby (1634–1689) are representative. The French have particularly excelled in this genre; three outstanding examples from the 17th century are the *Mémoires* of Madame de Motteville (c. 1621–1689), of the Cardinal de Retz (1614–1679), and the Duc de Saint-Simon (1675–1755). The memoir, however, while it inevitably reveals much of the tastes and character of the writer, is primarily focused on outward happenings and on other persons; hence it is not, in the strict sense, a form of autobiography. The word "autobiography" was not coined until the close of the 18th century; prior to that time "memoirs" was frequently used for works which would now be called autobiographies. The distinction between the two forms often turns out to be one of degree rather than kind, depending on the amount of self-revelation contained in the memoir; but on the whole it seems best to restrict autobiography to the self-written biography in which the focus is primarily on the self rather than on outward events.

Early Autobiography.—Writers of antiquity often reveal a great deal about themselves—Horace, for instance, in his poems, and Cicero in his letters—but there are, strictly speaking, no examples of autobiography surviving from classical literature. Although a sustained tradition of autobiographical writing did not begin until considerably later, the *Confessions* of St. Augustine (354–430) deserves the title of the earliest extant autobiography. Written about A.D. 399, it describes, in lively and charming detail, the early life of Augustine, his affection for his mother, his striving against sensuality and sin, his search for philosophic truth, and, most dramatically, his conversion, in the summer of 386, to Christianity. Candid and unassuming, devout in spirit, it remains to this day one of the best of autobiographies and one of the most influential on succeeding writers. The *Retractions*, composed shortly before St. Augustine's death, affords a survey of his writings and stands as a kind of supplement to the earlier and more famous autobiography.

The earliest autobiographical account in English which has come down to us is the strange and absorbing *Book of Margery Kempe*, written in the early 15th century but not discovered until 1934, in a private library in Lancashire. It is the narrative of the spiritual struggles and adventurous life of a devout—and somewhat trying—woman of Lynn, born about 1373, who in 1414 made a pilgrimage to the Holy Land and was in Rome for the celebrations held in honour of the canonization of St. Bridget. She made other journeys too, and her "book" not only provides one of the most vivid accounts of the life of a pilgrim in the middle ages but also (and here it qualifies as an autobiography) is a realistic portrayal of an interesting and complex personality. Her narrative, dictated at different times to two amanuenses, was published (in a modernized version) by the owner of the manuscript, William Butler-Bowdon, in 1936, and (the original text) by S. B. Meech for the Early English Text society in 1940.

From the Renaissance to the 19th Century.—The tradition of autobiographical writing begins in the Renaissance, with the fascinating *Vita di Benvenuto Cellini*, partly written and partly dictated between 1558 and 1562, and the *De vita propria* of the Italian physician Geronimo Cardano, begun as "a natural history of himself" in 1574. The upsurge of freedom from medieval restraints, the spirit of scientific inquiry, and the new interest in the human personality—all characteristic features of the Renaissance—undoubtedly contributed to the development of a genre which was to increase in the succeeding centuries and to become in the 20th century one of the most popular of all literary forms. Other examples are the narrative of Thomas Whythorne (written c. 1576 and not discovered until 1955), music master to Archbishop Matthew Parker; the vainglorious autobiography of Lord Herbert of Cherbury (written c. 1643 but not published until 1764); the curious *Exemplar humanae vitae* (1687) of Uriel Acosta; and two notable spiritual autobiographies—John Bunyan's *Grace Abounding to the Chief of Sinners* (1666), an extraordinarily frank and vivid account of the inward struggles of one who had "tarried long at Sinai to see the fire and the cloud and the darkness," and the *Reliquiae Baxterianae, or Mr. Richard Baxter's Narrative of the Most Memorable Passages of His Life and Times* (1696), a book which has remained a favourite even with those who have not shared Baxter's religious point of view. Both books seem to have been written not so much as a mode of self-justification as from a strong compulsion to set down the artless record of an inner spiritual struggle. "I could have stepped into a style much higher than this," writes Bunyan, "and could have adorned all things more than I have seemed to do; but I dare not. God did not play in convincing of me, wherefore I may not play in my relating of these experiences, but be plain and simple, and lay down the thing as it was." To these may be added the remarkable series of autobiographies composed by women in the 17th century—the fragmentary "life" of herself prefixed to the *Memoirs* of her husband Colonel Hutchinson (1615–1664) by Lucy Hutchinson; the *Memoirs* of Anne, Lady Fanshawe (1625–1680); the autobiographical account of Mary Rich, countess of Warwick (1625–1678); and the "True Relation" of Margaret Cavendish, duchess of Newcastle (c. 1624–1674), "written by herself." Although most of these were not published until the 19th century, they afford vivid descriptions not only of the times in which they were written but also of the personalities of interesting and strikingly different women of the 17th century.

The 18th century witnessed the writing of several autobiographies which have become classics of world literature: the autobiography of Benjamin Franklin (1795); the series of memoirs of himself composed by Edward Gibbon (1798); and, above all, the *Confessions* of Jean Jacques Rousseau (1781–1788) whose importance to the development of autobiography is evidenced in his insistence, at the beginning of the *Confessions*, on his unique individuality, and in the discussion which his autobiography aroused, particularly in England, of the proper evaluation of egotism. The number of autobiographies at this time is too great to be enumerated in detail, but mention should be made of the beautiful *Memoirs of the Life of Elizabeth Cairns* (1762), the spiritual autobiography of a Scottish woman preacher; the lively autobiography of the bluestocking, Mary Delany (1700–1788); the life of the Italian dramatist Vittorio Alfieri (1749–1803), written by himself; and the *Travels* (1790) of John Macdonald, reprinted in 1927 as *Memoirs of an Eighteenth Century Footman*. This century is also notable for a number of autobiographies of actors and actresses, of which the best known is the *Apology for the Life of Colley Cibber* (1740).

It was at this time that the word "autobiography" seems to have come into being. The first example in the *Oxford English Dictionary* dates from 1809, in a remark by Robert Southey on a life of the Portuguese painter, Francisco Vierira, composed by himself. "It is singular," writes Southey, "that this very amusing and unique specimen of auto-biography should have been entirely overlooked" (*Quarterly Review*, i, 283). Curiously enough, in the same issue of the *Quarterly* (May 1809) another writer

(Isaac D'Israeli), reviewing the *Memoirs of the Life and Writings of Percival Stockdale*, and struck with the popularity of this kind of writing, observes that "we shall expect to see an epidemical rage for auto-biography break out" (i, 386). The word is to be found earlier, however, partly as a result of the interest aroused by the translation of Rousseau's *Confessions*. William Taylor, writing in the *Monthly Review* (Dec. 1797) raises the question whether the term "self-biography" can be properly coined: "it is not very usual in English to employ hybrid words partly Saxon and partly Greek: yet *autobiography* would have seemed pedantic" (xxiv, 375). John Foster, writing in 1805, entitles the first of his *Essays, in a Series of Letters to a Friend*, "On a Man's Writing Memoirs of Himself," and although he does not use the term "autobiography," he points to the example of Rousseau and stresses the value of the "deep self-knowledge" which results from this kind of writing, in which "the exterior life will hold but the second place in attention."

The Nineteenth Century and After.—It is not surprising that in the romantic era of Byron and Shelley, with its emphasis upon individualism and the *étalage du moi*, the number of autobiographies should grow at an extraordinary rate. From the early 19th century the amount of autobiographical writing of all kinds has in fact increased so enormously that only a few representative names can be cited—evocations of childhood in works by Alphonse de Lamartine, Ernest Renan, John Ruskin, Maksim Gorki, Selma Lagerlöf, Carl Spitteler and Richard Church; recollections of literary struggles and triumphs by Anthony Trollope, G. K. Chesterton, Joseph Conrad, Norman Douglas, H. G. Wells and W. B. Yeats; accounts of educational experiences in one form or another by Henry Adams, John Stuart Mill, Booker T. Washington and Helen Keller; records of outstanding spiritual adventures by Cardinal Newman, "Mark Rutherford," and Sir Edmund Gosse; and explorations of the inner life by a long series of writers, including Vera Brittain, Sheila Kaye-Smith, T. E. Lawrence, C. S. Lewis and Sir Herbert Read. Autobiography has become in fact one of the most popular and commercially profitable kinds of writing, and "life-experiences" of every type find their way into print. The hairdresser, the store detective, the boxing referee, the charwoman, the newspaper seller, the steeplejack, the movie organist—these and many more have offered their autobiographies to the public. They are entertaining and informative, but only rarely do they combine a sense of artistic form with a perceptive and illuminating scrutiny of the subject. An age, however, which has seen the publication of such autobiographies as Siegfried Sassoon's *Memoirs of a Fox-Hunting Man* (1929), or the series by Mrs. Belloc Lowndes which began with *"I, Too, Have Lived in Arcadia"* (1942), or G. G. Coulton's *Fourscore Years* (1944), or Sir Osbert Sitwell's *Left Hand, Right Hand!* (1944) and its successors, need not despair.

See also BIOGRAPHY.

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AUTOCEPHALOUS, a term used in the early church to describe bishops who were independent of a superior authority and now used to describe the independent Orthodox churches of Constantinople, Antioch, Alexandria, Jerusalem (*i.e.*, the four eastern patriarchates), Cyprus, Russia, Greece, Rumania, Yugoslavia (Serbian Orthodox), Bulgaria, Albania, Georgia (U.S.S.R.) and Poland. Autocephaly has also been given by the Russian Orthodox Church to the Czechoslovak Orthodox Church. (There is some disagreement as to whether Finland and Mount Sinai should rank as autocephalous churches.) *See* further ORTHODOX EASTERN CHURCH. (H. M. W.)

AUTOCLAVE, a strong closed vessel of metal in which liquids can be heated above their boiling points under pressure, to effect sterilization of instruments and equipment in bacteriology and medicine and to effect chemical reactions. Etymologically the word indicates a self-closing vessel, in which the tightness of the joints is maintained by the internal pressure, but this characteristic is frequently wanting in the actual apparatus to which the name is applied. The prototype of the autoclave was the steam digester of Denis Papin, invented in 1679, which is still used in cooking and called a pressure cooker, but the appliance finds a much wider range of employment in the chemical industry, where it is utilized in various forms in the manufacture of candles, coal-tar colours, etc.

Frequently an agitator, passing through a stuffing box, is fitted so that the contents may be stirred, and renewable linings are provided in cases where the substances under treatment exert a corrosive action on metal.

AUTOCRACY: *see* ABSOLUTISM, POLITICAL.

AUTO-DA-FÉ (more correctly AUTO-DE-FÉ; "act of faith") the name of the ceremony during the course of which the sentences of the Spanish Inquisition (*q.v.*) were read.

The ceremony comprised a procession in which members of the Holy Office, with familiars and agents, and the accused persons who had confessed their guilt and declared their penitence took part; a solemn mass; an oath of obedience to the inquisition, taken by the king and all the lay functionaries; a sermon by the grand inquisitor; and the reading of the sentences, either of condemnation or acquittal, delivered by the Holy Office.

The handing over of impenitent persons, and those who had relapsed, to the secular power, and their punishment, did not usually take place on the occasion of an auto-da-fé, properly so called.

AUTOGAMY (from the Greek *autos*, "self," and *gamos*, "marriage") is the phenomenon of self-fertilization in protozoa and self-pollination in flowers. In some multicellular animals, and the paramecium and certain other protozoa autogamy takes place by the division of the nucleus into halves, which reunite after maturation. Self-pollination in a hermaphrodite flower (as contrasted with pollination of a pistillate by a staminate flower on the same individual of a monoecious plant) frequently occurs at the end of the life of a flower and results in fertilization if cross-pollination has failed. *See* POLLINATION: *Self-Pollination (Autogamy)*; *see* also references under "Autogamy" in the Index.

AUTOGIRO: *see* AIRPLANE; HELICOPTER.

AUTOGRAPH. An autograph is any manuscript written by its author, either in alphabetical or musical notation, in his own hand. A manuscript entirely in its author's writing is also sometimes called a holograph. By common usage the term autograph may also refer to a separate signature. The practice of collecting such signatures dates back to the 16th century, when students in Germany and the Low Countries collected their friends' autographs in small albums known as *alba amicorum*.

An autograph may be a fair copy of an original manuscript made by its author for a friend. The autograph manuscript of Thomas Gray's *Elegy Written in a Country Church Yard* (1751) for example, which is preserved in the British museum, London, is one of several fair copies circulated by the poet among his friends. It adds nothing to our knowledge of the text or composition of the poem, and apart from its considerable "association value" is mainly of interest because it provides an authenticated specimen of the poet's handwriting. It is thus possible for more than one autograph to exist of the same work, none of which is necessarily the original. An autograph may also be an early or

corrected draft, and provide valuable evidence of the stages of composition. The unique collection of literary autographs on permanent exhibition at the British museum contains specimens of autographs, many of them corrected drafts, of most famous writers in English from Sir Thomas Wyatt onward. Other notable collections are to be found in the Bibliothèque Nationale in Paris, the Vatican library in Rome and the Library of Congress in Washington, D.C.

No autographs of Greek or Roman authors survive, although ignorance of paleography occasionally led medieval scholars to describe as being in the hands of their authors manuscripts of classical works which appeared to be of extreme antiquity. In fact, such manuscripts are rarely older than the 6th century A.D. and more often belong to the 9th or 10th centuries.

In the middle ages, literacy was mainly the prerogative of the clergy. It was an age of anonymity rather than individuality and works such as chronicles are often of unknown authorship. Before the invention of printing, theological, historical and literary works were copied in regular "book hands" by professional scribes who were monks. It is thus difficult to speak of medieval autographs, although some manuscripts of chronicles appear to have been actually written by their compilers. However, an autograph survives of the *Gesta Pontificum* by the 12th-century English historian William of Malmesbury, as well as several autographs of Matthew Paris.

Probably the earliest known European lay signature is that of the Spanish captain, The Cid, dated 1096. Official documents of the kings of England were in early medieval times normally validated by the affixing of a seal. Some of the Norman kings signed with a cross. Edward III (1327–77) is the first English king whose writing survives, though he was not the first literate king. Specimens survive of the autographs of all subsequent monarchs.

By the end of the middle ages literacy had become more widespread. The invention of printing ended the large-scale anonymous copying of manuscripts by hand. The hallmarks of individualism became more important. Examples of the autographs of most of the great figures of the Renaissance—Leonardo, Michelangelo, Ariosto, Dürer, to name a few—are preserved in national libraries.

Comparatively few autographs survive of the literary works of the great Elizabethan authors. There are six signatures of Shakespeare, on his will or other official documents, but of his autograph compositions there is only one controversial survivor. The unique manuscript of the play of *Sir Thomas More,* in the Harleian collection in the British museum, contains an additional scene of 147 lines which some scholars believe to have been composed by Shakespeare and to be in his hand. It seems that Elizabethan authors did not greatly value their own literary autographs. Most of the specimens of handwriting from this period are private or official letters which were preserved more for their literary or historical interest than for their value as autographs.

From the 18th century onward the supply of autograph material of almost every notable figure in the arts, sciences or public life becomes more abundant. Huge collections of private and semipublic political papers of statesmen like Lord Liverpool and W. E. Gladstone are preserved in libraries, and include examples of the autographs of almost everyone who was of sufficient importance to put pen to paper.

The popularity of such authors as Burns, Shelley and Byron led to the fabrication of numerous forgeries of their autographs, some of which are still in circulation. These forgeries were made by men who usually had access to only one or two genuine specimens, which they began by tracing, with the result that their forgeries are stiff, exaggeratedly uniform and lacking in the fluency and spontaneity of genuine autographs. The expert can usually detect a forgery by careful comparison with as many authenticated specimens as possible.

Forgeries must be carefully distinguished from facsimiles, which are copies of originals made by lithography or some other reproductive process. Some early editions of Byron's works, for example, contained a facsimile of an autograph letter of the poet. Such facsimiles, if detached from the volumes which they were intended to illustrate, may deceive the unwary, but can usually be distinguished without difficulty from a genuine autograph.

In general it may be said that, the earlier an author, the rarer his autograph. Specimens of the hands of such prolific 19th-century authors as Coleridge or Swinburne appear fairly frequently in the salerooms. Modern documents of any length are frequently typewritten, but an autograph signature remains the normal method of authentication, and many people prefer to write private letters in their own hands.

BIBLIOGRAPHY.—Most national and public libraries have published collections of facsimiles of their autograph manuscripts, for example, *Facsimiles of . . . Autographs in . . . the British Museum* (1895–99). Other collections include *English Literary Autographs, 1550–1650,* ed. by Sir W. W. Greg (1925–32); *English Poetical Autographs,* ed. by D. Flower and A. N. L. Munby (1938). *See* also A. W. Pollard, *et al., Shakespeare's Hand in the Play of Sir Thomas More* (1923); V. H. Galbraith, "The Literacy of Medieval English Kings," in *Proceedings of the British Academy* (1935); the last chapter of P. Lehmann, *Erforschung des Mittelalters* (1941); H. C. Schultz, "Thomas Hoccleve, Scribe," in *Speculum,* xii (1937). (K. W. G.)

Musical Autographs.—Most of what is said of literary autographs is true also of musical autographs, which are collected privately and in libraries both for the information they give to music scholars and for their associative value. The autographs of some of the 48 preludes and fugues by J. S. Bach, and the Beethoven sketchbooks, which are among the most precious of the British museum's collection of musical autographs, throw considerable light on the composers' original intentions and their revision, as do the autographs of Beethoven's opera, *Fidelio.* Autograph manuscripts of music can also be used to correct errors that may have been introduced by copyists in regard to tempo or dynamics, and may provide evidence of authenticity in cases of disputed authorship. For instance, study of the autograph of a composition by J. S. Bach which has long been attributed to his son, Wilhelm Friedemann Bach, reveals that the son's signature has been added to the father's work. Recognition of the importance of such autograph manuscripts has led to the collection not only of originals, but of photostat copies of them, begun by A. van Hoboken in Vienna in 1927, and later by Otto E. Albrecht in the United States. (E. LR.)

AUTOLYCUS, in Greek mythology, the father of Anticlea, mother of Odysseus. Later authors make Hermes his father. He lived at the foot of Mt. Parnassus, and was famous as a thief and swindler. On one occasion he met his match. Sisyphus, who had lost some cattle, suspected Autolycus of being the thief, but was unable to prove it, since the latter possessed the power of changing everything that was touched by his hands. Sisyphus accordingly burned his name into the hoofs of his cattle and, during a visit to Autolycus, recognized his property. It is said that on this occasion Sisyphus seduced Autolycus' daughter Anticlea and that Odysseus was really the son of Sisyphus, not of Laertes, whom Anticlea afterward married.

The object of the story is to establish the close connection between Hermes, the god of theft and cunning, and the three persons —Sisyphus, Odysseus, Autolycus—who are the incarnate representations of these practices.

AUTOMATIC WRITING is script produced involuntarily when the subject's attention is ostensibly directed elsewhere. The phenomenon may occur when the subject is in an alert waking state or may be induced in various levels of hypnotic trance. There may or may not be any correspondence between the agent's conscious mental content and what the hand is recording at the moment of writing. Sometimes what is produced—which may range from seemingly unrelated words, fragments of poetry, epithets, puns or obscenities to well-organized fantasies—can be reconciled with the writer's conscious thoughts, feelings and behaviour. More often, the contents are inconsistent with personal characteristics the subject consciously accepts. Thus during the height of popular interest in the phenomenon (1850–1900) inspiration for automatic writing was generally attributed to external or supernatural forces. Moreover, since automatic writing, which is often different in appearance from the subject's normal style, has occasionally been found to resemble closely the handwriting of a deceased person, such occurrences led to the attribution of mediumistic powers

to some automatic writers (*see* SPIRITUALISM).

Since the advent, around 1900, of theories of personality that reject the hypothesis that there are supernatural influences on behaviour but postulate unconscious (*q.v.*) as well as conscious motivation, the inspiration for automatic writing has been assumed to be completely endogenous. Modern psychodynamic theories of personality propose that traits, attitudes, motives, impulses, memories and even partially developed talents and skills which are incompatible with maintenance of security in significant interpersonal relationships may be dissociated from awareness and rarely expressed overtly in the course of normal waking behaviour. These subconscious characteristics may be revealed, however, in the content of automatic writing. Thus, in both clinical and experimental studies exemplified by investigations of multiple personalities, automatic writing is a valuable technique for gaining access to aspects of personality outside conscious awareness.

In the psychotherapy of personality disorders, especially in hypnotherapy, automatic writing may be induced as a means of achieving insight into unconscious conflicts, fears or impulses which gain overt expression only as symptoms.

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AUTOMATION, the name given to an automatic system of working, the difference between automation and mechanization, a related term, being mainly one of degree. (For the origin and development of the word, *see* below.)

Historical Survey.—Mechanization, the substitution of mechanical power for that of men or animals, can be traced back to antiquity. The handling of material provides many examples of the way in which man has sought to lighten his labours by employing mechanical devices—particularly in building, in mining and in the raising of water. Pulleys, cranes and simple conveyors have been known and used for more than 2,000 years. The mechanization of processes, on the other hand, did not become widespread until the beginning of the Industrial Revolution in the 18th century with the inventions of Richard Arkwright, Henry Maudslay, Elias Howe and many others. Simple automatic devices, however, have a long history. The Romans employed them in connection with the handling of water. Automatic striking clocks were in use in the 14th century. Denis Papin invented his steam safety valve in the latter half of the 17th century, and 100 years later James Watt developed the centrifugal governor to control the speed of the steam engine. Automatic devices were also used on early windmills for turning the sails into the wind and for feathering the sails to adjust their speed. The year 1801 saw the introduction by J. M. Jacquard of a loom on which the design of the cloth woven was controlled by the arrangement of pegs on a chain; the control operated on the same principle as that of a piano player. The invention by J. A. Fleming of the thermionic electron tube in 1904 proved to be of immense importance, for all the initial developments in the science of electronics depended upon this device.

By the end of the 19th century many factories were making considerable use of mechanization. They had come into being as a result of new machines, new processes and the availability of power. Even as early as 1775 Arkwright had patented a mill in which raw cotton was processed into thread, the whole work being carried out by machines. A flour mill in which the operations were similarly integrated was designed and built by Oliver Evans in Dec. 1787. About 1800 Eli Whitney built a factory to make firearms having interchangeable parts—a notable advance, for interchangeability is a key to mass production. The famous Portsmouth block-making plant commenced production about 1808; it employed special machinery designed by Samuel Bentham and M. I. Brunel and had an annual output of 160,000 ship blocks produced by 10 unskilled men who did the work previously done by 110 skilled men. Samuel Colt's Hartford works, operating in 1848, was one of the first examples of mass production.

In production operations in a factory there are four basic factors: the handling of material, the processing of material, the control of the operations and the production design of the product, whether it is a simple part or an electric motor. Maximum efficiency will be achieved if these four factors are fully integrated; that is, if the handling methods, the processing plant, the production design of the product and the control system are planned and designed as a whole from the point of receipt of the raw material to the department dispatching the final product.

Since the 1920s the rate of technical advance has rapidly increased. New materials have become available and new methods of processing have been developed; electronics has produced new conceptions of nondestructive testing and new methods of control culminating in the electronic computer. These materials and techniques have made possible an integrated approach in some industries, though even in the 1960s knowledge was not yet sufficient to permit it fully in others. (*See* also TECHNOLOGY, HISTORY OF.)

Origin and Use of the Word "Automation."—"Automation" was first used in 1936 by D. S. Harder, who was then with General Motors corporation in the U.S. He defined it initially as "the automatic handling of parts between progressive production processes." The word appears to have been used as an original term to describe the linking of machine tools with automatic materials-transfer and -handling equipment. He later extended the meaning so that the effects of automatic handling were considered in each and every phase of the manufacturing process. Thus the beginnings of co-ordination are to be seen; the idea was soon developed by other workers in the field so that the term covered the integration of the four factors detailed above. A definition given by L. Landon Goodman in 1956 is: "Automation is the technology of automatic working in which the handling methods, the processes, and the design of the processed material are integrated to utilize as is economically justifiable the mechanization of thought and effort in order to achieve an automatic and in some cases a self-regulating chain of processes."

The object of automation is, thus, to make the best possible use of available resources: man, material, money and machine. (The use of men in the process is not precluded by Goodman's definition.)

A new word without an accepted definition is apt to be variously used. Automation is no exception, and the word is sometimes employed in a reversion toward its original sense to stand for mechanization or to describe a simple automatic device, mechanized handling or a single process with automatic control.

Elements in an Automated System.—An automated system can be considered to be made up of four distinct but closely interlocked parts: (1) the processing system; (2) the mechanical handling system; (3) the sensing equipment; and (4) the control system. In planning an automated system it is necessary to consider all four parts at the same time in order to achieve self-regulation. Included in the term "processing" is the production design of the product. A change of product design, material or specification may allow another method of processing suitable for automation to be applied.

Sensing.—Sensing equipment plays a role analogous to that played by the physical senses. It observes what is happening, sends the information to the control unit and endows the whole system with a predetermined degree of sensibility. Electronic techniques have played an immense part in broadening the range of possible application, so that the physical senses can be considerably extended by these means. Such techniques employ photoelectric cells, infrared cells, high-frequency devices and devices making use of isotopes, X-rays, ultrasonics and resonance. These devices can be very sensitive indeed: not only can an infrared cell measure the temperature of stars, but it can detect, with the aid of only a small reflector, the heat of a 2-kw. electric heater at several miles' distance.

Sensing devices offer numerous advantages. Speeds of operation are many times faster than the maximum possible by human means. There can be no fatigue and absolute accuracy of inspection is ensured. Further, observations can be made in places which are inaccessible to or unsafe for human beings; *e.g.*, in a nuclear reactor. Many quantities and qualities cannot yet be measured

continuously or with sufficient accuracy or reliability, though each year sees their number diminishing.

Control.—Within the obvious limits of magnitude it can almost be said that if a quantity can be measured it can be controlled. One of the earliest studies of the theory of control was made by Clerk Maxwell in the 19th century, but it is only since the 1930s that the common principles involved in a diversity of control and regulating mechanisms have been recognized.

Manual control of an operation means that some person has to regulate the operation in order to achieve the desired result. In the figure (A) a man observes a meter and acts accordingly. He is "closing the loop." But the loop can be closed by a mechanical or electrical control, as shown in (B). A closed-loop system has a control unit which receives information from a sensing element, compares the actual state with that required by the program and, when there is a difference between the two (called the "error"), makes the necessary adjustment to the control element so that the desired state is maintained. This cycle of operations is continuous. A simple illustration is provided by the domestic automatically controlled electric cooker. In this instance the processing unit is the oven, the sensing device the thermostat, the control the on-off oven heat switch and the program the knob and its auxiliary springs, which are turned to a desired position, that is, oven temperature, which then will be automatically held. The method of operation is this: when the thermostat senses that the oven temperature has risen above the level set by the position of the knob, the control device—that is the switch—adjusts the temperature by switching off the electricity; similarly, when the thermostat senses that the oven temperature has fallen below the set level, the control device switches on the current again. Thus the oven temperature is kept reasonably constant between narrow limits. This is an example of a simple form of what is called "on-off" control. More sophisticated types, which do not switch the quantity controlled on or off, but regulate it automatically and continuously, are normally required for industrial applications. In this way not only temperature but speed, moisture, colour, thickness and many other variables met with in practice can be controlled.

Often the terms "automatic control" or "full automatic control" are encountered, and as these sometimes express the difference between mechanization and automation they are worth considering; they are shown diagrammatically in the figure (C) and (D). With automatic control the cycle of operations takes place in accordance with the program fed into the control and a sensing element or a man may inspect the results; if they are not up to the required standard, the material is either rejected or the plant is shut down. With full automatic control (D), the sensing element again inspects the material, but the information in this case is fed back to the control unit, which then automatically makes any necessary adjustments to the process, so that any tendency to deviation in the measured variable of the material is corrected.

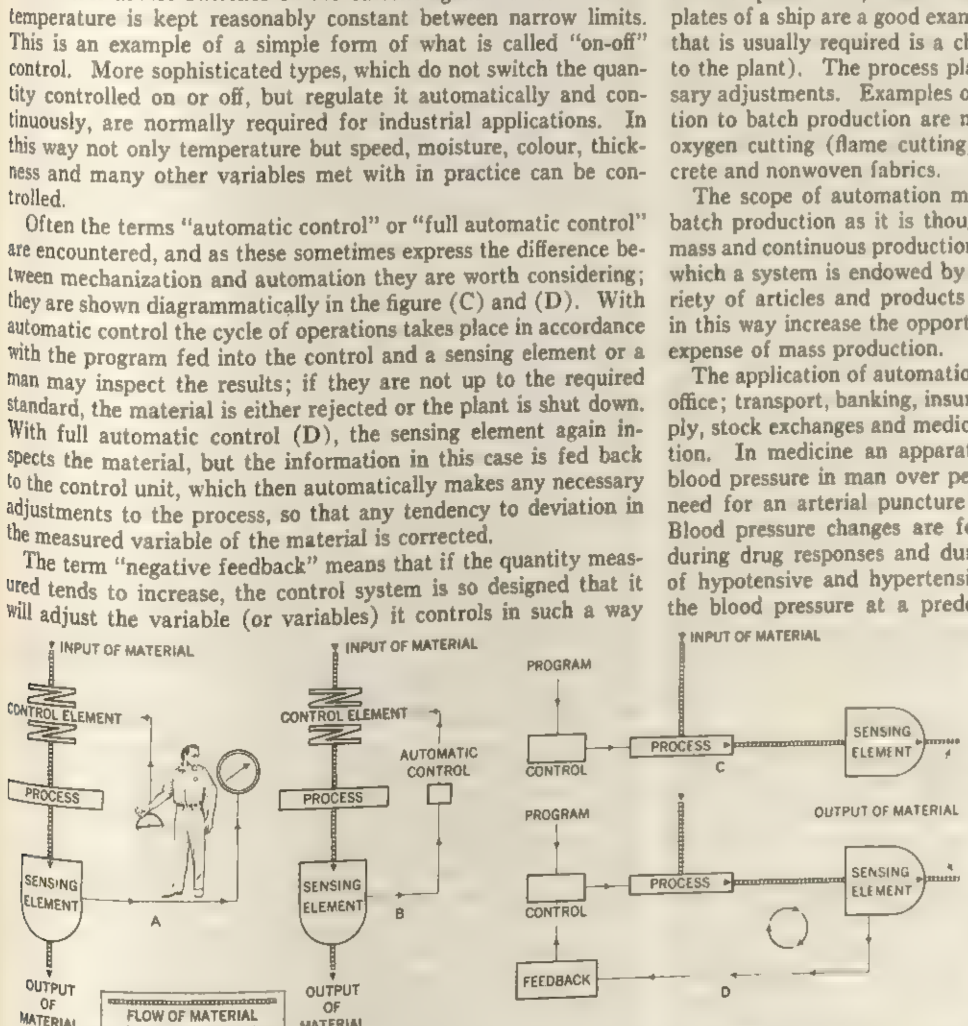
The term "negative feedback" means that if the quantity measured tends to increase, the control system is so designed that it will adjust the variable (or variables) it controls in such a way that the measured quantity will tend to decrease, and vice versa. In this way the output is kept reasonably constant. Automatic volume control in a radio operates in this manner: when the signal received begins to fade the automatic control raises the volume; when the signal increases the volume is lowered, so that better listening, close to the desired volume, results under variable conditions of reception.

Feedback control systems occur in the human body: the heartbeat rate and body temperature are two variables controlled in this manner. The method is also used in movement: when the hand reaches out for a glass of water a complicated series of operations begins—the will (the program) instructs the control (the brain) from which the hand receives its instructions; the eye senses the hand's position as it moves toward the glass and transmits the information back to the brain which then compares the actual position with the desired one and makes the necessary corrections; this series of operations is continuously carried out until the hand reaches the glass. (*See* CONTROL SYSTEMS.)

Scope of Automation.—It is often stated that automation can be applied only to large scale and repetitive operations. But this is not the whole story. A large output of identical articles can often be well-handled by highly mechanized systems. Variations from the norm occur gradually and over a period. Thus, inspection can take place outside the processing at suitable intervals and corrections made, say, at the end of a shift. The expense and complication of feedback control is not warranted in such a case. When, however, there are small quantities of a number of different articles of the same type which can be produced on the same machines or by the same process machinery, as is often the case in batch production, then automation can sometimes be used (the plates of a ship are a good example). With an automated plant all that is usually required is a change of program (the instructions to the plant). The process plant automatically makes the necessary adjustments. Examples of economic applications of automation to batch production are numerical control of machine tools, oxygen cutting (flame cutting) of ship plates, ready-mixed concrete and nonwoven fabrics.

The scope of automation may become as large in the area of batch production as it is thought that it will be in the realm of mass and continuous production. Indeed, the very versatility with which a system is endowed by automation may allow a wider variety of articles and products to be marketed economically and in this way increase the opportunities for batch production at the expense of mass production.

The application of automation is not confined to the factory and office; transport, banking, insurance, electricity supply, water supply, stock exchanges and medicine all supply examples of automation. In medicine an apparatus giving a continuous record of blood pressure in man over periods of several hours without the need for an arterial puncture has been designed and is in use. Blood pressure changes are followed during surgical procedure, during drug responses and during hypotension, and the infusion of hypotensive and hypertensive drugs is regulated to maintain the blood pressure at a predetermined level.



ELEMENTS OF AN AUTOMATED SYSTEM: (A) MANUAL CONTROL; (B) CLOSED-LOOP AUTOMATIC CONTROL; (C) MECHANIZATION (AUTOMATIC CONTROL); (D) AUTOMATION (FULL AUTOMATIC CONTROL)

Some Implications of Automation.—The difficulties that come about in endeavouring to define automation and the reason why some authorities dislike the word should now be clear. Most integrated systems of production, particularly if feedback control is used, could be described as automated systems. Automation makes a fresh approach necessary; indeed, some have gone so far as to describe automation as a "new philosophy of production." Be that as it may, there is no doubt that automation does seem to require a different and new consideration of management, labour,

unions and education. There are also social and economic implications. Before these matters are considered it is necessary to cite practical examples of automation at work in industry.

An automatic machine must be fed with raw material and the finished work must be removed. Manual adjustments usually must be made when the raw material varies, the tools wear or the specification is changed. Many of these operations require low mental decisions by the machine operator; he is the slave of the machine rather than its master and works to its tempo. With an automated machine system all these low-level mental decisions are undertaken by the control system; the operator is freed from the machine's dominance and can exercise a supervisory function. Then, however, decisions at much higher mental levels have to be taken, though not at frequent intervals, as, for example, when breakdowns or failures occur.

Automation then, is a way of putting power—usually electrical power—not only at the worker's elbow but also at his mental "elbow." It is a multiplier of man's physical and mental ability and in some cases a very large multiplier indeed; it is a unique means of multiplying his range of perception, speed of mental working and powers of co-ordination.

Effect on Management.—The effect of automation on management makes an interesting study. Traditional structures and organizations, it seems, are not suitable. The speeds of communication have to be increased; much more emphasis has to be placed on research (particularly production research), development and planning. Scientists and technologists have to be brought into the organization at all levels, both for specialist and general duties; various techniques such as market research and operational research become vitally necessary; and management training is important.

Effect on Labour.—Automation, by increasing the human span of work, makes for many more supervisory jobs and brings into being new skills. Men can tend to become isolated physically as well as mentally and the layout of people becomes as important as the layout of plant. Teamwork is essential, but individualism should be maintained, a most difficult result to achieve. The history of mechanization teaches that mass production, for instance, has created a multitude of jobs (compare the number that were employed in the making of horse-drawn carriages to the vastly greater numbers that are employed in motorcar manufacture). Automation brings products within the reach of the multitude and must therefore bring more jobs, but not necessarily the same type of jobs, into being. Problems of redundancy will arise, which should be of a short-term nature, but this of course is not much consolation to the individual who loses his job. Redundancy must be handled sympathetically, and proper planning to minimize disturbance should be undertaken. There is a pressing need for some trade unions to change their attitude toward retraining.

Social and Economic Aspects.—Automation will not necessarily bring in its wake greater happiness, but it will certainly bring a higher standard of living. More leisure will come about through shorter working hours and more people will have greater opportunities to pursue their interests and to travel. Heavy capital investment is involved, which implies a high level of saving. The economy will become tautened, or more highly tuned, and there will be a greater need for skilled direction.

AUTOMATION AT WORK

The following material has been drawn from a wide range of examples. Some of the illustrations may be on the border line of automation but they are included because they could take their place, say, in an automatic factory and they do indicate a definite trend.

Machine Tools.—The development of mechanization in industry often proceeded along simple lines. Each particular human job was mechanized, hence the mechanized span of work was equal to the human. The result is that the man is left as a linking device. The operator of a general-purpose machine tool frequently has to intervene in an otherwise automatic sequence and because of the shortness of the intervals he cannot be released for any other work. Programmed sequence control has been developed for work-holding, machine-slide movement, spindle feeds and speeds and similar motions which are usually under manual control. Electrical multibank stepping switches are used which signal a program through electrically operated air valves to air-operated cylinders controlling the machine. Besides the savings in costs, there are improvements in accuracy, finish and tool life. Another development which is becoming popular is the automatic replacement of worn-down tools by new ones; *i.e.*, automatic tool changing. There are also cutting machines which gauge each part as it is produced and compensate for tool wear by automatically resetting the cutting tool.

Punched tape, punched cards and magnetic tape can be used to position and operate a machine. Tape control on a nylon stocking knitting machine makes it possible to produce an almost infinite number of sizes with one tape. Changing from one size to another by the old method required from 10 to 30 min. shutdown time with the possibility of mistakes. A change by the new method takes but a few seconds and the control is remarkably flexible, easy to manipulate and saves time while increasing productivity.

The Drivmatic machine clamps the workpiece in position, drills and countersinks the rivet hole, injects the slug rivet, upsets the bottom of the slug, upsets the top into the countersink, mills the top head flush, unclamps the workpiece and resets itself for the next sequence. The sequence of operations and the operations themselves are automatically controlled by a tape unit using 35-mm. motion-picture film.

The same system of control is used for automatic co-ordinate setting on boring machines. Costly jigs are dispensed with, and much time is saved in setting up. The movements of the boring machine are operated by servomechanism (*q.v.*), and measuring devices record the relative movements between the respective parts of the machine and its bed.

Machine tool control by magnetic tape playback is another method which could have applications in a small factory and for batch production. A part is made manually and all the machine movements are recorded on a magnetic tape. When the tape is played back it repeats the operations and an identical part will be made, but much more quickly. The tape can be run any number of times.

Computer Control.—Numerical control of machine tools by computers has made great strides, particularly in the aircraft industry. Automatic machine tools are efficient and reliable when large quantities of identical parts are required, but changing automatic from one preset cycle to another is a long and expensive affair and would only be carried out for a long run. There are many instances when only a few parts are required and it is in such work that the computer-controlled machine is valuable. There are two types of computers used—digital and analogue. A digital computer operates with numbers represented in digital form, a digit being one of a definite set of symbols used to represent numbers. It is the digital computer which is used in electronic data processing. The analogue computer is based on an analogy of quantity; it deals with physical quantities and not numbers.

In a digital control system information from a drawing is put on a punched paper tape which is fed into a special type of computer which computes from the information the continuous path of the cutting tool. The output is recorded on a magnetic tape which is later fed into the machine-tool control unit when required. One computer services a number of machines. Tapes can be sent by mail, stored and used any number of times on future occasions, simply by replaying, if similar parts are wanted again.

For best results, the electronic control equipment and the machine tool must be designed together. The increase in productivity resulting from this type of control is remarkable. In machining one particular part, the time taken by the conventional method was ten hours. Using computer control, 92 min. were taken in planning time and the actual machining time was 14 min.

This method has been applied to the control of oxygen cutting of steel plate. When irregular shapes are required, as in shipbuilding, it has been the practice to make a wooden template and to follow its outline by hand control, a method which does not always give accurate results. Again, information is processed by

a special computer which then prepares a magnetic tape for use in the control console of the machine. With this tape the machine can automatically cut plates of complex shapes with great accuracy. This development has particular importance for fabricating steel plate and is a good example of automation applied to batch production. (*See* COMPUTER.)

Automatic Transfer.—The transfer machine line consists of a series of machines linked by mechanical handling equipment, the whole being centrally controlled. The parts are moved automatically from station to station along the line and have various operations performed on them such as broaching, drilling, milling and tapping. Automatic assembly operations are sometimes carried out by transfer machines. Usually no feedback control is employed, although various inspection procedures are carried out, for example, probes to indicate whether holes have been drilled; if the result is negative, then no signal is generated and the machine or one of its sections will be shut down. Tools have to be manually changed and there are various devices for indicating when this is necessary. One line, 350 ft. long, incorporates 181 electric motors totaling 996 h.p. and performs 555 machining operations on V-8 car cylinder blocks. It is controlled by one man.

Automatic transfer machines fall into three classes: straight-line, rotary and a combination of the two. The design of these machines differs in the United States and Europe. The U.S. favours highly specialized machines, whereas in Europe more flexible units have been developed with universal heads that can be modified with relative ease. To meet this need there is available a number of units or building blocks, which can be built up into quite complex machines. One such unit is an electrically driven indexing table which can undertake a series of up to 14 operations at once, including machining, forming, inspection and assembly. Another is an electromechanical unit head, with up to 30 spindles per head, which can be used in a single or multi-station indexing machine.

The electrical control of transfer lines is complex and a large number of switching units are required. In order to improve the reliability of the control system and to reduce maintenance, electromechanical switching is now tending to be replaced by electronic switching using cold-cathode tubes, magnetic amplifiers and solid-state devices. (*See* MACHINE TOOLS.)

Processing.—Many new methods of processing have been developed and are in use. It is interesting to note that a number are based upon principles which have been known for many years. These new methods are of particular importance in the application of automation in that they often lend themselves to a high degree of automatic control and are easily integrated into a production line. Dielectric heating, used in the furniture industry for gluing joints, enables new product designs to be made, eliminates the need for jigs and attendant storage space, and allows a much greater output to be obtained; increases of up to 300% are claimed. Induction heating is used for surface hardening, soldering, brazing and making glass-to-metal seals. Heating times are extremely rapid; for example, a two-station handling fixture connected to a 9-kw. generator hardens 38 tappet screws and 6 rocker pads in a minute (*see* HIGH-FREQUENCY HEATING). Soldering, brazing and hardening operations can thus be carried out automatically with machine-tool precision. Other processes of interest are electroforming, electropolishing, electro-spark machining, power spinning and powdered-metal forming.

Automatic Assembly.—Most products are assembled by hand, but the list of those which are automatically assembled increases year by year, though not as quickly as might be expected. Too often mass-produced articles fail or give trouble because of careless hand assembly. There are several reasons for the slow progress of automatic assembly. A product must be designed specifically for automatic assembly and must be accurately and consistently manufactured (otherwise it might jam the assembly machine). Parts easily grasped by human hands are not usually so easily handled by a simple mechanism. Many of the component parts made at present are not suitable for automatic assembly. Automatic assembly machines tend to be expensive and are somewhat inflexible; they are only economical if run at high outputs which are very large by present standards, but this situation could rapidly change with an increase in labour costs.

It is probable that outputs of individual manufacturers are not yet high enough to justify automatic assembly, but if any one manufacturing unit reached the break-even point for its adoption by expansion or amalgamation, it might soon force its competitors to employ this method, by amalgamation or other means. This argument is one that applies to other branches of automation, for there is no doubt that many of the new developments requiring large amounts of capital and having large outputs tend to create larger and larger manufacturing units.

Assembly machines can be built from some standard components, such as indexing tables and straight-line assembly machine bases, which are designed to provide basic movements for a wide variety of applications. They may be repeatedly used for different assembly operations by changing the working heads and resetting the controls.

One of the best examples of automatic assembly is provided by the use in the electronics industry of printed-circuit boards, component-inserting machines and dip-soldering techniques. The basic principle is relatively simple. The boards are moved by a special conveyor through a number of inserting stations, at each of which there is a component-inserting machine carrying a magazine of components. Each board stops and is clamped at a station and the inserting head then fixes a component to it; this procedure is repeated at every station with different components so that at the end of the line the board has a full complement of components. Automatic soldering is then carried out. This system is interesting for several reasons. It is highly mechanized, indeed automated, yet extremely flexible. Design of circuits can be changed easily and quickly. The components and their positions can also be changed. This example shows clearly that it is essential to redesign a product for automatic assembly; with the printed circuit, automation is simple, whereas it would be quite impracticable to mechanize the conventional method of wiring—the complex of wire and the soldering in, say, the older television set. Even if such a method had been developed it is unlikely that it would have been so flexible that circuit designs could be changed quickly. (*See* PRINTED CIRCUIT.)

Automatic assembly is being used in the production of subassemblies for 40-amp. and 60-amp. capacity contactors; the plant is made up basically of five circular indexing tables. In the motor-car industry, batteries, clutches, spark plugs, transmission couplings and door panels are among the components assembled in this way. At the Renault works in France a 17-station automatic transfer line is used for assembling rack-and-pinion steering boxes. A six-station unit inserts the studs, places the three main bearings in position on their seatings in the block, and threads the nuts on the studs and tightens them prior to fine boring. One operator does the work formerly done by six men.

The Bell Telephone company in Belgium has developed an automatic assembly line, which consists of a group of five machines, for the assembling, testing and packing of carbon microphones. The automatic machines are connected by synchronized transfer mechanisms. The assembling group is made up of 2 automatic machines, each having an indexing table with 12 positions that is driven by an air cylinder. The first machine assembles the front of the capsule, and the second the rear side. The company claims the following advantages for the system: (1) a shorter production cycle, so that exposure of the carbon chamber to dust is reduced to a minimum; (2) greater cleanliness of the product; (3) higher production; (4) better quality and greater uniformity of the product.

Ball pen refills are assembled on an indexing table at the rate of 60 a minute. The quality of the product has been improved and the saving in labour amortizes the cost of the machine in about 23 working weeks.

Industrial Finishing.—High costs are often incurred in finishing and painting; in the case of office furniture the cost per square foot may be much higher than that of the basic material. Automatic methods can play an important part in lowering these costs; electrostatic and hot-spray painting are examples. The present

trend is to work the finished material so that no finishing operations are required after fabrication and assembly. The idea is not new and has been used for many years in tin can making (see CANNING, COMMERCIAL). Plastic-covered steel sheet is already on the market; the adhesion of the coating to the base metal is so good that the material can be subjected to rather severe forming operations without delamination. Industrial finishing is used in the manufacture of office furniture, wall paneling, television cabinets, containers and cable trunking. There are distinct advantages in fabricating from pre-finished coated materials from the point of view of automation. The coating of continuous strips or sheets lends itself to automated working, whereas finishing articles of complex shape in their final form restricts its application. When the coating is carried out immediately after the final processing of steel, the cost of subsequent rust removal is eliminated.

Inspection and Testing.—Many different automatic inspection and testing machines are in use today. When the manufacturing process incorporates feedback, inspection machines may be a part of the control system. In some mass production industries, automatic machines are used to measure a number of dimensions of a part and then to sort the parts according to tolerance. Components are mated with others having suitable dimensions and a constant, close, predetermined fit is obtained.

A three-dimensional tape-controlled inspection machine has been developed. A measuring head with a stylus which can indicate movement in three dimensions replaces the cutting tool on a computer-controlled milling machine. The machine operates with a tape which so controls its movements that the stylus is always in contact with the surface being inspected. Any difference in shape from the programmed part as given by the tape causes the stylus to move and a recording is made.

Automatic machines are used for checking electronic circuits during manufacture. One machine with one unskilled operator handles over 100 different types of printed circuit board assemblies at a rate of about 3,000 a week. It performs up to 400 separate tests on each board, including continuity, leakage resistances, resistances, impedances and static voltages.

Electronic sorting by photoelectric cells of peas, lemons, coffee beans, nuts and other produce is in wide use. One installation of 140 machines can sort a total of 2,000 peas a second. The fully automatic sorting of coffee beans has allowed the upgrading of coffee, previously not considered suitable for export, to an exportable standard.

Nondestructive testing of material, which lends itself to automatic working, is making great strides because it is expensive, wasteful and unnecessary to use costly manufacturing facilities for processing parts from materials that are defective from the start. Jet and steam turbine blades, malleable castings, air frame parts, food, confections and ammunition are among the articles inspected in this way.

Instrumentation and Control in Process Industries.—Two major matters are delaying adoption of the computer-controlled process: lack of knowledge about particular processes and the theoretical relationship between all the variables involved, and lack of instrumentation for continuously measuring some of the process variables.

Continuous measurement of several physical quantities can now be made; *e.g.*, temperature, pressure, level, weight, flow and volume, together with viscosity, moisture content, conductivity, pH, liquid density, refractive index, specific gravity and, in some cases, chemical composition.

Much remains to be done. Not all analyses can be undertaken continuously, few analytical techniques are fast enough to apply in a continuous control system, and reliability is still generally not high enough. The infrared analyzer—fundamentally a simple optical system—has taken ten years of development by manufacturer and user before becoming moderately reliable. Reliability is of prime importance, because it is costly both to interrupt the process and to provide skilled maintenance. Many boilers have been working well below their maximum efficiencies because small users have found the maintenance of carbon dioxide analyzers and oxygen analyzers to be too expensive. Another major problem preventing the widespread use of process analyzers is the difficulty of securing a fair sample of a process stream in various types of plants.

As plants become increasingly complex and more and more process variables have to be measured, the necessity for checking a large number of measured and controlled values makes some form of data reduction necessary and automatic scanning desirable. Much of the information gathered is of no practical use except for research and during periods of disturbance or emergency. Data reduction, automatic monitoring and scanning of process variables are being used to an increasing extent. Such equipment in a power station will automatically and continuously scan, and record at very high speeds, readings of instruments measuring flows, levels, pressures and temperatures of boilers, furnaces and turbine units. The system will print out the relevant data at regular intervals, and will record and give warnings of any deviations from normal in the readings. It will also compute and record continuously the over-all boiler efficiency.

It is usually not the mathematical ability of digital computers that is required in industrial control applications but the ability to store and manipulate large numbers of observations. Computers are also needed which can receive information from any one of a large number of separate places, carry out the necessary calculations and issue the answer or order to one or more of a similar number of positions scattered around a plant in a matter of seconds, or, at most, a minute or two.

Several computers for on-line process control are on the market. One of the first installations controlled the polymerization stage of a petroleum refining process at Texaco's refinery in Port Arthur, Tex. Among the units available is an on-line process analogue computer. It employs time sharing of a minimum number of computer elements through the problem, by using the basic fact that in process control work the variables often change value relatively slowly. The computer accepts up to 48 inputs and computes up to eight outputs for control purposes. A complete scan is made in 25 sec. This is a useful unit for the piecemeal analysis of a plant, and also for subsidiary process control in large plants.

Two digital systems are also of interest. The Elliott system uses a central computer which controls the set points of individual controllers. Additional information not available from on-line instruments is fed manually into the system. Thus there are a number of local loops with one over-all loop. The Ferranti Argus process control computer can operate in this way or as a central controller. It is taking the place of conventional three-term controllers in a chemical plant; the outputs from thermocouples, pressure transducers and flow meters are fed straight into the computer and operated on in accordance with a program. Information is then sent out to various controlling devices. Between 200 and 300 variables are handled. In this instance, then, there is only one over-all loop. It is too early to prophesy which system will prove most efficient. Obviously the chances of complete plant shutdown are greater in the latter case. In this connection it is of interest to note Ferranti's statement that an Argus unit has run for 5,000 hr. on simulated control, with only four failures, all of transistors; but many years of operation may be needed before any true assessment is possible. Another development that has reached fruition is the sequence starting of plants. In the case of a power station boiler start-up about 700 variables are controlled by over-all regulation of three-term controllers.

These process computers are a new generation of machines. Among their features is a time-sharing facility which allows several different plants or processes to be handled concurrently. Even at this stage the application of a computer to plant control will allow much to be learned about plant characteristics, and hence will speed up this form of control as a result of monitoring process variables, continuous data collecting and logging, and performance computation. Between data-logging operations, the computer's general-purpose computing abilities can be used for statistical analyses, material and energy balances, and other complicated or tedious calculations.

The end-point optimizer or optimizing controller is another noteworthy development. This can be a relatively simple device

which searches continuously in an attempt to maximize the index that it is given as a measure of its success. The controller experiments by reading the index of performance, altering the set point of a conventional controller or similar plant setting by a small amount, allowing the plant to settle down and then finding whether the index has improved or deteriorated. From this result it decides its next move. The operation is repeated until the optimum index is achieved. This type of controller is the forerunner of a new type of computing system that will be able to learn or to gain experience. It will have a memory, and by trial and error within certain limits it will be able on its own to control a large plant, having in the learning process discovered what not to do in order to obey a program worked out according to a principle which simply says "optimize with respect to some particular characteristic." Computers are capable of following general instructions that are contingent upon the occurrence of particular events.

Centralized control implies the means of communication between the controller and both the controlled element and the sensing element. This is called "data transmission," and in factory or plant or between associated factories it is usually carried out with the aid of wires, though other methods are not precluded (microwave radio is used in a few cases). The subject is in its infancy. A simple equipment called a Multiplex indicating apparatus monitors direct-current signals which show the operating state of the unit being tested. Up to 12 units can be monitored simultaneously and instantaneously along a single pair of wires not exceeding 300 route miles. Thus great savings can be made in the complexity and cost of cabling.

Railways.—Railways throughout the world are beginning to apply automation and are drawing on experience gained with automatic control of industrial plants and with automatic control in other fields, as in the aircraft industry. A series of successful tests have been reported from the U.S.S.R. of new automatic control systems applied to a moving train. The equipment is in essence an electronic analogue computer designed to give optimal control of an electric locomotive running on a given track and following a given timetable. It limits the action of the driver to simple on and off operations of the automatic equipment during stops at the stations; he takes full control of the engine only in an emergency. The control commands are continuously fed to a system of servomechanisms in response to data gathered by sensing elements placed in strategic positions on the engine and track. The system operates the train with greater precision and economy than can even the most experienced driver. Results show a 7% saving in power consumption and a 15% increase in traffic.

The first fully automated underground railway in the world began operation in Hamburg in 1962. An electronic computer controls the whole system, which extends under the entire city. The control starts and stops trains, directs them to platforms, and changes speeds as necessary.

London Transport has installed a system of completely automatic operation of junctions on their underground railways. A progressive punched tape contains codes of train destinations and these arrange for the correct route to be set in a safe manner as a train approaches a junction. Previously these routes were set by signalmen located at junction signal boxes. Although automatic routing had not yet been applied to main-line railways in Great Britain by the early 1960s, amalgamation of signal boxes was being undertaken.

A different application of modern control techniques concerns the automatic operation of marshaling yards where freight cars (freight wagons) are collected and re-sorted. Such operations, when performed without automation, involve the use of a large amount of man power and consume a considerable amount of the total time freight is on the railways. In the most modern technique the cars are sorted by gravity in a hump marshaling yard (*see* RAILWAY: *Classification* [*Marshaling*] *Yards*) and on their way from the reception sidings down the gradient to the marshaling sidings the car speed is controlled by power-operated retarders. The routing of the cars is completely automatic from destination lists prepared beforehand. The running characteristics of cars in these yards are measured as they progress down the gradient and the requisite running distance into the sidings is given and corrected continuously; an analogue computer is used to calculate the correct speeds at which cars should enter the sidings. The speeds are controlled by retarders located on the track in accordance with the desired release speeds given by the computer. While the cars are passing through the retarders their actual speed is measured continuously by means of radar devices; this measurement and the calculated release speed are combined to control the retarder. These methods employ a minimum staff and result in speedier and safer handling of freight traffic. The yard at Margam in Wales can sort 4,500 cars and deal with 220 trains a day. Information on cars in reception sidings is given to the main control by radiotelephone and a tape, punched with holes to correspond to the information, is fed into a computer.

Air Transport.—Modern aircraft, particularly military planes, carry much equipment that is automated. A development of the automatic pilot can land an aircraft without the aid of a human pilot under conditions of zero visibility. Computers are being used for air-route traffic control; they relieve the operator of clerical detail involved in separating traffic in the air, carrying out this part of the work far more quickly.

Seat reservations in New York city are handled by a special central booking system. Ticket agents throughout the city can interrogate the machine to find out the available seats on particular flights. The vacancies are indicated, and if the agent sells the seats he communicates the details of the sale to the machine, which then subtracts the number from the inventory for that day's flight.

Flight simulators are used for aircrew training. A cockpit, identical to the one in the aircraft being simulated, is provided with a set of controls and instrumentation. The pilot's control movements are transmitted to an associated computer which computes the aircraft's response and displays the results on instruments. The pilot closes the loop by interpreting the information presented to him and making the necessary adjustments. A large number of different problems and flight conditions can be fed into the computer and so presented to the crew for their solution during the course of their mock flight. Such a simulator reduces the actual flying time required for general training purposes to about 25% of that normally required, thereby making large savings in money and freeing aircraft for more profitable duties.

Food Manufacture.—Automation has much to offer in food manufacture, including a guarantee of a high standard of cleanliness with the ingredients and products truly untouched by hand.

Biscuit and cookie manufacture provides some representative examples. Road tankers deliver flour, glucose, sirup and sugar to storage tanks, from which they are conveyed under automatic control to mixers and finally as dough to the ovens. Control is by a punched-card recipe system and a master control panel, by means of which the correct quantity and variety of flour is forwarded, while preset digital controls ensure the delivery of the required quantities of fat, sirup and glucose. Requests for a mix originate from the oven operator, who presses the appropriate button and so actuates the programmer which, in the event of more than one request at the same time, scans all the ovens in a set order until it finds one making a request. It then selects the recipe for that particular oven and initiates the supply of each ingredient to the receiver above the mixer. When weighing and dispatching operations are completed, the programmer hunts for another oven making a request.

In some cases there are added complications; in ice cream manufacture different mixes vary in content of butterfat and milk solids. The mix for a given formula must be recalculated daily—based on information from laboratory analysis—due to fluctuations in these contents. In one installation an analogue computer, separate from the control system, determines by simultaneous equations how much of each ingredient is required for a mix and digitally converts this information into pounds for translation by the batch-blending system. The manufacture of sugar, both cane and beet, and confections are other branches of the food industry which employ automation.

Mining and Quarrying.—A high level of mechanization has been employed for some time in the mining and quarrying indus-

tries, but developments involving automation have taken place in mining, *e.g.*, in the U.S.S.R. in the Donets basin, in Sweden at Kiruna and Malmberget (where there are large iron ore mines) and in Germany. In Great Britain a manless mine was being developed in the early 1960s. A nucleonic probe is fitted to the coal-cutting machine; this probe determines the thickness and undulations of the coal strata and directs the cutting head away from rock and other unproductive areas. The information obtained by the probe is transmitted to a control station from which the cutting machines are directed. The coal is carried on a conveyor to a loading head and raised to the surface without human attention. Hydraulic rams move the conveyor nearer to the coal face when the coal has been cleared. The roof supports automatically follow in a gradually advancing row, then cutting starts once more. Instruments on each support measure the vertical thrust against the roof and determine the exact position of the mobile supports. This data is required not only for controlling the sequence of operations but also for planning them in relation to strata formation.

Underground gasification of coal (burning the coal in its seam and piping the resultant gas to the surface) lends itself to the application of automation, but the method can only be used where conditions are suitable.

Textiles.—The mechanization of the spinning and weaving processes in the manufacture of cotton cloth took place at the beginning of the Industrial Revolution, but traditional designs of machinery are still in use. It is hard to conceive of any great increase in the application of electronics and automation to these machines; a large number of machines running in parallel means that even the introduction of a small item in one process results in possibly 100 or more pieces of apparatus being required. A new process for making nonwoven fabrics has been developed (such fabrics have their own characteristics that make them preferable for some uses and inferior for others in comparison with a spun and woven fabric). The new process readily lends itself to automation. Preparation machinery is still needed, but the large number of machines thereafter necessary in the conventional method are replaced by a single piece of equipment which takes the open and prepared fibres, turns them into a fabric by arranging them in the form of a mat and then bonds them chemically or physically so that they adhere together.

Retail Trade.—In the area of retail trade, automation is at present mainly used for inventory control or stock balances in department, chain and mail-order stores. In one store, all articles have information on their tags punched on one half and printed on the other. When a sale is made the printed half is handed to the customer as a receipt, and the perforated half is sent to a central processing department. Valuable information is quickly obtained, such as analyses of sales and stock positions. The system works at night, so that each morning buyers receive reports on the previous day's trading. The same system can work with information provided on printed or punched tape by special types of cash registers.

Warehousing.—Materials-handling studies have done much to change warehousing methods during the postwar years, and applications of automation now bid fair to make a further change. The driverless truck is a battery-electric tractor, electronically controlled to follow a continuous wire embedded in the floor. Trucks can be sent from one stopping place to any other station along the route, and routes can easily and quickly be changed. Safety devices are incorporated; for example, if a truck comes into contact with any object, it automatically stops. Driverless trucks have many uses in warehousing for the collection and distribution of goods as well as in other situations, such as railway terminal storage sheds.

It is possible to send some types of goods entirely through a complete warehousing cycle by mechanical equipment with electrical and electronic controls. Such procedure is economical only when there is sufficient activity among the stock items to keep the system fully utilized. Excellent opportunities often exist for introducing automatic handling and sorting without necessarily trying to make automatic the whole method of operation. A completely automatic installation might consist of conveyors from the receiving area feeding storage racks, which themselves would feed through selector gates onto other conveyors carrying the selected items down to the packing department. The whole installation would be under a master controller complete with memory unit. When goods are received, they would be recorded in the control and then routed to a storage point. An order for goods would be placed in the control unit, which would select the items from the storage racks and keep them together until they reached the packing department. No conventional paper records would be necessary, as the controller would maintain its own inventory.

In planning one punched-card automatic warehouse system to deal with orders throughout an entire sales area, it was decided that 72 of the most active items would be automatically handled. This resulted in 80% of the total volume being handled automatically. "Live" storage racks hold the 72 items, and the system can handle a variety of carton sizes ranging from 5 × 5 × 7 in. to 18 × 18 × 8 in. The automatic racks are manually filled. The control automatically reads, sorts and memorizes orders at a rate of 100 cards a minute; cartons are picked from the racks at the rate of 50 a minute, resulting in a total dispatching time of about one minute for the average order. The control ensures that cartons are discharged in a pre-established sequence which avoids pile-ups.

The Automatic Factory.—The ultimate object of automation is a state of affairs where the raw material enters the factory at one end and the product emerges at the other ready for dispatch, the whole production sequence being automatically controlled. Parallel and integral with the production would be automatic data processing (the equivalent of paper work) for ordering raw materials, scheduling, accounting and invoicing.

There are few automatic factories in operation, though one or two examples come very near to this description. One of the earliest was a plant designed and built by J. A. Sargrove in England in 1947 for making small radio receivers for the Chinese market. This project was abandoned for several reasons, among which were the collapse of the proposed market and the difficulties in obtaining consistency of results. The U.S. national bureau of standards developed project "Tinkertoy," a subassembly module processed from raw material, to meet the need for high-speed, high-volume low-cost production of electronic control equipment, suitable for defense purposes, available in an emergency, and on the assumption that there would be little or no skilled labour available.

Automatic plants that produce mixed and ready-to-use concrete are in operation. They are usually electronically controlled from a central panel, and manual labour is entirely absent.

A well-publicized example of an automatic factory is a plant in the U.S.S.R. which produces car pistons; it began operation in 1950. Aluminum ingots enter at one end and four sizes of piston emerge at the other, greased and wrapped. Apart from the initial loading of the ingots, all processes are automatic.

The Automatic Office.—The operations of an automatic office in commerce (for example, in banking, insurance and on stock exchanges), and in factories for production control, come within the scope of automation. The kernel is usually a data-processing system.

See also Index references under "Automation" in the Index volume.

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AUTOMATON: *see* ROBOT.

AUTOMOBILE, a self-propelled passenger vehicle designed to be operated on ordinary roads. In general, motor vehicles may be classified into several types, according to the service they render. Most numerous are the private passenger cars described in this article, intended usually to transport up to seven indi-

viduals; a subdivision of this type is formed by the so-called sports cars, which are designed primarily for speed and good road-handling characteristics, with passenger comfort a secondary consideration. Commercial passenger vehicles for carrying larger numbers of persons—buses and motor coaches—and commercial freight vehicles for carrying goods and materials are described in the article MOTOR TRANSPORTATION. Professional racing cars, some of them highly specialized and unsuited for ordinary road use, are the subject of AUTOMOBILE RACING.

This article is divided into the following parts:

An account of the industry to which demand for automobiles gave rise may be found in AUTOMOTIVE INDUSTRY, while the development of transport generally is described in TRANSPORTATION. (X.)

I. HISTORICAL DEVELOPMENT

Unlike many other major inventions, the idea of the automobile cannot be claimed for an individual. Perhaps because of man's universal concern with transportation, many individuals did simultaneous work on self-powered road vehicles. The idea surely occurred long before it was first recorded in the *Iliad*, where Homer (in Pope's translation) tells that Vulcan in a single day made 20 tricycles which

"(Wondrous to tell) instinct with spirit roll'd
From place to place, around the blest abodes,
Self-moved, obedient to the beck of gods."

Leonardo da Vinci considered the idea of a self-propelled vehicle. In 1760 a Swiss clergyman, J. H. Genevois, suggested mounting small windmills on a cartlike vehicle, their power to be used to wind springs that would move the road wheels. Genevois's idea probably derived from the Du Quet windmill cart of about 1714. Two-masted wind carriages were running in Holland in 1600 and for at least one of them a speed of 20 m.p.h. with a load of 28 passengers was claimed.

In April 1740, a carriage propelled by a large clock-work engine was demonstrated in Paris by its inventor, Jacques de Vaucanson. Later, toward the end of the 18th century, the idea of compressed-air engines became popular. William Medhurst patented an air engine in 1799, and suggested a grid of compressor stations to service vehicles propelled by it. Samuel Wright (1828) and William Mann (1829) worked along similar lines; Wright is said to have produced an air-powered road vehicle in 1832.

The air engine probably originated with Otto von Guericke (1602–86). Guericke invented an air pump, and was probably the first to make metal pistons, cylinders and connecting rods: the basic components of the reciprocating engine. The Dutch inventor Christiaan Huygens (1629–95) produced an engine that worked by air pressure developed by explosion of a powder charge. Denis Papin of France (1647–*c.* 1712) built a model engine on the vacuum principle, using condensation of steam to produce the vacuum.

A Belgian Jesuit missionary to China, Ferdinand Verbiest, is known to have made, in 1668, a model steam carriage using a principle that was suggestive of the modern turbine. Phillipe Lebon (1767–1804) patented a coal gas engine and was the first to mention electrical ignition. Isaac de Rivas (1752–1829) made and patented a gas-powered vehicle in Paris in 1807; his engine used hydrogen gas as fuel; the valves and ignition were operated by hand, and the timing problem appears understandably to have been difficult.

1. The First Automobile.—The Royal Automobile club of Great Britain and the Automobile-Club de France agreed on Nicholas Joseph Cugnot of Lorraine as the constructor of the first true automobile. Cugnot's vehicle was a large, heavy, steam-powered tricycle, and his model of 1769 was said to have run for 20 min. at $2\frac{1}{4}$ m.p.h. while carrying four people, and to have recuperated sufficient steam power to move again after standing for 20 min. One of the two models Cugnot produced is preserved in the Conservatoire des Arts et Métiers in Paris.

Most authorities are inclined to name Carl Benz (1844–1929) and Gottlieb Daimler (1834–1900) as the most important contributors to the gasoline-engine automobile. Benz ran his first car in 1885, Daimler his in 1886, both in Germany. There is no reason to believe that Benz had ever seen a motor vehicle before he made his own. Benz and Daimler had been preceded by the Belgian J. J. E. Lenoir (1822–1900) and the Austrian Siegfried Marcus, in 1862 and 1864, respectively, but neither Lenoir nor Marcus persisted. Benz and Daimler did persist, indeed to such purpose that the firm of Daimler-Benz could, in the 1960s, trace its origins back to 1895 and claim, with Panhard, to be one of the oldest automobile manufacturing firms in the world. Oddly, Benz and Daimler never met.

The four-stroke principle upon which most modern automobile engines work was discovered by a French engineer, Alphonse Beau de Rochas, in 1862, the year in which Lenoir ran his car from Paris to Joinville-le-Pont. The four-stroke cycle is often called the Otto cycle after the German Nikolaus August Otto (1832–1891), who designed an engine on that principle in 1876. De Rochas held prior patents, however, and litigation in the French courts upheld him. Lenoir's engine omitted the compression stroke of the Otto cycle: the fuel was drawn into the cylinder on the intake stroke, fired by a spark halfway through the stroke, and the burned gases exhausted on the next reciprocal stroke.

The idea for Siegfried Marcus's 1864 car came to him by chance. He was considering the production of illumination by igniting a mixture of gasoline and air with a stream of sparks. The reaction was so violent that it occurred to him to use it as a power source. His first vehicle was a cart carrying a two-cycle engine geared to the rear wheels without any intervening clutch. It was started by having a strong man lift the rear end while the wheels were spun. It did run, however, a distance of about 200 yd. (Marcus's second model, the 1874–75 car, was sturdy and well-preserved enough to make a demonstration run in the streets of Vienna on April 16, 1950, at a rate of 3 m.p.h. It had been bricked up behind a cellar wall in the Museum for Industry and Trade in Vienna in order to prevent its destruction at the time of the *Anschluss*. Marcus was Jewish, and the Nazi forces had specific instructions to destroy the machine and all copies of a 1924 brochure containing original photographs of the 1864 and 1874–75 models.)

In 1898 the Austrian Automobile club arranged an exhibition of motor cars and Marcus was a guest of honour. However, he denied interest in the entire idea of the automobile, calling it "a senseless waste of time and effort."

In 1823 or 1826 an English mechanical engineer named Samuel Brown drove a self-powered road vehicle up Shooter's hill in London, and he has sometimes been put forward as the first designer of an internal-combustion engine. An eye-witness account of Brown's drive exists and so do his patent specifications. His engine derived from the Newcomen condensing steam engine, had separate combustion and working cylinders, and apparently used carbureted hydrogen as fuel.

Léon Paul Charles Malandin produced a four-wheel vehicle with a four-stroke, two-cylinder gasoline engine in 1883, and he too is sometimes cited as the first to run an automobile with a true in-

ternal-combustion engine. However, his claim, like the others, falters before the continuity of the Benz-Daimler efforts.

2. The Age of Steam.—Before any internal-combustion engine had run, the followers of Nicholas Cugnot were on the road, notably in England, although the first post-Cugnot steam carriage appears to have been that built by Charles Dallery of Amiens, Fr., in 1790 and Amédée Bollée-Père (1844–1917) designed and built a successful steam coach. Steam buses were running in Paris about 1800. Oliver Evans of Philadelphia ran an amphibious steam dredge through the streets of that city in 1804. Less well known were Nathan Read of Salem, Mass., and Apollo Kinsley of Hartford, Conn., both of whom ran steam vehicles during the decade 1790–1800.

English inventors appear to have been in the van, and by the 1830s the manufacture and use of steam road carriages approached the status of a minor industry in the British Isles. James Watt's foreman, William Murdock, ran a model steam carriage on the roads of Cornwall in 1784 and Robert Fourness showed a working three-cylinder tractor in 1788. Watt was opposed to the use of steam engines for such purposes; his feelings were so strong that he inserted into the lease of a house he owned a clause stating that "no steam carriage should on any pretense be allowed to approach the house." Watt's low-pressure steam engine would have been too bulky for road use in any case.

Richard Trevithick developed Murdock's ideas, and at least one of his carriages, with driving-wheels 10 ft. in diameter, ran in London. Sir Goldsworthy Gurney, the first commercially successful steam-carriage builder, based his design upon an unusually efficient boiler. However, he could not be convinced that smooth wheels could grip a roadway, and so he arranged on his first vehicle for propulsion by iron legs digging into the road surface; this delusion persisted for some time and not only with Gurney. His second vehicle was said to weigh only 3,000 lb. and to be capable of carrying six persons. He made trips as long as 84 mi. in a running time of 9 hr., 30 min., and once recorded a speed of 17 m.p.h. (A rate of 32 m.p.h. was later claimed by two other builders, Nathaniel Ogle and William Summers.) To allay the public's fear of boiler explosions, Gurney designed a "drag," which was in effect a tractor or locomotive pulling one or more unpowered coaches.

Gurney equipment was used by Sir Charles Dance, who ran a regularly scheduled Gloucester-Cheltenham service of four round trips daily, at times doing the 9 mi., in 45 min. Between Feb. 27 and June 22, 1831, Dance's coaches ran 4,000 mi. on this route, carrying some 3,000 passengers. Dance and other steam-carriage operators had more than mechanical mischance to combat. The equipment was noisy, smoky, destructive of roadways and admittedly dangerous; hostility arose and it was common for drivers to find the way blocked with heaps of stones or felled trees. Finally, a minor accident (a broken axle) aroused so much public feeling that Dance's service was ended. Nevertheless, by 1829 some 20 steam carriages had been built, and many passengers carried, while the railways, although much used as freight movers, had not accepted a single paying passenger.

Walter Hancock of London dominated the most successful era of the steam coaches, from 1831 to 1838. He built at least nine vehicles, and they ran ambitious routes, including London-Cambridge. But by 1840 it was clear that the steam carriages had little future. They had had much to contend with, including the antimachinery attitude of the public and the enmity of the horse-coach interests, which resulted in such penalties as a charge of £2 for passing a tollgate that cost a horse coach only 3*s*. The government was of small help: a select committee of parliament recommended a research grant of £16,000 for Goldsworthy Gurney, but the treasury refused to pay it. The crushing blow was the Locomotive act of 1865, which reduced permissible speeds on public roads to 2 m.p.h. within cities and 4 m.p.h. in rural areas. This legislation was known as the Red Flag act because of its requirement that every steam carriage mount a crew of three, one to precede it by not less than 60 yd. carrying a red flag of warning. The act was amended in 1878 but it was not repealed until 1896, by which time its provisions had effectively stifled the development of road transport in the British Isles.

In addition to Murdock, Fourness, Trevithick, Gurney, Dance and Hancock, others who contributed to the steam-carriage movement were William Symington (1786); Thomas Allen (1789); Julius Griffiths (1821); David Gordon (1824); Sir James Anderson (1824); W. H. James (1824); James Nasmyth (1827); James Neville (1827); James Napier (1827); Onèsiphore Pecqueur (1828) of France; William Crawshay (1830); Francis Maceroni (1834); Thomas Squires (1834); F. Church (1832); Richard Roberts, probably the inventor of the differential gear, (1833); John Scott Russell (1833); Charles Dietz (1835) of France; and Harrison Dyer, Joseph Dixon and Rufus Porter of the United States.

3. Other Applications of Steam.—The decline of the steam carriage did not prevent continued effort in the field, and much attention was given to the steam tractor for use as a prime mover. Beginning in about 1868 the British Isles was the scene of a vogue for light, steam-powered personal carriages; if the popularity of these vehicles had not been legally hindered, it would certainly have resulted in the appearance of widespread enthusiasm for motoring in the 1860s rather than in the 1890s. Some of the steamcars were designed to carry as few as two people and were capable of speeds on the order of 20 m.p.h. Important figures in their development were the brilliant young inventors R. E. B. Crompton, Alfred Yarrow, J. B. Hilditch, and Isaac Watt Boulton. They had no lack of aristocratic patronage; the duke of Sutherland, the earl of Caithness and the marquis of Stafford supported them generously. The public climate remained unfriendly, however.

Light steam cars were being built in the United States, France, Germany and Denmark during the same period, and it is possible to argue that the line from Cugnot's lumbering vehicle runs unbroken to the American Doble steam automobile, the last example of which was made in 1926. The grip of the steam automobile on the American imagination has been strong ever since the era of the Stanley brothers (one of whose cars took the world speed record at 127.66 m.p.h. in 1906) and in the early 1960s it was estimated that there were still 7,000 steam cars in the United States, about 1,000 of them in running order.

4. Benz and the Gasoline Car.—Carl Benz was completely dedicated to the proposition that the internal-combustion engine would supersede the horse and revolutionize the world's transportation. He persisted in his efforts to build a gasoline-fueled vehicle in the face of many obstacles, including lack of money to the point of poverty and the bitter objections of his associates, who considered him unbalanced on the subject.

Benz ran his first car, a three-wheeler powered by a two-cycle, one-cylinder engine, early in 1885, a happy and triumphant day. He circled a cinder track beside his small factory, his workmen running beside the car, his wife running too, clapping her hands; the little machine made four circuits of the track, stalling only twice, before a broken chain stopped it. Even Max Rose, Benz's partner, whose money had made the car possible, conceded that he was mildly impressed; but, like Siegfried Marcus, he remained convinced to the end of his association with Benz that there was no future in the horseless carriage.

In the autumn of 1885, when Benz attempted a public showing of a slightly improved model, he forgot to steer and smashed it against the brick wall surrounding the yard of his own house.

Benz made his first sale to a Parisian named Emile Rogers in 1887. Later, however, the soundness of his design, and the quality and care that went into the material and the construction of his cars, bore weight, and they sold well. By 1888 he was employing 50 workmen to build the tricycle car; in 1890 he began to make a four-wheeler.

In his way, Benz was almost as dogmatic and reactionary as Marcus had been: he objected to redesign of his original cars, and some authorities believe that he was never really convinced that his original concepts had been improved upon.

5. Development of the Daimler.—Gunsmithing was Gottlieb Daimler's first vocation, and he showed marked talent, but he abandoned the trade to go to engineering school, studying in

Germany, England, Belgium and France. In Germany he worked for various engineering and machining concerns, including the Karlsruhe Maschinenbaugesellschaft, a firm that much earlier had employed Benz.

In 1872 N. A. Otto offered Daimler the position of technical director of his firm, then building stationary engines. Daimler was of notable utility to Otto during the next decade, when important work was done on the four-stroke engine. Daimler brought in several brilliant researchers, among them Wilhelm Maybach, but in 1882, both Daimler and Maybach resigned because of Daimler's conviction that Otto did not understand the potential of the internal-combustion engine. They set up a shop in Bad Cannstatt and built an air-cooled, one-cylinder engine. This was the first high-speed internal-combustion engine, for it was designed to run at 900 r.p.m., while Benz's first tricycle engine had operated at only 250 r.p.m. Daimler and Maybach built a second engine and put it into a wooden bicycle, which first ran on Nov. 10, 1885. The next year the first Daimler four-wheeled road vehicle was made: a carriage modified to be driven by a one-cylinder engine. (Daimler appears to have believed that the first phase of the automobile era would be a mass conversion of carriages to engine drive; Benz apparently thought of the motorcar as a separate device.)

Daimler's 1889 car was a departure from previous practice. It was based on a framework of light tubing, had the engine in the rear, driving by belt, and was steered by tiller. Remarkably, it had four speeds. This car had obvious commercial value, and in the following year the Daimler-Motoren-Gesellschaft was founded. The British Daimler automobile, for so long holder of the Royal Warrant, originated as a patent licensee, but later became quite independent of the German concern. (To distinguish machines made by the two firms in the early years, the German cars are usually referred to as Cannstatt-Daimlers.) The products of the Daimler-Benz company (the two firms were merged in 1926) are sold under the name Mercedes-Benz.

6. Early Efforts in the United States.—The Daimler-Benz claim to the invention of the automobile was attacked in 1895 when U.S. patent 549,160 was granted to George B. Selden as inventor of the automobile. Selden had filed on May 8, 1879, although he had not at that time built an automobile. He was successful in an effort to keep the patent pending for 16 years.

Some authorities are inclined to credit Charles E. and J. Frank Duryea as creators of the first American gasoline-powered automobile, in 1892–93. The idea for the car apparently originated with Charles Duryea, and the machine was built by Frank. The Duryea consisted of a one-cylinder gasoline engine, with electrical ignition, installed in a second-hand, $70 carriage. It might be said to have been assembled out of existing components. It ran first on Sept. 21, 1893; and J. Frank Duryea, driving a later model, won the first automobile race in America in which more than two cars competed, the *Chicago Times-Herald* race from Chicago to Evanston, Ill., and return, in Nov. 1895; the distance was 54.36 mi. and the total running time was 7 hr. 53 min. Duryea cars remained on the market until 1917.

However, the magazine *Antique Automobile,* after five years of investigation, announced its conviction that the Duryea had not been the first U.S. internal-combustion automobile, and that this distinction should be assigned to a car built in 1890 and run in 1891 by John William Lambert of Ohio City, Ohio.

The Duryea was certainly not the first U.S.-built road vehicle. A number of steam carriages had been built after Oliver Evans's first example. Sylvester Howard Roper, J. K. Fisher and Richard Dudgeon were familiar to people concerned with the steam carriage. Roper, in particular, appeared to be gifted: in March 1863, the magazine *Scientific American* described a test of a Roper vehicle that weighed only 650 lb. and achieved a speed of 20 m.p.h. Roper persisted, and in Sept. 1865 the publication *American Artisan* reported that he had reduced the weight of his carriage to 480 lb. Another American, Frank Curtis of Newburyport, Mass., is remembered for a special reason: he built a personal steam carriage to the order of a Boston man who failed to meet the payment schedule, whereupon Curtis made the first recorded repossession of a motor vehicle.

The U.S. patent office issued patents to F. A. Huntington in Sept. 1889 and W. T. Harris in April 1893 for three-wheeled, gasoline-engine carriages, and Gottfried Schloemer of Milwaukee, Wis., built a successful car in 1890, a machine that still exists. Henry Nadig, a machinist of Allentown, Pa., produced an automobile in 1899 that ran quite well despite its dependence on the most primitive possible carburetor: a wooden wick that delivered fuel to the cylinder by capillary attraction. Charles Black constructed a car in Indianapolis, Ind., in 1891, aided by Elwood G. Haynes, and Haynes followed the Duryea brothers with a gasoline car demonstrated in Kokomo, Ind., on July 4, 1894. Charles Brady King built a car in Detroit, Mich., the first of the millions to issue from the city, that first ran on March 6, 1896.

Ransom E. Olds, whose name survives in the Reo and Oldsmobile vehicles, was active in gasoline engine research in the 1890s, after initially being interested in steam: so were Alexander Winton and James Ward Packard. By 1898 there were more than 50 automobile companies in existence—although the name "automobile" had not been settled upon (also considered were motor fly, diamote, automotive, autometon, mocole, oleo locomotive, motorig, bolvite, locomotive car, autobaine, autokenetic, paramount and electrobat).

The 3-h.p., curved-dash Oldsmobile was the first commercially successful American made automobile: 425 of them were sold in 1901, 5,000 in 1904 (the model is still prized by collectors), and the firm prospered. Its prosperity was noted by others—from 1904 to 1908 241 automobile-manufacturing firms went into business in the U.S. One of them was the Ford Motor company, which was organized in June 1903 and sold its first car on the following July 23. The company produced 1,700 cars during its first full year of business.

7. Ford and the Automotive Revolution.—Henry Ford produced eight models before the Model T of 1908 with which his name is synonymous; these were the models A, B, C, F, K, N, R and S. They were not remarkable automobiles, but public response to the less expensive ones (the firm made some fairly costly cars at first) indicated the soundness of Ford's basic idea—to turn the automobile from a luxury and a plaything into a necessity. This, not mass production, was Ford's contribution to the world. Mass production was an old idea in Ford's time. In 1776 Jeremiah Wilkinson had invented the fixture or jig, a means of making identical parts in series, which is the root principle of mass production. Even before Wilkinson, in 1775, the French army had attempted to standardize musket parts. Ford's concept of the automobile as a necessity was much more important than the idea of mass production.

Ford also understood something that has defeated hundreds of automobile manufacturers and thousands of automobile dealers down the years: service. In the second year of his company's existence factory-trained mechanics were in the field.

Within two decades, the American automobile had won the revolution Henry Ford had begun. The country was on wheels, and the manufacture and sale of the automobile was a main prop under the U.S. economy. The closed car was no longer exclusively a rich man's possession. In 1920, most cars had been open models, the occupants protected from the weather by canvas-and-isinglass side curtains; ten years later Detroit was producing closed models almost exclusively.

The 1920s saw also the emergence of the great European producers, Austin, Morris, Singer, Fiat, Citroen, as the revolutionary Ford doctrine was carried forward on the continent and elsewhere. Universal motor transportation was a long way off, but the concept of the small car that arose in the Austin 7 and the Fiat Topolino, to name two of the descendants of Ettore Bugatti's tiny Bebe Peugeot of 1911, was to have a profound effect, culminating in the compact car revolution in the United States in 1959–61.

8. Age of the Classic Cars.—The decade 1925–35 was notable not only for the appearance of many new small automobiles: it also saw the building of many ultra-large ones. The years from 1925 to 1942 are cited by collectors of automobiles as the classic

years, a period which saw the rise of the luxurious fast motor car to a peak it seemed unlikely to reach again.

The first name in this field was Rolls-Royce, founded in 1904. Most Rolls-Royce chassis are designed for limousine and large sedan bodies, but the firm once made a car (called the Twenty) that would be judged compact today, and it has throughout its history produced fast models in addition to its regular line; *e.g.*, after World War II, the Continental, built under the Bentley label.

Other motorcars of this type included the Hispano-Suiza of Spain and France; Bugatti, Delage, Delahaye, Hotchkiss, Talbot (Darracq) and Voisin of France; the Duesenberg of the United States; the Horch, Maybach and Mercedes-Benz of Germany; the Belgian Minerva, and the Italian Isotta-Fraschini. These were costly machines, priced roughly from $7,500 to $40,000; fast, at 90 to 130 m.p.h.; as comfortable as the state of the art would allow; and limited in luxury only by the purse of the purchaser. The great custom coach builders of England who furnished bodies for Rolls-Royce machines were unruffled by the whims of their clients. They were prepared to satisfy any request, whether for upholstery in matched ostrich hide with ivory buttons or for a dashboard in rosewood carrying instrument labels in Old English script.

The most expensive standard automobile of which there exists convincing record was the Type 41 Bugatti, produced in the 1920s by Ettore Bugatti, an Italian of extraordinary gifts who built cars in France, most of them racing and sports types, from 1909 until his death in 1947. The Type 41 Bugatti, also called La Royale, was catalogued at a chassis price of $20,000. Only seven of the cars were built, and one of them, carrying a four-passenger convertible sedan body by a German coachmaker, cost $43,000.

The market collapse of 1929 sealed the doom of the really luxurious motorcar. After World War II even Rolls-Royce abandoned its long-held policy of chassis production only, and offered a standard sedan that could be bought straight off the showroom floor. Custom bodies were still available to Rolls-Royce purchasers through the old-line suppliers, of course. Throughout the rest of the world, save Italy, the custom body was a thing of the past. Even in Italy, most "one-off" designs were commissioned by automobile manufacturing firms, not, as in previous times, by individuals.

9. Developments After World War II.—The effect of Italian ideas on the world's automobile body designers was profound when manufacture began to be resumed in 1946. Pini Farina of Turin was best known of the coachmakers who established the characteristic Italian approach: grace, lightness in line and substance, and minimal use of decoration. Designs clearly derivative appeared everywhere, and manufacturers in France, England and the United States contracted for the services of Italian *carrozzerie*.

The trend toward the small automobile in the United States, clear, if not obtrusive, after 1932, was strongly accelerated by World War II. A leading factor was the return from duty in Europe of servicemen who had previously not known of the existence of the sheer variety of automobiles the world afforded. Particularly the sports car, designed for pleasure, not transport, was new to young Americans. The characteristics of automobiles like the British sports two-seater M.G., plus their availability at a time of short domestic supply, made them attractive, and the importation of European-made models into the U.S. increased rapidly. Automobile racing, which in the Vanderbilt Cup days around 1910 had drawn the biggest crowds in U.S. sports history, began to regain popularity, and by 1954 the *Wall Street Journal* reported that motor racing had become the no. 1 ranking American spectator sport.

While the size of the standard U.S. motorcar increased steadily from 1947 onward, and its design became ever more bizarre, the small segment of the population that leads in forming taste habits demonstrated strong preference for smaller cars, and for the comparatively demure Italian styling. Except for American Motors, successor to Nash and producer of the Rambler, the industry was slow to react. However, indications to be derived from the sale of Ramblers, Volkswagens and Renaults finally became quite clear and the major producers simultaneously undertook the production of smaller automobiles, generically termed "compact." At around 110-in. wheelbase, they were smaller than the less-big U.S. cars, bigger than the average European model. The first three on the market, Corvair (Chevrolet), Falcon (Ford) and Valiant (Chrysler), were instantly successful and began a predictable reduction in the sale of imported machines, which had peaked at around 500,000 units yearly. At first it seemed that even smaller models, of the size of the Volkswagen and Renault, might prove profitable to U.S. manufacturers, and two or three designs were on the drawing boards. U.S. buyers continued to show a preference for large automobiles, however, and many "compact" models grew bigger, heavier and more powerful, rather than smaller and lighter.

In Europe, a need for strict economy, the increasing high price of fuel and congested traffic conditions gave impetus to the development of a new series of ultra-light cars of simple specification and relatively inexpensive running costs. Many of these cars had two-stroke engines, such as the British Bond and the A. C. Petite. In Germany the Heinkel minicar was introduced, with a front-entry type of body, and the ingenious Messerschmitt tandem two-seater with a hinged airplane-type canopy. The B.M.W. Isetta, powered with a 245-c.c., four-stroke, single-cylinder engine with chain drive to the rear wheels, was one of the many varieties of four-wheeled designs introduced by various countries in search of economical road transport.

In France the 2CV Citroen was one of the most ingenious designs, particularly regarding suspension. First produced in 1948 as an economy vehicle, the relatively inexpensive 2CV was powered by a 375-c.c., horizontally-opposed, overhead-valve engine producing only 9 h.p. at 3,800 r.p.m. It gave a form of rather austere but economical motoring. The emphasis on economy, improved road surfaces, congested roads and the problem of parking directed manufacturers to a new phase in light car design. Bodywork radically altered under this influence, giving place to the modern stylized full-width envelope form of body that reduced both wind resistance and production costs.

Postwar expansion and experimentation produced many flurries of interest in new power sources. Gas turbines and free-piston engines were demonstrated. Improved batteries suggested the revival of the electric automobile (as improved burners and boilers suggested the revival of the steamer), and the practicability of the fuel cell was cited. Heat engines and air engines were redesigned. Of the new forms, only the gas turbine and the rotary-combustion (Wankel) engine saw actual use. The Rover company of England demonstrated a gas turbine automobile in 1950, and a decade later had the capability of entering the world market with it. The NSU Motorenwerke A. G. Neckarsulm in west Germany ran its Prinz model experimentally with a Wankel engine in 1961.

(K. W. Pu)

II. MODERN AUTOMOBILES: MECHANICAL OPERATION

1. Chassis.—The chassis of an automobile comprises the main structure of the vehicle, carrying the engine, wheels and axle assemblies, steering gear, transmission and gearbox and the suspension members. These components conventionally have been attached to a pressed-steel frame formed of channel or box-section members and usually reinforced by a central member. The frame serves as the structural foundation or backbone of the chassis. It unites and positions the various members, takes the torque reactions of the engine and driving axle, and receives the driving, braking and suspension forces from the wheels.

Since the mid-1930s, some automobile manufacturers have eliminated the chassis frame and made the body the major structural member of the vehicle. Instead of the body serving only as a passenger enclosure bolted to the chassis frame, its pressed-steel shell is provided with reinforcing braces that make it sufficiently rigid to resist the stresses applied to it. This unitized or frameless construction offers several advantages, and in the early 1960s there was a worldwide trend toward its adoption. The greater vertical height of the stress-carrying steel panels utilized

the steel more effectively, thus reducing the weight of material required. The sheer lines of modern automobile bodies are better adapted to load carrying than those of earlier years, and in a collision, because the points of impact crush with a delaying action, the rate of deceleration is reduced and the force with which the passengers are thrown forward is less. The greater torsional rigidity of the structure reduces noise and improves the functioning of the suspension system. A saving in cost of manufacture is possible, and the floor of the body can be lowered as required by modern styling.

Several objections originally were raised to the unit construction, but these have since been minimized. It was maintained that corrosion of the light metal body components, especially from salted highways, would seriously weaken the structure. This possibility led to the use of corrosion-resistant coatings and treatments that are formulated to provide the necessary durability. However, with frameless construction, repairs of collision damage must be made more effectively in order to restore the strength as well as the appearance of the damaged section.

Vehicle stability and control depend principally upon the weight distribution between the front and rear wheels, the height of the centre of gravity, the type of suspension system and whether front or rear wheels are used to drive the vehicle. Weight distribution is largely affected by the weight and location of the engine and transmission. Because there are both advantages and disadvantages in each possible arrangement of engine and transmission, no best possible layout is conceivable, but mechanical simplicity is greatly enhanced if the engine and the driving wheels are at the same end of the vehicle. Front-wheel drives and rear engines have always been in the minority, but the advent of lower body lines stimulated interest in both as means of eliminating the drive shaft and transmission humps in the floor of the car. Several European automobile manufacturers adopted front-wheel drive, and rear engines became common in the smaller European cars.

The development of aluminum engines and the use of air cooling helped to make practical the location of the engine at the rear of the car. One objection to water-cooled rear engines was the difficulty in operating the cooling system, because radiators function best at the front of the vehicle where the necessary air enters readily. Air-cooled engines present no special cooling problem when mounted at either front or rear.

Overconcentration of weight at the rear of a vehicle affects steering stability. This objection is met effectively by the air-cooled engine, especially if made of aluminum. Air-cooled engines in general are lighter than liquid-cooled engines of similar design and construction. The use of aluminum in air-cooled engines not only increases the weight advantage but also improves heat transfer from the cylinder walls to the outer surfaces of the cooling fins.

2. Engines.—The internal-combustion engine operating with gasoline as its fuel became the universally accepted source of power for propelling the automobile quite early in its development. This application placed demands upon the gasoline engine far more difficult to meet than those imposed by most other uses. Greater flexibility was necessary to permit the engine to operate over a wider range of crankshaft speeds; the weight of the engine had to be reasonable, and it had to be designed so it could be produced by economical mass production methods. Quiet operation also came to be demanded of the engine, along with compactness. All of these requirements dictated that the engine for an automobile of conventional size should have at least four cylinders of moderate capacity, with higher crankshaft speeds than for other applications.

The Increase in Horsepower.—One of the most conspicuous changes that took place in the development of the automobile, particularly in the U.S. models, was the increase in engine power. This increase was gradual at first, then became rapid in the period following World War II. The design improvements incorporated in the postwar engines utilized all of the known methods of increasing engine capacity.

Three factors determine the horsepower developed by an internal-combustion engine. The first is the effective average pressure in the cylinders during the operating cycle and is known as the brake mean effective pressure (b.m.e.p.). This pressure was increased by several design changes. Compression ratios were made higher, with accompanying increases in operating pressures and improved thermal efficiency. Because of higher efficiency, more of the energy released by combustion of the fuel was made available to react on the pistons and more work was done by each pound of fuel burned. The amount of fuel and air drawn into the cylinders was increased by enlarging the valves and increasing the amount they opened, by enlarging intake manifolds and carburetor throats, and by timing the valves to open earlier and close later. Refinements in combustion chamber design also improved combustion efficiency so that more of the energy in the fuel was utilized. These increases in b.m.e.p. could not have been accomplished without the contributions of the petroleum chemists and fuel-research engineers who developed higher antiknock quality fuels to meet the more severe fuel requirements of higher cylinder compression and greater charge density.

The second factor governing engine horsepower is the total swept volume, the volume displaced by all the pistons moving through the full length of stroke. This can be increased by enlarging the cylinder bore or by increasing the number of cylinders. Utilizing one or both methods, manufacturers produced a greater number of eight-cylinder engines and more engines with larger cylinder bore diameters.

The third factor determining horsepower is the average piston speed, which can be increased either by lengthening the stroke of the pistons or by increasing the rotational speed of the crankshaft. A considerable increase in crankshaft speed was offset in the new engines, to some extent, by shorter piston strokes, but the net effect was higher piston speeds. Shortened strokes resulted in larger cylinder bores in proportion to the piston displacement of the engines, with more room for the larger valves desired for improved cylinder charging. Shortening the stroke also reduced engine height, an important consideration with lowered automobile body lines. Stroke-to-bore ratios of less than 1 to 1 in post-World War II engines contrasted sharply with those of 1.5 to 1 commonly used earlier.

Shortening the Crankshaft.—Higher cylinder pressures and larger piston areas increased the forces transmitted to the crankshaft by the connecting rods and at the same time, higher engine speeds increased the dynamic forces acting on the crankshaft. The combined effect of these increases created a crankshaft vibration problem, a tendency for the crankshaft to twist and untwist cyclically under the alternating forces applied at the connecting rod bearings. This problem caused the virtual abandonment of the eight-cylinder in-line engine and the adoption of the V-8 engine for all piston displacements in excess of 240 cu.in. The long eight-throw crankshaft could not be made sufficiently rigid. The shorter V-8 crankshaft occupies less length in the automobile and is more resistant to vibration because of its greater lateral and torsional stiffness.

Return of Smaller Engines.—The smaller compact cars introduced by several U.S. manufacturers among their 1960 models returned engines of less than 100 h.p. to production. These were six-cylinder engines of from 140 to 195 cu.in. piston displacement, rated as low as 80 h.p. One of these was a rear-engine type, made largely of aluminum, with two banks of three horizontally-opposed cylinders. The typical standard size automobile engine in the U.S. at that time was a V-8 of large cylinder bore and relatively short piston stroke with a displacement of about 350 cu.in. Compression ratios for the larger engines were between 8½:1 and 11:1. Horsepower ratings were generally in the range from 250 to 350.

European Engines.—European automobile engines were of a much wider variety than those built in the United States, ranging from 1 to 12 cylinders with 18 to 302 cu.in. piston displacement, and with cylinder bores as small as 2.22 in. A majority of the models had four cylinders with less than 125 cu.in. displacement and horsepower ratings from 19 to 120. Several three-cylinder, two-stroke-cycle models were built in England, Germany and Sweden. All were in-line engines except the V-type models built

by five manufacturers and ten horizontally opposed two- and four-cylinder makes. Overhead camshafts were frequently employed. The smaller engines were commonly air cooled and located at the rear of the vehicle; compression ratios were relatively low.

The German Volkswagen was among the most popular European cars and had many features that contrasted sharply with American practice. The air-cooled engine, mounted at the rear, developed 36 h.p. at 3,700 r.p.m. Size of each of the four cylinders was 3.03 in. by 2.52 in. The short stroke and moderate rotational speed produced an average piston speed of 1,550 ft. per minute, which was only half that of contemporary American engines and contributed to the long life for which the VW engine was noted.

The cylinders in the VW engine were horizontally opposed, with the two on the left side displaced forward from those on the right, permitting a four-throw crankshaft to be used. The left front and right rear pistons moved in unison and oppositely from those in the right front and left rear cylinders. The two front pistons thus moved inward as the two rear ones moved outward, and the inertia forces produced by the reciprocating masses were almost completely balanced without counterweights on the crankshaft. The cylinders were finned to increase the heat transfer surface, and the valves in the cylinder heads were operated by rocker arms and push rods from a camshaft directly beneath the crankshaft. A radial-flow fan was mounted above the engine, belt-driven from the crankshaft, to supply cooling air to ducts surrounding the cylinders and to an oil cooler. A thermostatically-operated inlet damper varied the amount of cooling air in accordance with the cylinder temperature. An outlet butterfly valve permitted warm air to enter the passenger compartment in cold weather or to be discharged to the rear.

(*See* INTERNAL-COMBUSTION ENGINE; HORSEPOWER.)

3. Fuel.—Gasoline, or petrol, is essentially the only fuel used for automobile operation. The most important requirements of a fuel for automobile use are proper volatility and sufficient antiknock quality. The volatility is adjusted by the refiners so that sufficient gasoline vaporizes, even in extreme cold weather, to permit the engine to be started, but without being so volatile that vapour lock will prevent proper functioning of the fuel system at the highest outdoor temperatures encountered.

The antiknock quality is controlled by refining processes that produce compact, stable molecules instead of long, straight-chain molecules, as well as by the addition of antiknock compounds, principally tetraethyl lead. Antiknock quality is rated by the octane number of the gasoline and is the essential difference between the regular, premium and super premium grades offered for sale by the petroleum industry.

The octane number requirement of an automobile engine depends principally upon the compression ratio of the engine, but it is also affected by combustion chamber design and deposits formed on the chamber walls. Various additives intended to minimize the effects of deposits are used in most automotive gasolines. No advantage is gained by using a fuel of higher octane number than that necessary to eliminate objectionable knock.

(*See* also GASOLINE; FUELS: *Fuels for Light Internal-Combustion Engines.*)

4. Lubrication.—All moving parts of an automobile require lubrication. Without it, friction would increase the power consumption and also would soon destroy the parts. The lubricant also serves as a coolant, a noise-reducing cushion, and a sealant between engine piston rings and cylinder walls.

The engine lubrication system consists of an oil sump and a gear-type pump that delivers the oil under pressure to a system of drilled passages leading to various bearings. These include the crankshaft main bearings, the camshaft bearings, and the rocker shaft of the overhead valve mechanism. Drilled passages in the crankshaft conduct oil to lubricate the connecting rod bearings, and leakage from these bearings sprays oil up into the cylinder bores to lubricate the pistons, piston pins and piston rings. The spray also lubricates the cams and valve lifters. Usually, the oil passes through a paper or cotton-waste filter before it enters the distribution passages; bypass filters sometimes are used to receive a small stream of oil from the system continuously and return it to the sump after removing any solids.

Engine oils are identified by letters designating the severity of service for which the oil is suitable and by SAE numbers indicating the viscosity range. The letters ML are embossed on the containers of straight mineral oils intended only for light duty, MM for moderate duty oils that are mildly detergent and contain other additives, such as corrosion inhibitors, and MS for severe or heavy-duty oils that are highly detergent with large amounts of protective additives. The selection of the proper oil depends upon the conditions under which it will be used; continuous high speeds, heavy loads, frequent starts and stops, and engine components such as hydraulic valve lifters that are sensitive to oil condition, all require consideration.

SAE viscosity numbers range from 5W to 50, the viscosity or body of the oil at 210° F., increasing with the number. The W oils are light, cold-weather oils whose viscosity is measured at 0° F. Multi-rated or all-weather oils, such as 5W-20 and 10W-30, contain viscosity index improvers that reduce the loss in viscosity at higher temperatures. They meet the lower number specifications at 0° F. and the higher number at 210° F., making them suitable for use in summer or winter.

Wheel bearings and universal joints require long-fiber grease; other chassis joints require a soft grease that can be injected by pressure guns. Hydraulic transmissions require a special grade of light hydraulic fluid, and manually shifted transmissions use a heavier gear oil similar to that for rear axles. Hypoid gears used in most rear axles require oils that are compounded to resist heavy loads on the gear teeth.

(*See* also LUBRICATION.)

5. Cooling System.—Except for some of the very early models, the majority of automobiles have employed liquid cooling for their internal-combustion engines. Notable exceptions in the early 1960s were the German Volkswagen and, in the U.S., the Chevrolet Corvair, both of which had air-cooled, rear-mounted engines.

A typical automotive cooling system comprises (1) a series of channels cast into the engine block and cylinder head, surrounding the combustion chambers with a circulating stream of water to carry away excessive heat; (2) a radiator, consisting of many small tubes equipped with a honeycomb of fins to radiate heat rapidly, that receives and cools hot water from the engine; (3) a water pump, usually of the centrifugal type, to circulate coolant through the system; (4) a thermostat, which maintains constant temperature by automatically varying the amount of water passing into the radiator; and (5) a fan, which draws fresh air through the radiator when the car is at a standstill in traffic or moving slowly.

For operation at outdoor temperatures below freezing, it is necessary to add some compound to depress the freezing point of the coolant. Alcohol formerly was commonly used, but its relatively low boiling point makes it less desirable than ethylene glycol and other compounds. By varying the amount of additive it is possible to protect against freezing of the coolant down to any minimum temperature normally encountered.

As an added precaution, the engine block normally is provided with two or more expansion plugs; should the coolant in the block freeze, these are designed to give way, relieving ice pressure that otherwise might crack the block.

Compared with water cooling, air cooling offers the important advantage of eliminating not only freezing and boiling of the coolant at temperature extremes but also expensive corrosion damage to the cooling system. However, control of engine temperature is more difficult, and the engine temperature is more likely to vary with the outside temperature. Air-cooled cylinders operate at higher, more efficient temperatures, but compression ratios (with the same fuels) must be lower because combustion control is more difficult. In addition, it is more difficult to utilize engine heat to warm the car interior during winter.

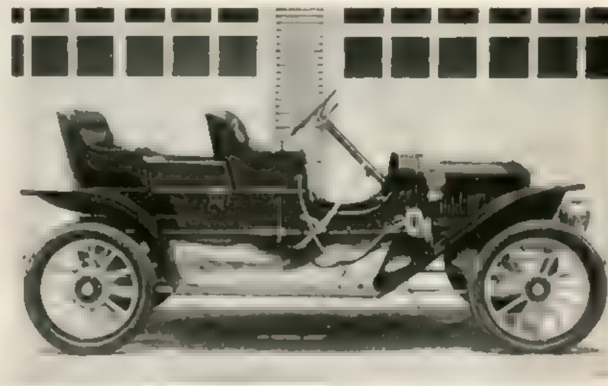
With the aim of eliminating seasonal draining of liquid cooling systems, manufacturers in the later 1950s and early 1960s introduced liquid coolants intended to replace water-antifreeze mix-

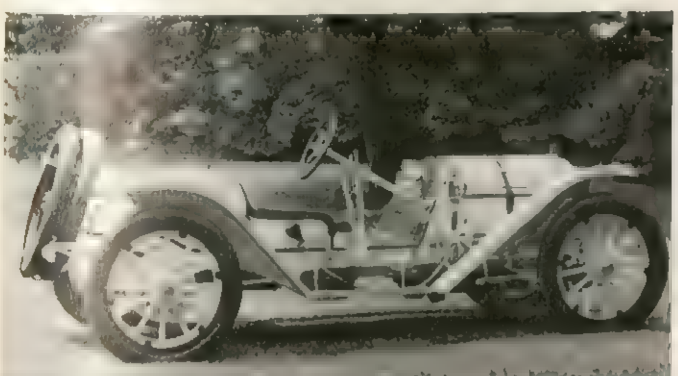

Duryea, 1893 first U.S. automobile


Oldsmobile, 1902, curved dash, first mass-produced U.S. car


Oldsmobile Limited, 1910

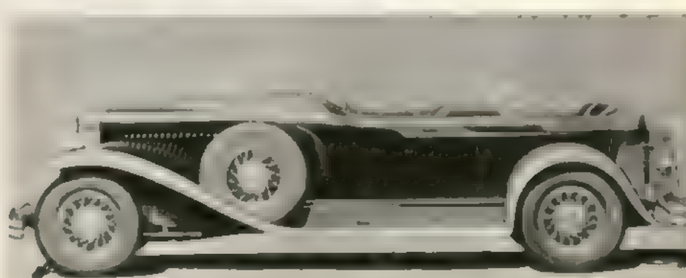

Ford, 1909, Model T


Stanley Steamer, 1911, touring car


Mercer Raceabout, 1911, sports car


Lozier, 1909, another early sports car

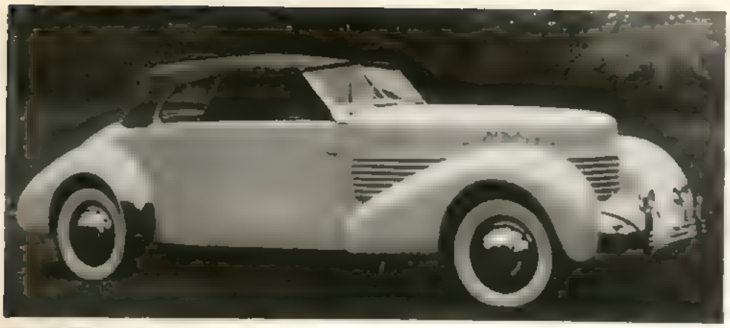

Chrysler, 1925, four-door sedan


Duesenberg, 1929, double-cowl phaeton

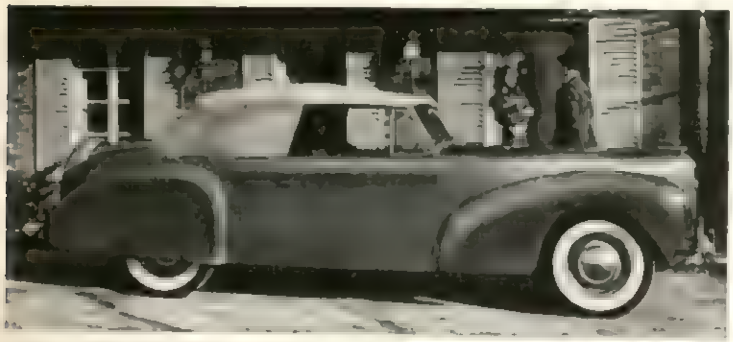
EARLY U.S. AUTOMOBILES

BY COURTESY OF (TOP LEFT) SMITHSONIAN INSTITUTION, (TOP CENTRE, SECOND ROW RIGHT, THIRD ROW LEFT) LONG ISLAND AUTO MUSEUM, SOUTHAMPTON, N.Y., (SECOND ROW LEFT) FORD MOTOR COMPANY, (THIRD ROW RIGHT) "SPORTS CARS ILLUSTRATED," PHOTO BY DON COLEE, (BOTTOM LEFT) CHRYSLER CORPORATION PHOTOGRAPH, (BOTTOM RIGHT) THOMAS ROBERT EDWARDS JR.

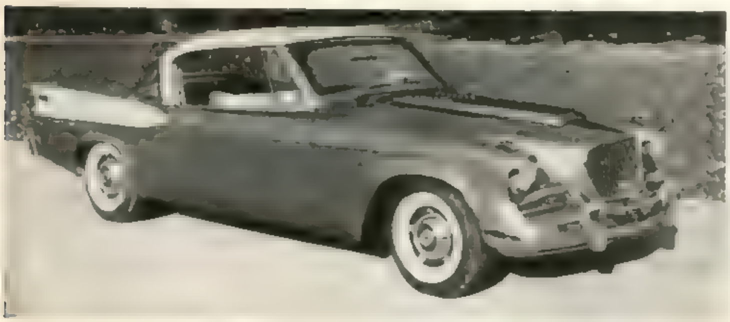
AUTOMOBILE


Cord, 1937, model 810 convertible phaeton sedan

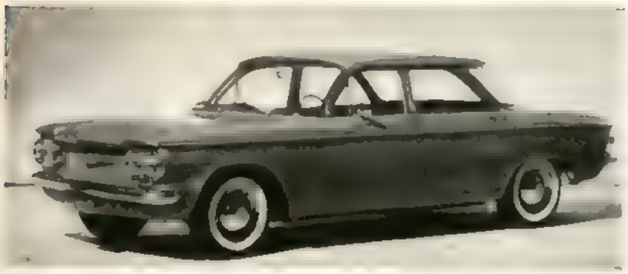

Crosley, 1940, standard convertible chassis with truck mounting


Lincoln, 1940, Continental


Willys Jeep produced for U.S. army, 1941–45

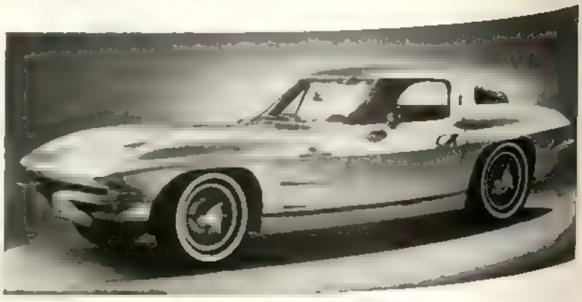

Studebaker, 1958, Golden Hawk


Rambler, 1950, convertible


Chevrolet, 1960, Corvair


Cadillac, 1959, Fleetwood Sixty Special sedan

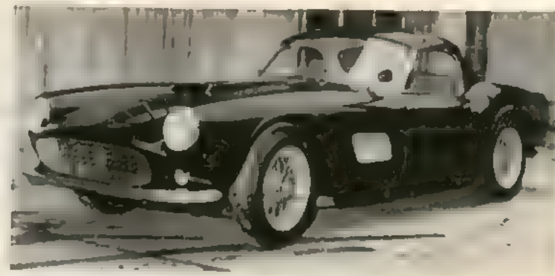

Ford, 1963, Thunderbird


Chevrolet, 1963, Corvette Sting Ray sport coupe

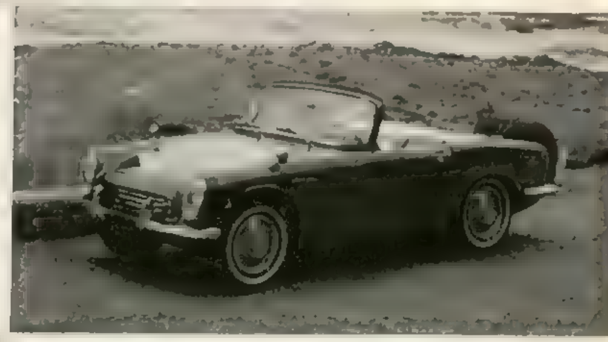
LATER U.S. AUTOMOBILE DESIGNS

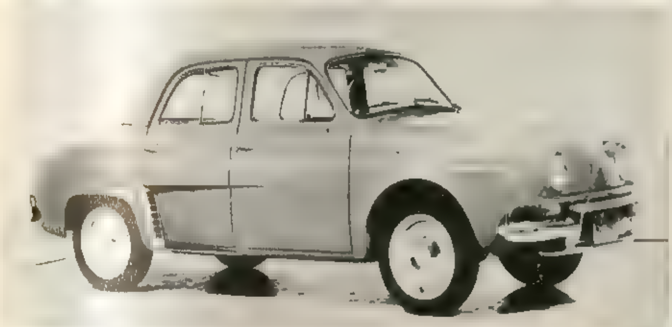
BY COURTESY OF (TOP LEFT, TOP RIGHT) LONG ISLAND AUTO MUSEUM, SOUTHAMPTON, N.Y., (SECOND ROW LEFT) FORD MOTOR COMPANY, (BOTTOM LEFT) FORD DIVISION, FORD MOTOR COMPANY (SECOND ROW RIGHT) WILLYS MOTORS INC., (THIRD ROW LEFT) STUDEBAKER PACKARD CORPORATION, (THIRD ROW RIGHT) AMERICAN MOTORS CORPORATION, (FOURTH ROW LEFT, BOTTOM RIGHT) CHEVROLET MOTOR DIVISION PHOTO, (FOURTH ROW RIGHT) CADILLAC MOTOR CAR DIVISION, GMC


Rolls-Royce, British; Phantom V seven-passenger limousine


Ferrari, Italian; *America* coupe

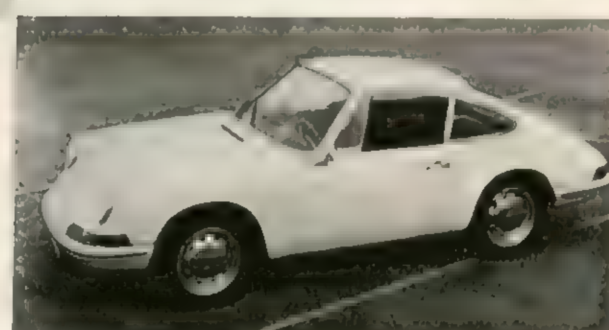

Mercedes-Benz, German; model 230SL


Honda, Japanese; sports convertible


Renault, French, *Dauphine*


Facel-Vega, French; *Excellence* four-door sedan


Tatra, Czechoslovakian; model T603


Porsche, German; model 911


Zil, Soviet; model 111

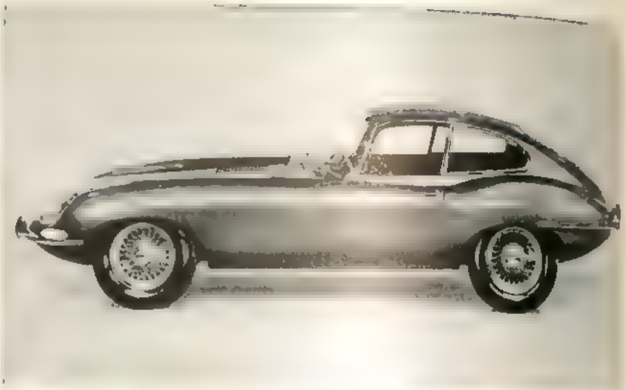

MG, British; model 1100 sports sedan

AUTOMOBILES MANUFACTURED IN EUROPE AND ASIA

BY COURTESY OF (TOP LEFT) ROLLS ROYCE INC., (TOP RIGHT) LUIGI CHINETTI MOTORS, INC., (SECOND ROW LEFT) MERCEDES-BENZ SALES, INC., (SECOND ROW RIGHT) AMERICAN HONDA MOTOR CO., INC., (THIRD ROW LEFT) RENAULT, INCORPORATED (THIRD ROW RIGHT) FACEL S. A. DIVISION, (FOURTH ROW RIGHT) PORSCHE CAR IMPORT INC., (BOTTOM RIGHT) BRITISH MOTOR CORPORATION; PHOTOGRAPHS, (FOURTH ROW LEFT) EASTFOTO, (BOTTOM LEFT) SOVFOTO

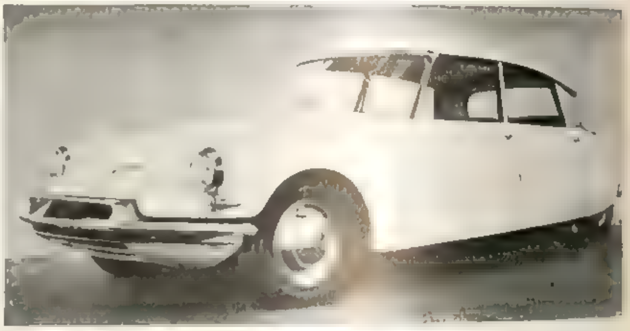
AUTOMOBILE

DAF, Dutch; variable-ratio belt-drive transmission



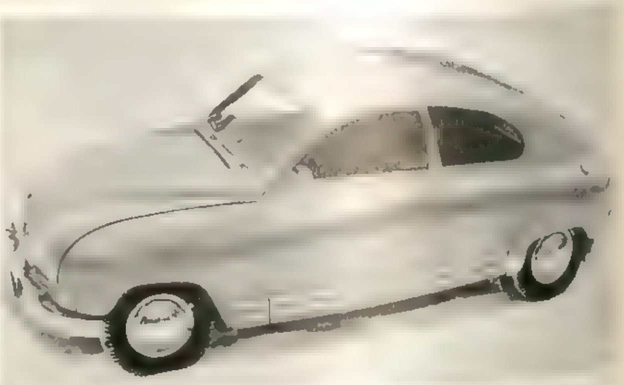
Jaguar, British; model XK-E coupe

Aston Martin, British; model DB4

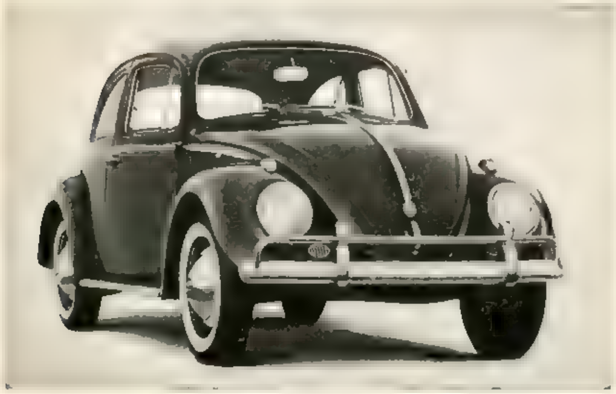


Citroen, French; model ID 19

Fiat, Italian; model 1500 sedan



SAAB, Swedish; model 750 Granturismo



Volkswagen, German

MG, British; model 1800 convertible

EUROPEAN AUTOMOBILES

BY COURTESY OF (TOP LEFT) IMPORTED CARS OF HOLLAND, INCORPORATED, (TOP RIGHT) JAGUAR CARS INCORPORATED (SECOND ROW LEFT) "THE AUTOCAR," (SECOND ROW RIGHT) CITROEN CARS CORPORATION, (THIRD ROW LEFT) FIAT, (THIRD ROW RIGHT) SAAB MOTORS INCORPORATED, (BOTTOM LEFT) VOLKSWAGEN OF AMERICA, INCORPORATED, (BOTTOM RIGHT) S. H. ARNOLT, INCORPORATED

tures. These solutions of deionized water and chemical additives had boiling points at about 240° and freezing points at about −40° F. They contained corrosion inhibitors that supposedly made it necessary to drain and refill the cooling system only once a year.

Other compounds under development in the early 1960s, some of which were organic silicates, contained no water and were permanent in characteristics. Such liquids permit the cooling system to be sealed and require no attention. The ultimate practicability of these permanent coolants will depend upon their specific heats. All previously known liquids with appropriate boiling and freezing points have much lower specific heats than that of water and are not as effective as engine coolants.

6. Electrical System.—Originally, the electrical system of the automobile was limited to the ignition equipment. With the advent of the electric starter on a 1912 model, electric lights and horns began to replace the kerosene and acetylene lights and the bulb horns. Electrification was rapid and complete, requiring only a few years to include most makes and models of cars. The electrical system comprises a storage battery, generator or dynamo, starting (cranking) motor, lighting system, ignition system and various accessories and controls.

Voltages at first were not standardized; 6, 12, 18 and 24 v. were employed before World War I. One U.S. manufacturer continued to use a 12-v. system until 1926, while all others who had used higher voltages changed to 6 v. after the war. Increased engine speeds and higher cylinder pressures of the post-World War II cars in the U.S. made it increasingly difficult to meet the high ignition voltage requirements. The larger engines also required higher cranking torque. To meet these two needs 12-v. systems had practically replaced the 6-v. systems by 1956.

The ignition system provides the spark to ignite the air-fuel mixture in the cylinders of the engine. In order to jump the gap between the electrodes of the spark plugs, the 12-v. potential of the electrical system must be stepped up to about 20,000 v. This is done by a circuit that starts with the battery, one side of which is grounded (earthed) on the chassis, leads through the ignition switch to the primary winding of the ignition coil and back to the ground through an interrupter switch or circuit breaker. The high voltage secondary terminal of the coil leads to a distributor that acts as a rotary switch, alternately connecting the coil to each of the wires leading to the spark plugs. The system consists of the spark plugs, contact breaker, coil, distributor and battery.

Power Sources.—The source of electrical energy for the various electrical devices of the automobile is a generator or dynamo that is belt-driven from the engine crankshaft. The generator is usually a two-pole, direct-current type with a shunt field controlled by a voltage regulator whose function is to match the generator output to the electrical load, and also to the charging requirements of the battery, regardless of engine speed.

A battery of the lead-acid type serves as a reservoir to store excess output of the generator by chemical changes in the sulfuric acid electrolyte and in the composition of the lead plates. Energy for the starting motor is thus made available as well as power for operating other electrical devices when the engine is not running or when the generator speed is not sufficiently high to carry the load. (*See* also BATTERY.)

High-wattage electrical loads, resulting from the addition of many electrical accessories, made commutation increasingly difficult in direct-current generators. Alternating-current generators, or alternators, with rectifiers were in use on buses where the electrical load had increased generator maintenance problems. In 1958 alternating-current generators with built-in rectifiers were introduced for passenger automobiles as a more practical way of providing for the high-wattage requirements.

The starting motor is a series-wound type that drives a small spur gear so arranged that it automatically moves into mesh with gear teeth on the rim of the flywheel as the starting motor armature begins to turn. When the engine starts, the small gear is accelerated above the armature speed and is then returned to its disengaged position, thus preventing damage to the starting motor from overspeeding. The starting motor is designed for high current consumption and delivers considerable power for its size for a limited time.

Lighting.—Headlights that satisfactorily illuminate the highway ahead of the automobile for night driving, without temporarily blinding approaching drivers, have long been sought. Early dimming devices of the resistance type that decreased the brightness of the headlights for passing gave way to mechanical tilting reflectors and later to double-filament bulbs with a high and a low beam.

The double-filament headlight unit, however, has only one of its filaments at the focal point of the reflector. Because of the greater illumination required for high-speed driving with the high beam, the lower beam filament was placed off centre, with a resulting decrease in lighting effectiveness. In an effort to improve all-round illumination, U.S. automobile manufacturers in 1957 began equipping their models with four headlights. In most instances the outer lamps were double filament types with a high-wattage low beam and a "soft" high beam for city driving. The inner lamps have a single filament high beam of high wattage that produces a spotlight effect. The low beam of the two outer lamps is focused slightly to the right and is used when overtaking or meeting other vehicles. The high beams of all four lamps are used on the open highway when there is no approaching traffic.

7. Transmissions.—The gasoline engine is inherently less suitable than the steam engine or the electric motor to propel a vehicle because it has no starting torque and must be set in motion before it can deliver any power. This characteristic necessitates some type of unloading and engaging device to permit gradual application of load to the engine after it has been started. The torque or turning effort that the engine is capable of producing is low at low crankshaft speeds, increases to a maximum at some fairly high speeds, and then decreases as the throttle is further advanced. Thus, the maximum or rated horsepower is attained only when the crankshaft is turning at its rated speed.

The specific fuel consumption of an automobile engine is best when the load on the engine is high and the throttle is nearly wide open. At moderate speeds on level pavement the power required to propel an automobile is only a portion of the power the engine is capable of developing in its upper range of speeds. Thus, under normal driving conditions at constant moderate speed, the engine may operate at an uneconomically light load unless some means are provided to reduce its speed and power output.

A speed-changing device known as a gearbox is necessary in the drive train that connects the crankshaft of the engine to the driving wheels. A device of this kind will permit the engine to operate at a higher speed when its full power is needed and to slow down to a more economical speed when less power is needed. Under some conditions, as in starting a stationary vehicle or in ascending steep grades, the torque of the engine is insufficient and amplification is desirable. Most devices employed to change the ratio of the speed of the engine to the speed of the driving wheels multiply the engine torque by the same factor that the engine speed is increased. Such devices are properly called torque converters, but are most commonly called transmissions.

Sliding-Gear Transmissions.—The simplest automobile transmission is the sliding-spur-gear type with three or four forward speeds and reverse. The desired gear ratio is selected by manipulating a shift lever. The early devices of this type required considerable skill on the part of the operator to shift the gears smoothly and without clashing the teeth. The shift from low to second gear was the most troublesome because this shift required that two gears, moving at different speeds, be slid sidewise into tooth engagement. This crudity in design was eliminated by the constant-mesh second gear in which the driven gear of the train is not keyed to the driven shaft of the transmission. Second gear is engaged by means of a toothed or jaw clutch, similar to that used to engage direct drive, arranged so that it can keep the driven gear from turning on the driven shaft.

Ease of shifting into second and high was further improved by the use of synchronizing clutches that engaged ahead of the toothed clutches and caused the two portions of the positive clutch to turn in unison before their engaging teeth touched each other.

The blocker ring later prevented any possibility of the two members of the clutch contacting each other before their speeds were synchronized. The only difficulty remaining in the operation of the sliding gear transmission was the need for simultaneously operating the accelerator pedal, the clutch pedal and the gear-shift lever. This manipulation taxed the limited mechanical ability of many automobile drivers.

Automatic Transmissions.—All automatic transmissions may be classified into two groups, those employing a fluid coupling with automatically shifted planetary gear trains and those employing a hydraulic torque converter in various combinations with planetary gear trains. All of them provide manual selection of reverse and a low range that either prevents automatic up-shifts or employs a lower gear ratio than is used in normal driving. Grade-retard provisions are also sometimes included to provide engine braking on hills.

The first fully automatic transmission produced commercially (in 1939) for passenger cars was of the type using planetary gears for all torque multiplication. In 1956, after over 7,000,000 of these transmissions had been built, several changes were made to permit smoother shifts from one gear ratio to another. This transmission is shown in fig. 1 in its improved form. All torque multiplication is produced by the three planetary gear trains, each of which comprises a sun gear, a ring or internal gear, and a set of planet gears interposed between them. The front two planetary trains provide four forward speeds and the rear unit is the reverse gear. The front unit coupling is used as a clutch to lock out the front planetary unit that drives the driving torus. A provision is made to engage the front unit coupling by filling its compartment with fluid and to release it by emptying the compartment. When engaged, the driving torus turns at engine speed and, when the front coupling is emptied, it turns at a reduction of 1.55 to 1. The rear clutch similarly controls the rear planetary unit; when it is released, the output shaft turns at a reduction of 2.55 from the speed of the driven torus. When the rear clutch is engaged, the output shaft turns at driven torus speed

When starting the car, both clutches are released and the speed reduction is the product of the ratios of the two planetary units of approximately 4 to 1. The front unit coupling is filled automatically when the first shifting speed is reached and the drive ratio becomes 2.55 to 1. The front unit coupling is emptied at the second shifting speed and the rear clutch engaged, making the drive ratio 1.55 to 1. Both the front coupling and the rear clutch are engaged for direct drive. The neutral clutch is engaged in all drive positions except reverse, which is engaged by the reverse cone clutch. The overrun clutch is engaged for reverse and also for descending grades, where it prevents freewheeling. The sprag one-way clutches are used to release the front sun and the rear internal gears when the clutches for those gears are engaged.

All shifting is done hydraulically by a speed-sensitive governing device that changes the position of valves that control the flow

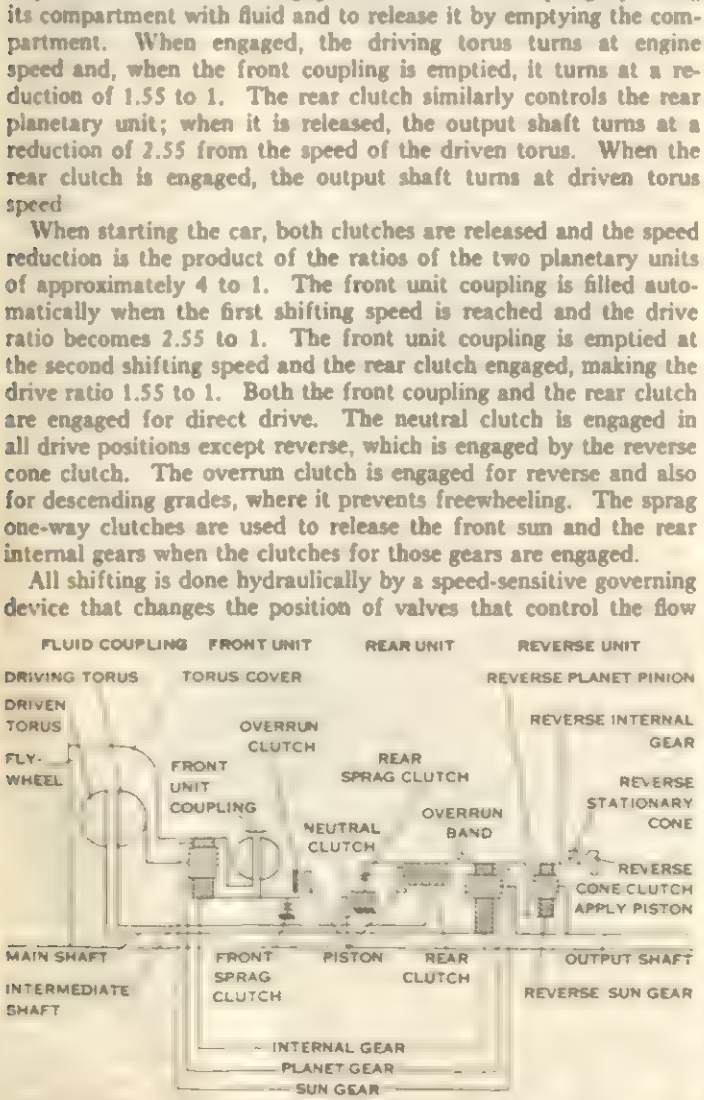


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FIG. 1.—DIAGRAM OF AUTOMATIC TRANSMISSION

of hydraulic fluid. The vehicle speeds at which shifts occur depend upon the position of the accelerator pedal, and the driver can delay up-shifts until higher speed is attained by depressing the accelerator pedal further.

Hydraulic Torque Converters.—The hydraulic torque converter is employed in all other automatic transmissions to provide a part of the needed torque multiplication. The hydraulic torque converter differs from the fluid coupling in having a stationary reaction member interposed between the impeller (driving torus) and the runner (driven torus); this serves to redirect the fluid so that it impinges on the vanes of the impeller as it returns from the runner The effect of the reaction member is to provide more torque tending to turn the runner than is applied to the impeller by the engine. It acts as a torque multiplier in the same fashion as a mechanical gear train.

Because of the need for a reverse gear and greater torque multiplication than the hydraulic torque converter provides, a planetary gear train is provided between the runner and the output shaft of the transmission. A type of compound planetary gear train with two sun gears and two sets of planet pinions has been designed that provides a low forward speed, a reverse, and a means of locking into direct drive. This unit is used with various modifications in practically all hydraulic torque converter transmissions. Control is by hydraulically engaged bands and multiple-disk clutches running in oil, either by the driver's operation of the selector lever or by a speed-sensitive governor.

Automatic transmissions not only require no skill to operate but make possible better performance than is obtainable with transmissions that necessitate the release of a clutch during gear shifts. Power is applied to the driving wheels continuously whenever the accelerator pedal is depressed and gears are shifted without closing the engine throttle or interrupting the drive.

Small, low-powered European cars usually have manually shifted, four-speed transmissions Power-operated clutches are sometimes used in combination with preselective or semiautomatic transmissions. Fully automatic transmissions are used chiefly in the larger cars and they are more commonly stepped-gear devices than hydraulic torque converters. (*See* also POWER TRANSMISSION: *Hydraulic Transmissions: Hydraulic Coupling;* TORQUE CONVERTER; CLUTCH.)

8. Rear Axles.—Power is conveyed from the transmission to the rear axle by a propeller shaft and universal joints. As body lines were lowered progressively, the floor level came closer to the propeller shaft, necessitating floor humps or tunnels to provide clearance. The adoption of hypoid or offset spiral bevel gears in the rear axle provided an increase in this clearance by lowering the drive pinion below the centre of the axle shafts.

The ring gear of the rear axle surrounds the housing of a differential gear train that serves as an equalizer in dividing the torque between the two driving wheels while permitting one to turn faster than the other when rounding corners. The axle shafts terminate in bevel gears that are connected by several smaller bevel gears mounted on radial axes attached to the differential housing and carried around with it by the ring gear. In its simplest form this differential has the defect that one driving wheel may spin when it loses traction and the torque applied to the other wheel, being equal to that of the slipping wheel, will not be sufficient to drive the car. Several types of nonslip or torque-biasing differentials were developed to overcome this difficulty.

European manufacturers quite generally adopted a wide variety of articulated rear axles that provide individual wheel suspension at the rear as well as the front. Individual rear suspension not only eliminates the heavy rear axle housing but also permits lowered bodies with no floor humps, because the transmission and differential gears can be combined in a housing that is mounted on a rear cross member moving with the body under suspension spring action.

In some instances, European manufacturers use articulated or swing axles similar to American rear axles except that the tubular housings surrounding the axle shafts terminate in spherical head segments that fit into matching sockets formed in the sides of

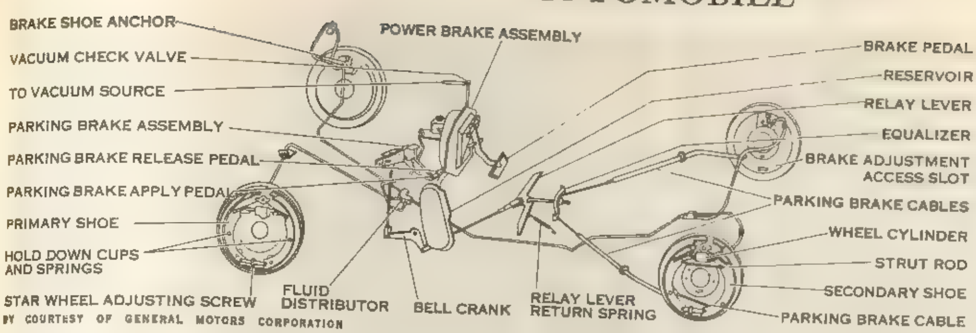

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FIG. 2.—HYDRAULIC BRAKE SYSTEM

the central gear housing. Universal joints within the spherical elements permit the axle shafts to move with the action of the suspension springs. The gear housing is supported by a rear cross member of the chassis and moves with the sprung portion of the vehicle, as does the driveshaft. Other types eliminate the axle shaft housings and drive the wheels through two open axle shafts, each fitted with two universal joints. The wheels are then individually supported by radius rods or other suitable linkage.

The driving train for rear-engine cars is simplified by individually supported rear wheels in that a combined transmission and differential assembly can form a unit with the engine, and two short transverse driveshafts, each having universal joints at both ends, transmit power to the wheels. In this case there is no rear axle, as such, and the wheels are individually suspended much the same as the front wheels.

9. Brakes.—Most automobile brakes are of the internally expanding shoe type, in which two nearly semicircular brake shoes are pressed against the inner surface of a drum attached to the wheel. Until the 1930s, most brake systems were of the mechanical type, *i.e.*, foot pressure exerted on the brake pedal was carried direct to the brake shoes by a system of flexible cables. However, mechanical brakes are difficult to keep in adjustment so that equal braking force is applied at each wheel; and as vehicle weights and speeds increased, they demanded more and more effort on the part of the driver.

Mechanical brakes were almost universally supplanted, therefore, by hydraulic braking systems, in which the brake pedal is connected to the piston in a master cylinder. Steel tubing with flexible sections at the wheels leads from the master cylinder to the wheel cylinders. The wheel cylinders are located between the movable ends of the brake shoes and each is fitted with two pistons that are forced outward toward the ends of the cylinder by the pressure of the fluid between them. As these pistons move outward they push the brake shoes against the inner surface of the brake drum attached to the wheel. The differing diameters of the pistons in the master cylinder and wheel cylinders provides a hydraulic force multiplication that reduces the effort required of the driver.

Further increases in vehicle weights and speeds in the 1950s made even hydraulic brakes difficult for drivers to operate effectively, and many of the larger automobiles consequently were equipped with power brake systems. These are virtually the same as the hydraulic system except that the piston of the master cylinder is operated by a vacuum piston and cylinder instead of by the pressure exerted on the brake pedal (fig. 2). The master cylinder and vacuum power cylinder are formed in one unit as shown in fig. 3. When the driver starts to depress the brake pedal the valve plunger moves to the right in the piston and closes the atmospheric port. Further movement of the valve opens the vacuum port connecting the vacuum inlet to the cylinder chamber at the right of the piston. The vacuum inlet pipe leads to the intake manifold and, when the vacuum valve opens the port, a vacuum is formed on the right side of the power piston. Atmospheric pressure acting on the left side of the piston causes it to move to the right. The plunger in the master cylinder covers the compensating port and places the hydraulic brake fluid under pressure in the wheel cylinders. As the brake fluid pressure builds up, the rubber reaction disk compresses and pushes back the vacuum valve. If the pedal is not depressed further, the vacuum port will close and the brakes will be held in application until the pedal is released. The amount of brake fluid pressure depends upon how far the pedal is depressed; the driver feels a resistance to pedal movement proportional to the fluid pressure actuating the brakes. The force he must exert is much smaller, however, than is necessary with ordinary brakes, and no appreciable physical effort is necessary to apply the brakes fully.

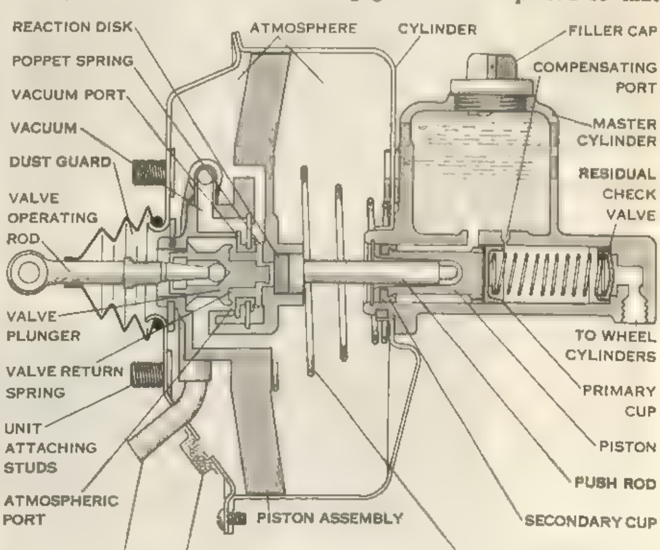
Overheating of the brake drums and shoes causes the brakes to fade and lose their effectiveness when held in engagement for a considerable length of time. This problem has been attacked by the use of aluminum cooling fins bonded to the outside of the brake drums to increase the rate of heat transfer to the air. Vents in the wheels are provided to increase the air circulation for cooling.

Disk brakes, originally developed for aircraft, have been fitted to some automobiles, but their greater cost has prevented widespread use. They are self-adjusting, and their ability to dissipate heat rapidly makes them practically immune to fading.

Parking brakes usually are of the mechanical type, applying force only to the rear brake shoes by means of a flexible cable connected to a hand lever or pedal. On cars with automatic transmissions, an additional lock is usually provided in the form of a pawl that can be engaged, by means of the shift lever, to prevent the drive shaft and rear wheels from turning. (*See* also BRAKE: *Motorcar Brakes.*)

10. Steering.—*Manual Systems.*—Automobiles are steered by a system of gears and linkages that transmits the motion of the steering wheel to the pivoted front wheel hubs. The gear mechanism, located at the lower end of the shaft carrying the steering wheel, is usually a worm-and-nut or cam-and-lever combination that rotates a shaft with an attached crank arm through a small angle as the steering wheel is turned. Tie rods attached to the arm convey its motion to the wheels. In cornering, the inner wheel must turn through a slightly greater angle than the outer wheel because the inner wheel negotiates a sharper turn. The geometry of the linkage is designed to provide for this.

When the front wheels are independently suspended, the steering must be designed so the wheels are not turned when the tie rods lengthen and shorten as a result of spring action. The point of linkage attachment to the steering gear must be placed so that



BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 3.—CROSS SECTION OF POWER BRAKE MASTER CYLINDER

it can move vertically with respect to the wheel mountings without turning the wheels.

Power Steering.—The distribution of weight between the front and rear wheels of automobiles shifted toward the front as the engine and passenger compartment were moved forward to improve riding comfort and road handling characteristics. As the weight carried on the front wheels increased to more than half of the total vehicle weight, the effort necessary to turn the wheels in steering increased. Larger, heavier cars with wider tires and lower tire pressure also contributed to the drag between tires and road that must be overcome in steering, particularly in parking. It was originally considered satisfactory to limit the pull on the rim of the steering wheel to 30 lb. but, with an increasing number of women driving automobiles, this limit proved to be too high.

Considerable reduction in the work of steering resulted from increased efficiency of the steering gears and better bearings in the front wheel linkage. Additional ease of turning the steering wheel was accomplished by increasing the over-all steering gear ratio (the number of degrees of steering wheel turn required to turn the front wheels one degree about the spindle bolts). However, large steering gear ratios make high-speed maneuverability more difficult because the steering wheel must be turned through greater angles in negotiating curves. Steering mechanisms of higher efficiency are also more reversible, with the result that road shocks transmitted from the wheels must be overcome to a greater extent by the driver. This causes a dangerous situation on rough roads or when a front tire blows out, because the wheel may be jerked from the driver's hands.

Power-steering gear was the solution offered to solve the steadily increasing steering problems. Power steering was first applied to heavy trucks and military vehicles early in the 1930s, and hundreds of patents were granted for devices to help the driver turn the steering wheel. Most of the devices proposed were hydraulic, although some were electrical and others used power take-off from the engine.

Hydraulic power-steering systems are of two basic types, the integral and the linkage types. The integral type applies the hydraulic power assistance at the steering gear, whereas the linkage type applies the power direct to the linkage connecting the front wheels to the steering gear. The various systems also differ in the location and type of sensing device that controls the flow of hydraulic fluid to the power cylinder in response to the driver's movement of the steering wheel. All employ a pump driven by the engine to maintain a quantity of hydraulic fluid under about 1,000 p.s.i. pressure.

The sensing device is the most vital element of the power-steering system. This valve mechanism must allow the hydraulic fluid to flow into and out of the two ends of the power cylinder when necessary. The power cylinder is simply a hydraulic cylinder with a close-fitting piston attached to the steering linkage in such a way that the piston moves in one direction when the wheels are being turned to the right and in the opposite direction when they are being turned to the left. The cylinder is closed at both ends, suitable seals preventing the escape of fluid past the piston rod that passes through one or both of the end covers. The cylinder is always full of hydraulic fluid. If fluid is admitted to one end of the cylinder under pressure from the engine-driven pump and the fluid in the other end of the cylinder is allowed to escape to the fluid reservoir, a force equal to the product of the fluid pressure and the piston area is applied to the steering linkage. If the fluid connections are then reversed by the valves and fluid admitted to the opposite end, the wheels will be turned in the opposite direction. The function of the control device is to open a valve admitting fluid to the appropriate end of the cylinder and another venting fluid from the other end in response to a slight turn of the steering wheel by the driver. In effect, there are four valves opened and closed in pairs so that fluid is simultaneously admitted to one and released from the other of the two ends whenever the steering wheel is being turned. When the driver holds the steering wheel stationary, all four passages are closed and the front wheels are held in position.

The sensing device that actuates the valve mechanism usually employs the torque reaction to the turning of the steering wheel through a very small angle. In some systems end thrust on the steering gear worm causes a slight axial movement of the worm that operates the valve element. Others employ a torsion member that permits a slight twist in the shaft to which the steering wheel applies its motion and this angular displacement shifts the valve. The valve itself is usually a spool type, requiring a very small travel to open or close. The motion of the spool is usually axial, but there are also rotary valve types. The linkage system usually employs tension and compression in the linkage rod to actuate the valves.

An integral power-steering gear with the power cylinder built into the gear housing is shown in fig. 4. The nut portion of the circulating-ball steering unit is incorporated in a combined piston and rack that rotates the pitman shaft. Fluid is admitted to the left side of the piston for a right turn and to the right side for a left turn. The sensing unit is a rotary spool valve actuated by the twist of a torsion bar when the steering wheel is turned by the driver.

11. Suspension Systems.—The suspended portion of the automobile is attached to the wheels by elastic members designed to cushion the impact of road irregularities. The nature of the attaching linkages and spring elements varies widely among U.S. and European automobiles. Riding comfort and the handling qualities of the vehicle are greatly affected by the functioning of the suspension system. Mechanical simplification is gained by connecting the front wheels with a rigid front axle just as the rear wheels are connected by the conventional rear axle housing. Several important advantages, however, are gained by so-called independent suspension systems that permit the wheels to move independently of each other. The unsprung weight of the vehicle is decreased, softer springs are permissible, and front-wheel vibration problems are minimized. Independent front suspensions entirely replaced the rigid-axle type after World War II and numerous independent rear suspensions came into use on European cars. The first American production car to use an independent rear suspension was a 1960 model. Spring elements used for automobile suspension members, in increasing order of their ability to store elastic energy per unit of weight, are leaf springs, coil springs, torsion bars and air rubber-in-shear devices, and air springs.

Leaf and Coil Springs.—The leaf spring, although comparatively inelastic, has the important advantage of accurately positioning the wheel with respect to the other chassis components, both laterally and fore-and-aft, without the aid of radius rods, control arms or other linkages. For

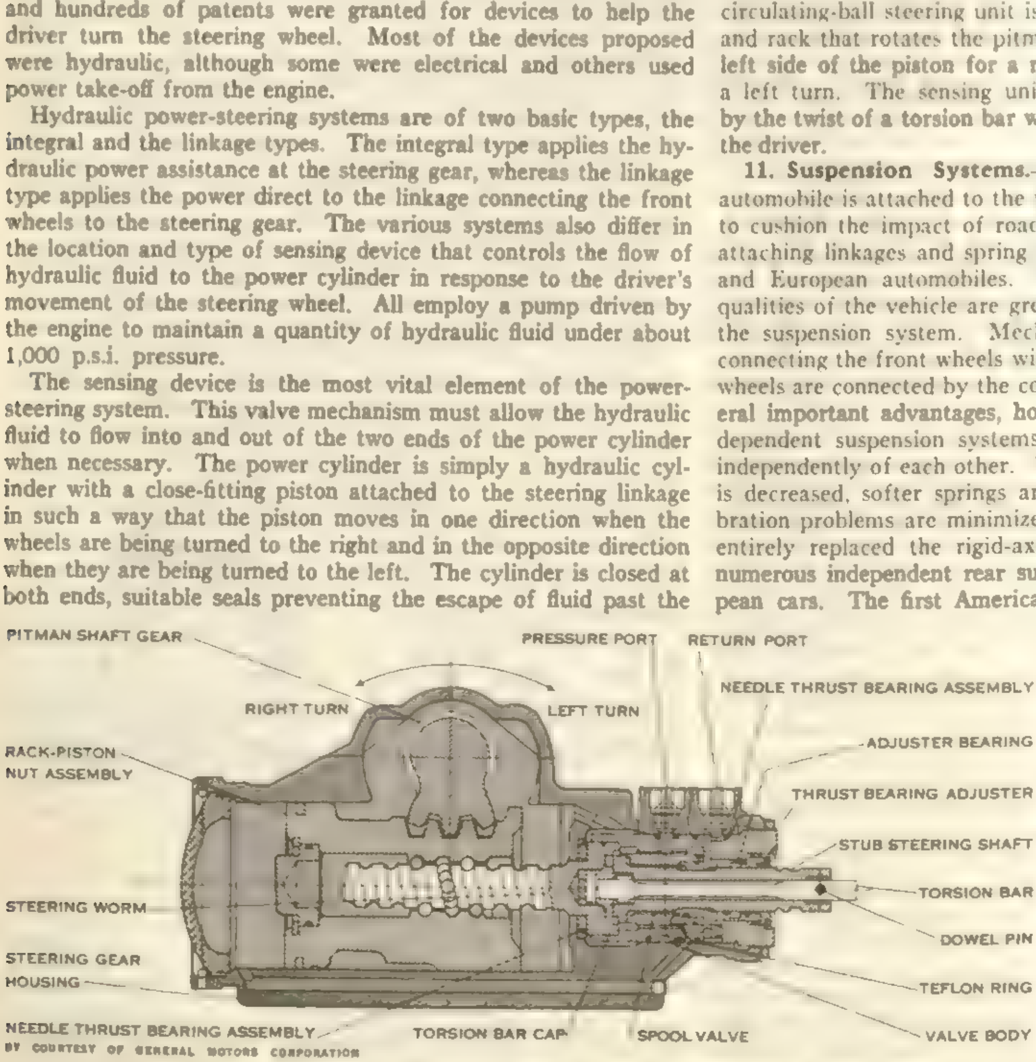


FIG. 4.—CROSS SECTION OF INTEGRAL POWER STEERING GEAR

this reason, semielliptic leaf springs were retained at the rear of most American cars until 1957, when coil springs with optional air springs were introduced by several manufacturers.

Coil springs met the requirements of independent front suspensions quite well and were adopted by most designers. One American manufacturer substituted torsion bar elements for the coil springs in a similar system of linkages.

Some cars equipped with rear leaf springs employ the Hotchkiss drive, in which the axle housing is rigidly attached to the spring seats so that the driving torque reaction, the brake torque, and the driving force are all imparted to the spring. Those using rear coil springs may have a torque tube enclosing the drive shaft and taking these forces to its point of attachment at the front of the axle housing. A diagonal transverse rod connecting one outer end of the axle housing to the chassis frame at the opposite side is provided to position the axle laterally. Other types with open drive shafts provide for these forces by radius rods and other linkages.

An important factor in spring selection is the relationship between load and deflection known as spring rate and defined as the load in pounds divided by the deflection of the spring in inches. A soft spring has a low rate and deflects a greater distance under a given load. A coil or a leaf spring retains a substantially constant rate within its operating range of load and will deflect ten times as much if a force ten times as great is applied to it. The torsion bar, a long spring-steel element with one end held rigidly to the frame and the other twisted by a crank connected to the axle, can be designed to provide an increasing spring rate.

A soft spring suspension provides a comfortable ride on a relatively smooth road, but the occupants will move up and down excessively on a rough road. The springs must be stiff enough to prevent a large deflection at any time because of the difficulty in providing enough clearance between the sprung portion of the vehicle and the unsprung portion below the springs. Lower roof heights made it increasingly difficult to provide the clearance needed for soft springs. Road handling characteristics also suffer because of what is known as sway or roll, the sidewise tilting of the car body that results from centrifugal force acting outward on turns. The softer the suspension the more the outer springs are compressed and the inner ones expanded by this force. Front-end "dive" under brake action is more noticeable with soft front springs.

Air Springs.—Air springs offer several advantages over metal springs. One of the most important of these is the possibility of controlling the spring rate. Inherently, the force required to deflect the air unit builds up increasingly with greater deflection because the air is compressed into a smaller space and greater pressure is built up, thus progressively resisting further deflection. The early air spring designs used a rubber bellows construction, basically like an accordion. The compactness required of modern automobile suspension units could not be had with this type. A piston and rolling diaphragm construction was found to meet the requirements. The piston is attached to the front wheel linkage or the rear axle housing by the bolt at the bottom, and the pressed-steel air dome is attached at its flange to the frame of the car. The laminated rubber diaphragm is molded with wire bead rings to permit sealed attachment at its outer periphery to the air dome and at the inside to the hollow steel piston. The piston is made smaller in diameter than the opening in the skirt so that the diaphragm can roll onto the cylindrical surface of the piston under compression and onto the skirt under elongation. Changes in alignment as the body of the car sways do not interfere with the operation of the spring unit.

Hydropneumatic Suspension.—A hydropneumatic or combination hydraulic-fluid-and-air suspension system was developed for the French Citroen model DS-19 car. The elastic medium is a sealed-in, fixed mass of air, and no air compressor is required. The hydraulic portion of each spring is a cylinder mounted on the body sill and fitted with a plunger that is pivotally attached to the wheel linkage to form a hydraulic strut. Each spring cylinder, of 1.375 in. bore, has a spherical air chamber about 4 in. in diameter attached to its outer end. The sphere is divided into two chambers by a flexible diaphragm, the upper occupied by air and the lower by hydraulic fluid that is in communication with the hydraulic cylinder through a two-way restrictor valve. This valve limits the rate of movement of the plunger in the cylinder, since fluid must be pushed into the sphere when the body descends and returned when it rises. This damping action thus controls the motion of the wheel with respect to the sprung portion of the vehicle supported by the spring.

The amount of hydraulic fluid in each spring unit is varied by front and rear leveling valves that transfer fluid to and from a central hydraulic system in which pressure is maintained by an engine-driven pump. These leveling valves serve to maintain constant clearance between the wheels and the sprung portion of the vehicle under varying passenger and luggage load.

A manual control is also provided that permits raising the vehicle to increase the road clearance when negotiating deep ruts. It also permits wheels to be lifted from the ground for tire changes by elevating the car, placing a support under either side and then allowing the unsupported side to descend by releasing the fluid pressure. The anti-roll or stabilizer bars, which limit lateral differences in spring displacement, then lift the wheels from the ground on the elevated side of the car.

The static pressure is about 480 p.s.i. in the front spring units and about 370 p.s.i. in the rear units. The softness of the suspension is intermediate between those of air and steel springs. The constant-clearance or level-ride feature is one of the major qualities of the hydropneumatic system.

See also references under "Automobile" in the Index.

(O. C. C.)

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AUTOMOBILE INSURANCE: *see* MOTOR VEHICLE INSURANCE.

AUTOMOBILE RACING. Automobile racing is the broad term for an amateur and professional sport of many categories: Grand Prix racing, sports car racing, production car (stock car) racing, endurance events, maximum-speed or maximum-acceleration events (drag racing), hill climbs, rallies and trials, etc. For the history of driving or touring by automobile for pleasure and the development of automobile clubs and rallies *see* MOTORING. Each racing category is composed of many classes and subclasses, depending upon the type and size of automobiles used and the course or track on which they may compete. There are also major differences between motor racing as practised in its two principal strongholds, the United States and Europe.

Wherever automobile racing is formal and official, it is conducted by organizing clubs. These are usually national organizations supervising racing, or a specified type of racing, in their home country. In the United States, for example, various organizations govern various kinds of racing: United States Automobile Club (USAC), National Association for Stock Car Auto Racing (NASCAR), Sports Car Club of America (SCCA), National Hot Rod Association (NHRA), etc.; in Great Britain the Royal Automobile Club (RAC) and the British Racing Drivers' Club (BRDC). The world governing body for automobile racing is the International Automobile Federation (Fédération Internationale de l'Automobile; FIA; founded 1904) at Paris. The FIA recognizes one national body from each member nation and sanctions events through the facilities of member clubs.

Pioneer Events.—Automobiles have been used for sport from the dawn of their history. Hardly was a self-propelled vehicle made for a utilitarian service in the 1880s than it was also tested

in competition of one style or another, often for the purpose of proving not only its speed but, more important in those pioneering times, its safety and reliability. By 1895, racing in a formal sense had begun. In the years that have followed, it has flourished in all the major western nations of the world, drawing huge spectator crowds and stimulating large investments of money by some manufacturers—who may have dual motivations: to use racing as a testing laboratory in which new and advanced designs are evaluated, and to earn popularity and good reputation as sales-promotion aids.

Though there had been a trial of horseless carriages on the road from Paris to Rouen, France, in 1894, the first real race was run from Paris to Bordeaux, France, in June 1895. It was won by a French Panhard automobile after more than 48 hours of driving at an average speed of 15 mph.

The next races, those from Paris to Vienna, Aus., and from Paris to Berlin, Ger., have justly been described as belonging to the heroic age. The crude vehicles traveled faster and faster through clouds of stinging dust on highways that were only imperfectly guarded. When passing another car, a driver could judge his direction and the approximate location of the road from what he could see of the treetops above the all-pervading dust. Tire trouble was common; dogs and farm carts ever-present dangers. Only men of pioneer calibre, aided by stouthearted mechanics traveling on the automobiles, could fight through to the finish against the troubles of untested mechanisms and the hazards of the road. (*See* also MOTORING: *Early Motoring*.)

The cars used in the early races were either those which were already in production or prototypes for future production, both submitted publicly to the most strenuous test possible. The races had therefore value as experiments leading to the evolution of better cars. This aspect made so great an impression on an enthusiastic U.S. newspaper publisher, James Gordon Bennett, that he offered a trophy to be won in a special race. The condition for the Gordon Bennett Çup was that a country might enter a team of three cars, every part of which, down to the smallest detail, had to have been made in that country. Thus was initiated a truly international series of six races, beginning in 1900.

By 1906, however, the large French automobile industry was no longer willing to be restricted to only three automobiles in the Gordon Bennett races and so organized the Grand Prix race with no limitations on the number of cars that might be entered from any nation. The first of these races was run in 1906 and it marked the end of the Gordon Bennett series; the French Grand Prix continued as a major automotive event.

While automotive events grew in numbers and popularity in Europe, interest in the automobile kept pace in the U.S. Most famous of the races held in the U.S. during the pioneer era of motor racing were the Vanderbilt Cup events beginning in 1904. These 300-mi. road races attracted some of the leading drivers and racing cars of Europe and were continued until interrupted by World War I in 1917. Two revivals of the Vanderbilt Cup races were held in 1936 and 1937. The American Grand Prize international road race was inaugurated at Savannah, Ga., in 1908 and continued as an annual event through 1916. It was won only once by an American car—a Mercer in 1914.

Also in this period, the first Indianapolis Speedway races were run in 1909 on a 2½-mi. macadam-surfaced track. In 1911 the surface was paved with brick and the first 500-mi. race was run, won by Ray Harroun in a Marmon averaging 74.59 mph.

Following World War I, the development of motor sport continued at a rapid rate. Almost every nation of Europe boasted its own Grand Prix event in addition to scores of lesser contests. As the automobile became man's most useful tool, so, too, it became one of his most popular instruments of sport.

Dangers.—Motor racing is a dangerous undertaking in all its forms. Although manufacturers and race promoters are usually reluctant to acknowledge the dangers inherent, spectacular and death-dealing accidents have marked the history of the sport from its earliest days. At various times, following fatal accidents involving either participants or spectators, the very continuance of motor racing has seemed to be in doubt because of public or official protests. For example, in 1903, during a race held on the roads between Paris and Madrid, several drivers and an uncounted number of persons were killed and maimed along the route. As a result the event was stopped short of its destination. This marked the end of the era of so-called point-to-point racing on open roads. During World War II, Benito Mussolini, appalled at the number of deaths caused during the running of Italy's Mille Miglia (thousand mile) race, placed a ban on future runnings of the event. This prohibition was ignored following the war, however, and the Mille Miglia continued to be run each year, usually with the loss of several lives. Finally, in 1957, an accident involving a car driven by the marquis de Portago brought death to the driver, co-driver, and several spectators and a final ban on the open-road race by the Italian government. In the United States, the death toll at the Indianapolis Memorial Day race has averaged more than one per year, yet the event is considered relatively safe by authorities. The most disastrous accident in the history of motor racing occurred in 1955, during the running of the famed 24-hour sports car event at Le Mans, France, when, after a collision, one of the automobiles hurtled into the crowd, killing 83 persons and injuring many more. For months, the entire future of racing was again in jeopardy, but eventually safety regulations were reviewed and strengthened and the sport continued. The opinion is often expressed by writers and close followers of automobile racing that this element of danger and the imminence of sudden death on the track plays no small part in the popularity of the sport with many participants and many spectators. Others disagree.

Midget Car Racing.—The sport of racing undersized cars emerged in the 1940s and quickly gained popularity. The cars must comply with rigid specifications. Wheelbases are 66 to 76 in. and tread widths 42 to 46 in. Racing at specially built tracks usually is conducted on a circuit plan providing series of races. The sport is supervised by the Midget Division of the USAC. (C. N. BA.)

Grand Prix Racing.—In the whole firmament of racing, Grand Prix events are the most elite. Grand Prix (*i.e.*, international formula) automobiles are commonly the ultimate in design, speed, horsepower—and romance. These are true racing cars in layman's language. In Europe, they are painted in national colours (British green, Italian red, French blue, German white, U.S. blue and white, etc.), entered by their manufacturers in events as teams (usually of two or three cars) and driven by the finest professional drivers. Races are held on closed circuits three or four miles to the lap; the total distance varying from 150 to 400 mi. Grand Prix cars have been constructed by Auto Union and Mercedes-Benz in Germany; by Bugatti, Delage, Gordini, and Talbot in France; by BRM, Lotus, Cooper, and Vanwall in England; by Alfa-Romeo, Ferrari, and Maserati in Italy—to name only a few. All modern Grand Prix cars conform to one of various formulas or sets of specifications which are laid down by the FIA and which govern the size, weight and type of vehicle permitted. In the late 1950s Formula I Grand Prix cars were limited to engine displacements of not more than 2,500 cc. without supercharger; not more than 750 cc. with supercharger. In 1961, Formula I was reduced to 1,500 cc. No supercharging was permitted. In 1966 this formula was changed to 3,000 cc. or 1,500 cc. if supercharged.

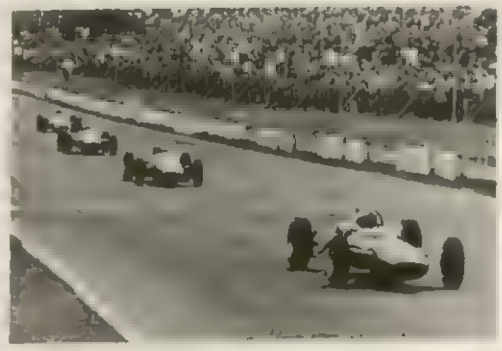
Based upon points earned in major Formula I events each year a driver is designated world champion. The qualifying events, called *grandes épreuves*, are customarily the Grand Prix of Monaco, Belgium, Netherlands, France, Great Britain, Germany, Italy, Mexico, South Africa, Canada and the United States (Watkins Glen; the Indianapolis 500—for track-type cars—no longer qualifies for championship points). In 1966 the FIA announced new rules, under which, beginning in 1967, drivers' performances would count in 9 out of 11 championship events. Points would be scored on the five best placings in the first six races of the season and on the four best places in the remaining five events. Competition for the title of world champion began in 1950 and it has been won by such famed drivers as Giuseppe Farina and Alberto Ascari of Italy; Juan Manuel Fangio of Argentina; Michael Hawthorne, Graham Hill, John Surtees, and Jim Clark

of Great Britain; Jack Brabham of Australia; and Phil Hill of the U.S. Prior to the establishment of the formal title many great drivers won international acclaim. The greatest of these was the Italian, Tazio Nuvolari; others of heroic stature include Rudolf Caracciola, J. P. Wimille, Luigi Villoresi, Richard Seaman, Achille Varzi, Raymond Mays, and Rene Dreyfus.

Sports Car Racing.—Although there are many conflicting definitions of sports cars, it is usually conceded that in normal production form they do not resemble Grand Prix machines. Whereas the latter is a single-seat design with spartan cockpit furnishings and utterly functional equipment throughout, the sports, or Gran Turismo (GT), car is usually a two seater, sometimes four, and is characterized by its nimble abilities (if not speed and power) together with general suitability for high-speed touring on ordinary roads. Unlike a Grand Prix car, it is intended to be a privately owned vehicle; also unlike its more exotic cousin, it is usually series-produced, seldom handmade. Some manufacturers of Grand Prix machines, such as Ferrari and Lotus, also make sports cars. Other makes include MG, Jaguar, Aston-Martin, Austin Healey, Triumph, Porsche, Lancia, Morgan, Chevrolet Corvette, and Cobra. Although not usually designed exclusively for racing, sports cars are nevertheless able racing machines and are often entered in competitions with their own kind. Some of the world's most famous races are sports car events and may even be designated as Grand Prix. (When the term Grand Prix is used in this context it does not refer to the type of car used but, rather, to the fact that the race is a major automotive event of the nation in which it is held.) The development of sports cars for racing, especially in such important events as the 24-hour endurance race at Le Mans (where the reputations of manufacturers are very much at stake) has brought about some sports cars that are, in reality, little different in their power and speed potentials from full Formula I machines. Based upon results attained each year in a select list of sports car races, a sports car championship is awarded. This list commonly includes: the Sebring 12-hour race, U.S.; the Monza 1,000 kilometres, Italy; the Nürburgring 1,000 kilometres, Germany; the Le Mans 24-hour race, France; the Targa Florio, Sicily; and the Tour de France. This championship was dominated by Italian Ferraris in the 1950s and 1960s although others, including British Aston-Martins and American Cobras, won many important races. The sweeping victory of Ford at Le Mans in 1966 broke Ferrari's domination. It should be noted that whereas the world championship in Formula I is awarded to a driver, the same title in sports car competition is awarded to a make of automobile.

Stock Car Racing.—Automobiles that are not racing models and not sports models usually are termed stock cars (U.S.) or production models. Production cars are the basis for some of the most widely attended and most commercially important events in the whole of motor sport. The origins of stock car racing are said to stem in part from the prohibition period in the U.S. when bootleggers, needing private cars of more than ordinary speed capabilities, tuned and altered ordinary passenger automobiles to suit their needs. Subsequently, these "hopped up" cars were often raced for pleasure. From these beginnings, an important branch of motor sport has grown. In the United States, largely because of the NASCAR, stock car racing flourished after 1949. Racing is conducted in several classes: grand national, modified, sportsman, etc., depending upon the type of automobile raced and the degree of modification allowed. Annual attendance at stock car racing events in the U.S. alone has been estimated at 10,000,000. Because results in these events are widely believed to have a powerful influence on brand preference among buyers of new cars, competition among manufacturers in the sponsorship of teams, engineers, drivers, etc., is often intense. Principal stock car events are held at Darlington (S.C.), Daytona (Fla.), and Atlanta (Ga.). The Monte Carlo (Monaco) rally and various national rally events in European countries fall in yet another category (*see* MOTORING).

Hot Rod Racing.—This subdivision of motor sport is largely confined to acceleration contests between privately designed and privately built automobiles which have been constructed along individualistic lines to provide maximum performance. Hot rods in various classes may also compete against time or distance in



(TOP LEFT) A. F. P.—PICTORIAL PARADE; (RIGHT, BOTTOM LEFT) PARIS MATCH—PICTORIAL PARADE; (CENTRE LEFT) CENTRAL PRESS—PICTORIAL PARADE

(TOP LEFT) DRIVERS RACE TO THEIR CARS AT THE START OF THE 24-HR. ENDURANCE RACE AT LE MANS, FRANCE, 1962; (RIGHT) MAURICE TRINTIGNANT IN THE LEAD DURING THE 1962 PARIS GRAND PRIX; (CENTRE LEFT) JIM CLARK LEADING THE FIELD DURING RUNNING OF THE LONDON TROPHY RACE, 1965; (BOTTOM LEFT) RACER COMING OUT OF A TURN IN THE MOROCCAN GRAND PRIX, 1958

[illegible] (BOTTOM) NATIONAL HOT ROD ASSOCIATION

(TOP) JACKIE STEWART TEMPORARILY TAKES THE LEAD FROM JIM CLARK IN THE 1966 INDIANAPOLIS SPEEDWAY 500-MILE RACE. (BOTTOM) TWO "SLINGSHOT" DRAG RACERS AT THE START OF THEIR RUN FOR TOP GAS ELIMINATOR TITLE

speed and endurance attempts. A large number of national and international records, some previously held by large European or U.S. manufacturers, fell to hot rod builders and drivers in the period following World War II. Hot rodding as a hobby-sport suffered and survived an early period of bad public and press relations because of its associations with illegal street racing, but under the National Hot Rod Association (NHRA) became self-policing and widely accepted by youth organizations, police officials, service clubs, and automotive manufacturers.

No definition of a hot rod is universally accepted. These cars may be constructed of components from many makes of old or new automobiles; certain basic types are well-defined and recognized, however—such as roadsters, coupes and sedans, pickups, streamliners, etc.—depending upon style of body and intended use. Thus, a street roadster would be a high-performance automobile, yet suitable for general use; a streamliner, by contrast, is designed for top-speed performance at dry-lake or salt bed courses and would be unsuitable for any other purposes. All are usually constructed with strict regard for safety.

Drag Racing.—Conducted at specially constructed and often elaborately equipped strips all over the country, this is one of the most widely attended auto sports in the U.S. A drag, or acceleration test, measures the time required to cover a quarter mile from a standing start. The most specialized hot rods—so-called slingshots (in which the driver sits on an extension behind the rear wheels)—compete in this category. Some develop up to 1,000 hp. and complete the standing quarter mile in under 8 sec., reaching speeds over 200 mph. Standard production cars and sports cars may also compete in drag races.

Records.—Any of the automobiles heretofore described—Grand Prix, sports, stock, hot rods, etc.—may, in addition to participating in races or contests with their own kind, also make solo attempts against established time-distance records. Automobiles constructed solely for record attempts are likewise not uncommon. Records are established in both standing-start and flying-start categories and in both miles and kilometres. They may also be expressed in terms of distance achieved within a given period of time, the record for one hour, for example, being 190.68 mi. Engine size in cubic centimetres of cylinder volume is used as the basis for determining ten competition classes, designated A through J by the FIA. Thus, for example, ten separate records for the flying mile may exist at the same time, but greatest public interest is usually centred on the records in class A—cars with engines of unlimited size. In this class a world land-speed record of 394.2 mph set by Englishman John Cobb at the Bonneville salt flats, Utah, in 1947 stood until July 17, 1964, when Donald Campbell, son of a former British record holder, drove his jet-powered (rear wheels driven) "Bluebird" 403.1 mph at the Lake Eyre salt flats in Australia. This record for wheel-driven vehicles was broken by Bob and Bill Summers of the U.S. on Nov. 13, 1965, with 409.28 mph at Bonneville. Driving pure-jet-thrust vehicles, Craig Breedlove of the U.S. became the first human to be officially timed at more than 400, 500, and 600 mph, all at Bonneville. He set a record of 407.45 mph in a three-wheeled jet in 1963, sanctioned by the Fédération Internationale Motocycliste. The FIA qualified jet-thrust propulsion for the land-speed record, but still required that the vehicle have four wheels. In 1964 Breedlove in a four-wheeled jet was timed at 526.28 mph (in 23 days during October 1964 the records were: Oct. 2, Walt Arfons/Tom Green [U.S.], 413.20 mph; Oct. 5, Art Arfons [U.S.], 434.02 mph; Oct. 15, Breedlove, 526.28 mph; and Oct. 27, Art Arfons, 536.71 mph). Art Arfons set the record at 576.553 Nov. 7, 1965, and on Nov. 15 Breedlove pushed it past the 600 mark with an average of 600.601 mph for two runs through the measured mile.

Although international records may be set wherever official (FIA sanctioned) timing apparatus and observers are present, the salt beds at Bonneville are most frequently used for this purpose, particularly in the unlimited category. Daytona Beach, once the mecca of the record seekers, is extensively used in production-car tests, but does not offer the hundreds of square miles of ideal surface found at Bonneville.

See also AUTOMOBILE; SPORTING RECORD. (C. N. BA.; X.)

AUTOMOTIVE INDUSTRY, the term usually applied principally to the manufacture of motor vehicles, although it also includes the manufacture of engine and body parts for motor vehicles. While the automobile is of European origin, the industry became heavily concentrated in the United States. From 1960 to 1965, for example, world automobile production approximated 14,288,000 vehicles annually, of which between 46% and 52% were made in the U.S. The economic importance of the industry was so great that automobile output became the principal index of U.S. business conditions and one of the important elements in the economic recovery of western Europe after World War II was the marked expansion of motor vehicle production. Along with the manufacture and sale of motor vehicles and parts the automotive industry brought into existence a substantial group of enterprises engaging in service functions: gasoline service stations, independent repair shops and dealers in automotive accessories.

The growth of the industry has been characterized by rapid technological changes both in the motor vehicle itself and in the techniques of production. Automobile manufacturing was, in fact, the first full-fledged mass production industry and it was the model followed by other manufacturers of durable consumers' goods (refrigerators, washing machines, etc.). The automotive industry also introduced changes in marketing practices, particularly in the American system of franchised dealers obligated to handle only one company's products. In addition, the industry underwent developments in business organization that had a striking uniformity in all the major automobile producing countries, namely, a progression from a large number of small firms to a small number of very large firms operating under conditions of limited competition.

ORIGINS OF THE INDUSTRY

Beginnings in Europe.—Like the motor vehicle itself, the automotive industry originated in Europe. The commercial manufacture of automobiles, as distinguished from the making of experimental models, was established in France and Germany about 1890. Carl Benz was advertising motor carriages in 1888 and the French firm of René Panhard and E. C. Levassor acquired the rights to manufacture vehicles using Gottlieb Daimler's patents in 1889. Daimler himself organized the Daimler-Motoren-Gesellschaft at Bad Cannstatt, Ger., late in 1890.

Interestingly enough, despite the undisputed primacy of Benz and Daimler as inventors of the gasoline automobile, France was the first to develop substantial commercial automobile production.

Daimler was successful in licensing his patents to manufacturers in other countries but he was not a major producer himself until his technical director, Wilhelm Maybach, designed the Mercedes in 1900 and the Daimler concern at the same time acquired a first-class business executive in Emil Jellinek. Benz likewise was a small-scale producer during the 1890s and the Opel firm, founded at Russelsheim, Ger., by Adam Opel, did not begin the manufacture of motor carriages until 1898.

On the other hand, Panhard-Levassor led the automotive field until 1900. The car that Levassor designed in 1891 was the prototype of the true automobile, instead of being just a "horseless carriage." It had the engine in front of, rather than under, the driver's seat, a sliding gear transmission and a differential gear with power transmitted to the rear axle by a chain drive. Armand Peugeot also began making automobiles with the Daimler engine in 1890. Then Count Albert de Dion and Georges Bouton, who had been building steam-driven road vehicles since 1883 with some success, turned to the development of a lightweight gasoline engine and became substantial manufacturers of motor tricycles. In addition the De Dion-Bouton engine was adopted by Louis Renault when he began to build automobiles in 1898.

Italy provided an early and important entry in the automotive field when the Fiat works (Fabbrica Italiana Automobili Torino) began to make motor vehicles at Turin in 1899.

Beginnings in Britain.—Britain had some promising experiments with steam-powered highway vehicles as far back as the 1830s, but its progress was seriously retarded by adverse legislation, culminating with the "red flag" law of 1865, which required all self-propelled vehicles on public highways to be preceded by a man on foot carrying a red flag. The real growth of the British automotive industry dates from the repeal of this law in 1896. At that time Frederick R. Simms organized a company to manufacture Daimler cars in Britain. F. W. Lanchester made the first all-British gasoline automobile in 1896; by 1900 such well-known makers as Riley, Napier, Wolseley, Sunbeam and Albion had appeared, followed by Vauxhall in 1904. Albion built only a few passenger cars before deciding to engage in the making of commercial vehicles exclusively.

The British automotive industry had the distinction of being the first to experience an attempt at monopolistic combination. The Daimler Motor company was owned by the British Motor syndicate, the creation of an energetic promoter named Harry J. Lawson, who hoped to control the industry through possession of the British rights to the Daimler and De Dion patents. The scheme collapsed in 1901 when the courts refused to sustain Lawson's claims.

Beginnings in the U.S.—In the United States, allowing for the manufacture of about a dozen cars by Charles E. and J. Frank Duryea between 1893 and 1898, commercial production of motor vehicles began in 1897 with the Pope Manufacturing company of Hartford, Conn., and the Winton Motor Carriage company of Cleveland, O. Two years later Ransom E. Olds organized the Olds Motor Works, followed by such concerns as Packard (1900), Cadillac (1902), Buick (1902), Ford (1903) and Maxwell-Briscoe (1903). The wagon manufacturing firm of Studebaker Brothers turned to automobiles in 1902.

Three Common Factors.—Several common factors emerge from this pioneering period of the automotive industry. Most of the early producers initially made automobiles as an offshoot of an existing enterprise, usually either the manufacture of machinery of some kind or of vehicles such as bicycles or carriages. Daimler, Benz, Lanchester and Olds were all engaged in manufacturing gasoline engines. Opel, Pope, Winton and Riley were bicycle manufacturers; William R. Morris and John North Willys were bicycle salesmen; Rover and Humber in Britain and Rambler and Peerless in the United States were popular names in bicycling before their makers turned to motor vehicles. Studebaker, as stated before, made wagons, Herbert Austin built his first car for the Wolseley Sheep-Shearing Machine company, Panhard and Levassor made woodworking machinery, James W. Packard manufactured electrical equipment, Henry M. Leland of Cadillac had a machine tool business, and the White Motor company grew out of the White Sewing Machine company. In other words, there was ordinarily a parent organization that could provide the initial capital and managerial and labour skill. The two most conspicuous exceptions to this pattern were Rolls-Royce and Ford. The former resulted from the association of C. S. Rolls, a wealthy motoring enthusiast, with F. H. Royce, an engineer, in a partnership that began by selling French cars and then decided to make its own. Henry Ford had two false starts before he founded the Ford Motor company in 1903 with financial assistance ($28,000) from a group of Detroit businessmen.

The second common factor was that to a very considerable extent these early automobile factories were predominantly assembly operations, especially in the United States. Independent supplier firms such as Briscoe Brothers, which converted a sheet metal business into a major producer of radiators, or the Hyatt Roller Bearing company made the components. Even engines were made separately; the Dodge brothers, John and Horace, got their start in the automotive industry by making transmissions for Olds and then engines for Ford. The assembly system was a method of financing as well as a technique of production. It became possible to go into automobile manufacturing with a minimum initial investment, since the "factory" was merely an assembly plant and the financing of production could be handled in the early stages by buying parts on credit and selling finished cars to dealers for cash.

Finally, the men who undertook to make motor vehicles had to decide whether the future lay with electric, gasoline or steam automobiles. While the electric automobile was very popular about 1900 because of its quietness and simplicity of operation, it was even then reasonably clear that battery capacity would limit the usefulness of the electric automobile. The failure of the steam automobile to remain in competition has been the subject of much speculation but no conclusive answer has been found. What is certain is that even the most successful manufacturers of steam highway vehicles, such as De Dion-Bouton in France, Thornycroft in Great Britain and White in the United States, switched to the internal-combustion engine by 1910. Only the twin brothers Francis E. and Freelan O. Stanley persisted with the manufacture of steam automobiles on a substantial scale until after World War I.

Troubles Over Patents.—The U.S. automobile industry, like the British, faced patent difficulties in its early years. The Pope Manufacturing company sold its motor carriage business in 1899 to the Electric Vehicle company, a syndicate whose initial intention was to manufacture and operate electric taxicabs. This company also acquired U.S. patent no. 549,160, issued in 1895 to George B. Selden of Rochester, N.Y., covering the basic features of a motor vehicle with an internal-combustion engine. Selden had filed his original application in 1879 and kept it pending for 16 years by methods then permitted by the patent law. The Electric Vehicle company's attempt to enforce Selden's patent resulted in an agreement among the principal U.S. manufacturers whereby the patent was to be administered by them, organized as the Association of Licensed Automobile Manufacturers (A.L.A.M.), for the purpose of promoting stability in the industry.

However some manufacturers, notably Ford, refused to recognize the validity of the Selden patent, and after an eight-year contest they effectively won their point when the U.S. circuit court of appeals held that Selden's patent was valid but only for cars with two-cycle engines. The long-range consequence was that in 1915 the automobile industry in the United States came to an agreement for cross-licensing patents that remained in effect until 1956. In addition the A.L.A.M. initiated a program, subsequently carried on by the Society of Automotive Engineers, for promoting technical standardization in the automotive industry.

MASS PRODUCTION

Demand Stimulates Production.—Few technical innovations have received as enthusiastic a reception as the motor vehicle. The demand for automobiles was so great that the fledgling industry of the 1890s became big business during the following decade. There was a rapid increase in the number of manufactur-

ing firms: the total number that entered the industry has never been calculated but we do know that 200 domestic makes of car had appeared on the British market by 1913 and 2,900 have been identified in the United States, most of them appearing before World War I. Nevertheless demand persistently exceeded the capacity of the industry to produce. This situation enabled manufacturers who were operating on slender capital resources to require cash payment from their dealers, because the dealers were clamoring for cars.

The vigorous demand for cars stimulated the manufacturers in two ways: first, there was constant pressure to improve methods of production so as to increase output; second, there was a realization that a vast potential market existed for low-priced cars. This condition applied most strongly to the United States, with its continental market area and high standard of living, so that American manufacturers were the first to adopt mass production techniques. While this development is indelibly and correctly identified with Henry Ford, there were other contributors. The basic techniques of mass production can be traced back at least to the work of the armories at Springfield, Mass., and Harpers Ferry, and to others at the beginning of the 19th century who applied machinery to the manufacture of interchangeable parts. The first low-priced automobile to be manufactured in quantity was the curved-dash Oldsmobile runabout—the original "Merry Oldsmobile"—which Ransom E. Olds put on the market in 1901. Production of this model reached a peak of 5,000 in 1904 but then Olds' stockholders decided to abandon it in favour of a heavier car. There were other attempts at low-priced cars along the same lines before Ford came into the field. A spectacular demonstration of interchangeability of parts in automobile manufacturing was provided in 1908 by Henry M. Leland when three Cadillacs were taken apart at the British Royal Automobile club's Brooklands track, the parts placed in a pit and scrambled, and 89 parts withdrawn from the pile at random and replaced from stock. The three cars were then put together again and made perfect scores on a 500-mile test run.

Ford's Moving Assembly Line.—None of this detracts from Ford's achievement. The lightweight roadster, like the curved-dash Oldsmobile, was unsuited to be the car for mass consumption because it was not built to stand up under hard usage. The secret of Ford's success was his realization that the first problem was to design an automobile that would be durable, capable of being used in city or country, easy to operate, and simple and inexpensive to maintain. He met these specifications with the Model T in 1908. Then he and his assistants went to work on the problem of manufacturing the car cheaply and in five years of experimentation evolved the moving assembly line. The new technique required a new factory to house it; complete assembly-line production of motor vehicles began in 1913 at the factory of the Ford Motor company in Highland Park, Mich., which had been designed and built for assembly-line operation.

The results were spectacular. The Ford Motor company made 15,000,000 Model T's before it discontinued the type in 1927; in 1920 the company was making half the motor vehicles in the world. The massive scale of Ford's operations was one of the principal factors in making Detroit the centre of automobile manufacturing in the United States. Ford's methods were widely studied and imitated and while no one else matched the phenomenal record of the Model T, the flow of low-priced cars increased markedly. Both William R. Morris (later Lord Nuffield) and André Gustave Citroën were inspired to do in their countries what Ford had done in his, although the advent of World War I delayed the realization of their ambitions.

Some other factors besides mass production and low price encouraged the widespread use of motor vehicles, conspicuous among them being improvements in the design and manufacture of tires and the introduction of electric starters in 1912. The latter, a joint achievement of the Cadillac Motor Car company and Charles F. Kettering, was particularly important in that it removed the most serious obstacle to the operation of gasoline-powered automobiles by women.

Effects on Other Industries.—Mass production of automobiles brought with it a number of far-reaching industrial consequences. The petroleum industry, naturally enough, was profoundly affected by the rising demand for motor fuels and lubricants and had to undertake both a vigorous search for new sources of crude oil and a virtual revolution in refining methods. The use of alloy steels in automobile manufacturing as a means of achieving strength without adding weight influenced the organization of steel production. For example, alloy steels were not manufactured at all in the United States until the growth of the automotive industry made it worthwhile to do so. In addition, the substitution of steel for wood in automobile bodies, which began about 1910 and became general practice in the 1920s, was directly responsible for the introduction of the continuous strip mill for making sheet steel in large quantities.

The manufacture of glass was similarly affected. When existing techniques proved inadequate to meet the automotive industry's requirements, the Ford Motor company in the early 1920s took the initiative in developing continuous-process manufacture of plate glass. The hazards of motoring led to the introduction of safety glass at the same time. Mass production also demanded quick-drying body finishes, and this need was filled in 1923 by the joint efforts of Charles F. Kettering and E. I. du Pont de Nemours and company. In addition the automotive industry became the largest user of machine tools, at the same time stimulating the development of increasingly elaborate and highly specialized tools.

There were indirect consequences also. Mass production by its very nature encouraged the growth of large-scale business organization, since it necessitated tremendous investment in plant and tools, and this investment in turn could be recovered only by a large volume of sales. After the introduction of the assembly line the number of new firms entering the industry declined appreciably and the smaller concerns found themselves either being merged into larger groups or squeezed out altogether.

CONCENTRATION AND COMBINATION

Since the United States offered the most favourable conditions for quantity production and sale of motor vehicles it was there that the first large-scale automotive enterprises came into existence. Henry Ford was the first figure to reach a dominating position in the industry, but the Ford story is exceptional. No other major automotive concern grew as a unitary organization concentrating on a single model.

The Creation of General Motors.—Far more typical was General Motors, which was formed in 1908, the same year Ford placed the Model T on the market. The founder of General Motors was William Crapo Durant, an energetic promoter who had made a fortune as a carriage builder and then in 1903 became interested in the Buick Motor Car company, which had an excellent design but was faltering in production and marketing. Under Durant's management the Buick became one of the leaders on the American market. Durant then became convinced that success in automobile manufacturing required an organization large enough to control its parts suppliers and to offer a variety of models, so that a bad year for any model would not have to mean disaster. He and Benjamin Briscoe, who had preceded Durant as Buick's backer and then produced the Maxwell-Briscoe, tried to consolidate the principal U.S. automobile companies, including Ford, but failed.

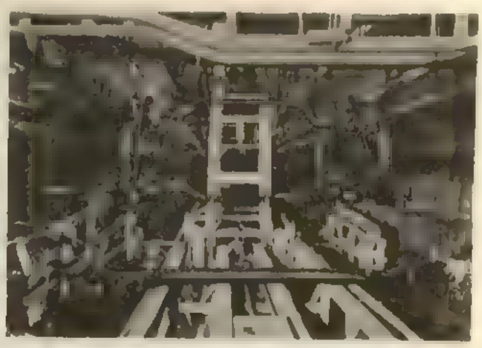
Durant and Briscoe then went their separate ways. Briscoe organized a combination called the United States Motor company that went into receivership in 1912 and was subsequently reorganized as the Maxwell Motor car company. Durant chartered the General Motors company in 1908, with Buick as its base. During the next two years he added Cadillac, Oldsmobile, Oakland and a variety of lesser automobile and parts manufacturers. Some, like the Champion Ignition company, which Durant himself financed to manufacture the porcelain spark plug designed by Albert Champion, were valuable properties; others, however, were speculative, and in 1910 General Motors was faced with insolvency.

The company was saved by a banking syndicate headed by James J. Storrow of Lee, Higginson and company. Durant was forced out and Charles W. Nash became president of Genera

Motors. Storrow also brought Walter P. Chrysler into the organization, first as Nash's assistant and then as president of Buick.

Meanwhile, Durant had joined forces with Louis Chevrolet to produce a low-priced car of the latter's design. The Chevrolet did so well that Durant was able to use its profits to buy back his control of General Motors. This he accomplished in 1916, with financial support from du Pont interests. When Durant returned to power, Storrow and Nash left General Motors and bought control of T. B. Jeffery and company, manufacturer of the Rambler car. This company they reorganized under Nash's name.

Durant's activities included the formation in 1916 of a combination of parts manufacturers under the name of United Motors, the most significant acquisitions being the Hyatt Roller Bearing company and its president, Alfred P. Sloan, Jr. and the Dayton Engineering Laboratories company (Delco), which brought Charles F. Kettering into the General Motors fold. In 1918 a new General Motors corporation absorbed United Motors and also ended the anomalous situation whereby Chevrolet controlled General Motors.


BY COURTESY OF GENERAL MOTORS CORP

Steps in final assembly of a car: (top left) steel top being placed on body; (top right) frames on chassis assembly line; (bottom left) body being placed on frame; (above) attaching wheel; (right) finished cars loaded on railway cars

The second Durant regime was in many ways similar to the first. There was continued expansion, some wise and some not. Durant himself devoted much of his attention to the stock market and both Chrysler and Sloan became disturbed by the lack of an effective administrative organization. Chrysler's disagreements with Durant led to the former's resignation. The panic of 1920 came close to ruining Durant; in order to avoid possible serious trouble for General Motors the du Pont family rescued him from his speculative involvements but insisted that he leave the company. P. S. du Pont assumed the presidency temporarily and turned it over to Sloan in 1923. Durant himself made still another effort in the form of a combination called Durant Motors but this lasted only until the economic crash of 1929.

Other U.S. Combines.—Still another promising automotive empire was the one built by John M. Willys. Willys began his career as a bicycle and automobile dealer and found himself in the manufacturing end of the business when he took control of the moribund Overland company in 1907 in order to keep it operating so he could secure delivery of cars he had ordered. The Overland became a popular low-priced car and Willys gradually acquired control of other automotive concerns, most of them loosely organized as parts of the Willys corporation. Like Durant, Willys was caught in the 1920 depression and while he was able to stay in business, he no longer had the prospect of rivalling General Motors or Ford.

Studebaker offers an example of a combination created by a company that made a conscious decision to add motor vehicles to an existing carriage and wagon business; in 1900, in fact, Studebaker was the world's largest manufacturer of horse-drawn vehicles. Shortly after the turn of the century the company began making automobiles, but it also undertook to employ its extensive distributing facilities to market cars manufactured by others. In 1909 Studebaker contracted to sell the EMF car (Everitt-Metzger-Flanders), but when this arrangement proved unsatisfactory, Studebaker bought out its affiliate and consolidated its enterprises in 1912 as the Studebaker corporation. The fact that the financing of this transaction was handled by J. P. Morgan and company, at about the same time Lee, Higginson and company was reorganizing General Motors, is clear evidence that in the U.S. the automotive industry had successfully emerged from its infancy.

THE MATURING OF THE INDUSTRY

Wartime Growth.—World War I stimulated the growth of the automotive industry by providing a heavy demand for motor vehicles and other commodities that automotive plants could produce. The potentialities of the motor vehicle for the transport of troops and supplies were appreciated if not fully developed. Apart from the need for strictly military vehicles such as tanks and armored cars, the principal demand was for trucks. Automotive factories also made aircraft engines and parts as well as shells, gun mounts and a variety of other military equipment. Among the European belligerents production of cars for civilian use was curtailed fairly early in the war; the U.S. automobile industry, however, functioned without appreciable limitation until 1918, and then was under wartime restrictions for only a few months.

Maturation in the 1920s.—The decade of the 1920s saw the automobile come into its own. In the United States the manufacture of motor vehicles, which had been too insignificant to be mentioned in the census of 1900, had now become the nation's largest industrial operation, absorbing 20% of the steel output, 80% of the rubber and 75% of the plate glass. The petroleum industry was geared almost completely to automotive requirements and the great increase in the number of motorists stimulated a program of extensive highway construction. It is fair to say that much of the business boom of the 1920s was a direct consequence of the growth of the automotive industry.

Expansion presented some problems. With automobiles multiplying in number, a market in used cars developed to proportions that handicapped the sale of new vehicles. In order to keep production moving, the manufacturers came to emphasize annual model changes, with their appeal to the customer to "keep in style"; in addition, installment selling was expanded to an unprecedented degree. One of Durant's last major achievements at General Motors was the organizing of the General Motors Acceptance corporation as a mechanism to assist dealers in financing time pay-

ments. This step in itself indicated that the industry had reached a new stage of development. In the early days the manufacturers depended heavily on their dealers for financing; now the relationship was being reversed.

The Decline of the Model T.—However, there was not a complete abandonment of the old order of things. In 1921 Henry Ford found himself in a falling market with a heavy indebtedness resulting from the building of the great River Rouge plant near Detroit, Mich., the necessity of paying accumulated arrears of dividends when he lost a stockholders' suit brought by the Dodge brothers, and his own decision to avoid further annoyance of this kind by buying out his stockholders. He resolved his difficulties by canceling orders for parts and materials, working off his inventory and shipping the finished cars to his dealers, who had to accept and pay for them or lose their franchises.

Ford, however, was rather markedly part of the old order himself. He ran his company autocratically and one by one forced out his ablest lieutenants, men like James S. Couzens, C. H. Wills and William S. Knudsen. This in itself would not have been so bad if he had not refused to recognize that times had changed and specifically that the Model T had had its day. The serviceable but distinctly ungainly "Tin Lizzie" lost its appeal in an era of improved highways and a buying public increasingly conscious of the automobile as a prestige symbol. Perhaps the used car market more than anything else killed the Model T, since for the price of a new Ford a buyer could have a perfectly usable and attractively styled second-hand car.

Yet Ford clung to the Model T until 1927. When he finally realized his error, he acted with his former decisiveness and produced the Model A of 1928 in a remarkably short time; by then, however, the Ford Motor company had forfeited its dominating position in the automotive industry and it never recovered the lost ground. It was securely enough in second place, but still second.

GM Assumes Lead.—The new leader was General Motors. After the fall of Durant, direction of the company's affairs fell into the hands of Alfred P. Sloan, Jr., under whom General Motors became the largest manufacturing enterprise in the world. His first step was to reorganize the company on the basis of his belief that it was much too big to be run by any one man and required a system that pooled talents and at the same time provided opportunity for subordinates to develop and exercise initiative. The result was a structure composed of a number of autonomous subdivisions with broad policy determined by coordinating committees. Sloan also created an effective research department, something Ford had neglected. His greatest single coup was to put William S. Knudsen in charge of the Chevrolet division, because it was Knudsen who pushed Chevrolet ahead of Ford in the low-priced car market.

Extension of Ford and GM.—Both Ford and General Motors became important factors in the European automotive industry. Ford built plants in England, Germany, France, Spain and Denmark; General Motors bought the British Vauxhall Motors in 1925 and the German Opel company in 1929. Both Ford and General Motors extended their interests to aviation, Ford through ownership for a few years in the 1920s of a company that made trimotored metal aircraft, General Motors through substantial ownership of stock in North American Aviation, founded in 1928. Ford was the only automobile manufacturer to make a success of farm machinery, especially tractors; General Motors, on the other hand, pioneered in the manufacture of electric refrigerators with the Frigidaire, a Durant legacy to the company.

The Rise of Chrysler.—These were the leviathans of the U.S. automotive industry but they were joined in the 1920s by a third concern, the Chrysler corporation, which grew large enough to make the dominant firms in the American automobile industry a "Big Three." It got its start when the Maxwell Motor Car company went into receivership during the 1920 depression and Walter P. Chrysler, who a short time before had resigned from General Motors, was asked to supervise its reorganization. He did so and eventually converted the company into the Chrysler corporation, based on a car of his design whose principal novel feature was a high-compression engine. The Chrysler car was an outstanding success and the Maxwell disappeared.

Nevertheless Chrysler would undoubtedly have remained in the ranks of the lesser producers but for his achievement in buying the Dodge Brothers Manufacturing company in 1928. This concern had been established in 1913 when John and Horace Dodge decided to become independent of Henry Ford. After the brothers died, their company was eventually sold to the banking firm of Dillon, Read and company, which in turn sold it to Chrysler. For the Chrysler corporation it meant the acquisition of a large dealer organization and manufacturing facilities that enabled Chrysler to introduce the Plymouth in 1928 as a competitor of Ford and Chevrolet.

Further Decline of the Smaller Firms.—The trend toward concentration in the automotive industry was revealed unmistakably both in the ascendancy of the "Big Three" and in the persistent decline of the smaller firms even in the prosperous period of the 1920s. The number of companies engaged in automobile manufacturing in the U.S. shrank from 108 in 1923 to 44 in 1927. At the peak of the boom the independents held only 25% of the automobile market and five companies (Hudson, Nash, Packard, Studebaker and Willys-Overland) accounted for three-fourths of that amount. The smaller firms played an important role in the industry in that they were more likely to introduce innovations than the big companies. Hudson, for example, was the first (in 1922) to offer a closed car at a price only slightly higher than that of the touring car, with the result that the latter was virtually driven off the market. E. L. Cord in 1929 produced a car with front-wheel drive that was a commercial failure mainly because it came on the market at the worst possible time. Nevertheless, the independents by and large could not maintain themselves against the advantages that large-scale techniques in production and marketing gave to the big companies.

This pattern did not apply as strongly in the manufacture of trucks, buses and other commercial vehicles. Since trucks and buses were specialized products that lacked the mass market of passenger cars, independent firms such as the Autocar company, the Mack Truck company and the White Motor company were able to maintain themselves in this field. These three were typical of most truck manufacturers in that they had all engaged in passenger car production, quite extensively in the case of White, before deciding to concentrate on commercial vehicles.

Similarities and Differences.—The British automotive industry displayed many similarities to the U.S. pattern of concentration of manufacturing in a few large concerns. Two companies, Morris and Austin, emerged as vigorous competitors for the low-priced car market and by 1929, along with Singer, they controlled 75% of the output of cars. The total number of firms engaged in automobile manufacturing in Britain declined from 88 in 1922 to 31 in 1929. The increasing importance of the automotive industry in the British economy was reflected in the growth of a considerable number of companies concentrating on the production of motor vehicle parts and components. Supplier firms had been an integral part of the industry in the United States from the beginning but they were a new development for Britain. When William Morris entered the automobile business just before World War I and sought to achieve quantity production by buying standardized parts from outside firms, he had to go to the U.S. to fill his needs.

In France the automotive field was dominated by Renault and Citroën, both emphasizing quantity production of low-priced cars. André Gustave Citroën, called "the Henry Ford of France," showed clearly the influence of American production and marketing methods. He began to make motor cars in 1919 and soon attained an output of 400 a day, until in the middle 1920s 40% of the automobiles in France were Citroëns. The most spectacular of his marketing techniques was his use of the Eiffel tower to display illuminated signs. The German automotive industry reflected the trend to consolidation in a historic merger; Daimler and Benz joined forces in 1926 as the Daimler-Benz A.G.

Along with the similarities in the development of the automotive industry in the principal producing countries, there were

some noticeable differences. The popular-priced European cars were light vehicles with engines not exceeding 10 h.p., whereas the Model T Ford began with a 20 h.p. engine. To some extent this situation was produced by tax laws, notably in Great Britain, which taxed motor vehicles according to their horsepower rating. The high cost of motor fuels in Europe was a more important consideration. Moreover, despite the efforts of men like Morris, Austin and Citroën, the ownership and use of motor vehicles in Europe did not approach the level reached in the United States, where by 1929 there was one automobile for every six people. In other words, the point had been reached at which the entire population of the United States could be transported by car simultaneously. The volume of highway travel by private automobile cut heavily into the passenger business of American railways and motor truck competition was becoming a serious threat to rail freight traffic.

The United States was counting its automotive output in millions while other countries were still counting theirs in hundreds of thousands. Consequently, although American methods were widely admired and imitated, they could not be adopted in full. It was simply not economically feasible for European manufacturers to employ the elaborately specialized and highly expensive machine tools that American automobile factories used. Even in as comparatively large-scale a producer as Morris Motors, the moving assembly line was not introduced until 1934.

THE IMPACT OF THE DEPRESSION

Government Controls and Falling Production.—The coming of the prolonged, worldwide depression of the 1930s was bound to have pronounced effects on an industry that had become as important economically as the automotive industry. There had been a few depressions in the brief lifetime of the industry but they had been short-lived, scarcely interrupting the continuously increasing output of motor vehicles. Now, however, automobile manufacturers found themselves in the unaccustomed position of facing a sustained decline in the demand for new cars. Moreover, governments reacted to the depression with political and economic remedies of varying kinds, and these of necessity included the automotive industries in their scope.

The most general consequence of the depression for the automotive industry was the extension of governmental controls to an area that had been a stronghold of *laissez-faire*. Except in the Soviet Union, which in the 1930s was not a significant producer of motor vehicles anyway, the industry had functioned as something close to a classic example of private enterprise and free competition. It is true that by the 1920s it was increasingly difficult for a newcomer to establish himself in the field and the smaller firms were engaged in a desperate struggle to survive, but these conditions were a consequence of mass production and the advantages of large-scale operation. They were not the result of either monopolistic combination or legislative direction of business policy.

This situation now changed drastically, with the degree of change varying in accordance with the response of the several industrial nations to the pressures of economic crisis. Moreover, the progressive deterioration of international relations during the 1930s drew governmental attention to the productive capacity of automotive plants for military purposes. Thus the Nazi regime in Germany, while it left the factories nominally in private ownership, regulated the activity of its automotive industry to conform to the objectives of the regime and particularly to implement Hitler's planning for war. It is a striking tribute to the universal appeal of the automobile that the Nazis themselves felt obligated to promise the German people what Henry Ford many years before had termed "a car for the multitudes"—in this case the Volkswagen. However, military exigencies, specifically the need for equipping the armored and motorized divisions that were later to swarm across Europe, kept the bulk of Germany's automotive output from reaching the civilian market.

In France, by contrast, while automobile production declined, the structure of the industry did not change appreciably. Citroen had to go into receivership and became the property of the Michelin Tire company. On the other hand, a newcomer, Simca, rose to be a major producer during the 1930s.

The U.S. automobile industry was hard hit by the depression. Production dropped from the peak of more than 5,000,000 vehicles in 1929 to a low of just over 1,000,000 in 1932, and while output climbed fairly steadily thereafter, the figure for 1929 was not surpassed in peacetime for more than 20 years. Yet while production fell off drastically, automobile registrations did not; the motor vehicle was so thoroughly integrated into the fabric of American life that even in the depth of depression people held on to their cars.

The industry's response to the depression was to cut costs (and here the larger firms had a considerable advantage in that minor economies could add up to a substantial aggregate for them) and to intensify sales efforts. The battle for sales offered a definite incentive to technical advance, since anything that could be advertised as an improvement was of value. So Studebaker introduced free-wheeling in 1930, Chrysler the overdrive in 1934, and Oldsmobile the automatic transmission in 1937.

Meanwhile, the automotive industry had to face the conditions resulting from the economic program of the New Deal. The effect of the provision of the National Industrial Recovery act of 1933 for codes of fair competition was slight. The act was opposed by the industry but all the manufacturers except Henry Ford complied with it. Ford successfully defied the code authorities and his competitors found themselves free of code restrictions when the supreme court invalidated the NRA in 1935.

Organization of the U.A.W.—Of more permanent significance was the unionization, with the full sympathy and support of the New Deal administration, of an industry that had previously been completely and even aggressively open shop. The United Automobile Workers was a product of the founding of the Committee for Industrial Organization (C.I.O.) in 1935. Their drive on the automotive industries began in earnest with the passage of the National Labor Relations act (Wagner act) in 1935 and was marked by bitter conflict. While the constitutionality of the act remained in doubt, the industry refused to yield; the union retaliated by importing from France the technique of the "sit-down" strike. However, the outcome of the election of 1936 and the sustaining of the Wagner act by the supreme court in the following year prompted General Motors to change its policy. It agreed to accept the U.A.W. as the bargaining agent for its employees, whereupon most of the rest of the industry followed suit. Ford, as usual, went his own way, and some years of violent conflict ensued before the Ford Motor company and the U.A.W. finally came to terms.

Continued Concentration.—The predominant influence of the depression on the American automobile industry was to confirm the trend toward concentration. The "Big Three" rode out the storm, not without difficulty but certainly with considerably less than their smaller competitors. General Motors even expanded into a new field, diesel engines. In 1930 it bought the Winton Engine company, founded by automobile pioneer Alexander Winton in 1912 to make diesels, and the Electro-Motive company, which had been designing gasoline-powered railroad cars since 1922 and was experimenting with diesel propulsion. The purchase brought the talents of Charles F. Kettering directly into the diesel field. Within a decade improvements on the diesel engine brought it to a degree of efficiency that resulted in diesel locomotives superseding the steam locomotive in railway transportation and in diesel power being used on trucks and buses.

The ability of a big organization to survive difficulties that would rapidly put a small one out of business was clearly illustrated by the Ford Motor company, which had to contend not only with depression but also with problems created by the personality of its aging founder. Henry Ford ruled his company as an autocrat. He had always done so but as he grew older he became more and more arbitrary and unpredictable. His defiance of the NRA and his long battle with the U.A.W. were typical of his unwillingness to accept any change that threatened his freedom to do as he pleased. The internal organization of the Ford Motor company offered evidence of a comparable unwill-

ingness to delegate authority. Not only were the responsibilities of Ford executives poorly defined, but assertion of initiative was more than likely to result in dismissal. Nevertheless Ford still had the technical skill to produce the first low-priced V-8 in 1932, a feat made possible by the daring innovation of casting the engine block and crankcase as a single unit. So Ford remained securely in second place among automobile producers despite the vigorous and well-organized competition of the Chrysler corporation.

The situation of the smaller companies was entirely different. Between 1929 and 1939 their share of the market dropped from 25% to 10%. Many famous names like Pierce Arrow, Stutz, Moon, Kissell and Franklin (the only American car of that time with an air-cooled engine) disappeared altogether. Some companies were able to remain in existence only by changing their operations: Reo (the company founded by Ransom E. Olds after his departure from the Olds Motor Works) abandoned passenger car production in favour of trucks; Hupp, maker of the Hupmobile, turned to the manufacture of automotive parts and subsequently expanded into electronics and chemicals; Marmon gave up luxury cars for special-purpose, all-wheel-drive trucks; Peerless, in the most astonishing conversion of all, became a brewery.

Of the surviving independents, Studebaker and Willys-Overland both had to go through receivership and reorganization. Hudson, Packard and Graham-Paige managed to remain solvent with considerable effort. Nash sought safety in diversification and merged in 1935 with the manufacturer of Kelvinator refrigerators as the Nash-Kelvinator corporation.

Differences in Britain.—The experience of the British automobile industry in the depression showed some distinctive features that appear to be deviations from the pattern established elsewhere. To begin with, British production of motor vehicles declined by only 15% between 1929 and 1932, compared with 75% in the United States and Germany, 33% in France and about 50% in Italy; and when business began to recover, British production by the mid-1930s was well ahead of what it had been in the previous decade. This impressive record was achieved without either the type of governmental intervention represented by the New Deal in the United States and the Popular Front in France or the stimulus of an armament program such as Germany and Italy employed. The explanation appears to be twofold: the British automotive industry grew rather more slowly than its competitors during the 1920s and therefore was less subject to the violent "boom and bust" cycle that occurred elsewhere; and, during the depression, per capita real income in Britain fell relatively less than in other industrial countries.

The British industry seemed to deviate also from the trend to concentration. Where there had been three major producers in 1929, there were six in 1938: Morris, Austin, Ford, Vauxhall, Rootes and Standard, in that order (Singer was no longer among the leading firms). On closer examination, however, it is clear that Britain was not as much of an exception as appearances suggest. Ford and Vauxhall were by no means "independents" competing with big combines. The rise of Ford in the British market was due to a reorganization of Ford's overseas operations in the late 1920s that gave Lord Perry, the head of Ford of Britain, both a new factory and a freer hand to run the business without interference from Detroit. Vauxhall, of course, had acquired the powerful support of General Motors. Rootes Motors, Ltd., and Standard Motors, Ltd., were new combinations, Rootes of Hillman, Humber and Sunbeam, Standard of Triumph and Standard. The "Big Six" accounted for 90% of British automotive production in 1938. The fact that the British had six major firms compared with three in the United States was due to the smaller size of the British market. British manufacturers built about 400,000 passenger cars in 1938 compared with 2,000,000 in the United States; the economies of large-scale operation were consequently less of an advantage in Britain.

WORLD WAR II AND AFTER

Contributions to the War Effort.—The outbreak of war in 1939 terminated the situation in which automotive producers had to contend with inadequate demand. Instead, their factories were called upon to work at full capacity to meet the requirements of mechanized warfare. The automotive industries of the belligerents not only made vehicles but participated in the manufacture of aircraft, guns, munitions and a host of other items.

Since the automotive industry was larger in the U.S. than in all the other countries combined, its war experience is the most useful to examine. As early as May 1940, William S. Knudsen, then president of General Motors, was called to Washington to assist in organizing defense production and efforts were begun to control automobile manufacture in order to conserve machine tools as well as to employ the resources of the industry to expand aircraft production. However, effective conversion to a war footing was not achieved until the United States became an active belligerent.

The total contribution of the industry to the war effort can be indicated by some sample production figures: 2,500,000 trucks; 6,000,000 guns; 500,000 aircraft engines; 5,000,000 bombs and so on through an extensive list to such items as 100 mi. of submarine nets. Among the motor vehicles manufactured special mention should be made of the Jeep, a four-wheel-drive, ubiquitous vehicle designed by Willys-Overland.

This wartime achievement was not without its problems. There was a too facile assumption that automotive manufacturing equipment and techniques could be readily transferred to the mass production of other things, especially aircraft. When delays occurred, as they were bound to do, both the automobile and aircraft industries were subjected to a good deal of criticism. The automotive industry in the end built about 10% of the aircraft made in the United States during the war. Automotive engineers and production men also analyzed techniques of aircraft manufacture and passed along their experience in quantity production. The same procedure was followed in such areas as ordnance manufacture and shipbuilding.

Postwar Surge in Demand.—The return of peace brought with it a demand reminiscent of the early days of the industry, but in this case caused by the suspension of nonmilitary production over a period of years. It was a situation that attracted several newcomers into the industry and thereby provided an impressive demonstration of the virtually insuperable handicaps such attempts faced.

The most promising of these efforts was made by the Kaiser-Frazer corporation (later Kaiser Motors corporation), formed in 1946 by Henry J. Kaiser, an industrialist with a spectacular record in war production, and Joseph W. Frazer, the president of the Graham-Paige corporation. The new organization took over Graham-Paige and was able to lease manufacturing facilities built by the government during the war. Subsequently (1953) it bought Willys-Overland. Kaiser thus entered the automotive industry under reasonably favourable circumstances, with a foothold in Graham-Paige, additional plant acquired at relatively low cost and a market absorbing any vehicle that would roll. Yet the venture prospered, building cars under the Kaiser and Frazer names, only until the established automobile companies were back on a regular peacetime basis. In 1949 Kaiser was unable to get support from the private money market and had to borrow from the federal government's Reconstruction Finance corporation. Five years later Kaiser automotive activity in the U.S. was limited to the manufacture of Jeeps and trucks by the Willys organization, although a subsidiary in Argentina continued to produce and sell the Kaiser automobile there until 1962.

One fundamental weakness was that Kaiser had nothing more to offer than a purely conventional passenger automobile differing neither in technical features nor in style from its competitors. Something more was needed by any newcomer to offset the reluctance of buyers to purchase a car that might become an "orphan." The American purchaser almost without exception had come to consider future trade-in value as an important factor in his decision to purchase and therefore tended to prefer the cars whose continuing marketability seemed most promising. This factor made it difficult for a new firm to attract dealers, so that while the technical problems of manufacturing cars were met readily

enough, given sufficient capital, the likelihood of selling enough cars to justify the investment was remote.

Organizational Changes.—Among the established automotive firms the process of concentration continued. Two mergers occurred in 1954: Hudson and Nash combined as the American Motors corporation, and Studebaker and Packard as the Studebaker-Packard corporation. Among commercial vehicle manufacturers the White Motor company became the largest single firm by absorbing Autocar and Reo. However, independent producers of specialized commercial vehicles remained in the field while for a time it appeared that not even the mergers would save the independent passenger car manufacturers. General Motors, Ford (reorganized after its founder's retirement in 1945) and Chrysler dominated the market, following each other closely in styling and price policies since they had too much invested in each year's models to risk deviations that might not sell.

Trend to Smaller U.S. Cars.—The two independents survived by withdrawing from this type of competition and offering smaller and more economical cars. American Motors led the way by discontinuing the Hudson and Nash lines and concentrating on the Rambler; Studebaker-Packard dropped the Packard and retained the Studebaker name. These "compacts" did so well that the "Big Three" were compelled to introduce small cars of their own.

The swing of consumer preference to smaller cars was reflected also in substantial buying of foreign cars. American purchases provided a stimulus to the European automobile industry and expanding automotive production was a major factor in the economic recovery of western Europe. France nationalized the Renault company in 1944 but this step did not affect the behaviour of the French automotive industry. In Germany the design of the Volkswagen was salvaged from the wreckage of the Nazi regime and within ten years the car accounted for half of Germany's automobile production.

Further Concentration in England.—The British automotive industry benefited from the rising demand for small cars after the war and in its growth continued the trend to concentration in a few large firms. The most important step in this direction was the consolidation of Austin and Morris in 1952 as the British Motor Corporation, Ltd., creating an organization that produced 40% of British automobile output and reducing the number of major firms from six to five. These five controlled 95% of the market for British cars. For some years after the war this was predominantly an export market. Britain had as large a backlog of civilian demand as any other country but motor vehicles bulked so large as assets for earning foreign exchange that most British automotive production was earmarked for export until the early 1950s.

This situation accentuated the handicaps under which the smaller firms laboured. The immediate postwar years constituted a period of shortages of materials and parts, and the big companies were not only more self-sufficient but, because of the larger volume of their orders, were at an advantage in bidding for limited supplies. Some of the British independents disappeared; some were merged with their larger competitors, as Singer was absorbed by Rootes in 1957. Those that survived either made highly specialized vehicles, such as the Jaguar (which sold so well that the manufacturer found it necessary to increase plant capacity and consequently bought the British Daimler factory in 1960), or they were in a category peculiar to Britain, that is, a group of cars manufactured by companies whose major interests lay elsewhere. The prime example was Rolls-Royce, Ltd. Only about 10% of its business was represented by the manufacture of Rolls-Royce and Bentley cars, the rest consisting principally of aircraft engines.

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AUTOPSY (Post-Mortem Examination; Necropsy) is the scientific examination of a dead body for the purpose of establishing the cause of death or of correlating the clinical manifestations of diseases with the morbid changes in tissues. The examination may be done for legal purposes (*see* Coroner; Medical Jurisprudence) or for the extension of medical knowledge. Cases of real or suspected homicide and other cases specified by law are referred for examination to the coroner or medical examiner. In other cases, consent for an autopsy is required from the nearest of kin, such as the widow or widower, a parent or offspring. Their rights are violated when an autopsy is made without consent, and legal redress is possible. Religious teachings have been offered as a reason for refusal, but authoritative search in the Jewish and Christian religions fails to reveal any interdiction.

Autopsies, as a rule, are performed by pathologists—physicians specifically trained in this field. Skill and special knowledge of the tissue changes caused by injury or disease are required for this work. In addition to a gross inspection, microscopic studies, bacteriologic and chemical examinations of tissues may be required, and in coroner's cases an understanding of all phases of forensic pathology is necessary. When autopsies are made for the extension of medical knowledge, both the physician and his living patients benefit. Without an autopsy, the cause of death is largely an opinion as distinguished from a fact. Physicians of great skill frequently see unsuspected diseases revealed by autopsy. In fact, the diagnosis of diseases by physicians rests upon the accumulated experiences of autopsies during many past generations. The benefits of autopsies to the public include improved medical practice, satisfaction in knowing the facts, disclosure of a communicable disease against which the living can be protected, insurance claim benefits and others. (E. F. Hh.)

AUTUN, a cathedral city in central France, is in the old duchy of Burgundy and the modern *département* of Saône-et-Loire. Pop. (1962) 14,003. The town, which is situated in a synclinal basin of sedimentary rocks surrounded by the crystalline highlands of the Morvan, overlooks the left bank of the Arroux, a tributary of the Loire, and lies 50 mi. S.W. of Dijon. Succeeding to the Gaulish *oppidum* of Bibracte, Augustodunum (Autun) was an important Roman city, renowned for its schools of rhetoric. Fine Roman gates of the 3rd century (St. André and Arroux) and much of the Roman walls remain, as well as a Roman theatre and, across the Arroux, a great tower (Temple of Janus). The cathedral of St. Lazare, once the chapel of the dukes of Burgundy, dominates the city and is one of the finest of the Burgundian group of Romanesque churches. The central bell tower and chapels in the Gothic style were added in the 15th century by Nicolas Rolin. The sculptured group of the last judgment above the west door and Jean Ingres' painting of the martyrdom of St. Symphorien (at Autun in 179) are especially noteworthy. The Hôtel (musée) Rolin (15th century), the ancient bishop's palace and the town hall house museums; collections in the hôtel include a painting of the Nativity attributed to the Maître de Moulins (15th century), the Virgin of Autun (15th century) in polychrome stone and a 12th-century sculpture of Eve.

Autun is an important market for the livestock of the Morvan, and has leather, timber and metal industries. A small refinery extracts oil from shale worked locally in the small Épinac coal field. (Ar. E. S.)

AUTUNITE or Calco-Uranite, a secondary uranium mineral which is one of the "uranium micas" and one of the ores from which uranium is produced. Autunite is usually found with pitchblende and other uranium minerals. A lime uranite, it differs from the more commonly occurring torbernite (*q.v.*) or cuprouranite in containing calcium in place of copper. It is a hydrous uranium and calcium phosphate, $Ca(UO_2)_2(PO_4)_2+8(\text{or } 12)H_2O$. The dehydration form, meta-autunite, differs only in the number of water molecules present. Though closely resembling the tetragonal torbernite in form, autunite crystallizes in the orthorhombic system and is optically biaxial. The crystals have the shape of thin plates with very nearly square outline. An important character is the perfect micaceous cleavage parallel to the basal plane, on which plane the lustre is pearly. The colour is sulfur-yellow, and this enables the mineral to be distinguished at a glance from the emerald-green torbernite. Hardness is 2 to 2.5 and specific gravity 3.05 to 3.19. Fluorescence under ultraviolet light is brilliant yellow to yellowish-green. Radiations can be

detected by Geiger counter. *See* URANIUM; NATURAL RESOURCES: *Minerals*.

AUVERGNE, an ancient province of France, corresponding to the modern *départements* of Cantal (ancient Haute-Auvergne) and Puy-de-Dôme (Basse-Auvergne) with the *arrondissement* of Brioude in Haute-Loire. It contains many mountains volcanic in origin (Plomb du Cantal, Puy-de-Dôme, Mont-Dore), fertile valleys such as that of Limagne, vast pasture lands and numerous medicinal springs.

In Caesar's time the Arverni (*q.v.*) were a powerful confederation, their chieftain Vercingetorix being his foremost opponent in Gaul. The Romans made Arvernia part of Aquitania Prima. It was the seat of a countship under the Carolingians. After the rule of the powerful Guilhem (William) the Pious, count from 886 to 918, the viscounts of Clermont (now Clermont-Ferrand [*q.v.*]) usurped the hereditary title of counts of Auvergne.

Through the marriage of Eleanor of Aquitaine with Henry Plantagenet, the counts became vassals of the kings of England. But Guilhem VII the Young (1145–68) lost much of his domain to his uncle Guilhem VIII the Old (who was supported by Henry II), retaining only the region bounded by the Allier and the Coux—it was this district that from the end of the 13th century was to be called the Dauphiné d'Auvergne (*see* DAUPHIN). Philip II Augustus of France intervened in the family quarrel and succeeded in possessing himself of a large part of the country (1195), which he annexed to the royal domain under the name of Terre d'Auvergne. For his concurrence in this matter the bishop of Clermont, Robert I (1195–1227), was granted the lordship of the town of Clermont, which subsequently became a countship (to be distinguished from the countship of Clermont-en-Beauvaisis). Such was the origin of the four great lordships of Auvergne.

The Terre d'Auvergne was from 1241 to 1271 an appanage of Alphonse of Poitiers, who was successful in curbing the local nobility. Then it was under the crown until 1360, when John II of France made it a *duché-pairie* for his son Jean, duc de Berry (died 1416). In 1425 the ducal title was secured to Jean I, duc de Bourbon, husband of Berry's heiress Marie. Jean I's younger son Louis, comte de Montpensier, married Jeanne, heiress of the Dauphiné d'Auvergne, in 1428, and their grandson Charles, the famous constable of France, was able to unite duchy and *dauphiné* when he became duc de Bourbon through his marriage with his second cousin Suzanne. But these Bourbon domains were confiscated by King Francis I on the constable's treason and assigned to the king's mother, Louise of Savoy, for the rest of her life, after which they were annexed to the kingdom (1532).

The countship of Auvergne, however, having passed in 1422 to the house of La Tour, descended to Catherine de Médicis, who moreover got possession of Clermont in 1551. These domains were annexed to the crown in 1615, on the death of Catherine's daughter Margaret of Valois. The *généralité* of Riom was established in 1577. The *intendants* had their seat at Clermont.

AUWERS, (GEORG FRIEDRICH JULIUS) ARTHUR VON (1838–1915), German astronomer whose name is now most closely associated with a new reduction of the observations made by James Bradley at Greenwich, London, in the middle of the 18th century, was born on Sept. 12, 1838, at Göttingen in Hanover and studied there and at Kaliningrad. In 1866 he was called to Berlin as astronomer to the Academy of Sciences. Auwers' results, combined with later observations of the same stars, served for the construction of a fundamental catalogue of some hundreds of stars. This catalogue formed the basis for the accurate determination of the positions of stars down to the ninth magnitude from observations made at observatories in a number of countries under the auspices of the German Astronomical society. Auwers directed German operations to observe the transits of Venus in 1874 and 1882, and himself traveled abroad to observe them. From the observed variable proper motions of Sirius and Procyon he confirmed F. W. Bessel's hypothesis that these stars had unknown invisible companions. He died in Berlin on Jan. 24, 1915. (J. JN.)

AUXERRE, a town in central France and capital of the *département* of Yonne in Burgundy, lies on the Yonne river 172 km (107 mi.) S.E. of Paris by road. Pop. (1962) 28,949. The town is irregularly built along the river bank, with steep and narrow streets. The cathedral of St. Etienne (13th–16th century) is a magnificent Gothic building with three richly sculptured doorways and a rose window on the west front. A massive square tower rises in the northwestern corner, but that in the southwestern corner was never finished. The early Gothic choir and the beautiful apsidal chapel contain some of the best 13th-century stained glass in France. In the 11th-century crypt is a unique fresco (12th–13th century) depicting Christ on horseback surrounded by four mounted angels. Beyond the covered market is the Place de l'Hôtel de Ville, the historic centre of the town and mostly 17th century. The church of St. Eusèbe, near the commercial centre was founded in the 7th century and shows styles from the 12th to the 16th. A clock originally installed in the belfry (then the highest point of the town) in 1411 was moved in 1483 to one of the Roman gateways, which was rebuilt after a fire in 1825 and is now known as the Tour de l'Horloge. Below the church of St. Germain crypts of the 9th century contain tombs of the bishops of Auxerre. The 6th bishop, St. Germain, was buried there in 1448 and every year on July 31 there is a procession when the saint's relics are exposed in the cathedral. Of the original Benedictine abbey of St. Germain nothing remains; it was rebuilt in the 17th century. There is an art museum and a library. The chief product of Auxerre is wine (especially Chablis) from the surrounding vineyards, while ochre, pies, cardboard boxes, trailers and metal goods are produced and printing is carried on. Auxerre (Autessiodurum) became the seat of a bishop and a *civitas* in the 3rd century. Founded under the Merovingians, the abbey of St. Germain in the 9th century became a seat of learning. Joan of Arc twice passed through the town, the second time with Charles VII on their way to his coronation at Rheims. Napoleon also went through Auxerre on his return from Elba.

AVA, the ancient capital of Burma, is situated in Sagaing district on the left bank of the Irrawaddy, where the Myitnge river joins it, 6 mi. S. of Mandalay, the last royal capital. The word is a corruption of *Inwa*, "the entrance to the lake." The foundation site was chosen in preference to Pagan in A.D. 1364, because from it the supply of rice from the Kyaukse irrigated area could be controlled. This area became vital to a royal city in the dry zone as the establishment of the independent Mon kingdom in Lower Burma, consequent upon the Mongol conquest of Pagan in 1287 threatened the rice supply from the wet zone in the south. At Ava Burmese-Buddhist culture flourished until the city was destroyed by the Shans in 1527. It did not become a capital city again until 1634. In 1752 the Mons captured it, but the Burmese leader, Alaungpaya, who recovered it and reunited Burma, made Shwebo 60 mi. N. of Ava, his capital. Under the Konbaung dynasty, which he founded, Ava was again the capital from 1765 to 1783 and from 1823 to 1837. The dynasty changed its capital frequently and built two new ones, Amarapura in 1783 and Mandalay in 1857 but its headquarters was always referred to by outsiders as the "Court of Ava." European travelers from the 15th century onward nearly always used the term "Ava" for Upper Burma in their accounts of the country. Today the site is almost desolate. (D. G. E. H.)

AVALANCHE, a large mass of snow and other materials which moves rapidly down a mountain slope. An avalanche begins when a mass of material overcomes frictional resistance of the sloping surface, often after its foundation is loosened by spring rains or is rapidly melted by a *föhn* (warm, dry wind) or other causes. Noises—artillery fire, thunder or man-made blasts—can start the snow in motion when the mass is just poised. Avalanches carry a considerable amount of rock debris with the snow and are therefore a geological agent of some significance; in addition to transporting unsorted materials to the bottoms of slopes, they may, if repeated, effect an important amount of erosion, as in some mountains of the western United States. Avalanches can be very destructive; in periods of exceptionally heavy snow in the Alps whole villages have been destroyed by them, in some cases with considerable loss of human life.

For discussion of the dangers presented by avalanches to mountain climbers, skiers, and travelers in mountainous terrain, *see* MOUNTAINEERING. For the geologic process involved, *see* GEOLOGY: *Physical Geology: Erosion by Mass Movements*; LANDSLIDE.

AVALON, the island of Avalon, to which King Arthur was conveyed for the healing of his wounds after his final battle, and from which he never returned.

It is first mentioned in Geoffrey of Monmouth's *Historia regum Britanniae*; in the same author's *Vita Merlini* (*c.* 1159), it is described as "the island of fruits (or "apples"), called Fortunate," where the soil yields harvests without sowing and where the inhabitants are noted for their longevity. Morgan rules the island, assisted by her eight sisters; all are skilled in leechcraft and other learned arts. Strongly influenced by his classical reading, Geoffrey's account may nevertheless reflect traditions about a Celtic elysium. The name in the *Vita Merlini*—"Insula Pomorum"—supports attempts to connect Avalon with the Celtic word for apple (modern Welsh *afal*). Sir John Rhys preferred the interpretation "Aballach's island," Aballach being a (hypothetical) "dark Celtic divinity." The identification of Avalon with Glastonbury, Somerset (attested in interpolations in William of Malmesbury's *De antiquitate Glastoniensis ecclesiae*), may have been based on Celtic stories about a mythical "summer land" and an "isle of glass" inhabited by deceased heroes, but it is equally likely to have been an attempt by Glastonbury monks to exploit the prestige of the Arthurian legends for the benefit of their own community, just as later the popularity of the Grail legend (*q.v.*) led them to claim that Joseph of Arimathea had established himself at Glastonbury.

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AVANTI, a kingdom of ancient India (roughly mod. western Malwa [*q.v.*]), whose capital, about 600 B.C., was Mahishmati (probably modern Mandhata [*q.v.*] on the Narbada), but soon after, as ever since, was the famed Ujjayini (near mod. Ujjain; *q.v.*). Through it passed the overland trade between northern and southern India, and also wares on their way to the great port of Bharukaccha (mod. Broach), thence by sea to southern India and Burma, Egypt, Arabia and Babylon. By the lifetime of the Buddha (*c.* 563–*c.* 486 B.C.), Avanti was one of the four powers of northern India, strong enough under King Pradyota the Fierce to threaten the empire of Magadha. At this time there was also an Avanti-dakshinapatha, "Avanti-of-the South" (mod. Nimar?), of which Mahishmati was quite possibly the capital. By the 3rd century B.C., however, Avanti had been absorbed into Magadha. Ujjayini, one of the seven holy cities of the Hindus, renowned for its beauty and wealth, became a centre of early Buddhism and of Jainism. After 150 B.C., in the empire's decline, the Sungas, Andhra-bhrityas and Sakas fought for Avanti; and in the 2nd century A.D., Ujjayini under Rudradaman was the prosperous capital of the western Saka satrapy. About A.D. 390 Chandra Gupta II finally expelled the Sakas and held court at Ujjayini: he may well have been the fabled Vikramaditya, hero and patron of the poet Kalidasa. The name of the Malava tribe now gradually replaced that of the Avantis as the designation of this land. (R. TH.)

AVARS, a people of undetermined origin and language, who played an important role in eastern Europe during the 6th–9th centuries A.D. They are called Abaroi or Varchonitai in Byzantine sources, Obri in Slavonic.

The Byzantine historian Priscus, writing of the years 461–465, mentions a migration in which a number of peoples, including the Avars, took part, and the scene of these movements was certainly a country remote from Byzantium. At the time of their first political contact with the Byzantines, through an embassy sent to the emperor Justinian I in 558, the Avars were living in the Caucasus region, near the Alans, where they were then relatively newcomers.

It has often been suggested that the Avars were identical with the Juan-juan, who, from the beginning of the 5th to the middle of the 6th century, controlled territories adjoining the western borders of China; and that when the Türks had ousted them from their empire in Mongolia (555), the Juan-juan migrated to the west and emerged there under the name of Avar. This theory is not only unwarranted but is untenable if the Avars appeared, as Priscus says, on the Byzantine horizon almost a century before the destruction of the Juan-juan empire. A statement by Theophylactus Simocattes, that the Avars were in fact only pseudo-Avars who assumed this name, has been shown to be only a literary cliché. Much better evidence is available to show that the Avars were in some way connected with the Hephthalites (*q.v.*).

Research into the origins of the Avars is greatly hampered by ignorance of their language. Some of their proper names and titles are undoubtedly derived from Turkic or Mongol languages, but most recorded Avar words have resisted explanation.

In 565 another Avar embassy visited Constantinople; this marked the beginning of a period of about 100 years during which relations with the Avars, in war and peace, remained in the foreground of Byzantium's foreign preoccupations. The Avars intervened in Germanic tribal wars, allied themselves with the Lombards to overthrow the rule of the Gepidae (allies of Byzantium) and, between 550 and 575, established themselves in the Hungarian plain, between the Danube and Tisza rivers. This area was to remain the centre of their empire and has yielded much relevant archaeological evidence (more than 30,000 Avar tombs have been unearthed in Hungary).

The Avar empire reached its apogee under the leadership of its khagan Bayan; it covered the vast expanses between the Adriatic and the Baltic seas, the Elbe and the Dnieper rivers and thus bordered upon and incorporated many peoples. The Avars engaged in wars not only against the Byzantines (in 626 they nearly succeeded in occupying Constantinople) but also against the Merovingians. They also played an important part in the historical development of the Slavonic peoples and particularly in the southward migration of Serbs and Croats.

The Avars in Hungary maintained links with central Eurasia, and in the second half of the 7th century the representatives of the first Avar rulers in Hungary were swept away by a new wave of invaders, also Avars, but from the eastern parts of the empire. Archaeology gives striking evidence of this great cleavage in Avar history. The revolt that led, in 680, to the creation of a Bulgarian state in the Balkans gave a further shock to the greatly weakened Avar state. This, however, survived for another century, until Charlemagne, weary of their periodic incursions into Frankish territory, led three successful campaigns (791, 795, 796) into the country of the Avars and occupied their circular fortifications (the "rings"). In 805 the remaining Avars, partly Christianized, made their submission to Charlemagne.

See also references under "Avars" in the Index.

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AVATAR (AVATARA), in Hinduism, an incarnation of God, especially of the god Vishnu. The doctrine of avatars—the belief that when evil becomes too great in the world God takes the form of a human being in order to save mankind—was first formulated in the Bhagavad Gita. There are ten avatars of Vishnu, the last of which is yet to come. *See* HINDUISM; VISHNUISM.

AVEBURY, JOHN LUBBOCK, 1ST BARON (1834–1913), English banker, politician and naturalist, was born in London, April 30, 1834, the son of Sir John William Lubbock, 3rd baronet, himself a highly distinguished man of science. John Lubbock was sent to Eton in 1845, but three years later was taken into his father's bank and at 22 became a partner. In 1865 he succeeded to the baronetcy. His love of science kept pace with his increasing participation in public affairs. He served on commissions upon coinage and other financial questions, and at the same time acted as president of the Entomological society and of the Anthropological institute.

Early in his career Lubbock initiated several banking reforms of great importance, while such works as *Prehistoric Times* (1865) and *The Origin of Civilization* (1870) were proceeding from his pen. In these studies he coined the terms Paleolithic (Old Stone

Age) and Neolithic (New Stone Age), which remain current in archaeology (although with changed connotations). In 1870, and again in 1874, he was elected a member of parliament for Maidstone. He lost the seat at the election of 1880, but was at once elected member for London university, of which he had been vice-chancellor since 1872. He promoted various measures in parliament, including the Bank Holidays act, 1871, and bills dealing with absconding debtors, shop hours regulations, public libraries and the preservation of ancient monuments. He was an indefatigable and influential member of the Unionist party. As a writer of popular scientific books, Lord Avebury (he was raised to the peerage in 1900) had few rivals in his day. He died on May 28, 1913, at Kingsgate Castle, Kent.

Among his other works were: *The Origin and Metamorphoses of Insects* (1873), *British Wild Flowers* (1875), *Ants, Bees and Wasps* (1882), *Flowers, Fruits and Leaves* (1886), *The Pleasures of Life* (1887), *The Sense, Instincts and Intelligence of Animals* (1888), *The Beauties of Nature* (1892) and *The Use of Life* (1894).

AVEBURY, a village in Wiltshire, Eng., part of which lies within one of the largest prehistoric ceremonial sites in Europe, enclosing 28½ ac. It is situated about 6 mi. W. of Marlborough, on the river Kennet and at the foot of the Marlborough downs. Pop. (1961) 631.

The prehistoric structure consists of a roughly circular bank of chalk 1,400 ft. in diameter, 20 ft. high and 75 ft. broad at its base, with an inner facing of chalk blocks quarried from a ditch within, 30 ft. deep, 40 ft. wide at ground level and with a flat floor 15 ft. across. There are three original entrances, north, south and west, and a fourth, facing east, which is probably prehistoric. Around the edge of the plateau so defined stands a circle of more than 100 stones, up to 50 tons in weight and made of sarsen, a silicified sandstone obtainable locally. Inside this are two smaller stone circles, each comprising about 30 uprights and approximately 350 ft. in diameter. At the centre of the southern circle stood a tall stone, with smaller boulders around it, together forming a D-shaped setting, the straight side at the west. The middle circle contained a central U-shaped structure of three large stones, the Cove. Three stones of what may have been a northern circle were found, apparently demolished to make way for the main ditch and bank. The Ringstone, a single sarsen, stood within the earthworks and main stone circle at the southern entrance. On the eastern side of the entrance causeway, the socket for a large timber post was found and on either side of this causeway there are additional stone holes that suggest a continuation of the Kennet Avenue (*see* below) into the interior of the great circle.

The sinuous West Kennet Avenue, 50 ft. wide, consists of sarsens 80 ft. apart, arranged in pairs of lozenge-shaped and rectangular stones. It linked Avebury with a small contemporary two-period temple of wood and stone, the Sanctuary, on Overton hill, 1 mi. S.E. Burials, two accompanied by late Neolithic beakers and one with a bowl of the same period, were found beside four of the Avenue stones and must be contemporary dedication deposits.

The circles of earth and stone at Avebury, and the wooden structure on Overton hill, were all probably built at the same time by native Neolithic communities, one of whose habitation sites was crossed by the Kennet Avenue. The latter is perhaps a little later and is attributable to the Rhineland Beaker Folk (*c.* 1800 B.C.), who also replaced the Sanctuary by a double stone circle.

Many prehistoric sites surround Avebury. Of these, the earthwork enclosure on Windmill hill and the West and East Kennet long barrows are earlier (*c.* 2500 B.C.); two isolated standing stones west of Avebury Trusloe (Adam and Eve; a burial with beaker was found at the foot of the former) are contemporary. Most of the round barrows must belong to the succeeding Bronze Age (*c.* 1600–1200 B.C.) but Silbury hill may be part of the Avebury complex. This mound, presumably covering a burial of unusual importance, is about 130 ft. high and is known to have a structure of sarsens at its centre.

The village of Avebury was taken over by the National trust in 1943. It includes a manor house, built about 1560, with additions dating from about 1600 and 1700, surrounded by eight gardens.

(N. DE L'E. W. T.)

AVELLANEDA, GERTRUDIS GÓMEZ DE: *see* GÓMEZ DE AVELLANEDA, GERTRUDIS.

AVELLANEDA, Argentine city, suburb of Buenos Aires 5 mi. S.E. of the federal district on the Río de la Plata estuary. Pop. (1960) 329,626. Formerly called Barracas al Sur, it was the 19th century slum, slaughterhouse and port area of Buenos Aires and was separated from it by the Riachuelo river. In 1904 it was renamed in honour of Nicolás Avellaneda, Argentine president from 1874 to 1880. Although a separate municipality, it has become enveloped in the general growth of the national capital. Its rapid and prosperous development in the 20th century has been the result of industrial and commercial growth. Among its establishments are tanning factories, distilleries, textile mills, meat-packing plants and extensive markets for agricultural and stock products. It is also the centre of the match industry. Several rail lines, tramways and motorbus lines cover the short distance to Buenos Aires and numerous bridges span the Riachuelo. The port facilities along the Riachuelo are connected to the port of Buenos Aires and utilize the same branch channel to reach the main Río de la Plata channel. The port, therefore, is a centre for foreign trade as well as for an active coastal and river trade. (Js R. S.)

AVELLINO, a city of southern Italy, Campania region, capital of Avellino province, is situated on the Sabato river 1,151 ft. above sea level, 54 km. (33.5 mi.) E. of Naples by road. Pop. (1961) 42,402 (commune). The town is built on a terrace and is surrounded by the Apennines, among which are Partenio or Monte Vergine (4,856 ft.), the site of a famous sanctuary founded in 1124 and Monte Terminio (5,860 ft.). The oldest part of the town lies around the cathedral; the modern part, the wide tree-lined streets and the Botanic garden, is outside the walls. The cathedral (12th century) was rebuilt in 1868 in the neoclassical style. The medieval customs house was rebuilt in 1675 by Cosimo Fanzago for Marino Caracciolo, prince of Avellino. The Palazzo Orsini (1461), the Seminario (1749) and the civic museum are also interesting. In the centre of the city are the ruins of the Lombard castle where in 1130 the antipope Anacletus II conceded the titles of king of Sicily, Apulia, Calabria and Capua to Roger (Ruggero) II of Altavilla, duke of Calabria. Agriculture and wine and flour production are the main industries of the people; felt hats and woolen cloth are made and sulfur is mined in the district.

Formerly known as Abellinum, the city belonged to the Hirpini and later became a Roman colony. The site was 3 km. (nearly 2 mi.) from the modern city. Conquered by the Lombards in the 8th century, Avellino was destroyed by Otto I and passed in turn to the princely families of Del Balzo, Filangieri and Caracciolo. In the rising of 1820 the first attempt was made to obtain a constitution from the king of Naples. The city became part of the Italian kingdom in 1860, and in World War II was occupied by the Allies in Sept. 1943. (M. T. A. N.)

AVEMPACE (IBN BAJJAH; in full, ABU-BAKR MOHAMMED IBN YAHYA IBN BAJJAH or IBN AL-SA'IGH) (d. 1138), the first outstanding Spanish representative of the Arabic Aristotelian-Neoplatonic philosophical tradition, was a native of Saragossa and died in Fez Mor. The tradition that he represents had been established in the east by al-Farabi on whose commentaries, now no longer extant, Avempace depended (*see* ARABIC PHILOSOPHY). He prepared the ground for Ibn Tufail and for Averroës, who used his exegesis of Aristotle to a large extent. There are editions of Avempace's work on botany, of his treatise on the union of the "active intellect" with the human soul and of his *Letter of Farewell* by M. Asin Palacios, with a Spanish translation, in *Al-Andalus*, vol. vii and viii (1940–43); and an edition of his *Rule of the Solitary* by D. M. Dunlop, with an English translation, in *Journal of the Royal Asiatic Society* (1945).

See V. A. Farroukh, *Ibn Bajjah (Avempace) and the Philosophy of the Moslem West* (1945). (R. R. WA.)

AVENARIUS, RICHARD (HEINRICH LUDWIG) (1843–1896), German philosopher, was born in Paris on Nov. 19, 1843. He became professor of philosophy at Zürich in 1877 and died there on Aug. 18, 1896. In his chief work, *Kritik der reinen Erfahrung* (2 vol., 1888–1890; 2nd ed. 1907–08), Avenarius developed a positivist theory of knowledge known as empiriocriticism

As strongly antimetaphysical as Ernst Mach, he rejected as false all differentiation between an "inner" and an "outer" experience and introduced instead the concept of "pure" experience: the presentation of the ego and that of its environment are equated as joint constituents of the single fact of experiencing. It was for his advocacy of this monistic theory of knowledge that Bogdanov (*i.e.*, A. A. Malinovsky), one of the most notable adherents of Avenarius, was attacked by Lenin in *Materialism and Empirio-Criticism* (1909); Lenin, following Friedrich Engels, maintained the standpoint of naïve realism, holding that objective reality, existing independently of consciousness, was the basis of all scientific knowledge. (M. O. G.)

AVENOL, JOSEPH LOUIS ANNE (1879–1952), French public official, was the second secretary-general of the League of Nations. He was born at Melle, Deux-Sèvres, on June 9, 1879. After graduation from the École des Sciences Politiques and the University of Paris, he became an official of the treasury in 1905. He was a member of the French financial delegation in London from 1916 to 1923 and of the League of Nations financial committee from 1920 to 1923. From 1923 to 1932 Avenol was deputy secretary-general of the League of Nations, and thereafter until his resignation in 1940 secretary-general in succession to Sir James Eric Drummond. Avenol died at Duillier, near Nyon, Switz., on Sept. 2, 1952. (D. R. Ge.)

AVENS, a name occasionally used for plants of the genus *Geum*, which belongs to the rose family (Rosaceae). Several of these easily cultivated perennials find limited use as ornamentals. *See* GEUM.

AVENTINUS (properly JOHANN TURMAIR) (1477–1534), German humanist and historian known as the "Bavarian Herodotus," was born at Abensberg (Lat. Aventinum) in Lower Bavaria on July 4, 1477. Having studied at Ingolstadt, Vienna, Cracow and Paris, he returned to Ingolstadt in 1507 and in 1509 was appointed tutor to Louis and Ernest, the younger brothers of William IV, duke of Bavaria. He wrote a Latin grammar and other manuals for his pupils and, in 1511, a history of the Bavarian dukes. In 1515 he traveled to Italy with Ernest and in 1516 assisted in founding, at Ingolstadt, a society devoted to the discovery of old manuscripts.

Appointed court historiographer by William IV and Louis in 1517, Aventinus was commissioned to write a history of Bavaria. For this he was authorized to inspect all monastic archives. The work, *Annales Boiorum*, was written between 1517 and 1521 and was later rewritten by its author in German with the title *Baierische Chronik* (first published 1566). The Latin version shows marked sympathy for the empire in its struggle with the papacy; certain passages were omitted from the German version and from the first Latin edition (1554) as unacceptable to Roman Catholics. Aventinus never definitely accepted Protestantism but sympathized with the reformers and their teachings and openly disapproved of monasticism. This was enough to cause his imprisonment for a short time at Abensberg in 1528. On his release he settled at Regensburg, where he continued to write, preparing a history of the German nation. He died at Regensburg on Jan. 9, 1534.

There is an edition of Aventinus' complete works by M. Lexer, five volumes (1882–86). There is also a modern edition of the *Baierische Chronik* by G. Leidinger (1926).

See W. Dittmar, *Aventin* (1862); Georg Leidinger, "Aventinus," *Neue Deutsche Biographie*, vol. i (1955), with bibliography.

AVENTURINE (AVANTURINE), a variety of quartz (*q.v.*) spangled with scales of mica or hematite. Most aventurine quartz is of yellow or brown colour, but a green variety containing scales of the chrome mica, fuchsite, is also known. The name aventurine is also applied to certain iridescent feldspars. The principal of these is the oligoclase occurring in gneiss at Tvedestrand in southern Norway.

The brilliant spangled appearance of such feldspars is a result of microscopic enclosures, the colours in reflected light being the interference colours of thin films. In most cases the reflecting lamellae are hematite. Aventurine feldspar is also known as sunstone. Aventurine iridescence is not confined to oligoclase, occurring also in orthoclase and labradorite. *See* FELDSPAR.

AVENZOAR (or ABUMERON; Arabic ABU MARWAN ABDAL-MALIK IBN ZUHR) (1113–62), Spanish Muslim physician, was born at Seville, where he pursued his profession with great distinction. He was a contemporary of Averroës, who, according to Leo Africanus, attended his lectures and learned medicine from him. He belonged, in many respects, to the Dogmatists or Rational school, rather than to the Empirics.

Avenzoar was one of a few "who had the courage to tilt against Galen," and in his writings he protested emphatically against quackery and the superstitious remedies of the astrologers. He described the itch mite (*Sarcoptes scabiei*) and certain diseases. His *Teisir* ("Rectification of Health") was translated into Hebrew (1280) and then into Latin by Paravicius (1490). (F. L. A.)

AVERAGE, a term used in maritime law to mean loss or damage, less than total, to maritime property (a ship or her cargo) caused by the perils of the sea. (For the mathematical meaning *see* MEAN; STATISTICS.) An average may be particular or general. A particular average is one that is borne by the owner of the lost or damaged property (unless he was insured against the risk). A general average is one that is borne in common by the owners of all the property engaged in the venture. The remainder of this article will be devoted to the theory and practice of general average. (*See* the article on MARINE INSURANCE for the treatment of particular average under marine insurance policies.)

The basic idea of general average is that when some property is voluntarily sacrificed to preserve the remainder of the property from destruction (as by throwing cargo overboard or cutting away masts to preserve the ship in a storm), the owners of the property saved must contribute to the loss suffered by the owners of the property sacrificed in such an amount that all will have contributed rateably in the proportion which the value of their property bore to the aggregate value of all the property embarked in the enterprise. The Digest of Justinian shows that such a custom of contribution was firmly established in Roman law: *Omnium contributione sarciatur quod pro omnibus datum est* ("That which is given for all is recompensed by the contribution of all"). The doctrine was attributed by the Romans to the Rhodians and is referred to in the Digest (14, 2) under the heading: *De lege Rhodia de jactu.* As a commercial society re-established itself in western Europe after the long interregnum which followed the breakup of the Roman empire, the idea of contribution among the owners of maritime property for losses incurred for the common benefit reappeared, in rich variety and with much local diversity, in all the medieval collections of customs which are often referred to as sea codes. What is now called the law of general average thus has a lineage of impressive antiquity, and the doctrine has been admitted by all seafaring nations as part of their maritime laws.

In many areas of maritime law efforts to achieve unification of diverse national laws led to the drafting of international conventions that were later ratified by most or all of the principal seafaring nations: an example is the Brussels convention of 1922 on the carriage of goods by sea (*see* MARITIME LAW). Repeated attempts to draft such a convention in the field of general average met with failure. However, a measure of agreement on a number of vexing questions was reached at meetings held at York, Eng. (1864), and Antwerp, Belg. (1877). From these meetings proceeded the so-called York-Antwerp rules (often referred to as Y.A.R.), which have been periodically revised and expanded, most recently in 1950. In their present form they consist of a series of "numbered" rules (which cover matters of detail), a series of "lettered" rules (which state general principles) and a "rule of interpretation" which provides in substance that in case of conflict the numbered rules prevail over the lettered rules. A few countries, *e.g.*, the U.S.S.R., Switzerland and Finland, have adopted the York-Antwerp rules by legislation, but in most countries the rules depend for their effect on their inclusion in contracts of affreightment (*q.v.*). There has been general acceptance throughout the world of the proposition that the particular rules on general average imbedded in national law can be displaced by voluntary agreement; thus the inclusion of the York-Antwerp rules in a charter-party or bill of lading will be effective no matter where a general average settlement takes place. Shipping interests in the United States had never

completely accepted the pre-1950 versions of the rules; with their adherence to the 1950 rules a substantial degree of world-wide uniformity was at length achieved.

Since about 1910 the courts have had little to do with general average: litigation on the subject has almost disappeared. For this phenomenon the rules are no doubt partly responsible. A satisfactory explanation of the disappearance of the subject of general average from the law reports requires, however, some consideration of the status of the general average adjuster. The statement of a general average can be, and usually is, an exceedingly complex affair: such a statement can easily make up a volume of several thousand pages. To put such a statement together requires a vast amount of technical knowledge and *expertise*. Preparation of the statement is entrusted to a general average adjuster, and since the mid-19th century the body of men engaged in this recondite profession has enjoyed an enviable reputation for skill and impartiality. In Europe and the Scandinavian countries the general average adjuster is a state official. In England and the United States he has no official status and may be associated with the offices of an insurance broker or underwriter. Irrespective of his status, appeals from his decisions are rarely taken. In this connection it is appropriate to point out that the real parties in interest in a general average settlement are not the owners of the ship and the cargo but their insurance carriers, as insurance against general average contributions is all but universal and the insurers will typically have indemnified their principals long before the conclusion of the general average settlement. Acquiescence in the adjuster's decisions is undoubtedly encouraged by the fact that he is a professional working for professionals. In several European countries, *e.g.*, Sweden and Finland, the general average adjustment is given some legal effect by statute: if not promptly appealed from, it becomes binding on all parties. In England and the United States the adjuster's statement appears to be taken merely as a proposal which is in no way binding unless assented to: the adjuster's statement, it was said in a U.S. case, is nothing more "than a provisional estimate and calculation which his principal, the owner, was free to adopt or to put aside" (*U.S.* v. *Atlantic Mutual Insurance Co.*, 298 U.S. 483 [1936]). Despite such judicial statements, the rare appeal from the work of the adjuster is almost certain to be unsuccessful.

The basic definition of a general average act is contained in rule A (Y.A.R., 1950): "There is a general average act when, and only when, any extraordinary sacrifice or expenditure is intentionally and reasonably made or incurred for the common safety for the purpose of preserving from peril the property involved in a common maritime adventure." In substance this definition reproduces the principles which had been developed by the courts as a matter of general maritime law. Where the rule touches on matters which have been left unresolved by the case law it seems to retreat into a baffling and no doubt deliberate ambiguity. We may mention two examples of issues which the draftsmen chose to leave undecided. (1) Is it necessary that the "peril," in view of which the act is taken, be objective and real or is it sufficient that the master reasonably believes that the peril exists although he is mistaken? (For example, the master, having reason to believe that fire has broken out in the hold, orders water to be pumped in. It later appears that there was no fire. If the cargo is damaged by water, is there a general average act?) (2) Is it necessary that the sacrifice (or expenditure) be successful in that the property (or some of it) eventually arrives safely at a port? Where the sacrifice is immediately unsuccessful and the entire venture is lost, it has never been supposed that there was any basis for a general average contribution: everyone has lost all he had and matters may be allowed to rest there. The infinite variety of circumstances has, however, brought up for consideration cases in which a general average act (typically an expenditure made by the shipowner) has rescued the ship and cargo from peril, after which the ship and cargo have been lost from a cause unrelated to the original peril. In a leading case an English court concluded that there could be no contribution in general average unless some property arrived safe in port (*Chellew* v. *Royal Commission* [1921], 2 K.B. 627); the leading English treatise has continued in successive editions to express disapproval and to support the opposite conclusion (R. Lowndes and G. R. Rudolf, *General Average*, 8th ed., pp. 47, 200 *et seq.*). The York-Antwerp rules leave the issue unresolved.

The prototypical general average act was the jettison (the throwing overboard) of cargo to lighten the ship. Gradually the concept was broadened to include any type of sacrifice of ship or cargo. Naturally the ship, under the contract of affreightment, owes the cargo owner the duty of acting so as to preserve the cargo: unless the circumstances are "extraordinary," the ship has no right to ask for a contribution from cargo. In modern times the greatest development in general average law has been the putting of extraordinary "expenditures" made by the shipowner on the same level as physical sacrifices of property. The expenditure question has been considered one of great difficulty and the practice of the adjusters has varied during the last 50–75 years.

The sacrifice or expenditure must, in the phraseology of rule A, be "intentionally" (as well as "reasonably") made. In the case law "intentionally" often appears as "voluntarily" and has led to such decisions as that the scuttling of a ship at its wharf by order of a municipal fire department was not a general average act because the act was not taken by the voluntary choice of the master (*Ralli* v. *Troop*, 157 U.S. 386 [1895]). The concept of a choice freely made between alternatives has also come up in the case of a master's decision to run his ship aground at a favourable point, in the hope of saving some of the cargo, when the only alternative is to run on reefs and rocks at another point and lose everything. In the United States the ship under such circumstances was allowed to claim contribution from the cargo that was saved (see *Barnard* v. *Adams*, 51 U.S. [10 How.] 270 [1850]), but in other countries a general average contribution was denied on the ground that the destruction of the ship was in any event inevitable. Rule v (Y.A.R., 1950) provides that voluntary stranding is not a general average act (except for the expenses of refloating the ship) if in any case the ship "would inevitably drive on shore or on rocks." Another manifestation of the idea that an "inevitable" loss cannot be made good in general average is the treatment of loss or damage caused in the course of putting out a fire (as by forcing water into the hold); in general such damage is made good, but cargo which was actually on fire or so situated that it would certainly have caught fire does not share, on the ground that it would in any case "inevitably" have been destroyed (rule iii, Y.A.R., 1950).

In a general average settlement the property which has been saved (which may be the ship, its freight and cargo) contributes to the loss suffered by the property which has been sacrificed (which may also be the ship, its freight and cargo) as well as to the extraordinary expenditures made by the ship. There is thus a set of claims for reimbursement and a set of values (referred to as "contributory values") on which contribution will be levied, to the end that all will bear the same proportion of loss. The valuation, on both sides of the equation, is obviously no simple matter. The general rule is that the valuation of the contributory values is to be made "upon the actual net values of the property at the termination of the adventure" (rule xvii, Y.A.R., 1950). With respect to claims for reimbursement, the rules go into elaborate detail on ship repairs (rules xiii, xiv) and provide that losses to cargo shall be made good on the basis of market values at the port of discharge (rule xvi).

It should be emphasized that the aim of a general average adjustment is not to indemnify any party but to see that all parties suffer equally, in proportion to the value that each party has at risk. The mechanics of apportionment have been stated as follows: "The value of each of the contributing interests is multiplied by a fraction which has as its numerator the sum of the general average expenses and has as its denominator the sum of the contributing values" (*Pacific Freighters Co.* v. *St. Paul Fire & Marine Ins. Corp.*, 109 F.2d 310 [1940]). A recent treatise suggests the following "highly simplified" example to illustrate the working of the principle (G. Gilmore and C. L. Black, Jr., *The Law of Admiralty*, p. 222 [1957]): Assume that a vessel under charter is worth $1,000,000, her cargo (all belonging to one owner) $1,000,000, and

the freight, to be earned on arrival, $100,000. In general average acts, the ship is damaged in the amount of $5,000; cargo worth $100,000 is destroyed, and, consequently, freight in the amount of $10,000 is lost. The sum of the contributing values (ship, freight and cargo) is $2,100,000; the sum of the general average expenses is $115,000; thus, under the formula in the *Pacific Freighters* case, the fraction by which each of the contributing values is to be multiplied to determine the share of the loss which it ought to bear is $\frac{115,000}{2,110,000}$ or $\frac{115}{2,110}$. This operation gives as the share of cargo (valued at $1,000,000) $54,761.90; as the share of the ship (also valued at $1,000,000) $54,761.90; as the share of freight (valued at $100,000) $5,476.19. Since both cargo and freight have lost more than their fair share, they must be reimbursed in an amount which will bring their loss down to that figure. The ship, which suffered a loss of only $5,000, must contribute $49,761.90 in order to bear its fair share. That contribution will be divided, $4,523.80 going to the freight interest and $45,238.10 to the cargo interest. After that distribution each of the interests will have suffered a loss of $\frac{115}{2,110}$ of its value and the general average adjustment is at an end.

The institution of general average has not escaped attack. Critics have long felt that this primitive form of self-insurance has outlived its usefulness in an age in which all the values are insured. All that is involved in a general average adjustment is a redistribution of certain losses between hull and cargo insurers; that is to say, since the insurance carriers write both types of insurance, between their hull and cargo departments. A general average adjustment is usually not only protracted but expensive. A study by Selmer of general average adjustments made in Norway and Sweden in the period after World War II indicated that the net result of the adjustments was a movement of capital from cargo interests to shipowning interests (K. S. Selmer, *The Survival of General Average* [1958]). If general average were abolished, the results would be a saving of the costs of making the adjustments and (if Selmer's conclusions are generally valid) a slight decrease in cargo insurance rates counterbalanced by a slight increase in hull insurance rates. The defenders of general average have been inclined to agree that in an age of universal insurance the institution serves no useful economic function but insist that it has a psychological justification: the master, who must come rapidly to a decision in situations of stress and danger, can exercise a fairer judgment if he knows that both the ship and the cargo must contribute to the loss; if the rule of contribution were abolished, there would be a temptation for him to sacrifice the cargo in order to save his owner's property, the ship. Selmer finds the psychological arguments no more convincing than the economic arguments and favours "a complete abolition of the general average distribution" (p. 294). Abolition of so venerable an institution will, however, be a long time coming, if it ever comes. The insurance carriers, who are the only parties in interest, appear to be content to pay a modest tribute to the general average adjusters, and the adjusters themselves are naturally in favour of a continuance of their exacting profession.

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AVERESCU, ALEXANDRU (1859–1938), Rumanian army officer and statesman whose political career owed much to the popularity that he won as a military commander, was born of a peasant family at Izmail in Bessarabia, on April 22, 1859. A volunteer in the war of independence against Turkey (1877–78), he remained in the army and was sent to Italy to study at the military academy in Turin. Appointed Rumanian minister of war during the peasant revolt of 1907, he quelled it with strong measures. In 1913, as chief of the general staff, he conducted operations against Bulgaria in the Second Balkan War. In World War I he restored the prestige of the Rumanian army by his successful resistance to the Germans at Mărășești, on the Siret line (July 1917).

In March 1918, called by King Ferdinand I to form a cabinet, Averescu conducted the preliminary peace negotiations with the Central Powers. He resigned, however, before the humiliating peace treaty of Bucharest was signed (May 7, 1918). He then formed a People's league, which in 1920 became the People's party, and was prime minister again from March 1920 to Dec. 1921. He became prime minister for the third time in March 1926. In home affairs he had no distinctive program; in foreign policy he retained pro-Italian sentiments and, after a treaty of alliance with France (June 10, 1926), concluded a treaty of friendship with Italy (Sept. 16, 1926). After his resignation in June 1927 he no longer played a leading role in Rumanian politics. He was made a marshal of Rumania in 1930 and appointed a member of King Carol II's permanent crown council in March 1938. He died in Bucharest on Oct. 3, 1938. (B. BR.)

AVERNO (LAGO D'AVERNO), a lake in Campania, Italy, 10 mi. W. of Naples and about 1½ mi. N. of the village of Baia (Baiae; *q.v.*), is an old volcanic crater nearly 2 mi. in circumference. Its depth is 118 ft. and its height above sea level 7 ft.; it has no natural outlet. Its Greek name, Aornos, was explained to mean that no bird could fly across it and live, because of its poisonous vapours; its Roman name was Lacus Avernus. In ancient times it was surrounded by dense forests and it was represented as the entrance by which Aeneas descended to the infernal regions. Hannibal made a pilgrimage to it in 214 B.C. Agrippa in 37 B.C. cut down the forest and converted the lake into a naval harbour, the Portus Iulius, by joining it to the sea by a canal via Lacus Lucrinus (the Lucrine lake) and to Cumae by a tunnel over one-half mile in length. The tunnel, now called Grotto della Pace, was bored through the hill on the northwest side of Lake Averno and was usable until damaged in 1943 during World War II. The canal, however, soon became blocked because of a gradual rise of the shore. Nero's works for his proposed canal from Baiae to the Tiber (A.D. 64) seem to have begun near Lake Averno; indeed, according to one theory, the Grotto della Pace would be a portion of this canal. On the east side of the lake are remains of baths, including a great octagonal brickwork hall known as the Temple of Apollo (1st century). The so-called Grotto of the Cumaean Sibyl, on the south side, is a rock-cut passage, possibly part of works connected with the naval harbour.

AVERROËS (ABU-AL-WALID MOHAMMED IBN AHMAD IBN MOHAMMED IBN RUSHD) (1126–1198), the most outstanding representative of Arabic philosophy in Spain, known also as a writer on astronomy, on medicine and on Muslim canon law, was born in Córdoba. His grandfather, who died in the year of his birth, had been a well-known legal scholar. Little is known of the early life of Averroës. From 1169 (when Ibn Tufail presented him at court) he enjoyed the favour of the Almohade princes. He was made judge in Seville in 1169 and in Córdoba in 1171, and became chief judge in Córdoba at some later date (administering the Malikite rite which was observed in those parts of the Moslem world). In 1182 he was appointed chief physician to Abu Yaqub Yusuf (1163–84). Under Abu Yusuf Yaqub al-Mansur (1184–99), Averroës was banished from 1195 to 1198 to the small town of Lucena because of his philosophical attitude, but was restored to favour shortly before his death, which took place on Dec. 10, 1198, at Marrakesh, Morocco. He was buried in Córdoba.

Works.—For an account of Averroës' most significant doctrines *see* ARABIC PHILOSOPHY. Of his books, his main independent philosophical work is the *Tahafut al-Tahafut* ("Incoherence of the Incoherence"), a subtle and vigorous defense of Neoplatonic and Aristotelian philosophy against al-Ghazzali's determined and able attack in the *Tahafut al-Falasifa* ("Incoherence of the Philosophers"). This work of Averroës was translated into Latin in 1328 and into Hebrew about the same time; from the Hebrew a partial translation into Turkish was made in the 15th century, as well as a second Latin version in the 16th; there is an English translation from the Arabic by S. van den Bergh (2 vol., 1955). Some minor works deal with the agreement of religion and philosophy (text with Fr. trans. by L. Gauthier, 3rd ed., 1948), proclaiming, as did al-Farabi, the primacy of reason; others summarize the doctrines of the theologians without taking the theologians' side. The greater part of Averroës' philosophical output consists, however, of commentaries on Aristotle's lecture courses; but, since

Aristotle's *Politics* was not available to the Arabs, his textbook of politics was Plato's *Republic*, as it had been for al-Farabi. There are three types of commentary: (1) the great commentaries, like those of Alexander of Aphrodisias, for instance, or of Simplicius; (2) the middle commentaries, like those of Themistius; and (3) short compendiums. Many of these commentaries were translated into Latin in the first half of the 13th century (first printed in 1472–74); and in the 16th century this Latin corpus was augmented by a number of previously unknown commentaries derived from 13th- or 14th-century Hebrew versions, among them the *Epitome of the Metaphysics of Aristotle* (German trans. by S. van den Bergh, 1924) and the *Commentary on Plato's Republic* (Hebrew text with Eng trans. by E. I. J. Rosenthal, 1956). For the Latin text the Giunta editions (1550–52, 1562 and 1573–75) are the most highly esteemed. The influence of these commentaries within the Islamic world was negligible, but the use to which they were put by the so-called Latin Averroists in the Christian world is an important part of the history of scholasticism. They also strongly influenced Jewish thinkers of the middle ages (*see* Jewish Philosophy: *The Medieval Period: The Averroists*).

Two of Averroës' medical works became well-known in Latin **and have often been printed. One is a complete handbook of** medicine, *Al-Kulliyyat*, whose name, by a curious misunderstanding, became *Colliget* in Latin (trans. 1255). The other is a commentary on Avicenna's *Poem on Medicine* (trans. 1280).

Like other Arabic scholars, Averroes in his astronomy shows some independence and does not follow Ptolemy in everything. **He also wrote a complete handbook of Malikite law, in which he always compares the views of other schools.**

See Averroism, Latin; Scholasticism.

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AVERROISM, LATIN, a term used to characterize the thought of a number of western Christian philosophers who, in the later middle ages and during the period of the Renaissance, drew their inspiration to a greater or lesser degree from the interpretation of Aristotle put forward by the Muslim philosopher Averroës (*q.v.*; and *see* Arabic Philosophy). Different senses may be given to the term according to the degree of influence by Averroës that it is understood to imply, and the answer to the question when Averroism is first to be discerned in western scholastic philosophy depends on the sense intended. (*See* Scholasticism.)

Averroism in the 13th Century.—Ernest Renan, in his *Averroès et l'averroïsme* (1852), claimed to recognize traces of Averroist thought in scholastic philosophy from the beginning of the 13th century. Though he could not say how it had reached them by that time, he believed that it was then being disseminated by some masters of the University of Paris and by the Franciscans, and that signs of a contemporary reaction against it can be discerned in the writings of William of Auvergne, Albertus Magnus, Thomas Aquinas, Giles of Rome and Raimon Lull. Renan's view, however, is open to criticism on various counts: William of Auvergne, for instance, can be shown to have been combating not the doctrines of Averroes but those of Avicenna (*q.v.*); and it was likewise from Avicenna that some of the early Franciscans acquired the concept of a unique active intellect which, in accordance with the Augustinian doctrine of divine illumination, they identified with God—a doctrine neither Averroist nor heterodox. P. Mandonnet, on the other hand, maintained that Averroism did not develop until after 1250, but he regarded Siger (*q.v.*) of Brabant, whose works he edited, as the pioneer and leader of this school of thought in the 13th century. Mandonnet, however, had been misled by Renan's arguments and had never thoroughly investigated the sources of Siger's philosophy, with the result that he could not rightly judge the exact degree of Averroist influence on Siger.

A large number of the works of Averroës had in fact been translated into Latin—largely by Michael Scot (*q.v.*)—between 1217 and 1230, and it is clear that his importance as a commentator on Aristotle was accepted at Paris, at Oxford and at other studia from about 1230 onward. Consequently, if the appellation Averroist had to be given to any scholar who regularly consulted Averroës' commentaries and frequently deferred to his views in the interpretation of Aristotle, then Albertus Magnus, Adam of Buckfield (fl. c. 1250) and, in particular, Thomas Aquinas would have to be called Averroists, and the presence of Averroism in western Christendom could be dated from the middle of the 13th century. That, however, would give to the term Averroism a sense so broad as to be of little use to the historian of philosophy.

Another sense in which the term might be applicable to 13th-century scholastics was proposed by the Spanish historian M. Asin y Palacios, who used the expression "theological Averroism" to denote a certain method of reconciling reason and faith which he thought to be derived from Averroës and to be exemplified in the work of Aquinas. The extreme rationalism of Averroës, however, made it in fact impossible for any Christian theologian to be guided by him along this path.

The earliest recorded use of the word "averroistae" admittedly occurs in Aquinas' treatise *De unitate intellectus* (1270), where it is applied specifically to those who adopted from Averroës the doctrine of monopsychism; *i.e.*, the doctrine that there is only one single intellect or "intellective soul" for the whole of humanity. Heterodox opinions of this sort were already being advanced by Christian philosophers in the 1260s, and monopsychism was quite important for some time, but even so the fact that a philosopher maintained monopsychism is not enough to justify describing his whole system as Averroist. Furthermore, Siger of Brabant, the principal opponent of Aquinas, believed that the true interpretation of Aristotle's *De anima* was a monopsychist one and so adopted monopsychism out of loyalty to Aristotle, not out of affection for Averroës.

If, on the contrary, the appellation Averroist is reserved, as it should be, to describe only those philosophers who adopted in its entirety the whole system of Averroës, then no genuine Latin Averroists can be found in the 13th century. The doctrines condemned by Étienne Tempier, bishop of Paris, in 1270 and 1277 were not specifically Averroist, but comprised a wide variety of pagan errors, many of which were immediately derived from the works of Aristotle.

Averroism Properly So Called (14th–17th Centuries).—Genuine and complete Averroism can be found in the 14th century, in the works and teachings of John of Jandun (d. 1328) at Paris and of Taddeo da Parma (fl. *c.* 1320) and Angelo d'Arezzo (fl. *c.* 1325) in Italy. These schoolmen unreservedly adopted Averroës' interpretation of Aristotle—John of Jandun actually calling himself the "ape" of Aristotle and Averroës. Their thought was thus confined to elaborating a closed system, derived exclusively from the tradition of Averroës and completely impervious to external influence.

The basic tenet of the Latin Averroists and that which was most vehemently attacked by orthodox Christian thinkers was their assertion of the superiority of reason and philosophy over faith and knowledge founded on faith. In this they displayed an attitude of mind quite unlike that of the more or less heterodox Aristotelians of the 13th century such as Siger of Brabant and Boetius of Dacia. Siger, for example, had thought that certain logically necessary philosophic conclusions were inconsistent with Christian dogma; but he was sincere in his assertion that only the latter could be called "true," and he spared no effort to explain the apparent disparities as the result of "supernatural" or "miraculous" interventions on God's part, whereby the normal conclusions of science were contradicted in actual historical fact. At first sight the 14th-century Averroists may appear to use much the same language as Siger, but their position was utterly different. A careful study of their work and behaviour exposes the insincerity of their professions of faith, which they made from motives of prudence in order to appease the guardians of orthodoxy. They were in fact rationalists as Averroës had been a rationalist, with no Christian

belief behind their learning.

Averroës and the Latin Averroists have sometimes been credited with the theory of "double truth," which maintains the existence of two contradictory truths, one taught by reason, the other commanded by faith. In fact no medieval writer or teacher professed such a view, and those who found religion and reason irreconcilable fell apart into two groups, the Averroists giving their allegiance to reason, the others, such as Siger and Boetius, giving theirs to faith. It was only insofar as one side or the other refused to opt for either allegiance that their enemies could charge them, as in the prologue of the 1277 condemnation, with speaking as if there were two contrary truths (*quasi sint duae contrariae veritates*).

Apart from its assertion of the supremacy of reason over faith, the most characteristic tenets of Latin Averroism were: (1) the eternal and necessary creation, both for the world of spirits and for the world of matter; (2) the unicity of the human intellect—with all the psychological, religious and moral consequences of such monopsychism, which negated belief in personality, in individual immortality and in the transcendent destiny of man; and (3) psychological determinism—which is incompatible with moral responsibility.

Averroism was not taught at Paris after John of Jandun's time but it retained a stronghold in northern Italy for more than three centuries after Taddeo da Parma and Angelo d'Arezzo had propounded it. At Padua it was taught by Paul of Venice (1368–1428 or 1369–1429), Cajetanus de Thienis (1387–1465), Agostino Nifo (*q.v.*), Alessandro Achillini (*q.v.*) and Marcantonio Zimara (1460–1523). Achillini and Zimara, however, professed a mitigated Averroism which they strove to reconcile with the doctrines of the church.

The Averroists of Padua in the 16th century became involved in controversy with the Alexandrists (*q.v.*) led by Pietro Pomponazzi. These Alexandrists followed Alexander of Aphrodisias in adopting a materialistic interpretation of Aristotle and denied the spiritual nature and immortality of the human soul, whereas the Averroists postulated the existence, temporarily individualized in each man, of an eternal and universal intellect. Thus, though they disagreed about the nature of the soul, Averroists and Alexandrists were at one in denying immortality to the soul of the individual, and for this reason both their doctrines on it were condemned at the fifth Lateran council (1513). Averroism yet continued to be taught at Padua until the 17th century. Cesare Cremonini (1550–1631) was its last adherent.

For information on Jewish Averroism *see* JEWISH PHILOSOPHY.

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AVERSA, a town of southern Italy, region of Campania, province of Caserta, is situated in the Campanian plain 17 km. (10½ mi.) N.N.W. of Naples by road. Pop. (1961) 39,862 (commune). The cathedral (11th century, rebuilt 18th century) has a fine bell tower. The other chief buildings include the 13th-century convent of the Annunciation, the Angevin castle and a psychiatric hospital founded in 1813. The musician Domenico Cimarosa was born in Aversa in 1749. Agriculture and viticulture are the main industries and Asprino wine, mozzarella (a sweet Neapolitan cheese) and dairy produce are marketed. Aversa was the centre of a Byzantine duchy until 1030 when Sergio IV, duke of Naples, gave it to the Norman, Rainolfo Drengot, making him count of Aversa. Thus Aversa became the first Norman county in Italy and a centre of culture, known for its grammar schools. It became a diocese of the Holy See. In 1860 Aversa became part of the kingdom of Italy and in World War II it was captured by the Allies in Oct. 1943. (M. T. A. N.)

AVERY, SAMUEL PUTNAM (1822–1904), U.S. artist, art dealer, connoisseur and philanthropist, who is best remembered for his philanthropic endeavours in the arts and education, was born in New York city on March 17, 1822. Beginning as an engraver on copper, he later became a skilled wood engraver and illustrated numerous books. In 1865 he established himself as an art dealer, and two years later he was U.S. commissioner at the International exposition at Paris. In memory of his son, Henry Ogden Avery, a successful architect who died in 1880, he established the Avery architectural library at Columbia university. In 1893, in memory of a daughter, he established a library in the Teachers college, Columbia university. He was one of the founders of the Metropolitan museum. To the New York public library he presented a collection of prints. He died in New York city on Aug. 11, 1904.

Avery hall, commemorating both father and son, was built at Columbia university, housing a valuable collection of works on architecture and decorative art.

AVES, the zoological class comprising the birds. *See* BIRD.

AVESTA, the original document of the religion of Zoroaster. *See* ZOROASTRIANISM.

AVESTAN LANGUAGE: *see* IRANIAN LANGUAGES.

AVEYRON, a *département* of southern France, comprises the southwestern portion of the Massif Central (*q.v.*). It is bounded on the north by Cantal, on the east by Lozère, on the southeast by Gard and Hérault and on the west by Tarn, Tarn-et-Garonne and Lot. Area 3,386 sq.mi. Pop. (1962) 290,442.

Aveyron consists of contrasted plateaus of crystalline and limestone rocks, extending westward from the Cévennes (*q.v.*), across the Causses (*q.v.*), to the margins of the lowlands of Aquitaine. The volcanic highlands of Aubrac form its northeastern border. The plateaus, with large areas between 2,500 and 4,000 ft. in the Causses, are deeply dissected by the Lot, Aveyron and Tarn rivers and their tributaries, which often flow in gorges 1,500 ft. or more below the flanking plateaus. The limestone Causses plateaus are in the form of the letter Z. Their northern limb, the Causse Comtal between the Lot and Aveyron rivers, is connected with the Causse Larzac in the south by the Causses de Sauveterre, Méjean and Noir of the Tarn basin. These separate the high granite plateau of Lozère to the east from lower crystalline plateaus of the west. Along the margins are some small lowland depressions such as those around St. Affrique and Décazeville etched in softer rocks. These basins and the low-lying valleys are warm and sheltered, but the plateaus have a much wetter and more severe climate. Orchards, vineyards and irrigated meadows are characteristic of the sheltered valleys, but the plateaus are mainly pastoral. The lower plateaus of the west, with more cultivation, were traditionally concerned with rye and chestnut, and were variously known therefore as *Ségalas* and *Chataigneraies*. Their farm lands, a patchwork of small enclosed fields, are mainly devoted to pasture and other fodder crops, and to potatoes. Cattle raising is the mainstay. In the Causses cultivation is much more restricted by lack of soil and water, but wheat is here the main grain crop. Sheep rearing, however, is the most widespread activity and became increasingly important after the middle of the 19th century with the emphasis changing from production of wool to that of sheep's milk for the manufacture of Roquefort cheese, which is matured in limestone caves at Roquefort near the margin of the Causses. At the same time Millau, formerly concerned with woolen manufacture, has become an important glovemaking centre. The tourist industry, especially attracted by the Tarn gorges, has become increasingly important. In the vicinity of Aubin and Décazeville is a small coal field which provides railways and gasworks over a wide area of southwest France and has local iron, zinc, glass and chemical industries.

Aveyron is especially rich in dolmens and other prehistoric monuments, and was evidently well settled in Roman times. That it now contains some of the most desolate tracts of France is especially attributable to deforestation and the ravages of grazing animals. Since the beginning of the 20th century depopulation has continued more rapidly than in most rural areas of France.

Rodez (*q.v.*), the capital, on the Aveyron; Millau, chief town for the Causses, at the outlet of the Tarn gorges; and Villefranche-de-Rouergue gave their names to the three *arrondissements* into which the *département* is divided. The *département* forms the bishopric of Rodez, under the archbishop of Albi. It lies in the educational district of Toulouse, and its court of appeal is Mont-

pellier. It corresponds closely to the ancient county of Rouergue, which was united to that of Toulouse in the 11th century, and its history is also linked with the historic province of Guienne (*q.v.*) of which it formed part. After the devastation of the Albigensian wars new colonists were settled in the area, and several regularly planned settlements (bastides), notable among them Villefranche and Sauveterre, date from this time. The monastery of Conques in the north, with a Romanesque church, is one of the most famous in France. Espalion, Najac and Sylvanès also have noteworthy castles and churches. (AR. E. S.)

AVIATION (ARTICLES ON): *see* AERONAUTICS (ARTICLES ON).

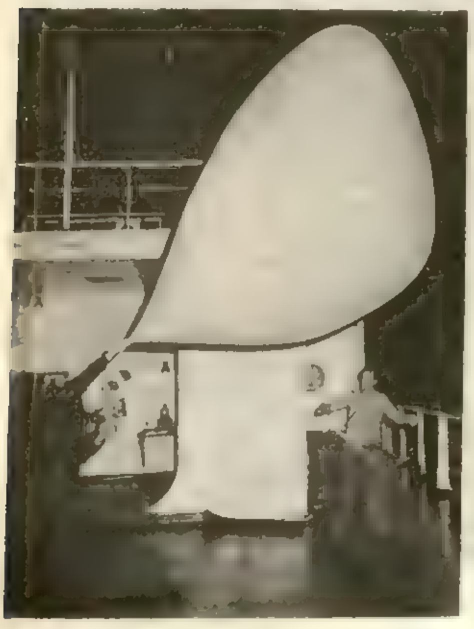
AVIATION, CIVIL. In the broadest terms, civil aviation includes all flying other than military aviation (for the latter, *see* AIR POWER). In the most common definition, civil aviation refers to the air transportation service provided to the public by airlines or private operators, but it also includes private flying for business or pleasure as well as such diverse activities as agricultural crop dusting, geological prospecting, mapping, and automotive traffic regulation. These activities are described below in the section *General Aviation.*

Most air travelers, however, associate commercial flying with civil airline operations. There are two types of airlines: scheduled carriers, which provide services between a given number of points according to an established, published schedule; and nonscheduled airlines, which offer transportation under charter contracts or in accordance with traffic demands. Scheduled airlines in turn can be classified in three principal service categories: long-range or intercontinental services; medium-range or regional services; and local service or interurban operations. All three have developed into an intertwining network of routes throughout the world that permit direct, convenient air-flight connections between all economically important points. The growth of this system has modified the travel habits of millions of people and has influenced sociological, political, and economic characteristics in many lands. These effects have been made possible not only by the rapid technological development of the transport aircraft itself but also by the introduction of uniform air navigational and communications facilities throughout the world, by a steady advance in flight safety, and by the progressive evolution of international air agreements, regulations, rules of flight conduct, and regulatory agencies that together provide a worldwide code of civil aircraft operation.

PRE-WORLD WAR II DEVELOPMENTS

International air transportation began on a large scale immediately following World War II when the long-range, four-engined aircraft emerged to pave the way for practical transoceanic flights. Prior to World War II, the British, Dutch, Belgians, and French inaugurated long-range air services to their colonial possessions in Africa and the Far East, but these services were possible only because of the availability of intermediate refueling points along the routes. Germany operated services to South America in the early 1930s and developed local air routes in Argentina, Bolivia, Brazil, Colombia, and Ecuador. In 1929 a U.S. commercial air carrier began regular service from Miami, Fla., to the west coast of South America and, in 1935, operated a transpacific service with flying boats, using a chain of islands as refueling and maintenance stops en route. The Germans began dirigible service between Friedrichshafen, Ger., and Recife, Braz., in 1932 and inaugurated transatlantic dirigible flights in 1936. By 1939 a regularly scheduled service using airplanes was available over the Atlantic. These beginnings were modest because of the operating limitations of transport aircraft available at the time. Engine power was low, payloads were restricted and operating ranges were circumscribed by limited fuel capacities. Maintenance facilities were haphazard at best and radio navigational aids were not available to any significant extent until the mid-1930s. These factors, together with dubious safety records, deterred many travelers from using air services. The first modern aircraft to achieve any notable degree of reliable performance and comfort was the U.S.-built Douglas DC-3, which entered commercial service in 1936. The DC-3 was an all-metal, twin-engined monoplane that could carry up to 21 passengers. The performance of this airplane attracted passengers in sufficient numbers to establish the pattern of air routes that constitute modern airways, and its reliability and generally excellent design tended to standardize airline equipment requirements subsequently.

BY COURTESY OF UNITED NATIONS



(Above) An International Civil Aviation Organization weather ship, one of 23 ships patrolling the North Atlantic. (Left) Launching an instrumented weather balloon south of the Arctic circle to obtain information helpful to airlines and ships. (Below) A student pilot practising at a flight training centre of the ICAO in Mexico

United States.—Interest in air service lagged in the United States and it was not until 1926 that a regularly scheduled air service was founded with any real promise for the future. A number of experimental airmail flights were conducted in 1918, and in May of that year the Post Office Department began the first scheduled airmail service between Washington, D.C., and New York City. In 1924 the first scheduled transcontinental mail route was opened between New York City and San Francisco, Calif., and, also in 1924, the first regular night operations were conducted on the segment between Chicago, Ill., and Cheyenne, Wyo.

With the passage of the Kelly Act in 1925, the post office was authorized to contract with private operators for the transportation of mail, and within a year scheduled airline service within the United States had commenced. The Ford trimotor transport, an all-metal airplane with ten passenger seats, attracted some passengers but it was not until 1934, when Pres. Franklin D. Roosevelt ordered the cancellation of airmail contracts and directed the Army Air Corps to fly the mail, that the airlines showed any serious interest in passenger trade. The Army flew the airmail on a restricted basis only for a matter of months, and new mail contracts then were granted under competitive bidding to private operators in accordance with the Air Mail Act of 1934.

The reduced dependence on airmail revenues and the introduction of faster and larger aircraft brought about the dawn of passenger air transportation. The number of passengers flown by U.S. carriers was 5,782 in 1926; it rose to 461,743 in 1934; and had reached a total of 4,060,545 by 1942. The speed of the average transport airplane rose from about 110 mph in 1934 to about 158 mph in 1938, while the efficiency of aircraft utilization through improved maintenance increased during the late 1930s and costs per passenger-mile declined markedly. In 1934 the average seat capacity per passenger aircraft was 8; in 1938 the average had climbed to 12.7.

United Kingdom.—The British government recognized the commercial value of air transportation before the end of World War I and, following a report by the Civil Aerial Transport Committee under Lord Northcliffe in February 1918, created a Department of Civil Aviation within the Air Ministry on Feb. 12, 1919, under Maj. Gen. Sir Frederick Sykes. By the beginning of 1920 there were three British companies operating air services across the English Channel to Paris, Brussels, and Amsterdam, carrying passengers, freight, and mail. Success was limited and the carriers, in stiff competition with continental airlines, suffered financial loss. Government subsidy, totaling £105,000 in 1922, failed to rescue the carriers and, in 1923, the Hambling Committee was appointed to review the nation's civil air policy. It recommended that the four leading British airlines should be consolidated into a single, subsidized carrier for overseas air services.

The result was the organization of Imperial Airways, Ltd., established on April 1, 1924. One of the main tasks of Imperial Airways was the development of air routes to the Commonwealth countries, an important aspect of which was the transportation of empire airmail, under a provision guaranteeing an assured load of mail, carried at regular postal rates between the various countries. In 1927 Imperial Airways took over from the Royal Air Force the mail route between Cairo and Baghdad. The route was extended to Karachi, Pak., in 1929, and by 1935 Imperial Airways was operating throughout India and to Burma, Malaya, and Brisbane, Austr., a route distance of 12,754 mi. from London. Singapore was connected with Hong Kong in 1937, and a route was surveyed through Africa from the Mediterranean to the Cape of Good Hope.

While Imperial Airways was extending its routes, a number of independent, unsubsidized companies also were operating services to the continent and within the United Kingdom, but most of them were unable to work at a profit. In 1935 the Fisher Committee, therefore, recommended the formation of a second carrier to develop services to Europe. British Airways was formed for the purpose, but the government's policies caused so much dissatisfaction in civil aviation circles that a new committee under Lord Cadman was set up in 1937 to report on the whole situation. It was decided to create a single public corporation officially financed and responsible for all British overseas air services. This new instrument, British Overseas Airways Corporation, was formally established on Nov. 24, 1939, but by this time World War II had begun and the new corporation was placed under the operational control of the Air Ministry for the duration of the war.

Europe.—In Europe, as well as in Great Britain, an overabundance of services in relation to demand prevented the airlines from earning a profit. A large number of airlines were organized between 1920 and 1930 in response to demands for flag carriers to bolster national prestige, trade, and commerce. There were two results of the heavy competition: the merger of a number of airlines within individual countries, as in the case of Great Britain and France, and the creation of cartels by companies of different nationalities as a means of coping with high operating costs on highly competitive routes. One example of the latter arrangement was the organization of Deruluft, an international carrier established in 1921 by a German airline and the Soviet government.

In France the government early recognized the commercial value of air transportation; by 1931 French airlines were flying as far east as Indochina and virtually all of France's colonial possessions were connected with Paris by air routes. However, a large number of airlines, operating without a coordinated and regulated policy, suffered heavy losses during the 1920s and retarded the orderly growth of a national airline system. In 1933 five airlines finally merged to form the Compagnie Nationale Air France, which became the nationalized airline following World War II. Meanwhile, a number of smaller carriers continued throughout the 1930s to serve routes not covered by Air France.

Germany was particularly active in the development of an airline system prior to World War II, and between 1915 and 1926 had organized a total of 30 airlines, all but 6 of which were controlled by 2 air transport combines, Junkers Luftverkehr and Deutsche Aero-Lloyd. Because of the intense competition between the two groups, the government forced a merger in 1926 to form Deutsche Lufthansa. With the rise of the Nazi regime the airline became a political instrument and was used, among its other activities, as a device to penetrate South America. It established many subsidiaries throughout the world and held a one-third interest in Eurasia Aviation Corporation, founded in 1930 under German-Chinese auspices. By 1939 Deutsche Lufthansa routes covered Europe and extended to many parts of Asia and South America.

In the Netherlands KLM (Royal Dutch Airlines) was organized with government aid in October 1919 by Albert Plesman. After establishing a network of European services, it organized links with the Dutch East Indies and colonial territories in the Caribbean area.

In 1923 Belgium formed a national airline, Société Anonyme Belge d'Exploitation de la Navigation Aérienne (Sabena), which operated until Belgium was invaded by the German Army in 1940. It resumed operations after the war.

WORLD WAR II DEVELOPMENTS

It was the participation of the airlines in World War II that gave the industry the impetus it needed to make the potential of air transportation a reality. During the war commercial aviation came to a virtual standstill but the aircraft and the airlines' experienced personnel were pressed into military service to provide an air transport service that covered every major theatre of war. Regular service was launched across the North Atlantic, through the Pacific, over the Himalayas from Burma to China, into the Arctic regions, across Africa, and throughout Latin America. Efficiency of performance, never before attained, kept these long-range flights transporting troops and matériel on a regular basis. World War II revealed the real potential of the transport airplane and, just as important, it familiarized thousands of servicemen with the advantages of air travel.

POST-WORLD WAR II DEVELOPMENTS

The four-engined transport airplane was introduced commercially immediately after World War II and, beginning in 1946, the pressurized cabin, which maintained a near-normal air density

even while the aircraft was flying at high altitudes, came into widespread use. Navigational facilities were improved and all-weather operation became a reality. Speeds were increased up to 370 mph, seating capacity reached as high as 100 per airplane by the early 1950s, and the increased range of the new airplanes provided travelers with a wide variety of nonstop schedules between major cities. At first these innovations, as well as such travel inducements as reduced fares, did not attract passengers in the volumes originally anticipated by the airlines, and an overexpansion resulted that led to new deficits from 1947 through 1949. However, by 1950 passenger and freight traffic began to make notable gains, spurred to some extent by increased travel requirements brought about by the Korean War. Nonstop flights between New York and the West Coast of the United States were inaugurated in 1953 with the long-range Douglas DC-7 and, later,

BY COURTESY OF AERO SPACELINES

SUPER GUPPY, DESIGNED TO TRANSPORT LARGE AEROSPACE EQUIPMENT, HAS 25-FT. MAXIMUM INSIDE DIAMETER AND 49,790 CU.FT. OF CARGO SPACE. WAS BUILT BY COMBINING BOEING 377 AND C-97J AIRFRAMES, AND IS POWERED BY FOUR PRATT AND WHITNEY TURBOPROP ENGINES

nonstop flights with this airplane and the Lockheed 1049 (Super Constellation) were conducted between New York and Paris, London, and Lisbon. During the 1950s air transport developed into one of the world's most significant industries and was accepted as a common mode of transportation; on the North Atlantic routes it surpassed steamships in the number of passenger-miles traveled.

Regional Services.—Growth of long-haul travel was accompanied by an equally successful development of regional or medium-haul airline services. Expansion of this type of service was particularly marked in North and South America and Europe. From 1955 it grew rapidly in the U.S.S.R. and China, and notable progress with regional airline services was made in India and the Middle East countries. In the U.S.S.R. and China the Soviet-built Ilyushin Il-14 was used extensively for this service, while in other countries of the world the British-built four-engined Vickers Viscount, the Fairchild/Fokker F-27, and the Nord 262 turboprops and the twin-engined U.S. Convair 440 and Martin 404 were widely used on medium-haul schedules. By the mid-1960s jet aircraft such as the Douglas DC-9, Boeing 737, and BAC-111 were in general use in regional services.

Helicopter Services.—Helicopters serving large metropolitan areas began to make their appearance in the postwar years, but, because of the helicopter's relatively high cost of operation and restricted payload, progress initially was slow. By the 1960s helicopter services were playing a significant role in some areas, but scheduled flights by rotor planes were still not being made on a large scale. In Belgium Sabena eliminated its Brussels helicopter services in 1965 because of high operating costs; British European Airways operated scheduled helicopter flights in the United Kingdom; and, in the United States, New York, Chicago, Los Angeles, and San Francisco were served by active helicopter airlines that linked trunk-line airports with suburban communities. In the U.S.S.R. helicopter schedules flown with Soviet-built rotor planes (notably the Mi-4) began in 1958 to serve such intercity routes as that between Simferopol and Yalta. The U.S.S.R. also used the helicopter to provide transportation to hard-to-reach areas of the Urals, Siberia, Central Asia, and Kamchatka.

Feeder Airlines.—Feeder or local-service airlines sprang up in many parts of the world during the early postwar years and grew rapidly in favour as a necessary link between trunk-line hub areas and smaller cities. Many local-service airlines used the Douglas DC-3, but by the mid-1960s a number of the small carriers in the United States had replaced these with turbine-powered aircraft.

All-Cargo Airlines.—A number of all-cargo airlines—carriers confined to the movement of freight and sometimes mail—were organized in the years immediately following World War II, but by the 1960s they had declined in many areas. The survivors met with remarkable success after introducing jet all-cargo aircraft. Cargo operations were particularly successful in Latin America, and by the 1960s they were also being conducted extensively in the U.S.S.R. In countries where highways and railways were not fully developed, cargo flying showed particular promise.

Nonscheduled Airlines.—Nonscheduled or supplementary airlines—carriers devoted to the movement of special groups of passengers on charter or to the operation of flights without reference to published schedules—flourished during the early postwar years and by 1950 posed a serious competitive threat to the scheduled airlines. In the United States, however, the scheduled lines inaugurated reduced fares that matched the lower rates of the nonscheduled operators and the latter had substantially dwindled in size by the 1960s. Later, as in the case of all-cargo airlines, jet aircraft bolstered the fortunes of the nonscheduled lines.

Reduced-rate operations, however, remained especially successful in Latin America, where the large number of airlines made competition especially keen. In the United Kingdom the nationalized airlines were in competition with private operators who were able to offer transportation on certain routes and for certain classes of traffic at fares well below those established as standard by the scheduled airlines. In France, Air France also encountered serious opposition from some of the larger private airlines. Competition between charter airlines and the Scandinavian Airlines System consortium grew particularly keen in the 1960s on the routes from Norway, Sweden, and Denmark to the Mediterranean resort areas.

THE JET AGE

The introduction of jet aircraft reinforced the growth of air transportation to a significant degree. Because of the high speed of these aircraft (each new type approached nearer and nearer the speed of sound) as well as the greater passenger comfort inherent in jet flight, *e.g.*, lack of vibration and relative quiet, the pure jet (turbojet) was an immediate success with the traveling public.

The first jet airplane to make its appearance on commercial routes was the British de Havilland Comet. Comet service began in 1952 on the routes of British Overseas Airways Corporation, but two serious accidents in 1954 led to the grounding of the aircraft. Investigation of the accidents disclosed metal fatigue to be the cause, and an intensive modification program designed to correct the fatigue problem was conducted. Comets were flying again in 1955 and were reintroduced into commercial service in the fall of 1958.

Soviet Airlines.—Aeroflot, the Soviet airline, began pure jet service in 1956 with the twin-engined Tu-104, which was later modified to accommodate 100 passengers. In addition, Aeroflot in the 1960s was operating the An-10, An-16, An-24, Il-18, Il-62, Tu-114, Tu-124, and Tu-134. Coincident with the achievements of the airline, the U.S.S.R. eased its policy of isolationism in commercial aviation and negotiated bilateral air transport agreements with a number of European, Near Eastern, and Far Eastern nations. By the 1960s Moscow was linked by air with the capitals of a number of non-Communist countries, including New Delhi, Cairo, Paris, London, Brussels, Copenhagen, and Amsterdam. Within the U.S.S.R. turbojet and turboprop aircraft were operating into the Ukraine, the western U.S.S.R., and Siberia. Jet flights were conducted on a scheduled basis to Murmansk and Norilsk, well above the Arctic circle. A two-track system on the trans-Siberian route to permit flying around bad weather afforded the airline an opportunity to fly more regularly on this route, which extends from Moscow through Sverdlovsk, Omsk, Novosibirsk, and

on to Irkutsk and Vladivostok. Another major route on which turbine equipment was introduced in 1960 was that running from Irkutsk to Alma-Ata and from Khabarovsk to Magadan. A shuttle service conducted between Leningrad and Moscow was so popular that in one six-month period traffic increased 1,000%. In 1967 the Soviet Union opened its trans-Siberian routes to flag carriers of other nations: first to Japan Airlines and then to the Scandinavian airlines system on the Moscow–Tokyo route.

United States Airlines.—In the United States the first pure jet service with the Boeing 707 transport was started on the North Atlantic route by Pan American World Airways System, and American Airlines began domestic operations on its coast-to-coast route with the same type of airplane in January 1959. The first turbine service in the United States was started by Capital Airlines (which later merged with United Airlines) in 1955 with the Vickers Viscount turboprop transport. The Lockheed Electra turboprop was placed on commercial routes in early 1959 and was followed by a larger version of the Boeing 707, the Douglas DC-8, the Convair 880, the Convair 990, the Boeing 720, Boeing 727, French-built Caravelle, British-built BAC-111, Douglas DC-9, and the Boeing 737, all pure jet aircraft.

The U.S. domestic routes by the 1960s were served by 11 carriers, each of which operated turbine as well as piston-engine aircraft. Of these carriers, 7 also operated international routes, the most extensive services being Braniff International Airways to South America, Northwest Orient Airlines across the Pacific Ocean by way of Alaska, and Trans World Airlines across the Atlantic Ocean to Europe and the Far East. Pan American World Airways System had no domestic routes, except to Alaska and Hawaii, but served a system that, except for the gap in the central United States, included a round-the-world route and routes into South America and Africa. Pan American-Grace Airways, known as Panagra, was merged into Braniff in 1965. Seaboard and Western Airlines, Inc. operated an all-cargo service between the United States and Europe. There were 23 local service carriers in the United States, including 8 in Alaska and 2 in Hawaii, as well as 4 scheduled helicopter airlines and 3 domestic all-cargo airlines. Several carriers with permission to fly all-cargo services had withdrawn from active operations by 1960. Twenty supplemental airlines were authorized to conduct a maximum of ten round-trip flights each month between any two points.

United Kingdom Airlines.—In Great Britain, British Overseas Airways Corporation in 1960 inaugurated Boeing 707 service and later supplemented this fleet with the Vickers VC-10 and Super VC-10, as the de Havilland Comet and Bristol Britannias were retired. Pure jet service was offered by the corporation to six continents: Montreal–London and New York–London; London through the Near East to India, Hong Kong, and Tokyo; London to Australia and South Africa; London to South America; and New York to Nassau and Jamaica. Britain's second nationalized corporation, British European Airways, operated an all-turbine-powered fleet of aircraft on its external routes as early as 1958, the first of the world's airlines to achieve this. In 1960 the airline introduced the large Vickers Vanguard turboprop transport but later added the Hawker Siddeley Trident jet transport to its fleet for blue ribbon services.

Other Airlines.—The Belgian airline, Sabena, began the operation of Boeing 707 pure jets across the Atlantic in 1960 and jet services to Léopoldville (now Kinshasa) and Johannesburg later that year. Boeing 707 flights were also operated on the route to Moscow, and later the airline placed the French-built Sud Caravelle turbojet transport on its medium-range routes. Lufthansa of West Germany also began transatlantic service with the Boeing 707 in 1960 and later that year started polar-route flights between San Francisco and Frankfurt with the same airplane. Air France began using the Boeing 707 on its transatlantic flights and on the polar route Paris–Anchorage–Tokyo. Air France also operated the Sud Caravelle on its medium-range routes. A private firm, Union de Transports Aériens (UTA), formed by a merger of TAI and Union Aéromaritime de Transport, operated DC-8 jets. KLM, flag carrier of the Netherlands, started flying the DC-8 in 1960, as did Iberia Airlines of Spain. Scandinavian Airlines System—a consortium flag carrier representing Denmark, Norway, and Sweden—operated the Douglas DC-8 between Copenhagen and New York and over its polar route, Copenhagen–Anchorage–Tokyo, beginning in 1960. The same year Air-India International, flag carrier for India, began jet service over two routes: New York–London–Paris–Rome–Cairo–Bombay and New York–London–Frankfurt am Main–Geneva–Beirut–Bombay–Calcutta. Ja-

BY COURTESY OF (ABOVE, RIGHT) AMERICAN AIRLINES; (BELOW) SOVFOTO

(ABOVE) FORKLIFT UNLOADING A DC-7F AIRFREIGHTER. (RIGHT) PASSENGERS LEAVING A 727 ASTROJET. (BELOW) A LARGE SOVIET JET AIRLINER, THE IL-62, DESIGNED FOR PASSENGER AND CARGO FLIGHTS ON TRANSCONTINENTAL ROUTES

pan Air Lines began transpacific jet service with the Douglas DC-8 in the summer of 1960 and, in South America, Aerolineas Argentinas, the Argentine airline, put de Havilland Comets into service between Buenos Aires and New York and on its South Atlantic route to Europe. Varig Airlines of Brazil flew the Sud Caravelle between New York and Rio de Janeiro, Brasília, and Saõ Paulo. In Canada both Canadian Pacific Airlines and Trans-Canada Airlines were operating the Douglas DC-8 on major routes by 1960. Canadian Pacific also used the Bristol Britannia turboprop transport, and Trans-Canada operated the Vickers Viscount turboprop on its medium-haul routes. Qantas Empire Airways, Ltd. of Australia was operating its round-the-world route with the Boeing 707 by 1960.

Problems Accompanying the Changeover.—The revolutionary transition from piston-engine power to the jet age was accomplished with remarkably little difficulty, but there were problems. Operating costs began to climb and, because of the high seating capacity of the pure jet and its ability to fly twice as far in a normal workday as the fastest piston-engine plane, the available passenger service outstripped normal passenger traffic growth; it became difficult to maintain satisfactory payloads. The initial cost of the equipment was high—up to $6,500,000 per airplane—and new ground equipment, larger terminal buildings, and higher training costs added to the financial burden of an industry that had always contended with a narrow earnings margin. Smaller airlines, unable to undertake new equipment programs, suffered a serious competitive disadvantage.

Gradually, however, plans and programs evolved that softened the pressure of these problems. A differential in passenger rates was agreed upon in 1959, permitting some underdeveloped carriers, particularly in South America, to charge lower fares than those charged by financially stronger carriers, thus allowing them to attract the economy-minded passenger. Consortiums were formed to allow carriers to pool equipment, expenses, and maintenance, the most notable being Air Union, comprised of Air France, Alitalia of Italy, Sabena of Belgium, and Swissair of Switzerland. British European Airways reached a consortium agreement with Olympic Airways of Greece in 1960, and the major airlines of the British Commonwealth formed a pooling system in 1959. In South America as many as 70 airlines were serving the continent in the 1960s, and heavy competition forced deficits on a number of them. In some instances they were kept from foundering by financial aid from their governments, which were anxious to maintain flag carriers for national prestige.

By the mid-1960s, it had become evident that as a result of an expanding acceptance of air travel and the popularity of the jet aircraft, the airlines of the world had entered an era of prosperity. The majority of leading airlines placed large volumes of new orders for jet aircraft to meet the growing demand from the public. The new models were designed to serve all categories of air transportation and were responsible for an almost complete transition from piston-engine to turbine-powered planes.

British Aircraft Corporation introduced the Super VC-10 for long-range operations and the BAC-111 for short-haul services. In the U.S., Douglas Aircraft Company offered the DC-9 and Boeing designed the 737 jet aircraft for short-range operations. At the same time, both Boeing and Douglas increased the size of their 707s and DC-8s to accommodate more passengers. The Soviet Union followed a similar pattern in providing transport aircraft for the state-owned airline, Aeroflot, but had small fortune in finding an export market for its planes despite this increase in inventory. During the mid-1960s the U.S., the Soviet Union, and, working together, Britain and France began to develop supersonic transport airliners that would be capable of flying 2–2½ times the speed of sound.

Many airlines of underdeveloped nations received technical assistance not only from the governments of stronger nations but from the larger airlines as well. Trans World Airlines lent technical aid to Ethiopian Air Lines and Saudi Arabian Airlines, and Pan American World Airways System was active in establishing air service within Afghanistan. The Export-Import Bank issued large loans during the jet reequipment period to help foreign flag carriers buy new aircraft. The U.S. government's International Cooperation Administration, in conjunction with the Federal Aviation Agency, helped to establish airways and navigational systems in countries unable to cope with the technicalities of modern air navigation. Major nations in Europe made equally important contributions to the development of air transportation in the jet age.

INTERNATIONAL REGULATION OF AIRLINES

Generally, the transition to turbine power in commercial service was accomplished in an orderly manner, and the standards of operation, airworthiness, and service that had distinguished the growth of civil aviation after World War II were maintained despite strong national differences on a number of major issues. The fact that these differences did not disrupt growth at this vital stage of airline development was the result of international agreements controlling the operation of the whole system of airlines and the cooperation of regulatory agencies of the individual governments.

Air transportation is conducted on the internationally accepted principle that each nation has a sovereign right to the air above it. This concept, so different from the "freedom of the seas" code that directs maritime policy, necessitated a series of agreements that would respect this air sovereignty yet permit commercial "freedom of the skies." The agreements that emerged from various conferences are not treaties and therefore do not constitute international law. Thus an agreement between two nations for air services can normally be broken off merely by the announcement by either of the parties that it intends to do so upon the expiration of a previously agreed interval.

Although the first conference to establish some type of air law was held in Paris in 1889, no real progress toward international regulation in the conduct of air transportation was made until after World War I. Participants in the Paris Conference of October 1919 agreed that private aircraft should be permitted to fly over the territories of the participating states, but this permission was not extended to the aircraft of commercial airlines offering scheduled service.

During the next 20 years development of international air transportation progressed through bilateral rather than multilateral agreements. Pan American World Airways System was able to negotiate unofficially with a number of South American countries for the expansion of air routes from the United States throughout South America. Imperial Airways of the United Kingdom expanded its routes through the use of airports in colonial possessions and Commonwealth nations. The French, Dutch, Belgians, and Germans developed international routes in a similar manner. Generally, however, the common method of establishing routes between nations was a bilateral air transport agreement granting operating rights and traffic privileges to the airlines of the nations involved. By the 1960s there were approximately 500 bilateral agreements in effect throughout the world.

During World War II the real significance of international air transportation became clear, largely as a result of the experience gained in the worldwide military airlifts operated by the various belligerents. It was obvious that some agreement was needed to permit the orderly development of postwar air routes without infringing upon sovereign air rights. At the same time provision had to be made for a controlled form of competition that would prevent large airlines from destroying smaller ones. In addition, it was realized that certain standards were needed for airworthiness of aircraft, qualifications of flying personnel, and specifications for navigation and air traffic control.

Chicago Convention.—At the invitation of the United States, representatives of 54 nations met at Chicago on Nov. 1, 1944, for the purpose of reaching some agreement that would provide for the control of air transportation and, at the same time, foster its development. During the conference a serious difference of view appeared between the United States and the United Kingdom, the latter being supported by a number of other European countries. The U.S. favoured a policy of free competition based on complete freedom of the air, while the Europeans wished to impose certain conditions designed to eliminate wasteful competi-

tion and ensure to individual countries an equitable share of the traffic through their own air space. Between these divergent points of view the conference failed to reach agreement.

The International Air Transport Agreement that incorporated the U.S. doctrine of complete freedom is of particular interest, though it failed to obtain the adherence of more than ten countries and was soon denounced by the U.S. government itself, largely because of criticism at home. It set forth for the first time the "Five Freedoms of the Air," the granting of some or all of which formed the basis upon which all bilateral air agreements between pairs of countries subsequently were negotiated. These freedoms are (1) the right to fly across the territory of a foreign country without landing; (2) the right to land for nontraffic purposes, *i.e.*, to refuel or obtain mechanical attention; (3) the right to discharge in a foreign country traffic coming from the home country; (4) the right to pick up in a foreign country traffic destined for the home country; and (5) the right to carry traffic from a point of origin in one foreign country to a point of destination in another foreign country. Traffic, in all cases, refers to passengers, mail, and cargo. (The right to pick up traffic at a point within a foreign country and carry that traffic to another point in the same country is termed "cabotage" and is generally banned by all nations.)

The International Air Services Transit Agreement, on the other hand, called for the mutual exchange of only the first two freedoms. This was more readily acceptable to the delegates to the Chicago Convention, and only ten of the nations represented failed to ratify it. Failure to reach multilateral agreement on the overall principles of air transportation might be taken as an indication that the conference was unsuccessful. Nevertheless, many solid achievements emerged, notably the drafting of a new civil aviation convention to supersede those of Paris (1889) and Havana (a Pan-American civil aviation convention signed in 1928). The groundwork was laid for the formation of an international airline system embracing all views without creating conflicts that would prevent general cooperation in air transportation or a worldwide linking of routes to permit an easy flow of traffic between nations.

International Civil Aviation Organization.—The principles developed under this agreement are administered by the International Civil Aviation Organization (ICAO), which was founded by agreement of the Chicago Convention and which came into being on April 4, 1947, with permanent headquarters at Montreal. This organization, which is charged with coordinating and administering all aspects of international civil aviation, consists of these component bodies: (1) an assembly of delegates from all member nations; (2) a council of representatives of 21 member states, which is elected by and is responsible to the assembly and which sits in continuous session at the headquarters of the organization; (3) an air navigation commission appointed by the council from among persons nominated by member states; and (4) an air transport committee also appointed by the council, but made up of representatives of council member states. The members of both the commission and the committee devote full-time membership to their respective bodies.

Other committees were established by the assembly, including the Legal Committee and the Committee on Joint Support of Air Navigation Services. The legal committee, which replaced the Comité International Technique d'Experts Juridiques Aériens (CITEJA), is concerned with the study and drafting of conventions in the field of air law and with cooperation with other organizations in the codification of international law. One of its achievements is the Convention on International Recognition of

BY COURTESY OF (TOP) FEDERAL AVIATION AGENCY, (BELOW) AMERICAN AIRLINES

(TOP) TRAFFIC CONTROLLERS IN THE TOWER AT DULLES INTERNATIONAL AIRPORT, NEAR WASHINGTON, D.C. (BELOW) LOADING RAMPS, BUSINESS AND PASSENGER AREAS, AND THE PARKING LOT AT O'HARE AIRPORT, CHICAGO

Rights in Aircraft, which is designed to protect the interests and rights of contracting states in their own aircraft crossing international borders. The Committee on Joint Support of Air Navigation Services advises the assembly on requests from member states for technical and financial assistance in the field of air traffic control.

In the 1960s ICAO had a number of international agreements to ensure cooperation in the performance of navigational functions. Floating sea stations, owned or financed by a number of nations, were maintained in the North Atlantic for communications and weather-reporting services.

Two loran (long-range radio navigation) units were financed through ICAO agreements, one located in Iceland, the other in the Faroe Islands.

ICAO established and periodically reviews standards for air transportation on a worldwide basis. These standards cover licensing of personnel, airworthiness of aircraft, aeronautical charts, meteorological codes, registration of aircraft and identification markings on aircraft, rules of the air, accident investigation, airports, communications, facilitation (immigration and customs), and air traffic control and navigation.

ICAO has ten regions, each of which conducts regular meetings to consider problems peculiar to the region. These regions are the North Atlantic, European-Mediterranean, Middle East, Caribbean, South Pacific, South America, South Atlantic, Southeast Asia, North Pacific, and Africa-Indian Ocean. Although ICAO membership is not universal, the 74 member nations operate 90% of all international airlines.

The Hague and Warsaw Conventions.—Two other widely accepted agreements, dating from many years before the Chicago Convention but of continuing importance in the regulation of international civil aviation, are worthy of note. First, the International Sanitary Convention on Air Navigation, originally signed at The Hague in 1933 and brought up to date at New York City in 1946, gave the right to each contracting party to impose upon the aircraft of other contracting parties entering its territory certain measures designed to prevent the spread of communicable diseases. Next, the Warsaw Convention, which was originally signed in 1929 and which had received general agreement by 1960, was concerned with the liability of air operators for damage to persons or property in international air transportation. It also contained provisions relating to the form and legal effects of air transport documents, including baggage and passenger tickets and air waybills. In 1965 the two conventions were drastically revised by a substantial increase in maximum liability ceilings for damage.

International Air Transport Association.—In April 1945 the new International Air Transport Association came into being and was given wide authority to fix rates and fares subject to the approval of the governments involved. Headquarters were established in Montreal and membership came to include most of the world's airlines. Meetings are scheduled annually. Biannual conferences are held by the Traffic Conference, which establishes rates subject to governmental approval.

Bermuda Agreement.—One of the most significant of the bilateral air transport agreements was that signed between the United Kingdom and the United States at Bermuda in 1946. Known as the Bermuda Agreement, this pact became the prototype for a large majority of the other bilateral agreements signed in the following years. The Bermuda Agreement represented a compromise between the policies of the United Kingdom and the United States. It incorporated the Five Freedoms but placed curbs on their application through the introduction of capacity clauses. In effect, these clauses prevent overscheduling and relate schedule frequency and seat capacity to public demand on the routes exchanged.

The Bermuda Agreement opened the way for additional bilateral agreements, and by the 1960s virtually every nation of the world was either operating air services or was served by a foreign airline. Even such small nations as Burma, Ghana, Iran, South Korea, and Lebanon had signed bilateral agreements with larger nations and were operating flag carriers.

INTERNAL REGULATION OF AIRLINES

The International Air Transport Association is a self-governing organization, voluntarily operated by the airlines. The International Civil Aviation Organization is an arm of the United Nations and is directed by member governments. Within each country civil aviation is usually government-regulated.

British Commonwealth.—In the United Kingdom the Ministry of Transport and Civil Aviation lays down civil aviation policy and directs the operation of British Overseas Airways Corporation and British European Airways, which were nationalized under the Civil Aviation Act of 1946. In 1951 greater freedom was granted independent airlines, and by 1955 the number of privately owned carriers in the United Kingdom reached 40. In Australia the control of civil aviation is under the jurisdiction of the minister for air. Canada regulates civil aviation through the air services branch of the Ministry of Transport. The national carrier is Trans-Canada Airlines, which was organized by act of Parliament in 1937. In 1947 the airline took over the operation of transatlantic services, which previously had been the responsibility of the government. In 1959 Trans-Canada lost its monopoly on Canada's domestic routes when Canadian Pacific Airlines was granted competitive routes across the continent.

Europe.—In France the nationalized airline, Air France, competes on a number of routes with two privately owned carriers—Transports Aériens Intercontinentaux and Union Aéromaritime de Transport. The airline of the Federal Republic of Germany, Lufthansa German Airlines, has its ownership divided between the federal government (92%) and the states (8%), while the airline of the German Democratic Republic, Interflug, is totally controlled by the central government. Belgium's airline, Sabena, is 50% privately owned, with the balance owned by the Belgian government. The Netherlands government owns more than 96% of its flag carrier, KLM. The Scandinavian Airlines System (SAS) consists of a single operating company in which Sweden holds three-sevenths and Norway and Denmark two-sevenths each of the capital. Italy reentered the field of civil aviation after World War II with two airlines, but in the late 1950s these were amalgamated into a single company, Alitalia, with substantial governmental participation. In Spain and Portugal similar subsidized airlines, known as Iberia and Transportes Aereos Portugueses (TAP) respectively, concentrate mainly on serving their colonial possessions and South America in addition to their European networks. In the U.S.S.R. civil aviation was organized as a government department under the general title of Aeroflot, while each of the Soviet Union's European satellites possesses a national air carrier.

Asia.—In Communist China the government operates the Civil Aviation Service, while the flag carrier serving the Chinese Nationalist government in Formosa, Civil Air Transport, is Chinese-owned but operated under U.S. management. Japan Air Lines is partly government-owned and is required to obtain governmental approval for large expenditures such as the purchase of new aircraft. Air Ceylon, Ltd., provides services within the island and connections to the Indian peninsula, where three officially regulated airlines operate—Air-India International and Indian Airlines Corporation in India and Pakistan International Airlines in Pakistan. Thailand and Vietnam each possess government-subsidized air carriers. Egypt is represented by Misrair and Israel is served by the state-owned flag carrier El Al (El-Al Israel Airlines). In Turkey the state airways administration operates a domestic air service.

United States.—U.S. airlines are privately owned. The Civil Aeronautics Board regulates rates and routes on domestic operations, and the Federal Aviation Agency maintains and operates the U.S. airways system and has jurisdiction over safety regulations. The president of the U.S. gives final approval of all U.S. bilateral agreements, which are negotiated by the U.S. Department of State.

GENERAL AVIATION

The term general aviation is often used to describe all types of aviation except military applications and commercial air trans-

BY COURTESY OF BUSINESS JETS

A PRIVATELY OWNED FANJET PLANE USED FOR BUSINESS TRAVEL

port. Among the major activities included within the scope of general aviation are business, charter, survey and patrol, agricultural, instructional, and pleasure flying. In the 1960s about 60% of the world's airplanes were engaged in general aviation; the types of planes used ranged from large multiengine airliners to light single-engine craft capable of carrying only one or two passengers.

One of the fastest growing branches of general aviation was that of business flying; in the mid-1960s more than 50% of the total hours flown annually in general aviation were in business aircraft. Many large companies purchased one or more aircraft for use by their officials, thereby gaining the advantage of increased flexibility as compared with previous dependence on scheduled airliners. Business planes were often two-engine models capable of accommodating eight to ten passengers.

Chartered or rented aircraft ranged from multiengine airliners used for passenger and cargo transportation to light single-engine planes. Aircraft were chartered for a variety of purposes, among the most prominent of which were aerial mapping and photography, mineral prospecting, pipeline patrolling, forestry patrolling, and advertising.

Airplanes were used frequently by farmers and ranchers for spraying and dusting crops and for seeding and fertilizing land. Aircraft employed for those purposes were often rented, but some farmers purchased their own planes. Most agricultural aircraft were light single- or twin-engine models that had been adapted for their mission by being equipped with storage tanks and spray booms for spraying and with bins and blowers for dusting. These planes were also occasionally used to spray hordes of destructive insects, such as locusts.

Instructional and pleasure flying in the 1960s together accounted for about 35–40% of the annual hours flown in general aviation. Aircraft used for these purposes were usually light single- or twin-engine models. A branch of pleasure flying that maintained its popularity was aviation sports, which included racing, stunt flying, and endurance competitions. Related sports that gained in popularity during the 1950s and 1960s were gliding and soaring, and skydiving (sport parachute jumping).

See also AIR LAW; AIRPORT; AVIATION INSURANCE; NAVIGATION. (L. L. D.)

AVIATION, HISTORY OF. The general purpose of this article is to give a condensed survey of man's conquest of the air. It is not intended to cover the theoretical aspects of flight but to place in proper perspective the various kinds of aircraft that have been developed—from the first balloon to the supersonic bomber.

A few definitions are first in order. The word aviation in its modern usage refers generally to the art of flying. During the latter half of the 19th century the terms flying, aeronautics and aerial navigation were used more or less synonymously to cover any effort of man to fly through the air. The words aviation and aviator, both of French origin, first appeared in the literature of the mid-1880s. They did not achieve general acceptance, however, until about the time of World War I. By about 1914 they were generally used in connection with heavier-than-air flight, and the terms aeronaut and aerostat were used to describe lighter-than-air pilots and their equipment.

In Great Britain the term aeronautics first appeared in vol. 1 of the 1824 Supplement to the *Encyclopædia Britannica* to describe the art of flying in general. As late as the 1920 edition of *Jane's All the World's Aircraft* reference was made to the "development of naval and military *aeronautics*." In the same edition, however, there was a reference to "civil *aviation*." By the 1922 edition *Jane's All the World's Aircraft* had dropped the word "aeronautics" and had adopted the subtitle "Notes on the Development of Naval and Military *Aviation*."

Charles Dollfus and Henri Bouché, in their *Histoire de l'aéronautique* (1932), describe Dec. 17, 1903 (the date on which the Wright brothers first flew a powered heavier-than-air craft), as the beginning "*de l'histoire de l'aviation*," and go on to say that "*l'aviation*" was born in France between 1904 and 1910.

Thus, as it is commonly used, the word aviation generally refers to the operation and usage of heavier-than-air flying machines, but it is also applied to operation of lighter-than-air equipment; *i.e.*, balloons and airships. In the present article the important landmarks and events in lighter-than-air flight will also be noted. Principal concern, however, will be with those classes of aircraft whose flight depends upon the dynamic reaction of lifting surfaces (or wings) and the atmospheric air flowing over and around them. Additional information on the history of lighter-than-air flight is contained in the articles AIRSHIP and BALLOON FLIGHT.

For convenience in this discussion, aviation history is divided into five main periods: (1) prehistoric—prior to 1783; (2) exploratory—between 1783 and 1903; (3) trial and error—1903 to about 1914; (4) practical development—World War I to World War II; (5) accelerated development—World War II and after. Actually, only the first two of these five periods are definitive. The last three cannot be differentiated by sharp lines of demarcation; they merge in shadow zones which extend over several years in either direction.

For the purposes of this article, the placing of objects into orbit around earth is not considered to be an aviation activity. It is true that to reach outer space, and to return to earth safely, flight through earth's atmosphere is necessary. Some form of aerodynamic support or control is involved in this portion of the flight. But the true space vehicle differs markedly from the airplane or airship. (*See* SPACE EXPLORATION.)

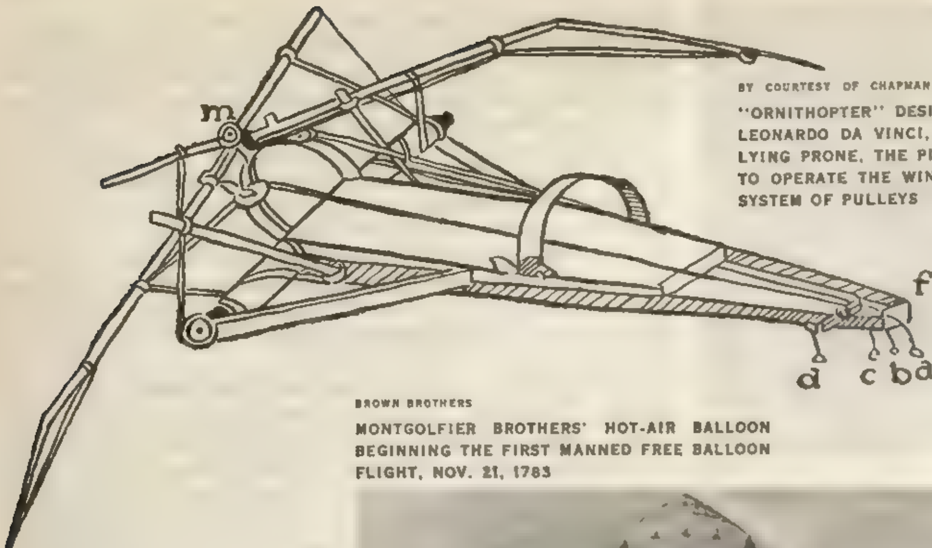
The presentation of topics in this article is as follows:

I. Prehistoric Period
II. Exploratory Period (1783–1903)
III. Period of Trial and Error (1903–14)
IV. Period of Practical Development (1914–40)
V. Period of Accelerated Development (1940–)

I. PREHISTORIC PERIOD

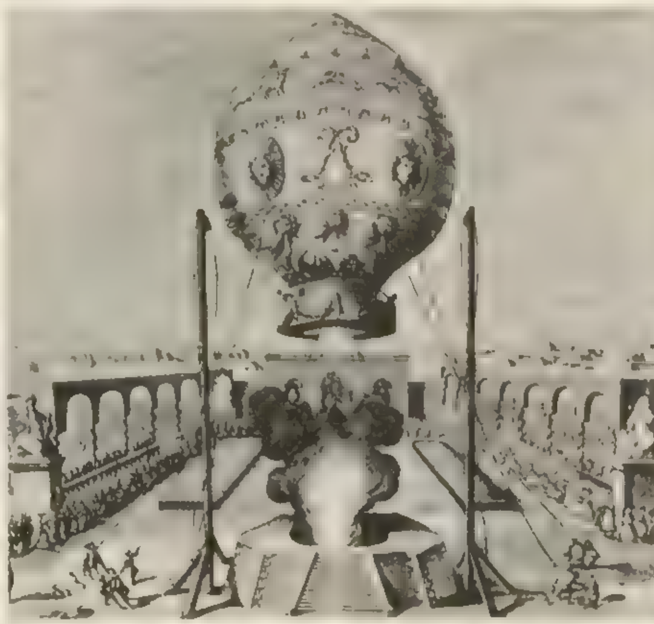
From time immemorial man's aspirations seem always to have been directed upward. He has thought of his blessings as descending from *above*—and to reach heaven the souls of the departed must fly *upward*. Many of the old religions clothed their celestial beings in birdlike forms. Ancient Egyptian and Greek deities wafted through the air without benefit of wings, or, like Mercury, with an embryonic pair sprouting from their heels. The ancient seraphim and cherubim of the Hebrews, and the heavenly hosts of later dispensations, have all been provided with wings.

It was not surprising, therefore, that when man first thought of translating his dreams into actualities, he began to study the flight of birds. He soon realized that, although it looked amazingly easy, a practical solution of the problem was going to be exceedingly difficult. In fact, after several hundred years of speculation, computation and experiment, no man-carrying wing-flapping machine (ornithopter) has ever been built. The combination of high structural strength, light weight and energy-conversion capability that exists in even the smallest bird has never been duplicated by any man-made contrivance. Late in the 15th



BY COURTESY OF CHAPMAN AND HALL

"ORNITHOPTER" DESIGNED BY LEONARDO DA VINCI, *c.* 1500. LYING PRONE, THE PILOT WAS TO OPERATE THE WINGS BY A SYSTEM OF PULLEYS



BROWN BROTHERS

MONTGOLFIER BROTHERS' HOT-AIR BALLOON BEGINNING THE FIRST MANNED FREE BALLOON FLIGHT, NOV. 21, 1783

century Leonardo da Vinci made sketches and built models of birdlike machines, as have many people since his time. None has achieved even a modicum of success. However, research has been undertaken in the fields of ornithology and biology to try to determine how and why birds perform as they do. (*See* FLIGHT [NATURAL].)

A few people, at a very early date, observed that certain birds could soar, or could glide through the air without flapping their wings. John Wilkins (1614–1672), lord bishop of Chester, one of the founders of the Royal Society, observed that "if a bird can so very easily move itself up and down in the air without so much as stirring the wings of it, certainly then it is not improbable . . . that when men, by long practice, have arrived to any skill and experience, they will be able, in this, to come very near unto the imitation of nature." Actually, if more men had followed this line of thought and had abandoned the wing-flapping idea earlier, some form of heavier-than-air craft might have been achieved long before the Wrights flew. The real problem then, and continuing to the early part of the 20th century, lay in the lack of a lightweight power plant from which necessary propulsive force could be derived.

Several abortive efforts to make gliding flights are recorded between 1670 and 1780; however, shortly thereafter, with the appearance of the first hot-air balloon (1783), attention was focused in another direction; *i.e.*, toward lighter-than-air techniques.

II. EXPLORATORY PERIOD (1783–1903)

Free Balloons.—Late in 1782 the two Montgolfier brothers, sons of a paper manufacturer in the small town of Annonay near the centre of France, discovered that if they trapped a quantity of heated air in an inverted lightweight paper bag, the bag would float upward through the air. They had invented what shortly came to be known as the *glôbe aérostatique* or hot-air balloon. After the Montgolfier brothers made demonstrations with balloons of varying size, Jean François Pilâtre de Rozier and the marquis François Laurent d'Arlandes made the first man-carrying free balloon flight on Nov. 21, 1783. Their flight across Paris, nearly six miles, lasted about 25 minutes. In Dec. 1783 the newly discovered hydrogen gas was substituted for hot air in a balloon. The physicist J. A. C. Charles, accompanied by M. N. Robert, made the first manned flight using hydrogen. These four pioneers proved conclusively that man was no longer earthbound.

The history of the next 100 years is dotted with the names of balloonists and their exploits. The first great European balloonist, J. P. Blanchard, accompanied by an American physician, John Jeffries, crossed the English channel in a free balloon on Jan. 7, 1785. James Sadler, Vincenzo Lunardi, Francesco Zambeccari and many others made numerous flights in England and on the continent. By 1804 scientific exploration of the atmosphere was attempted by two French chemists, Joseph Louis Gay-Lussac and his assistant, Jean B. Biot. They reached an altitude of over 23,000 ft. in the course of their researches. They were followed by the retired dentist H. T. Coxwell who, with the scientist James Glaisher, claimed to have reached an altitude of about 37,000 ft. in 1862. Obviously, however, such an altitude could not have been attained without proper high-altitude breathing equipment (not then invented) and the claim must have been the result of faulty instruments, a misreading of the instruments under low-oxygen conditions (hypoxia), or both.

Early in the century the sport had spread to America. Blanchard made demonstration flights in Philadelphia in 1793 that inspired Charles Durant and John Wise to become balloonists. They made a number of long balloon flights in the United States between 1830 and 1875.

The use of balloons as observation posts in warfare was early recognized. The French army organized a balloon corps in 1789, which played a part in the battle of Fleurus in June 1794. After the first bombing raid in history (carried out by unmanned hot-air balloons sent by Austria against Venice in 1849), the most important early use of balloons in warfare was in the American Civil War, when T. S. Lowe, a disciple of Wise, built observation balloons for the "Aeronautic Department, U.S. Army." They were used by the Union army during the campaigns of 1862 and early 1863 to observe the movements of the Confederate army. Confederate forces also made limited use of balloons to observe Union troops. In 1870–71, during the Franco-Prussian War, about 70 free balloons were used to evacuate personnel and to carry mail out of the besieged city of Paris. Of comparable importance was the transport of carrier pigeons which returned to Paris with messages and letters.

Probably the most notable free-balloon enterprise of the latter part of the 19th century was the unsuccessful effort of Salomon Andrée and two companions to fly across the north pole. They took off from Spitsbergen, Nor., on July 11, 1897, and were not heard of again until, in 1930, entirely by accident, a Norwegian exploring party found the frozen bodies of Andrée and his two companions on an island north of Spitsbergen. As an interesting sidelight to this incident, photographic films which were exposed by Andrée and his party in 1897 were developed and provided a photographic record of the wreck of the balloon on the polar ice.

Except for intermittent use as a sports device (international

balloon races were first held in the early 1900s), free balloons had no great significance until they appeared many years later (1940 *et seq.*) as a means of scientific exploration on the fringes of earth's atmosphere. (*See* further BALLOON FLIGHT.)

Airships.—One other form of lighter-than-air craft became significant in the latter half of the 19th century—the dirigible balloon or airship. It early became obvious to Blanchard, Wise and others that little dependence could be placed upon natural wind currents to carry balloons to places where men were likely to want to go. Sails and oars had long since become commonplace for the propulsion and steering of waterborne vessels, but experimenters soon found that such devices were of little use in the air. All kinds of sweeps, and even hand-driven paddle wheels, were tried, but all proved impractical. The true airship had to await the development of a powerful, lightweight, self-contained engine that would be capable of driving large propellers continuously. It was not until the Frenchman Henri Giffard succeeded in building a three-horsepower steam engine which, complete with its boiler, weighed only 350 lb., that the first airship flight could be made. On Sept. 24, 1852, he took off from the Hippodrome in Paris and made a flight to a preannounced destination. Giffard's experiment led to the development of larger and more powerful airships. The first planned round-trip flight by airship was made on Aug. 9, 1884. Designed by two French army officers, Capts. Charles Renard and A. C. Krebs, this airship was powered by an 8-h.p. electric motor fed by heavy batteries.

The most colourful character involved in airship development in the late 1800s was the Brazilian-born Parisian Alberto Santos-Dumont. The full history of his work with airships is contained in his book, *My Airships*, published in 1904. Altogether he built 16 small airships, most of them powered with small, lightweight air-cooled motors, similar to motorcycle engines. He later switched his attention to heavier-than-air craft. All of Santos-Dumont's airships were of the nonrigid type. The elongated gas bag to which the pilot's car and the engine were attached maintained its shape solely because of the pressure of the gas inside. If the gas bag were punctured the whole container would collapse in a heap like any spherical balloon.

About 1900 the work of the great proponent of the rigid airship, Graf Ferdinand von Zeppelin, became known in Germany. Although most of Zeppelin's work took place in the third historical period (trial and error—1903 to 1914), it should be noted that the LZ-1 was built and flown from Lake Constance in 1900.

Cayley's Glider Experiments.—Although for many years most people believed that the only practical way for man to fly was by floating through the air in balloons or airships, the concept of a mechanical flying machine continued to find adherents. Birdlike wing flapping was very early abandoned as a practical idea except in the minds of a few zealots. The rigid fixed-wing machine seemed to be the answer, but, even more than the airship, it required the development of a powerful, lightweight engine.

It was a Yorkshire baronet, Sir George Cayley, who, in the period 1799–1810, first laid the basis of aerodynamics and, in the opinion of many, became the true inventor of the modern airplane. Between 1804 and 1853 he established the basic configuration of the airplane, both in small and large model gliders, and finally (1852–53) in the first man-carrying glider of history, in which his coachman was successfully flown with locked controls. Cayley built his gliders with the now familiar features of forward main planes, fuselage, adjustable fin and tail plane, rear rudder and rear elevator. He understood and provided for both longitudinal and lateral stability (the latter with dihedral wings), and understood the travel of the centre of pressure. He also realized the need for a lightweight internal combustion engine, the importance of streamlining and the need for a lightweight cycle-wheel type of undercarriage. His suggestion of superposed wings (biplanes, triplanes, etc.) led to their adoption by John Stringfellow in 1868. He realized that cambered wings give better lift, and even that there is an area of low pressure (partial vacuum) over the upper surface that contributes a powerful lifting force. Cayley's theoretical and practical work led directly to many subsequent developments in aviation.

Steam-Powered Airplanes.—The idea of powered flight lay dormant until the historic collaboration of Stringfellow and William Samuel Henson, two inventive Englishmen, in 1840. Together they built a steam-powered model airplane and designed (on paper) an Aerial Steam Carriage which was to have been used on the first regularly organized air transport system in the world, a proposed route from London to India. Although the model failed its final test, illustrations of the Aerial Steam Carriage influenced the whole of Europe.

From 1850 onward a series of inventors, particularly Félix du Temple, Alphonse Pénaud, F. H. Wenham, Victor Tatin, Horatio F. Phillips and Clément Ader, made valuable contributions to heavier-than-air flight. Some made practical progress, especially Ader, who in 1890 claimed to be the first to take off in an airplane under its own power; this was a steam-powered machine which could not, however, make a sustained and controlled flight. Ader made two tests in 1897 with his "Avion III" but (despite his later claims) did not succeed in leaving the ground.

In 1894 Sir Hiram Maxim in England may also have been close to success. He built a huge monoplane and tested it on specially laid railway track. In the course of his experiments he accumulated a great deal of data on air resistance, propulsive efficiency, etc. The machine gave some signs of lifting but was wrecked on its rails and never achieved controlled free flight.

The one thing that all early efforts had in common was the use of a steam power plant. At that time, however, it was impossible to build an efficient, lightweight steam power plant suitable for aircraft propulsion. Such a device might now be possible with modern design techniques, but a steam-driven airplane is considered economically impractical.

Langley's Experiments.—One other man of that period, a scientist of considerable repute, the secretary of the Smithsonian institution in Washington, D.C., almost attained the goal of man-carrying mechanical flight. Samuel Pierpont Langley's story is perhaps one of the most poignant in the long history of aeronautical research.

After many years of experimentation with small models of varying configurations (which he called "Aerodromes"), one of which made a circular flight of ¾ mile in 1896, he attempted to build and fly a full-scale machine. Using a remarkably light (for its time) gasoline engine designed and built by his assistant, Charles Manly (based on an earlier design), he made two attempts to launch his machine from the top of a houseboat in the Potomac river below Washington. On both occasions the launching catapult fouled the machine, causing failure. The machine crashed into the river for the second and last time on Dec. 8, 1903, just nine days before the successful flights by the Wright brothers near Kitty Hawk, N.C. Langley became a butt of ridicule by the nation's newspapers. A few years later (in 1906) he died.

Many years later (in the summer of 1914) Langley's "Aerodrome" was rebuilt and flown in its allegedly original condition from the waters of Lake Keuka, N.Y. Actually, however, a number of major modifications had been made in the structure of the machine, and it was also fitted with an engine much more powerful than the original Manly engine. Whether or not it could have flown given more favourable circumstances in the autumn of 1903 is still a matter of considerable doubt. Nevertheless, Langley remains as one of the great experimenters in aviation's age of exploration. (S. P. J.)

Man-Carrying Gliders.—Because practical, lightweight power plants were not available until almost the end of the 19th century, man's first real steps toward heavier-than-air flight were made in man-carrying gliders. A Breton sea captain, J. M. Le Bris, made the first man-carrying glider in the shape of an albatross around 1856 and a similar machine a few years later, but made no successful flights. By 1865, however, Louis Mouillard had built and attempted to fly a gliding machine in Algiers. His efforts were largely unsuccessful, but the book that he wrote as a result, *L'Empire de l'air*, was an important inspiration for later experimenters.

Although a number of men had made tentative experiments with gliders, it was the German engineer Otto Lilienthal who (during

BY COURTESY OF (RIGHT) SCHWEIZER AIRCRAFT CORP.; PHOTOGRAPH, (LEFT) AUTHENTICATED NEWS INTERNATIONAL

(LEFT) BIPLANE GLIDER, 1895, ONE OF TWO BUILT BY OTTO LILIENTHAL, GERMANY. (RIGHT) MODERN TWO-PASSENGER SAILPLANE

the period 1891–96) became the first to fly and control gliders in the air, and so to lay the groundwork for successful airplane pilotage. After many experiments and the building of a number of monoplane (and two biplane) gliders, Lilienthal succeeded in achieving a limited but successful method of glider flying, in which—after launching himself from a hill—he hung in the machine by his arms and controlled its stability and steering by swinging his torso and legs in any desired direction, thus shifting the centre of gravity. It was the widespread descriptions and photographs of his flying and the tragedy of his death in a gliding accident (1896) that directly inspired the Wrights in America, Percy S. Pilcher in England and many less successful pioneers, and led to the conquest of the air. (*See* GLIDING.)

The Wright Brothers.—Powered airplane flight—effective powered, sustained and controlled flying—was first achieved by the American brothers Wilbur and Orville Wright of Dayton, O. After studying all the literature they could find on flying, especially the American Octave Chanute's classic *Progress in Flying Machines* (published 1894), they experimented with a large kite in 1899 and then went on to construct and fly three biplane gliders (1900–02) near Kitty Hawk, N.C., in which stability and control were at first secured by the use of a front elevator and warping (twisting) of the wings for banking, turning and maintaining lateral stability. Success did not come, however, until they had carried out extensive aerodynamic experiments and later modified their third glider (during their 1902 season), on which they made nearly 1,000 glides. The secret of their mastery of glider flight—which they were determined to achieve before going on to make a powered machine—lay in their adoption not only of the forward elevator and wing-warping but of a vertical rear rudder operated simultaneously with the warping. This arrangement permitted banked turns and ensured proper control laterally and directionally in flight.

After the success of their 1902 efforts the Wrights at once set out to construct their first powered airplane, called "The Flyer" (or, by Orville in his diary, "the machine"); however, they were temporarily stymied by the absence of a suitably light and powerful motor on the market, and the lack of knowledge of the all-important subject of airscrews. Both of these difficulties were overcome by brilliant research and through the design and construction by themselves, with the aid of Charles Taylor, of a 12-h.p. motor which they installed in a machine based on their 1902 glider and fitted with two chain-driven pusher propellers. It had a skid undercarriage which rested on a yoke fitted with modified cycle hubs and took off along a wooden rail under engine power alone. "The Flyer" was deliberately made unstable and had to be continuously controlled in the air. After a single failure at take-off on Dec. 14, the brothers made four flights near Kill Devil hill (south of Kitty Hawk) on Dec. 17, 1903, which were the first powered, sustained and controlled airplane flights in history. The first lasted 12 seconds, the last 59 seconds during which the machine covered 852 ft., which—because it was flying into a stiff breeze—actually amounted to one-half mile through the air. The age of heavier-than-air flight had begun.

III. PERIOD OF TRIAL AND ERROR (1903–14)

Garbled reports of the Wright brothers' flights, together with other extraordinary circumstances, prevented all but a handful of men from realizing that the Wrights had flown, or that they were later succeeding in perfecting the airplane during 1904 and 1905 in a field near Dayton. With their powered "Flyer" No. 3 in 1905 the Wrights achieved the first really practical airplane in history; it could bank, turn, circle, make figures of eight and keep flying easily for one-half hour at a time. In 1904 the brothers had adopted their weight-and-derrick method of accelerated take-off, which they used until 1910. After the 1905 season, beset by business spies and troubles in promoting their invention, the Wrights did not leave the ground until May 1908; however, they built new engines, together with several improved "Flyers," one of which was shipped to France in 1907 and remained there in customs until the following year.

European Progress.—In Europe, meanwhile, interest in aviation was all but dead, although the Austrian Wilhelm Kress and Capt. Ferdinand Ferber of the French army were attempting heavier-than-air flight. The European situation was transformed however, when the Wrights' friend Chanute visited Paris in 1903 and lectured on his own and the Wrights' gliding, showing photographs and giving details of the 1902 machine. A number of Frenchmen, especially Ferber and Robert Esnault-Pelterie, started to build Wright-type gliders; however, as is clear from their statements and actions, they totally misunderstood what Chanute had told them and thus failed to make successful machines. Most important, they did not realize the overriding importance of obtaining control in the air by operating the warping and rudder together. They also failed to comprehend the Wrights' reasons for making their machines unstable, *i.e.*, to make constant control necessary, and were determined to aim at inherent stability, which had been attained earlier by Cayley and by Pénaud. In this pursuit they were aided by a better appreciation of the Australian Lawrence Hargrave's box kite (which had been invented in 1893), the principles of which some Europeans now applied to their designs. In 1905 Gabriel Voisin, in co-operation with Ernest Archdeacon and Louis Blériot, made two biplane float gliders which were towed off the Seine river by a motorboat. Although unsuccessful they established one of the basic configurations of the European biplane, with Wright-type wing structure divided to make a giant box kite, a forward elevator, a box-kite tail unit and no lateral control.

The following year Santos-Dumont, turning from airships, built a *canard*-type (tail-first) biplane with a 50-h.p. motor, box-kite wings and a combined forward elevator and rudder, and succeeded in making a few short flights at Bagatelle (the longest was 722 ft.). Because progress had been so slow these hops were given prizes and Santos-Dumont was officially credited with the first

powered flights in Europe. Also in 1906 Trajan Vuia (in Paris) established the European monoplane tradition with an ingenious but unsuccessful machine which, however, led directly to Blériot's becoming interested in the monoplane type soon afterward.

Dogged by impatience and lack of careful experimentation, the many French pioneers pursued both the monoplane and biplane in a hopelessly confused manner; until Nov. 1907 no European could stay in the air even for a full minute, and only Henri Farman could make an approximate circle by the year's end.

European aviation was stimulated in 1908, when Wilbur Wright went to Europe and first flew in public in August near Le Mans, France. He displayed a mastery of flying which dumbfounded the French. Orville remained in America and started making acceptance flights for the U.S. army near Washington, D.C., in September. These tests were brought to a sudden and tragic suspension when, on Sept. 17, a fractured propeller caused the machine to crash. Orville was injured and his passenger, Lieut. Thomas Selfridge, was killed—the first fatality in powered aviation.

By the end of 1908 Wilbur Wright had made more than 100 flights in Europe, had broken every record and had even made a flight lasting 2 hours and 20 minutes. The chief points he demonstrated were how to control an airplane in the air (especially laterally), and the technique of making and gearing propellers. From that time onward, having absorbed the lessons taught them by Wilbur Wright, the Europeans drove ahead successfully. They combined their ideal of a reasonable amount of inherent stability —to make it easier for the average pilot—with proper lateral control by means of the Wrights' wing-warping, or its European derivation of hinged ailerons (as used to this day); they also abandoned their inefficient primitive propellers in favour of the type pioneered by the Wrights.

By the time of the world's first air meeting in Aug. 1909 at Reims, European aviation had rapidly come of age, and two basic and efficient types of airplane had emerged—the light rotary-engine-powered Henri Farman biplane, which used large ailerons instead of warping, and the monoplane with either ailerons (as on some of Léon Levavasseur's Antoinettes) or the Wrights' wing-warping (used on the other Antoinettes and Blériot's No. XI). It was Blériot himself—after Hubert Latham had crashed into the sea with his "Antoinette IV"—who, on July 25, 1909, flew his frail little No. XI to victory in the competition to fly the English channel. It was this historic flight, from near Calais to Dover, that not only impressed the airplane forcibly on the public mind but also frightened the chancelleries of Europe into realizing that a new vehicle of terrifying potential had suddenly appeared.

U.S. Progress.—American aviation, apart from the Wrights, had come alive in March 1908 with the tentative flight of the first machine ("Red Wing") built by the Aerial Experiment Association. The most important of the association's aircraft was Glenn Curtiss' "June Bug," which in July won the *Scientific American's* prize for the first public flight of more than one kilometre in the United States. Curtiss was soon to become the most outstanding American designer and pilot after the Wrights.

There followed a period of competition for speed and distance flying which saw new records constantly being set. Flying meets were organized in Europe and America, and the pilots and airplane designers became familiar names to the public. The average citizen looked upon the airplane as strictly a device for daredevils. At that time few believed that it would be utilized either as a weapon of war or an instrument of commerce.

Several significant events occurred in the period 1910–11. In Nov. 1910 Eugene Ely, flying a Curtiss biplane, made the first successful take-off from a ship, the U.S.S. "Birmingham." Two months later he succeeded in landing on and taking off from the U.S.S. "Pennsylvania." In 1911 Curtiss won the first Collier trophy for outstanding aviation achievement for flying the first practical float plane (the first successful such craft was flown in 1910 by Henri Fabre of France). (C. H. G.-S.)

1912–14 Developments.—During the two years preceding the outbreak of World War I (1912–14) aircraft development was rapid, but was still fundamentally on a trial-and-error basis. A few wind tunnels had been built—largely in France—but no significant amount of aerodynamic or structural data had been compiled for the use of designers. Each airplane was more or less an invention. The over-all configurations were many and varied. A few significant changes, however, began to be observed. The original timber-and-wire openwork construction, in which pilots sat in exposed positions, had given way to the development of the fuselage to contain power plant, pilot and passengers, and to serve as a connecting structure for the wings, tail and landing gear.

The fact that the air itself offers considerable resistance to the rapid passage of bodies through it began to be recognized. What is now commonly referred to as streamlining began to be studied. The Deperdussin monoplane, which won the Gordon Bennett cup in 1913, embodied many of the elements that appeared in high-performance airplanes of later decades.

Military staffs began, in the few years prior to World War I, to speculate on the possible employment of the airplane in war. But until 1915, when actual aerial combat between opposing pilots began, the airplane was looked upon only as a possible substitute for light cavalry—a means of reconnoitering the positions and intentions of an enemy army in the field. The long-range capabilities of the airplane were early realized. By midsummer of 1914 a German pilot succeeded in keeping an Albatross biplane in the air over Berlin for more than 24 hours. In the United States that year Glenn Curtiss built for Rodman Wanamaker a three-engined flying boat designed to fly the Atlantic. It was tested at Hammondsport, N.Y., but the planned Atlantic crossing was never attempted because of the outbreak of war.

CULVER PICTURES

WRIGHT BROTHERS' "THE FLYER" RISING FROM GROUND AT KILL DEVIL HILL, N.C., DEC. 17, 1903, TO BECOME THE FIRST POWERED AIRPLANE

years of the 1930s the improved capabilities of the airplane were dramatically demonstrated by a number of new record flights. Wiley Post and Harold Gatty made the first fast round-the-world trip in June 1931 in the single-engined Lockheed monoplane "Winnie Mae." They covered 15,474 mi. in 8 days and 16 hours. Two years later, in July 1933, Post flew solo around the world in 7 days and 19 hours. In 1938 Howard Hughes, flying a twin-engined Lockheed, circled the world in 3 days and 19 hours. These records should be contrasted with the U.S. army's round-the-world performance of 1924, mentioned above.

Air Transportation.—During this period air transportation systems covering the land masses of the globe were established. The transportation of people and goods by air proved to be not only technically feasible but economically profitable. The 1930s brought great improvements in economy, efficiency and safety of air transportation over land. Scheduled air transportation linked many European cities before much active development occurred in the United States. In the late 1920s and the early 1930s air transportation in the United States began with the establishment of a few intercity routes (Detroit-Cleveland, New York-Washington, New York-Miami, Chicago-San Francisco) which more or less followed the routes laid down by the U.S. contract airmail services.

Aircraft available to operators at the time included the famous all-metal Ford trimotor and the large and clumsy Boeing 80 and Curtiss Condor biplanes. The airplanes were slow, airways facilities (lights, radio communication and weather-reporting services) were inadequate and unreliable, and airports equipped to handle large volumes of passengers or goods were few and far between. The advent of the Boeing 247 transports in 1933 and the introduction of the Douglas DC series in 1934 changed the whole trend of development. These airplanes embodied the spectacular advances of 1930–31; *i.e.*, all-metal construction, cowled engines and retractable landing gear. They were also large enough to provide comfortable and relatively soundproof accommodations for passengers. They could carry with them enough electronic navigation and communications equipment for reasonably safe operation in all but the worst weather conditions. Most of the earlier types were powered with two engines. As the 1930s came to an end, however, more four-engined types began to appear; they were the prototypes of the equipment which handled the bulk of the long-range military transport requirements of World War II.

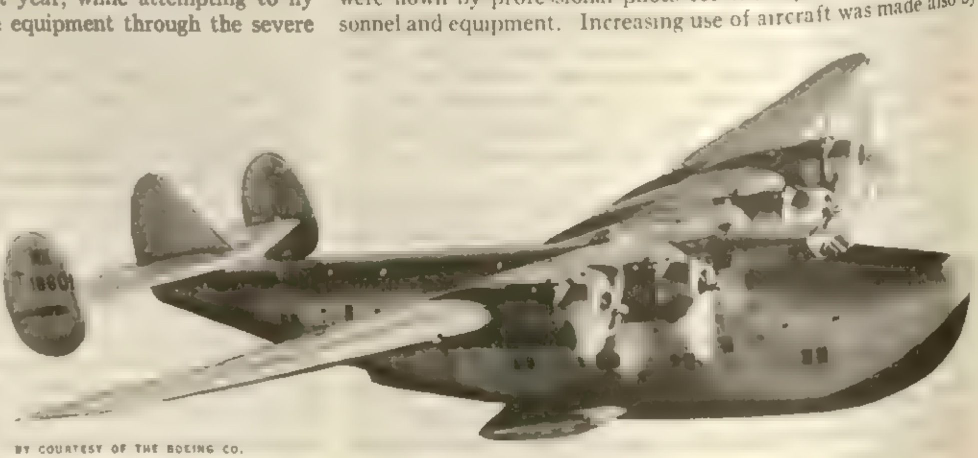
Early in 1934 an event occurred which was to have a profound (and continuing) effect on air transport development in the United States. This was the issuance of an executive order by Pres. Franklin D. Roosevelt canceling out of hand all existing mail contracts on the grounds of alleged fraud and collusion, and ordering the army air corps to take over the operation of the airmail services. Apart from any discussion of the reasons for this sudden and drastic action, the order temporarily disrupted air transportation in the country, and threw an unexpected burden on the military establishment that it was ill prepared to undertake. During the period Feb. 19–June 1 of that year, while attempting to fly mail on schedules with inadequate equipment through the severe weather conditions of the winter and spring, a dozen pilots and many aircraft were lost. This tragic episode had at least two important and long-lasting results: (1) it led to the development of new and adequate legislation for the control and expansion of commercial air transportation in the United States; and (2) by exposing the deficiencies in equipment and personnel training in the U.S. armed services, it initiated an intensive re-examination of requirements for men and matériel which was to prove invaluable when the United States entered World War II.

Toward the end of the 1930s commercial operators were beginning to link up internal air transport systems by regularly scheduled transoceanic flights. By the time the United States entered World War II in Dec. 1941, air transportation, both for military and for commercial purposes, was on a world-wide basis. In such a development it would appear logical that commercial transoceanic operations should be conducted by water-based aircraft; *i.e.*, large flying boats. This was, in fact, the approach made by all countries in first attacking the problem of transatlantic and transpacific operations. Large multiengined flying boats were developed for the purpose. The huge German-built Dornier Do X, having 12 engines, made an experimental round-trip crossing of the Atlantic in 1931–32 but never went into commercial service. The British inaugurated Atlantic services in 1934, beginning with schedules between New York and Bermuda. By the mid-1930s the French were making regular crossings of the South Atlantic in Latécoère flying boats. By 1935 Pan American World Airways System was operating both in the Atlantic and the Pacific, first using Sikorsky S-42's, and later the huge flying clippers built by Glenn Martin and by Boeing. As experience in overseas flying accumulated, however, and particularly after the lessons learned from a vast amount of intercontinental flying during World War II, the concept changed completely. With the increased reliability of aircraft, engines and communication equipment, the advantages of the land-based airplane over the flying boat became so apparent that the latter had disappeared entirely from international commercial services by 1950. (*See* AVIATION, CIVIL.)

Private Flying.—The extent of private ownership and operation of aircraft in the 1930s was much less than had been predicted by the prophets of the post-Lindbergh era. One of the principal reasons for this was the onset of the depression in the early 1930s, which limited the amount of money that manufacturers were willing to spend on development as well as that which potential customers were willing to spend. Nevertheless, a slow increase in private flying took place during the first five years of the decade and, as prosperity returned, private flying accelerated noticeably up to the period of the U.S. entrance into World War II.

Many people took up flying for pleasure and, as the interest increased, a number of new airplane types aimed at the private-owner market became available. Except for training and for purely sport use, a marked trend toward enclosed-cabin types occurred. People wanted to fly but they wanted to fly in comfort. The glamour of the "helmet, boots and breeches" type of pilot dimmed. People wished to travel in the same comfort (and in the same style) as they did in their privately owned automobiles.

The chief deterrents to widespread popular use of airplanes however, were the relatively high costs of equipment and operation and a general inability to navigate and fly safely in any but good weather conditions. Some larger, well-equipped machines capable of all-weather operations were built for a few people who could afford the luxury of professional pilots, but their number was small. Public companies also began to use airplanes, which were flown by professional pilots for the rapid transport of personnel and equipment. Increasing use of aircraft was made also by



BY COURTESY OF THE BOEING CO.

BOEING CLIPPER, INTRODUCED IN 1938, ONE OF THE FIRST AIRPLANES CAPABLE OF OPERATING COMMERCIALLY ON TRANSOCEANIC FLIGHTS

oil companies and public utilities for inspecting long pipelines and power lines. In some places, particularly the midwestern United States, Canada and Australia, farmers began to fly their own airplanes to inspect their properties and herds, or to spray insecticides. Altogether, however, the manufacture and sale of aircraft for such purposes engaged only a small part of the industry.

Gliding.—On the purely sport-flying side, gliding and soaring in motorless aircraft occupied a good deal of attention and came to a high degree of development both in Europe and America during the 1930s. This activity had its roots in Germany where, during the late 1920s, and under the provisions of the Versailles treaty of 1919, severe restrictions had been put on the development of powered airplane flight. Although soaring and gliding had not been unknown in the United States prior to that time (*e.g.*, Orville Wright soared for almost 10 minutes in a biplane glider in 1911 at Kitty Hawk), there was a considerable upsurge of interest in motorless flying in the early 1930s. The machines in use, however, were far removed from the clumsy gliders of Chanute and the Wright brothers. Some of these beautifully designed and highly refined soaring machines represented tremendously high levels of aerodynamic efficiency. The activity also led to extensive and detailed research in weather phenomena, which was of great subsequent benefit to all forms of flying.

Helicopters.—Before turning to the advances of the World War II period (1939–45) three other developments of the late 1920s and the 1930s—two in the heavier-than-air field, the other in the lighter-than-air category—should be mentioned.

An early idea for a means of flying was to use a system of overhead horizontally-rotating propeller blades. This is the helicopter (*q.v.*). Leonardo da Vinci was for many years credited with originating the idea but it is now known that the Chinese made helicopter toys before da Vinci's time. A number of later inventors had the same idea, including Sir George Cayley in England, Paul Cornu and the Breguet brothers in France and Thomas Edison in the United States. To all these people the idea seemed good, but as was the case with all other experimenters prior to 1900, they lacked an engine that could develop enough power to produce sufficient vertical thrust to raise its own weight (plus some useful load) from the ground. Actually, Cornu made the first, though primitive, free vertical ascent in a helicopter in 1907. During those years no one approached close enough to a solution to realize that there were also many difficult and complicated problems of control to be solved before a vertical rising machine, or helicopter, could become a practical device.

It is of interest to note that the brilliant designer of large airplanes and flying boats, Igor Sikorsky, designed and built a helicopter in Russia in 1909. His machine actually lifted its own weight from the ground but had no reserve left for pilot or passengers. Much later Sikorsky returned to the study of helicopters and produced in 1940 the prototype of a long line of successful machines under his own name, and touched off the development of many others by other designers.

During the 1920s Henry Berliner and George de Bothezat in America, Étienne Oehmichen in France, Raoul Pescara in Spain and Corradino d'Ascanio in Italy built awkward and clumsy machines which did succeed in getting a few feet off the ground with pilot aboard, but it remained for the Germans in the last half of the 1930s to produce the first real helicopter development. In 1937 the Focke-Achgelis helicopter was demonstrated in Berlin. Hanna Rasche made a number of successful cross-country flights, and in Feb. 1939 Ewald Rohlfs set an altitude record of 11,700 ft.

Once the basic principles had been established the development was rapid on both sides of the Atlantic, and a considerable use of these vertical-lift machines was made during World War II. It was not until the war in Korea (1950–53), however, that they really proved their value as military vehicles.

Autogiros.—Another type of aircraft, which resembled the helicopter very closely in outward appearance but operated on substantially different principles, also appeared in the early 1920s, and went through a considerable development cycle prior to 1940. This was the Autogiro, or the so-called gyroplane. The Autogiro differs from the helicopter in that the rotor system is not power-driven during flight but is in effect a set of rotating wings, rotation being derived from aerodynamic action of the air (autorotation). Power for forward motion is provided by a conventional propeller. Autogiros are incapable of true vertical flight but they can take off and land at relatively slow speeds with little take-off or landing roll, a combination which permits safe operation in and out of extremely small areas. The basic principle of the Autogiro, *i.e.*, autorotation, was evolved first by the Spanish inventor Juan de la Cierva. Between 1920 and 1923 he developed a number of machines with rotating wing systems; however, none was successful until, in 1923, he hit upon the idea of articulating the rotor blades at the rotor hubs, thereby making possible satisfactory aerodynamic control of the machine. During the following ten years a number of commercial and military Autogiro designs appeared in Britain, France and the United States. Most of these were open-cockpit two-seaters, but toward the end of the period several three- and four-seat enclosed-cabin machines were offered for sale. Toward the end of the 1930s the inherent limitations of the type, however, slowed down interest in their development in most countries, and the revival of interest in the helicopter virtually eliminated the Autogiro from further consideration by most manufacturers. The gyroplane idea was revived again in the late 1950s when Igor Bensen put on the market a "build-it-yourself" design for a single-place, low-powered gyroplane for sport use. An un-powered version also became available for use as a manned "kite" towed by automobile or by motorboat.

Airships.—The major development in lighter-than-air craft in the period between World Wars I and II was in the field of large, rigid airships—ships of the type developed by Graf von Zeppelin prior to World War I. Some development of nonrigid airship types (blimps) continued after 1918 but tapered off very rapidly during the following 15 years. The major military interest was evidenced by naval staffs, who found several uses for such machines for offshore patrol or coastal defense purposes. Considerable technical developments took place in the use of materials and in aerodynamic design. In the United States helium was made mandatory as a lifting gas in place of inflammable hydrogen. Few nonrigid airships were produced, however, until World War II when more than 150 saw service in various theatres, principally as antisubmarine weapons.

The so-called "semirigid" airship, a compromise between the blimp and the Zeppelin types, attracted a few experimental designers in the 1902–12 decade. The Italians revived the concept toward the end of World War I. The U.S. army purchased the Italian-built "Roma" in 1921, but it was wrecked and burned at Langley field, Va., shortly after delivery. An all-U.S. design, the RS-1, was purchased in 1925, flown experimentally for about two years, and then abandoned. In 1926–27, the Italians built two large semirigids, "Norge" and "Italia," both of which were used successfully in polar exploration. During the following few years the Russians were said to have built several airships of this type, but since that time little attention has been given to this category of aircraft.

During World War I the Germans achieved considerable success in long-range bombing operations with the Zeppelin-type rigid airship. On two occasions during 1917 German Zeppelins made flights of almost 100 hours' duration. Such performances led many people to believe that large airships would play a prominent part in aviation development during subsequent periods. A number of Zeppelins were distributed to the Allied nations as a part of postwar reparations. In this way the U.S. navy acquired the LZ-126 (ZR-3), renamed the "Los Angeles," which was flown to the United States in Oct. 1924.

In Great Britain construction of two large airships had been undertaken during the last year of the war. In July 1919 one of them, the R-34, took off from Scotland, made a transatlantic round trip and returned to England. Inspired by this performance the U.S. navy ordered a British-built airship, the R-38, which, however, was destroyed on its trial flight in England in Aug. 1921. This ended U.S. interest in British-built airships. However, in the United Kingdom design and construction continued, and culmi-

nated eight years later in the launching of the R-100 and the R-101, ships which were designed for commercial use across the Atlantic ocean and to the far east. The R-100 made one transatlantic round trip in 1930, but after the R-101 was destroyed over France in Oct. 1930, work on rigid airships was abandoned by the British.

During this period the Germans carried the development of the rigid airship to its highest point. Under the Versailles treaty airship work was prohibited until 1926, at which time the Zeppelin company began the construction of a purely commercial airship, the LZ-127, which became famous as the "Graf Zeppelin." Under its commander, Hugo Eckener, this ship made many flights to all parts of the world during the following years. Based on its record, the Germans undertook a much more ambitious project, construction of the LZ-129, christened the "Hindenburg." Ten round trips across the Atlantic were made by the "Hindenburg" in 1936, but on the first trip of 1937 the airship, while making a landing at the Lakehurst (N.J.) naval air station, caught fire, and was completely destroyed in minutes. Like all other German airships, it had used hydrogen as a lifting gas.

The U.S. navy undertook the design and construction of a rigid airship, the "Shenandoah." It was commissioned in Oct. 1923, but was destroyed in a storm over Ohio in Sept. 1925. Shortly thereafter the German-built "Los Angeles" was delivered, and remained in service with the U.S. navy without accident until it was finally decommissioned in June 1932. Meanwhile, two larger airships were designed and constructed in the United States, the U.S.S. "Akron" and the U.S.S. "Macon." The "Akron" was commissioned in Oct. 1931, but was destroyed less than two years later in a storm off the New Jersey coast. The "Macon" went into service in June 1933, but was wrecked off the California coast in Feb. 1935. These ships had many novel design features, such as internally mounted engines, water recovery systems, and a capability of housing, launching and retrieving small fighter airplanes. After the unfortunate experiences with the "Akron" and the "Macon" interest in the construction of rigid airships virtually disappeared in the United States and elsewhere.

V. PERIOD OF ACCELERATED DEVELOPMENT (1940–)

All the research and development, the speculation as to utility and utilization, and the theorizing as to the role of aircraft as military weapons came suddenly into focus with the outbreak of World War II in Europe in Sept. 1939. Military requirements on a scale never before contemplated accelerated development toward new levels of performance and utilization. The limitations which confronted aircraft designers were imposed less by technical feasibility than by economic considerations, human operating skills and human physical endurance.

For the most part, the fighter and bomber pilots of all the combatant nations of World War II flew aircraft which were no more than improvements upon designs which had been evolved in the late 1930s. Everything that research scientists had learned from wind tunnels and in structural test laboratories was incorporated in the production models in an effort to outfly and to outfight the opposition. Aircraft in all categories were markedly better in 1944 than they had been in 1939, but progress had been evolutionary, not revolutionary.

Military Jet Aircraft.—A really revolutionary concept, one that was to provide a breakthrough in aircraft design and operation, was, however, in the offing. In the mid-1930s, working secretly under strict security measures, German, Italian and British designers were experimenting with a new form of aircraft propulsion, the gas-turbine jet. (For a description and details of this type of engine, *see* AIRCRAFT PROPULSION: *Jet Engines*.) An Englishman, Frank Whittle, took out his first patents for a jet-propelled aircraft in 1930. Two German students, Hans von Ohain and Max Hahn, applied for their first patents in 1935.

The first flight of a jet aircraft occurred on Aug. 27, 1939, with the German Heinkel He 178. Almost two years later, in May 1941, a Gloster aircraft powered with a Whittle engine was flown in England. The first jet flight in the United States took place on Oct. 1, 1942, when a Bell XP-59A, powered by two I-16 General Electric turbojet engines (based on the Whittle design), was flown from Muroc Dry lake (later Edwards air force base), Calif. By the end of the war in 1945 almost 1,300 Messerschmitt Me 262 twin-jet fighters had been built, and Britain had the Gloster F-9-40 Meteor in full production. Both these aircraft became operational too late to have much effect on the outcome of the war but their performance proved conclusively that a new era in design had arrived.

Air Power in World War II.—Great efforts were made by all combatants of World War II to secure control of the air in every theatre of operation and to destroy opposing economic capabilities by mass bombing raids against centres of industry and population (*see* AIR WARFARE). Germany tried to bring England to terms by air bombardment during the summer and early fall of 1940, an effort which was nullified by the heroic defense put up by British fighters, aided by radar. The tables were turned in 1943–45 when the combined air power of Great Britain and the United States subjected German industrial centres to round-the-clock bombings, thus helping pave the way for the Allied victory.

Meanwhile, carrier-borne naval aircraft played a vital role in the drive by U.S. amphibious forces across the Pacific toward Japan. Finally, U.S. air force bombers, operating from the Marianas, destroyed Japanese industrial centres, culminating in the atomic bombing of Hiroshima and Nagasaki in early Aug. 1945. As an indication of the production effort behind such large-scale operations, it may be noted that between Dec. 1942 and Jan. 1944 the United States produced (in round numbers) 29,000 bombers, 39,000 fighters, 7,000 transports, 20,000 trainers and almost 6,000 miscellaneous types. In 1944 the U.S. purchased 96,318 airplanes.

German V-1s and V-2s.—One other radical new development which was to have far-reaching effects on military strategy occurred during the last year of World War II. In a desperate, last-ditch effort to break through British defenses and cripple British industry the Germans developed two new types of aerial weapons—the V-1 flying bomb (also called robot bomb and buzz bomb) and the V-2 ballistic rocket.

The V-1 was, in effect, an unmanned airplane, powered by a simple pulse-jet engine and carrying a 2,000-lb. warhead in its nose. Launched from prepared sites along the French channel coasts, these machines flew on

BY COURTESY OF U.S. NAVY

RIGID AIRSHIP "MACON" ABOUT TO RETRIEVE TWO OF ITS COMPLEMENT OF FIVE FIGHTER AIRPLANES BY MEANS OF A RETRACTABLE TRAPEZE MECHANISM SHOWN PROTRUDING BENEATH ITS HULL

preset courses with London as a target. Initially the effort was successful and considerable damage was done in London, but the British defenses soon learned to cope with this type of attack, and the effort was abandoned in the early fall of 1944. The rocket attacks by the V-2s began shortly thereafter. These large rockets (about 45 ft. long, weighing initially 13 tons and carrying a 2,000-lb. explosive warhead) were launched from sites in the Netherlands, rose about 60 mi. into the air and plunged vertically into the London target area 200 mi. away. They did considerable damage in London, and were stopped only when the ground forces overran and captured the assembly points and the launching sites in early March 1945.

BY COURTESY OF (LEFT) SIKORSKY AIRCRAFT (RIGHT) BENSEN AIRCRAFT CORP

(LEFT) SIKORSKY S-64 SKYCRANE CARRYING REMOVABLE CARGO AND PASSENGER VAN; (RIGHT) BENSEN GYROCOPTER

Although these German weapons failed to accomplish their intended purpose they laid a pattern which, in the next decade, led to the development of huge, intercontinental ballistic missiles (ICBM's) and eventually provided the technical knowledge from which the capability of putting satellites into orbit was derived. (*See* ROCKETS AND GUIDED MISSILES; SPACE EXPLORATION.)

Postwar Disruption of Aviation Industry.—The termination of the war in 1945 and the subsequent cancellation of orders for thousands of military aircraft brought severe disruption to the aviation industry. Huge factories were shut down, the flow of materials in pipelines ceased and thousands of workers were released. Several years went by before growing orders for new airline equipment could relieve the situation. Huge fleets of mothballed military aircraft were put into storage. Although the purchase of new military aircraft by governments practically ceased, manufacturers continued to develop new designs built around the jet engine.

Air Power in the Korean and Vietnam Wars.—When the war in Korea broke out in June 1950 a few of the newer types were available. In the air over Korea, U.S. Sabrejets engaged Soviet-built MIG-15s, marking the first time in history that jet aircraft met in aerial combat. During this period (1950–53) jets also came to be used more and more for low-level attacks on ground targets when slower conventional aircraft (mostly of World War II vintage) proved too vulnerable to antiaircraft fire.

It was during the Korean operations that the helicopter first came into common use as a military machine. Large numbers of these rotary-wing aircraft played a major role in rescuing downed pilots, directing artillery fire and transporting personnel to and from front-line positions. Many hundreds of wounded were transported directly from front lines to base hospitals.

After the Korean War there was a great upsurge in the use of helicopters both by the armed forces and by civil transport companies. They were extensively used by the U.S. in the war in Vietnam during the mid-1960s. On the civil side, regular passenger-carrying shuttle services were offered from downtown (sometimes rooftop) areas to outlying airports in many U.S. and European cities. Speed, range and carrying capacity were tremendously improved.

Postwar Air Transportation.—Meanwhile, considerable progress had been made in the postwar development of commercial aircraft to implement the growing network of domestic and international airlines. Thousands of twin- and four-engined transport types had been used throughout the world during World War II, and the experience gained thereby was invaluable in the first postwar decade in developing passenger and cargo-carrying systems. In the first three postwar years domestic route mileage in the United States multiplied more than three and one-half times, and passenger traffic increased at the rate of 20%–25% per year. Airmail tonnages climbed, and the shipment of freight by air increased rapidly.

The transition from the improved postwar propeller-driven transport types to the high-speed jet-powered transport began with the introduction into service of the de Havilland Comet by the British Overseas Airways corporation in 1952. Britain had taken the lead in jet transport development in the early postwar period and had also pioneered the development of turbine propeller-driven types, the Vickers Viscount being the best-known of these turboprops. For a time Britain was definitely in the lead with these two transport aircraft. Comets were on regularly scheduled service to South Africa, India and the far east, and the Viscounts were being sold in all countries, including the United States.

Within two years' time, however, a series of dramatic accidents caused the grounding and withdrawal from service of the Comets. Almost five years elapsed before the modified Comet IV came back into commercial operation. During the late 1950s the French-built Caravelle (with twin jet engines mounted in the tail of the fuselage) found considerable use on many European and U.S. airlines.

Meanwhile, U.S. designers had turned their attention to jet transport design, and early in 1960 the Boeing 707 jet transport came into commercial operation in the United States. During the following two years the Boeing 707, the Douglas DC-8 and the Convair 880 were produced in large quantities and took over practically all long-range U.S. domestic and overseas routes and were also widely used by many foreign airline operators.

During the 1962–64 period most jet aircraft for long-range operation were corrected to the so-called "fanjet" engines for greater power and economy. Several new intermediate range transports appeared during the 1960s, notably the Boeing 720, the Boeing 727, and the DC-9. The Boeing 727 was characterized by the installation of three jet engines, all mounted in the tail of the fuselage.

During the 1950s and 1960s the Soviets, also starting from scratch, made great strides in their development of jet-powered and turboprop commercial air-transport equipment. Beginning with the post-World War II development of twin-engined propeller-driven machines (similar in size and performance to the U.S. DC-3s), they produced in little over a decade a large fleet of pure jet and turboprop transports of a size and capability equal to any in the world. Typical are the TU-104 pure jet and the huge multiple turboprop transport, the TU-114.

During the 1960s a great deal of attention was focused on the possibilities of supersonic transport. A design study (and some construction) was undertaken jointly by the U.K. and France in an attempt to develop a Mach 2 (two times the speed of sound, or about 1,500 m.p.h.) machine. In the U.S. the Federal Avia-

BY COURTESY OF (TOP) TRANS WORLD AIRLINES; (CENTRE BOTTOM) THE BOEING CO.

(TOP) DOUGLAS DC-3, WHICH HELPED CHANGE COMMERCIAL AVIATION; (CENTRE) BOEING B-29 SUPERFORTRESS, FOUR-ENGINED U.S. BOMBER USED IN WORLD WAR II; (BOTTOM) BOEING 707 INTERCONTINENTAL JET AIRLINER

tion agency and a group of manufacturers began evaluating designs for a Mach 3 airplane, but an actual flight date remained several years in the future. Many basic problems (heat-resistant materials, high-energy fuels, economic feasibility, "sonic booms," etc.) had to be solved before commercial Mach 3 flight could become a reality.

Air Lifts.—Beginning in the late 1940s the capability of air lifting large numbers of people and great quantities of goods into almost every area of the world had a profound effect upon the political, economic and sociological trends of the times. Such operations included the Berlin air lift (1948–49), in which large quantities of food and fuel were flown into the blockaded city, and Operation "Magic Carpet" (1952), in which thousands of Muslim pilgrims, stranded in Lebanon by a transport shortage, were flown to Jidda, Saudi Arabia, enabling them to reach nearby Mecca in time for an important Islamic festival. The dropping of food and other supplies into areas isolated by fires, floods or other natural disasters has often prevented major economic losses and has saved hundreds of human lives. This was again dramatically demonstrated by the mass evacuation of white refugees from the Congo during the uprisings in that area in the fall of 1964. And finally, the swift and economical transportation available to all parts of the globe has allowed an interchange of people and of ideas which has helped create a better basis of understanding among nationalities.

International Regulation of Airlines.—The rapidly expanding network of international airlines brought a need for international regulation of traffic and of equipment. As a result of an international convention called by Pres. Franklin D. Roosevelt in Chicago in Sept. 1944, two permanent international bodies were formed—the International Civil Aviation organization (ICAO) and the International Air Transport association (IATA). The history of these organizations, and an account of their operations, is covered in AIR LAW and AVIATION, CIVIL.

Military Aircraft.—During the 1950s the military aircraft of all the major powers underwent a revolutionary change in appearance and performance of an even more radical nature than occurred in the early 1930s. After the U.S.-built experimental airplane X-1 demonstrated in Oct. 1947 that flight beyond the so-called sonic barrier is feasible, fighter aircraft with supersonic capabilities became standard equipment. In design they tended to become very large and complicated, and, as a corollary, very expensive. Wings tended to become smaller and smaller, and the swept-wing or delta configurations were generally adopted. The ever increasing demand for power to achieve high-speed flight resulted in the rapid development of larger and larger turbojet power plants with thrust capabilities many times in excess of that of the original Whittle engine.

Few new fighter planes were designed in the 1960s. Improvement in armament and performance, however, was continuous in all countries. A number of research aircraft of unconventional configuration appeared in the United Kingdom, including several direct-lift supersonic fighters (*e.g.*, the Hawker Siddeley P.1127). In the U.S. the inventory included developed versions of the Ling Temco Vought Crusader, the Douglas Skyhawk and Skyraider, the Convair Delta Dart, the Grumman Intruder, the Lockheed Starfighter, the McDonnell Phantom and Voodoo, the North American Vigilante, the Northrop Talon and the Republic Thunderchief. A new development was a variable-sweep winged, all-service fighter, the F-111 (TFX) developed for the air force and navy by General Dynamics and Grumman.

Bomber types also underwent radical revisions. The Boeing B-29 Superfortress, the type that bombed Japan and dropped the first atomic bombs there, was also flown in the Korean War. By 1949, however, the Convair B-36D, with six conventional and four jet engines, was in service with the U.S. strategic air command, joined in the early 1950s by the six-engined, swept-wing, Boeing B-47 jet.

At the same time the prototypes of Britain's "V" series bombers were already flying. These were the Avro Vulcan, the Handley Page Victor and the Vickers Valiant, all large long-range machines powered by four to six jet engines. In the mid-1950s an even larger

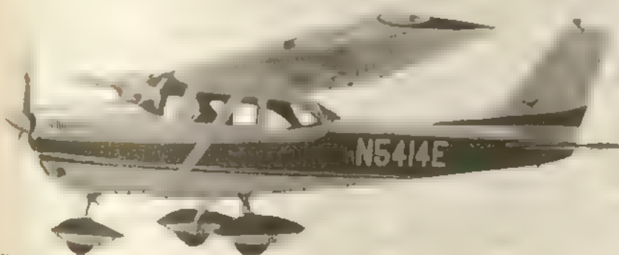
jet bomber, the Boeing B-52, went into service with the strategic air command. With it was developed the Boeing KC-135 tanker for in-flight refueling of bombers. The KC-135 tanker utilized the design from which the Boeing 707 jet transport was derived. A delta-winged 4-jet supersonic bomber, the B-58 built by Convair, was also used by the U.S. air force in considerable numbers. In Dec. 1957 a contract was let by the U.S. air force to North American Aviation for the development of a Mach 3 bomber (B-70), of which three prototypes were to be built. The first of these large planes (approximately 550,000 lb. weight at take-off, 170 ft. long, powered by six turbojet engines) was test-flown in the autumn of 1964. The program was officially abandoned, however, because of the improved United States intercontinental missile capability.

Postwar Private Flying.—Again, as in the post-Lindbergh period (1927–33), aviation enthusiasts predicted a great development of private flying for the post-World War II decade. "An airplane in every garage" had been forecast, with thousands of people flying on business and for pleasure. Estimates of as many as 300,000 privately owned machines in use in the United States within five years of the end of World War II were made by many responsible people. Such demand was confidently expected to replace the cancellation of military orders.

Unfortunately these predictions did not materialize. Pilots trained during the war years soon found that they could not afford to own and operate their own machines. Moreover, the majority of airports were not available for large-scale private flying. Private flyers found that they could operate only in near-perfect weather and in the vicinity of their home airports unless they installed an expensive array of communications and navigational equipment, which few could afford.

As a result, the ownership of airplanes by private citizens virtually disappeared in most countries. In flying clubs, open-cockpit "sports" airplanes were in fairly wide use but under the economic conditions of the 1960s few persons outside the United States could afford to own their own machines for personal use.

In the United States the decade from the mid-1950s to the mid-1960s witnessed a great expansion in the use of non-airline aircraft for business executive travel. Many large corporations with



BY COURTESY OF CESSNA AIRCRAFT CO.

CESSNA SKYHAWK, FOUR-PASSENGER AIRPLANE FOR PERSONAL OR BUSINESS TRAVEL

plants and offices spread over the entire country maintained fleets of their own aircraft. Some of these aircraft were originally used for short-haul airline work, but a number of fast and efficient machines—both jet and turboprop—were designed specifically for this type of service and were in use in large numbers.

Aviation Research; Unsolved Problems.—Despite the fact that public attention was usually focused on putting man into space, there were still many unsolved problems involved in navigating safely within the boundaries of earth's atmosphere. Government budgeting for aeronautical development was at a relatively low level in the 1960s, but remained substantial.

By the mid-1950s speeds were well into the supersonic range. In 1960 the North American X-15 experimental rocket-powered airplane had already exceeded Mach 3 and on Nov. 9, 1961, it attained a speed of more than 4,000 m.p.h. Although designed primarily for shallow penetrations of outer space and for the collection of data on controlled re-entry into earth's atmosphere, the X-15 also provided data on high-speed flight through the air.

The problem of combining vertical take-off and landing (VTOL), or short take-off and landing (STOL), with high-speed horizontal flight engaged the attention of researchers and designers in the late 1950s and 1960s. Helicopters can rise vertically but their top speed is far below desirable limits. The development of a successful VTOL/STOL airplane would go a long way toward the

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XC-142 VTOL/STOL AIRCRAFT. WINGS TILT TO HORIZONTAL POSITION AFTER TAKEOFF

solution of the airport problem. Such vehicles could pick up their loads in small areas (possibly on roofs) near population centres, rise vertically (or at least very steeply) and proceed at high speed to their destinations, where the process would be reversed. Costly and time-consuming transfers to ground vehicles, as well as long trips between airports and industrial centres, would be eliminated. By the late 1960s aircraft with STOL and VTOL capabilities were being flight tested.

Another area where active research is needed and is being intensified is in the control of air traffic in the vicinity of airports. With the rapidly increasing number of high-speed jet aircraft approaching and leaving terminals, positive separation in flight as well as absolute control of their movements in the air and on the ground is essential for safe operation (*see* AIRPORT). This control becomes more important and more difficult in periods of bad weather. The danger of collision of two jet airliners carrying several hundred passengers over a thickly populated area must be avoided at all cost. On Dec. 16, 1960, the worst aviation disaster in history occurred when a jet airliner collided with a propeller-driven airliner over New York city, resulting in the deaths of 134 persons.

Such problems, difficult as they may seem, will be resolved in time. Probably relatively few human beings will participate in space exploration or indulge in space travel. Many millions will, however, use the atmosphere as a medium for travel. It is important, therefore, for man to explore every means at his disposal to attain complete mastery of the ocean of air which surrounds him.

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AVIATION FUEL: *see* AIRCRAFT PROPULSION.

AVIATION INSURANCE. The rapid development of the aviation industry between World Wars I and II led to a demand for insurance for both planes and passengers. As new government agencies were created to exercise controls over pilots and flights and to establish safety standards, the development of aviation insurance underwriting was greatly assisted. By the end of World War II aircraft hull and aircraft liability insurance underwriters had developed insurance policies patterned after other forms of property and liability insurance. However, the relative inexperi-

ence of aviation insurance underwriters, coupled with the almost phenomenal growth in air traffic with its attendant hazards, resulted in inadequate insurance rates and substantial underwriting losses. By 1960 some stability had been achieved, but aviation insurance was still a relatively new form of insurance that dealt with an industry subject to changing hazards and catastrophic accidents.

UNITED STATES

In addition to aviation personal accident insurance, the principal types of aviation insurance coverage are aircraft hull, covering loss or damage to the plane; aircraft liability (similar to automobile liability insurance), covering the insured's legal liability for bodily injury or property damage; admitted aircraft liability, under which voluntary settlements with passengers may be made without recourse to the legal liability of the insured, thereby releasing the insured from legal liability; cargo liability, covering the airline's liability for loss or damage to baggage and cargo (physical damage to air-borne cargo is usually not considered aviation insurance but it is written by inland marine departments of fire insurance companies or by inland marine insurers); hangarkeeper's liability, covering the hangarkeeper for his liability for damage to aircraft hulls entrusted to him for repair or storage (similar to automobile garage keeper's liability); airmeet and airport liability, covering on-premises liability (similar to on-premises liability coverage under an Owners', Landlords' and Tenants' policy commonly used by other businesses); products liability, covering the hull manufacturer, those responsible for aircraft repair and maintenance and salesmen; medical payments, which, like automobile medical payments coverage, will pay up to policy limits for necessary medical expenses for injuries, without regard to fault liability. The aircraft and aviation industry also uses other forms of insurance to cover real estate, inventories, automobiles, workmen's compensation and employer's liability.

Certain users of airplanes, such as those who charter or rent them and who operate from a given airport, may obtain many of the above types of coverage in one special package policy. The owners of light planes weighing less than 2,000 lb. fully loaded have available a special comprehensive light plane policy to cover the hull.

Owners of cargo shipped by air may wish to insure their interests through air cargo coverage because the airlines are not required to insure the cargo they transport, and airline liabilities may not be identical. The movement of air cargo, it should be noted, is not limited to air travel but includes surface carriers such as trucks and railroads. The Railway Express Agency, Inc., for example, provides the same service for air express cargo as for railway express cargo. Not all cargo shipments are domestic but may be shipped in international commerce. The liability of air carriers may not be identical for domestic shipments and international shipments, which may be subject to the terms of the Warsaw convention (1929). (*See* AIR LAW.) Furthermore, cargo may be shipped through consolidators or forwarders via scheduled or nonscheduled airlines. Scheduled airlines are common carriers, and their liability may be different from that of a nonscheduled airline, which may not be a common carrier. Cargo owners may, for the above reasons, wish to insure consistent with the nature of their risks of loss in relation to probable recoveries under the insurance or liability of air carriers, scheduled or nonscheduled, in domestic or international commerce.

Aviation insurance rates are no more standardized than are the aviation insurance policies. Although certain classes of risks may lend themselves to so-called average rates, these rates are no more than guides subject to adjustments based upon the underwriter's judgment of a particular risk within the class. Underwriters consider such factors as the experience of the airline and its pilots; the condition, age and depreciated current market value of the equipment; the financial condition of the airline and its relative competitive position; and the airline's safety record. These and many other factors will determine the insurance rate. In many forms of coverage the total premium for the year will be determined from the insured's own report of the total exposure during the contract term. As is partially the case in automobile insurance, aircraft are often classified for rate purposes according to use; *i.e.*, commercial, limited commercial and private business and pleasure.

Jet and turboprop transports typify the need for a dynamic insurance company management responsive to the needs of modern business or industry. Judgment is essential especially when rates and coverages must be promulgated for new types of hazards, many of which are catastrophic. New jet and turboprop planes with high value per aircraft, large seating capacity and high speed practically double the exposure per unit over the straight piston-type aircraft. Besides the air-borne risks, limited fleets mean a limited number of ground or surface passenger and maintenance installations with concentrated values in aircraft hulls and relatively costly maintenance equipment and facilities. This results in further lack of spread of risk along with a high concentration of values exposed to catastrophic losses. (J. W. CE.)

GREAT BRITAIN

In Great Britain, as in the United States, many of the earlier troubles of aviation insurance were overcome with the rapid growth of civil aviation after World War II, but new problems arose with each succeeding year. From the very beginning of civil aviation in Great Britain the resources of the established insurance market were made available to the aircraft industry. From this close association with the fortunes of the aviation industry for more than 40 years, aviation insurance, once regarded as a mere sideline for the marine underwriter, progressed to a broadly based independent section of the British market.

The aviation insurance market in London consists of two specialist companies formed by groups of influential British insurance companies, a number of Lloyd's underwriting syndicates formed expressly for the purpose of underwriting aviation risks, and other Lloyd's syndicates. There are also a few insurance companies that underwrite aviation risks mainly as an adjunct to their marine departments.

Nothing in the nature of tariff rating exists and, apart from the use of standard policy forms, underwriters have virtually complete freedom. There are, however, market agreements on matters such as war risks. There are two associations of underwriters, one representing Lloyd's and the other representing the company market. These two bodies frequently co-operate on matters of market interest, or where the interest of clients is concerned. They have done much valuable work in conjunction with government departments concerned with national and international legislation affecting carriage by air. As a result, the liability of the carrier on internal carriage in the United Kingdom is, with certain modifications, brought into line with that applicable to international carriage. Internationally, Great Britain subscribes to the Warsaw convention but has not ratified the Rome convention.

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AVIATION MEDICINE, the science of preventing or treating illnesses and injuries that occur to aviators and those who work in the manufacture, maintenance and operation of aircraft and missiles. (For a description of space medicine *see* SPACE EXPLORATION: *Space Science: Life Sciences.*)

The practitioners of aviation medicine must be intimately acquainted with the science of flight, the characteristics of aircraft and the nature of the tumultuous atmosphere in which they are operated.

The first scientist to go aloft for the purpose of making medical observations was John Jeffries, a U.S. physician who ballooned from England to France in 1785. Since that time aviation medicine has continued to be international in nature, with all the leading European and North American countries contributing major advances in research, practice and teaching.

French physiologist Paul Bert (*q.v.*) is generally regarded as the "father" of modern aviation medicine. In his *La Pression Barométrique*, published in 1878, he described his pioneer in-

vestigations of the physiological effects of air pressure, both above and below normal. The work was translated into English in 1943 and used extensively during World War II.

In the early 1960s all major aircraft companies had departments of "human engineering," a field of knowledge comprising one of the basic sciences of aviation medicine. In these departments, physicians, psychologists, engineers and other scientists worked at such tasks as designing the arrangement of instruments for easy comprehension; the size, shape and position of controls, seats, and lights; the insulation, ventilation and pressurization of passenger and crew compartments; and the sanitation of food and waste facilities. Each aircraft company also had a medical department to provide pre-employment and periodic medical examinations of aviators and ground personnel and to treat occupational diseases and accidents of employees.

On or near each airport there usually was at least one aviation medicine specialist who examined aviators in accordance with standards established by a national regulatory authority and also exercised surveillance over personal protective equipment, ventilation, cleanliness, noise levels and toxic hazards of employees at the airport. In addition, each large airport had on its staff a chief medical officer who supervised the sanitation of the port in accordance with health standards established by national and international authorities.

A primary function of aviation medicine has been to examine and determine the fitness of aviators and of candidates for flight training. It is universally recognized that the safety of a flight may be threatened if the pilot or other members of the flight crew possess inadequate sight, hearing, strength, co-ordination, intelligence, courage, equilibrium, emotional stability or lack ability to retain consciousness. Specialists in aviation medicine have sought to ensure that persons in whom these inadequacies are found or suspected are not permitted to operate aircraft. The aviation medicine specialist is equally concerned with ensuring that the health of crew members is not impaired during flight. For this reason, aviation medicine specialists constantly study the hours crews spend per month at the controls, their diet, their peace of mind and the physical and mental stresses to which they are subjected by low air and oxygen pressure, noise, vibration, air turbulence, poor visibility and heavy responsibility.

An aeromedical task almost as old as aviation is that of flying the patient to the doctor. Early air ambulances were developed in the United States and Europe in 1910, and the French army transported wounded soldiers by air in 1915. During World War II more than 1,000,000 military patients were transported by air. The number of civilian patients carried by air to and from many of the world's great centres of medical care had increased by the early 1960s to hundreds monthly.

The armed services of most nations were served in the early 1960s by aviation medicine specialists, commonly called flight surgeons. These doctors were assigned to aircraft carriers, operational squadrons, groups and wings, air staff organizations, hospitals that cared for aviators, and to aircraft and missile research design and test organizations where they performed the same general functions as their civilian colleagues. Most specialists in aviation medicine have been trained in military schools of this specialty. Such schools are or have been maintained by the armed forces of the United States, Canada, Great Britain, Germany, the U.S.S.R., Argentina, Brazil and France. In the 15 years following the end of World War II specialty training programs in aviation medicine were established at four universities in the United States.

Specialists in aviation medicine, both medical and nonmedical scientists, have organized a number of professional societies. The foremost of these in the early 1960s was the International Aero-Space Medical association, which was founded in 1929 by Louis H. Bauer and a group of examiners appointed by the Civil Aeronautics administration.

In the United States, aviation medicine was recognized by the medical profession as a specialty in 1953, and in the first seven years after recognition approximately 900 doctors were certified in this specialty by the American Board of Preventive Medicine. The specialist in aviation medicine in the late 1950s acquired the responsibility for the health and safety of rocket launch crews and future spacemen. These men and women operate in an extremely hazardous environment where the dangers of poisoning, temperature, pressure and anxiety become extreme. In missile support operations the aviation medicine specialist must combine clinical knowledge and psychological understanding with a detailed knowledge of fuel toxicities, firing systems and ground and range safety to prevent human failures that can cause missile failures.

See also MOTION SICKNESS.

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AVICENNA (ABU-ALI AL-HUSAIN IBN ABDULLAH IBN SINA) (980–1037), Persian philosopher and physician, very influential in both the Islamic world and the Latin middle ages, was born in a village near Bukhara in Turkistan. His father had joined the Ismaili movement, and although Avicenna did not follow in his steps, the preference that he shows for the Plotinian element in the late Greek synthesis of Platonism and Aristotelianism may have some root in early acquaintance with the Ismailis. At the age of 18 he could consider himself an accomplished physician and had acquired all the immense philosophical knowledge displayed in his large philosophical encyclopaedias and in his numerous small treatises. After the collapse of the Samanid empire in 999 he decided to leave Bukhara, and the later decades of his life are marked by some vicissitudes. About 1020 he was vizier in Hamadan. The last 14 years of his life were spent in the company of 'Ala ad-Daula, the ruler of Isfahan, whom he followed on all his journeys and on all his military ventures. He died in Hamadan in 1037. His extant writings, some of which are in his native Persian though most are in Arabic, include an autobiography (completed by an intimate pupil).

Philosophical Works.—Avicenna's philosophical doctrines are described in the article ARABIC PHILOSOPHY. Unlike Averroës, Avicenna did not write commentaries. The best-known of his large philosophical encyclopaedias is *Ash-Shifa* ("The Recovery"; *i.e.*, of the soul from error), called *Sufficientia* in Latin versions. In this he treats logic (nine books), the natural sciences, including psychology (eight books), the *quadrivium* (four books) and metaphysics, but there is no real exposition of ethics or of politics. The logic, the psychology and the physics were translated into Latin in the 12th century; and by the middle of the 13th century versions of the section on metaphysics, of the summary of the *De Caelo*, of the meteorology and of the zoology had been added. Editions of this partial translation were printed in 1495 and 1508.

A résumé of *Ash-Shifa*, called *An-Najat* ("The Salvation") became rather popular and was printed as an appendix to *Al-Qanun* in 1593. Both *Ash-Shifa* and *An-Najat*, as well as *Al-Qanun*, were finished in Isfahan, where Avicenna also composed the last great work of his to have come down to us in its entirety, *Isharat wa-Tanbihat* ("Demonstrations and Affirmations"). This covers the whole of philosophy and may represent its author's most mature thought.

The important work in which Avicenna distinguished his "oriental" philosophy from the "occidental" philosophy of the Christian philosophers of Baghdad, the *Kitab al-Insaf* ("The Book of Equitable Judgment"), was lost when his belongings were scattered during the pillage of Isfahan in 1034; only three unconnected sections have survived. His "Oriental Philosophy" itself seems to be irretrievably lost (with the exception of a few pages) and may never have been completed by him. Some smaller theological or mystical treatises and the "Poem of the Soul" also deserve mention.

Medical Works.—Avicenna's most famous medical work is *Al-Qanun fi'l-Tibb* ("The Canon of Medicine"), a systematic encyclopaedia based for the most part on the achievements of Greek physicians of the Roman imperial age and on other Arabic works and, to a lesser extent, on his own experience (his own clinical notes were lost during his journeys).

This work not only became extremely popular in the Islamic

world, but also was studied in European universities for centuries, first in a 12th-century translation by Gerard of Cremona (printed 15 times before 1500), then in a new translation by Andrea Alpago of Belluno (1527 and later editions). It was also the second text ever to be printed in Arabic (1593).

See also references under "Avicenna" in the Index.

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AVIGNON, a city of southeastern France, capital of the *département* of Vaucluse, lies on the Rhône river where it leaves its narrow valley for the wide delta plain, 66 mi. N.W. of Marseilles by road. Pop. (1962) 64,581.

The city is built on the left (east) bank of the Rhône where rising ground on both sides of the river gives defensible sites (Avignon on the east and Villeneuve-lès-Avignon on the west). The Île de la Barthelasse is in the river between them. In the winter the town suffers severely from the mistral winds. A few miles below Avignon the Durance reaches the Rhône from the east, and the city is a nodal point for the roads from this valley and the east side of the Rhône generally. Similarly, Villeneuve is a focus of roads on the west. The division of the river somewhat reduced the difficulty of crossing, and so helped to give the site its importance, but the power of the Rhône was so great that a bridge could not be built in antiquity even by the Romans. In 1178–88, however, St. Bénézet built one which was broken down and repaired at various times and was finally abandoned in 1680. The part of the bridge supported by the four arches nearest Avignon still stands and has on it the original Romanesque chapel (with 16th-century portions above) dedicated, as is usual on such sites, to St. Nicholas. The true version of the famous song "Sur le pont d'Avignon" should read "Sous le pont . . ." as the dancing took place in the shade of the bridge on the Île de la Barthelasse. Lower down the river a suspension bridge and a modern bridge cross the Rhône.

W. SUSCHITZKY

FORTRESS-PALACE OF THE POPES, AVIGNON, 14TH CENTURY

Avignon is still almost surrounded by its 14th-century ramparts, built by the popes, with machicolated battlements, towers and gateways. Outside the walls is a ring of boulevards. The town is dominated by the palace of the popes, which stands on top of a steep hill, and the cathedral close to it. The latter, a Romanesque building of the 12th century, contains the tombs of Popes Benedict XII and John XXII, the former a masterpiece of 14th-century Gothic work. The cathedral is more or less dwarfed by the fortress palace of the popes, begun in 1316 by John XXII in the Gothic style and continued until 1370. It now belongs to the city. The palace is surrounded by high walls, flanked with eight towers, inside which are also the Clementine chapel (over the Hall of Great Audience) and two chapels with 14th-century Italian frescoes. Among the Gothic churches of the town are St. Pierre (14th and 16th centuries) with a graceful façade and richly carved doors and St. Agricol (14th and 18th centuries) with a façade dating from 1489. The Calvet museum, in a 15th–18th-century house, contains paintings, furniture, wrought iron, Greek and Roman remains, etc., as well as a fine library. There is a sculpture museum in the 17th-century Jesuit church. An annual arts festival (in July) takes place when plays are staged in the palace of the popes.

Avignon is on the main line from Paris and Lyons to Marseilles and there is an airport at Caumont, five miles to the southeast. John Althen, a Persian, introduced in 1765 the culture of the madder plant which long formed the staple, and is still an important branch, of local trade. There are flour mills, and oil and leather works. Soap and chemicals are manufactured, and wine, teasels and almonds are traded, while the city is well known for its sarcenet and other fabrics.

Avenio, as it was known in classical times, was a town of the Gallic tribe of Cavares, but under the Romans it enjoyed only a secondary importance in Gallia Narbonensis. Severely harassed by barbarians and Saracens, it later belonged successively to the kings of Burgundy and of Arles and to the counts of Provence, Toulouse and Forcalquier. At the end of the 12th century it became a republic, but in 1226 it was dismantled by Louis VIII as punishment for its support of the Albigenses, and in 1251 was forced to submit to the counts of Toulouse and Provence. Pope Clement V made it his residence, and from 1309–77 it was the papal seat. In 1348 the city was sold by Joan, countess of Provence, to Clement VI. After Gregory XI had migrated to Rome two antipopes, Clement VII and Benedict XIII, resided at Avignon, from which the latter fled in 1408. Avignon was a bishopric in the 3rd century and became an archbishopric in 1475. The town and the surrounding territory of Comtat-Venaissin (*q.v.*) remained in possession of the popes, who governed by means of legates (*see* Papacy), until annexation during the French Revolution by the national assembly in 1791, when conflicts between the adherents of the papacy and the republicans led to much bloodshed.

In World War II Avignon was in German hands from Nov. 1942 to Aug. 1944.

ÁVILA (from the Latin *Abula, Avela,* but perhaps also from the Punic *Abyla*), a province (area 3,107 sq.mi.) and its capital city situated in Old Castile (*q.v.*) in central Spain. Pop. (1960): province 238,372; town 26,807 (mun.). The city (officially Ávila de los Caballeros) lies 54 mi. W. of Madrid on the Adaja river. It is surrounded by 8,202 ft. of walls in polygonal form, with 82 forts, 2,500 merlons and 9 gates, built during the 12th century when the city was finally reconquered from the Moors. The whole of ancient Ávila is contained within the walls; the

modern part is outside. The apse of the Romanesque cathedral forms part of the walls, giving it the appearance of a fortress. The city is a noted tourist centre. St. Teresa was a native of the town and a convent and church mark the site of her alleged birthplace. The fact of Ávila's having been a *ciudad real* (Queen Isabella was born there) is reflected in the number of palaces and noble houses. Many of these buildings are in the plateresque (Renaissance) style, with magnificent doorways, as in the house of Gil González de Ávila. Particularly noteworthy are the work of the goldsmith Juan de Arfe y Villafane (16th century), preserved in the cathedral, and the paintings of Pedro de Berruguete.

Ávila province extends to the Tiétar; it advances north for some distance across the plateau of Old Castile. On the level ground in the north, the centre of which is Arévalo, agriculture predominates, but the soils are poor, resting on outwash from the central Sierras. For the rest, Ávila is a province of sierras, mainly granite, rising steplike from the plateau to the Sierra de Gredos, and separated from each other by longitudinal valleys which are, in some cases, dried-up lake bottoms along lines of structural weakness. Of these the best known are the Barco de Ávila and the Valle de Amblés; the latter lies at the eastern end of an important structural line, giving a natural route from Plasencia to Ávila. The headwaters of the Alberche and Tiétar rivers, flowing to the Tagus, and of the Tormes and Adaja, flowing to the Duero, occupy these longitudinal valleys. The province is crossed by two main roads, from Madrid to La Coruña and from Villacastin to Vigo, and also by the railway lines from Madrid to Irún and from Ávila to Salamanca. The most important towns are Candeleda, Arenas de San Pedro and Arévalo. There is little industrial development and the economy is mainly agricultural. The raising of stock, especially of the Merino sheep (of which the purest breeds surviving in Spain are found in the central Sierras), is the principal occupation; the forests, mostly pine, are still important in places. The pastures and forests formed the basis of the life of the medieval communities, subdivided into *sexmos*, between which the area of the present province was divided. Wheat, with and without irrigation, is increasing its acreage. Rye, barley, oats, maize and tobacco are also grown. Modern methods are widely adopted; production of cereals exceeds consumption, and a surplus is exported to other parts of Spain. The vine flourishes only in such areas as the Tiétar and Alberche valleys, which produce wines of some repute; olive cultivation is confined to a few sheltered localities (Arenas de San Pedro, Cebreros) with very high yield. Estates are generally large; there is often a shortage of labour, and harvesters are brought in from Galicia. The sierras formerly abounded in game, but the diminution of the ibex of the Sierra de Gredos led to the creation in 1905 of an ibex sanctuary. There are also graphite quarries. (M. B. F.)

AVISON, CHARLES (1709–1770), English composer, organist and writer on musical aesthetics, was born at Newcastle upon Tyne, and baptized there in Feb. 1709. Little is known of his early life: he may have gone to Italy, and was perhaps a pupil of Francesco Geminiani, who was certainly a friend of his later.

He was appointed organist at St. John's, Newcastle, in July 1736 and at St. Nicholas' in October. He taught harpsichord, violin and flute, and conducted the newly founded subscription concerts. He composed and published many concertos for stringed instruments, sonatas for harpsichord and strings, etc. His *Essay on Musical Expression* (1752) excited comment and evoked a pamphlet, published anonymously, from William Hayes, professor of music at Oxford (1753), to which Avison replied with an enlarged edition of the *Essay*. A third edition appeared in 1770. Avison lived all his life at Newcastle, refusing appointments at York, Dublin, Edinburgh and London. He was visited by Geminiani in 1760; among his many friends was the composer John Garth of Durham, whom he assisted in editing Marcello's *Psalms*. He died at Newcastle, May 10, 1770.

As a composer, Avison was a representative of the last phase of the late baroque "ancient" style. It is difficult to enumerate his many concertos, for, like Geminiani, he was continually revising his earlier works. Although his music lacks the vigour of Handel or Vivaldi, it has its own wistful beauty. His trenchancy as a critic is shown in the famous *Essay* and in his explanatory or didactic prefaces to his own and his friends' works, which also throw considerable light on 18th-century methods of performance.

See M. Kingdon-Ward, "Charles Avison," in *The Musical Times* (Sept. 1951); A. Milner, "Charles Avison," in *The Musical Times* (Jan.–Feb. 1954). (Cs. Ch.)

AVITUS (Eparchius Avitus) (d. A.D. 456), Western Roman emperor from 455 to 456, was born of a distinguished Gallic family and was father-in-law of Sidonius Apollinaris. He acquired much influence with the Visigoths settled at Toulouse, and in 451 persuaded their king, Theodoric I, to join the Roman general Aetius in repelling Attila and the Huns from Gaul. He was appointed *magister utriusque militiae* ("master of both services") by the emperor Petronius Maximus, and when Maximus fell, the Goths proclaimed him emperor at Toulouse. At Arles, accompanied by a Gothic force, he was recognized as emperor by the Gallo-Romans. He then proceeded to Rome and entered upon his consulship on Jan. 1, 456, when Sidonius recited a panegyric on him. On Oct. 17, 456, he was forced by Ricimer (*q.v.*) to abdicate and to become bishop of Placentia. He died soon after. (E. A. T.)

AVOCADO, the fruit of *Persea americana* of the family Lauraceae, a tree native to the mainland of the western hemisphere from Mexico south to the Andean regions of Colombia and perhaps Venezuela. The common name is a sound substitute for the Aztec *ahuacatl*, originating probably in Jamaica, where also the name alligator pear arose as a sound substitute, plus reference to the pearlike shape and appearance of many varieties.

The avocado first became known to Europeans through a description published in 1519 by Martin Fernández de Enciso in his *Suma de Geografia*. Enciso had seen the fruit near Santa Marta, Colom., as he coasted along those shores with one of the first Spanish expeditions to the mainland. In 1526 Gonzalo Fernandez de Oviedo described it in greater detail. Garcilaso de la Vega tells how it was carried from Ecuador to the warm valleys near Cusco by the Inca Tupac Yupanqui, shortly before the Spanish conquest. The common name in Peru and southward is *palta*. In most Spanish-speaking countries, *aguacate*, an adaptation of *ahuacatl*, is used; in Brazil this becomes *abacate*.

The tree may be tall or spreading, with entire leaves commonly elliptic to obovate in form and 4 to 12 in. in length. The flowers, which are borne in dense racemes, are small, greenish, devoid of petals, with six perianth-lobes, nine stamens arranged in three series, and a one-celled ovary. The fruit is exceedingly variable in shape, size and colour; some of the Mexican varieties are no larger than hens' eggs, while those of other races may attain three or four pounds in weight. The form varies from round to pear-shaped with a long slender neck, the colour from green to dark purple. The single large seed, with two cotyledons, is round to conical. Between it and the outer skin, which is sometimes no thicker than that of an apple, sometimes coarse and woody in texture, is the greenish or yellowish flesh, of buttery consistency and rich nutty flavour, containing in some varieties as much as 25% of oil, and eaten most commonly in salads, whence the name "salad fruit" which has been used to emphasize the peculiar characteristics of the avocado.

BY COURTESY OF U.S. DEPARTMENT OF AGRICULTURE

AVOCADO (PERSEA AMERICANA): (LEFT) WHOLE FRUIT; (RIGHT) CROSS SECTION OF FRUIT SHOWING SEED

Though it was widely cultivated in tropical America before the Spanish conquest—in the form of individual seedling trees in dooryards—the avocado did not begin to receive serious horticultural attention until about 1900. At that time George B. Cellon

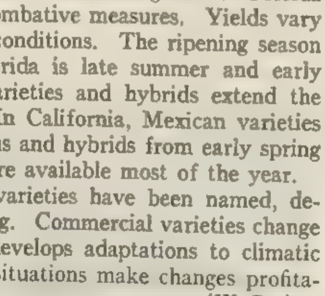
and other horticulturists in Florida found that the production of grafted trees is not difficult, thus making possible the perpetuation of superior seedlings and the establishment of orchards that would produce fruit of uniform size, appearance and quality. After that time flourishing industries developed in Florida and California, in South Africa and on a somewhat smaller scale in Chile, Brazil, Hawaii, Australia and some of the islands of the South Pacific. Cuba produces quantities sufficient for its own needs and for export to the United States. Mexico, where avocados are extremely popular, produces large quantities annually; commercial plantings have been made in Israel, and there are numerous trees in other countries around the Mediterranean.

Horticulturally, avocados are commonly divided into three races, recognized as early as 1653 by Fray Bernabe Cobo. These are the Mexican, the West Indian and the Guatemalan. The first-named, considered by some botanists to be a distinct species, *Persea drymifolia,* is native to Mexico, and is characterized by the aniselike odour of the leaves, and by small (3 to 8 oz.) thin-skinned fruits of rich flavour and excellent quality. This is the hardiest race and therefore of value in regions too cold for the others. The Guatemalan race is native to the highlands of Central America; is slightly less frost-resistant than the Mexican; and produces fruits of medium to large size (8 to 32 oz.), characterized by thick woody skins and a ripening season different from that of the others. The West Indian race (it would more properly be termed South American) is the most tropical in character, and its cultivation in the United States is limited to southern Florida. Its fruits are frequently of large size and excellent quality. Natural crossing has taken place between these three races, resulting in numerous varieties of mixed character, some of them important commercially.

Avocados can be grown on a wide variety of soils, from the light sandy ones of central Florida to the heavy clays of southern California, but drainage must be perfect. A rich sandy loam or clay loam is perhaps best. Propagation of commercial sorts is by grafting or budding, though seedlings are more commonly grown in the tropics and are to be seen as dooryard trees in California and Florida. In the former state, the Mexican race is used as a rootstock; in Florida, the West Indian is more popular. Avocados will not tolerate severe drought, hence irrigation is used in many regions, especially those where there is lack of rainfall during the period when the trees are flowering and setting fruit. Cultural attention varies in different regions; little pruning is required. Various insect pests and fungous diseases attack the groves in Florida and California, some requiring combative measures. Yields vary with variety and environmental conditions. The ripening season of West Indian varieties in Florida is late summer and early autumn, but the Guatemalan varieties and hybrids extend the period to February or March. In California, Mexican varieties ripen in late autumn, Guatemalans and hybrids from early spring to late summer. Fruit is therefore available most of the year.

Several hundred pomological varieties have been named, described and propagated by grafting. Commercial varieties change from time to time; experience develops adaptations to climatic and soil conditions; and market situations make changes profitable.
(W. Po.)

AVOCET (AVOSET), a wading bird about 18 in. long related to the sandpipers and placed in the family Recurvirostridae together with the stilts and the ibisbill. There are four species: one in North America; one in Europe, Asia and Africa; one in Australia; and one in South America. All have slender, upcurved bills, webbed feet and plumage that is largely white with much black in the wings.



ALLAN D. CRUICKSHANK FROM NATIONAL AUDUBON SOCIETY

AVOCET (RECURVIROSTRA AMERICANA)

The avocet lives in shallow shores of ponds and even muddy seacoasts. Sometimes the birds gather into large flocks. They usually feed by swinging the bill from side to side through the water to capture small insects and crustaceans. They frequently wade while feeding, although they can swim.

The avocet builds a simple nest on the ground near water; four boldly marked eggs are laid, and the downy young are active soon after hatching.
(A. L. RD.)

AVOGADRO, AMEDEO, CONTE DI QUAREGNA E CERETTO (1776–1856), Italian physicist, was the enunciator of the hypothesis known later as Avogadro's law (*see* AVOGADRO'S CONSTANT), one of the basic concepts of modern chemistry. He was born at Turin on Aug. 9, 1776, and died there on July 9, 1856. For many years he was professor of higher physics at Turin university. His hypothesis (1811), which made an important distinction between atoms and molecules, was not accepted generally until after Stanislao Cannizzaro in 1858 had constructed a logical system of chemistry based on it.

For the historical position of Avogadro's law, *see* CHEMISTRY: *Studies of Chemical Composition (1800–1900)*; *see* also ATOM: *Avogadro's Hypothesis.*

AVOGADRO'S CONSTANT is the number of molecules in one mole or gram-molecular weight of a substance, both defined as the molecular weight in grams. The constant is invariably the same, whatever the substance, its value being $(6.02486 \pm 0.00016) \times 10^{23}$ as determined by R. T. Birge in 1941 and is denoted by the letter N. The concept, based on Avogadro's law, was enunciated by Amedeo Avogadro in 1811. The previous value assigned to the constant, approximately 6.06×10^{23}, was proved to be incorrect by X-ray diffraction from crystals.

Avogadro's law states that equal volumes of different gases at the same temperature and pressure contain the same number of molecules; *i.e.,* the volume of a mole or gram-molecular weight is constant for all gases. This is correct only for perfect gases but is approximately true for real gases.

See ATOM: *Gases and the Molecular Hypothesis.*

AVOIRDUPOIS WEIGHT (from the French *avoir de pois,* "goods of weight"), the name of a system of weights used in Great Britain and the United States for all commodities except precious metals, gems and medicines. The foundation of the system is the grain. There are 252.458 gr. in one cubic inch of water. There are 27.3 gr. in one dram; 437.5 gr. (or 16 drams) equals one ounce; 7,000 gr. (16 oz.) equals one pound. Fourteen pounds equals one stone; two stones equals one quarter. Above this point the U.S. and British avoirdupois systems differ. In the United States 100 lb. equals one hundredweight; 2,000 lb. equals one ton. In Great Britain eight stones (112 lb.) equals one hundredweight; 20 cwt. (2,240 lb.) equals one ton. In the United States the British ton is referred to as a gross ton or long ton.

See WEIGHTS AND MEASURES: *The U.S. Customary System; The British Imperial System.*

AVON, (ROBERT) ANTHONY EDEN, EARL OF (1897–), British statesman, was prime minister from April 6, 1955, to Jan. 9, 1957. His distinction rests upon his skill in diplomacy and his ability, for the greater part of his public career, to express the middle opinion of the British people, irrespective of party, on foreign affairs. Yet, during his political life, he was twice at the heart of national storms. The Suez conflict in 1956 was one occasion. His resignation from the office of foreign secretary in Neville Chamberlain's government (Feb. 20, 1938) was the other.

From his birth everything seemed to be in Eden's favour. He was born on June 12, 1897, at Windlestone hall, Durham, of an old county family. He was sent to Eton and, on leaving school, went into the army during World War I. He was an infantry officer in France by 1915, became a brigade major at the age of 20 and was awarded the military cross. After the war he went to Christ Church, Oxford, where he obtained a first-class honours degree in oriental languages. He entered parliament in 1923 as Conservative member for Warwick and Leamington (the constituency which he represented until his resignation in 1957). He quickly made a mark in the house of commons. He was young, handsome and devoted to the task of building a new world from which war should be eliminated. Eden was appointed parliamentary private sec-

retary to the foreign secretary, Sir Austen Chamberlain, in 1926; he held the post until 1929. He became undersecretary of state for foreign affairs in 1931, was promoted lord privy seal (with special responsibility for foreign affairs) in 1934 and was made minister for League of Nations affairs in June 1935. In Dec. 1935 he was appointed foreign secretary in succession to Sir Samuel Hoare—a move which was taken by critics of Hoare's policy of appeasement toward Italy (expressed in the Hoare-Laval pact which envisioned the cession to Italy of some Ethiopian territory) to mean that a firmer League policy would be followed and that resistance to Hitler and Mussolini would be stiffened.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LORD AVON

However, British diplomacy was hindered by the relative weakness of the country. The government was reluctant to convince public opinion, still shocked by the casualties of World War I, that rapid and powerful rearmament was necessary. Consequently, it was not possible for Eden as foreign secretary always to take as strong a line in foreign affairs as his supporters wished. By the beginning of 1938 Hitler's aggressiveness was frightening the whole of Europe and had begun to alarm Pres. Franklin D. Roosevelt in the United States. The president sent a message to Prime Minister Neville Chamberlain in Jan. 1938 asking for the British government's views on the value of a proposal to hold a conference to discuss the international situation. Eden was vacationing in France when the president's message arrived and when Chamberlain replied. Chamberlain suggested the deferment of such a conference until British approaches to Italy had been completed. Eden returned to London on Jan. 15 and protested that Chamberlain not only had missed a precious opportunity to strengthen Anglo-U.S. co-operation at a time of mounting danger but had done so to placate Italy when its conduct forfeited the right to any gesture of friendship from Great Britain. Eden therefore resigned on Feb. 20, 1938. Sir Winston Churchill, writing of this event in *The Gathering Storm,* said it had taken from the government the man who "seemed to me at this moment to embody the life-hope of the British nation."

On the outbreak of World War II in Sept. 1939 Eden re-entered the Chamberlain government as dominions secretary. When Churchill became prime minister in May 1940 Eden's place was assured; he served for a short time as secretary of state for war, but from Dec. 1940 until the Churchill government fell in 1945 he was, once more, foreign secretary. Churchill advised King George VI that if he (Churchill) became a war casualty Eden should be his successor.

When the Conservatives returned to office in Oct. 1951 Eden again became foreign secretary. During his final term at the foreign office he added to his reputation for diplomatic skill. He assisted in the settlement of the Iranian oil dispute, in resolving the quarrel between Italy and Yugoslavia over Trieste and in ending the war in Indochina. The Indochina problem was especially difficult, and Eden's strenuous efforts during the Geneva conference in 1954 contributed greatly to the final settlement. After peace was made, he was instrumental in establishing the Southeast Asia Treaty organization. In 1954 Eden's personal intervention secured the establishment of a western European defense system and averted a European crisis. The French assembly rejected the plans for a European Defense Community in August 1954. Eden immediately made a tour of the European capitals and then arranged a nine-power conference in London. His announcement at the conference that Great Britain would maintain its present forces on the continent unless a majority of the Brussels treaty powers agreed to their withdrawal went far toward removing French grounds for objection, and the western European defense agreements were signed in October. He was created a knight of the Garter.

Eden had married in Aug. 1952 Clarissa Churchill, a niece of Sir Winston (an earlier marriage having been dissolved). He became seriously ill in 1953, underwent three operations and spent several months in convalescence, but he appeared to be quite well when he returned to duty. He succeeded Churchill as prime minister in April 1955 and led his party successfully through a general election a few weeks later. He continued his efforts to relax international tension by welcoming to Great Britain in April 1956 Nikita Khrushchev and Marshal N. A. Bulganin, the leading representatives of the U.S.S.R.

Within two years Eden had resigned the premiership and his seat in parliament. He had never regained full health after the illness of 1953 and he was unable to withstand the strain and shock caused by the Suez conflict (*see* EGYPT: *History*). Eden's direct concern with Suez began when, as foreign secretary, he had negotiated the agreement with Egypt (Oct. 1954) that led to the withdrawal of British troops from the Suez canal zone. He answered Conservative critics of this withdrawal by expressing a hope that it would permanently improve Anglo-Egyptian relations. He was angered, therefore, when Col. Gamal Abd-al-Nasser, head of the Egyptian government, announced (July 26, 1956) the nationalization of the Suez Canal company, in which the British government was a principal shareholder.

This action set in motion the chain of events which led to the Anglo-French attack on Egypt. International discussions in the United Nations and elsewhere had stopped immediate military action, but the French government began to work closely with the Israeli government, which had been moved, by constant Arab provocation, to try its military strength against Egypt. Eden himself denied (Dec. 20, 1956) that he had had foreknowledge of Israel's attack on Egypt, but added that the risk of such an attack had been known and that consequently "discussions" with the French had taken place.

The development of the Suez policy was accompanied by a series of storms in the British house of commons. Eden was accused of flouting the United Nations, alienating the United States, offending the commonwealth, running the risk of a third world war and, by some of his own supporters, of bungling the military operations. His defense was that Anglo-French action had stopped the fighting between Israel and Egypt and had at last forced the United Nations to take effective action. Eden's show of aggressiveness toward Egypt was more widely supported in Great Britain than the Labour and Liberal parties had expected. The main complaint of Eden's supporters was that he had not completed the intention, announced in the ultimatum of Oct. 30, 1956, to occupy "temporarily" the key positions of Port Said, Ismailia and Suez.

Eden's health collapsed under the strain of these events. It was stated on Nov. 21, 1956, that on medical advice he would spend three weeks in Jamaica. He returned to London on Dec. 14 and defended his Suez policy once more in the house of commons on Dec. 20, but on Jan. 9, 1957, he resigned because of recurring ill-health. He published his memoirs in three volumes: *Facing the Dictators* (1962), *The Reckoning* (1965), and *Full Circle* (1960); the last volume (but the first to be published) covered the years 1951–57. A volume of essays, *Toward Peace in Indochina,* was published in 1966. He was created earl of Avon in July 1961. *See* also ENGLISH HISTORY. (J. F. B.)

AVON, the name of several rivers in the British Isles and in parts of Europe. In this form the word is Celtic and itself means river or water. It has been suggested that another proper name may have been associated with it, as is the case in Welsh where it appears as *afon.* The same root appears in place names throughout Celtic areas—*Evan, Aune, Anne, Ive,* etc., in Britain; *Aff, Avon, Aune* in France; *Aven* in Breton; *abhann* in Irish; and *aon* in Manx. Related forms are the Sanskrit *ap,* "water," and the Latin *aqua* and *amnis.* In England the following are the principal rivers of this name.

The East or Hampshire Avon rises on the north side of the Vale of Pewsey in Wiltshire and flows across the vale through

Pewsey to Upavon. Length excluding minor sinuosities, 48 mi.; total fall 500 ft.; drainage area 1,132 sq.mi. From Upavon the river follows a very nearly north-south course across the eastern part of Salisbury plain to Amesbury and Salisbury and the western part of the Hampshire basin by Fordingbridge and Ringwood, to enter the English channel through the nearly landlocked Christchurch harbour. From Upavon to Salisbury the river meanders considerably among meadowland in a narrow valley with many villages and much evidence of early settlement. Below Salisbury the valley is wider with several watercourses in places, but there are few settlements near the river itself. The main tributaries are the Bourne on the east bank and the Wylye on the west at Salisbury, and the Stour which enters just above Christchurch harbour. The river is not navigable but was probably greatly used in prehistoric times giving access to the important early settlement area of Salisbury plain. It has valuable salmon fisheries and a good deal of coarse fish.

The Lower or Bristol Avon and its upper tributaries drain the dip-slope of the south Cotswolds toward the vale of west Wiltshire in which it passes through Chippenham and Melksham. Length of the river, excluding minor sinuosities, about 75 mi.; total fall just over 500 ft.; drainage area 891 sq.mi. At Bradford-on-Avon the river enters a narrow gorgelike valley as it swings abruptly northwestward through the Cotswolds past Bath and on to Bristol. In Bristol the Avon has a straight channel excavated in the early 19th century when the original meandering course was converted into the city docks which are reached by seagoing vessels. Below Bristol the river traverses a section of Carboniferous Limestone through the well-wooded and picturesque Clifton gorge, spanned by the famous suspension bridge. At Avonmouth, the ocean port of Bristol, the Avon enters the Severn estuary whose large tidal range it shares. The most important tributaries are the Somerset Frome which joins the Avon on its south bank just below Bradford-on-Avon and the Bristol Frome which joins it in the middle of Bristol. At Bath the river is linked by a ladder of seven locks with the Kennet and Avon canal. (Fk. Wr.)

The Upper Avon, also called the Warwickshire, and sometimes the "Shakespeare" Avon from its associations with Stratford, is an eastern tributary of the Severn. It rises near Naseby in Northamptonshire, and, with a course of 96 mi., joins the Severn immediately below Tewkesbury in Gloucestershire. After flowing southwest to Rugby it runs west and southwest to Warwick, receiving the Leam on the east. Continuing southwest it goes past Evesham to Tewkesbury. The valley is broad, and especially after Warwick, through the Vale of Evesham, the scenery is very beautiful, the rich valley being flanked by the bold Cotswold hills on the south and by the wooded Arden district on the north. Famous beauty spots include Warwick castle, Stratford and Evesham. The river is locked, and formerly carried some trade up to Evesham, 28 mi. from Tewkesbury; the locks from Tewkesbury upward to Stratford (45 mi.) are decayed, but there are many reaches suitable for pleasure boats. Total fall of river, about 500 ft.; from Rugby about 230 ft.; and from Warwick 120 ft. Coarse fish abound.

Among other streams of this name in Great Britain are one from Dartmoor to the English channel; one in south Wales with its mouth at Aberavon in Glamorgan; and, in Scotland, tributaries of the Clyde, Spey and Forth.

AVRANCHES, a town and port of Manche *département*, northwestern France, stands on a 341-ft.-high hill above the estuary of the Sée, overlooking Mont-Saint-Michel, 89 mi. S. by road of Cherbourg. Pop. (1962) 8,828. The town, largely destroyed in World War II, was rebuilt, and retains some of its old houses. The town hall library contains illustrated manuscripts of the 8th and 15th centuries brought from the abbey at Mont-Saint-Michel, and incunabula from the abbey of Lucerne near Granville. Avranches is in the centre of a cattle- and sheep-rearing region; salmon and trout are fished in the Sée. The chief manufactures are knitted goods and copperware. Important under the Romans and in the duchy of Normandy, Avranches endured its worst siege in 1591. In 1639 it was the centre of the peasants' *va-nu-pieds* revolt against the salt tax. From 511 to 1790 Avranches was a bishop's see, when the cathedral was pulled down as unsafe. The site is now open, one stone remaining to mark where Henry II of England received absolution for the murder of Thomas Becket. In July 1944 U.S. forces under Gen. George S. Patton broke out of the Normandy "pocket" there. (R. T. T.)

AVUNCULATE. A special relationship between a maternal uncle (Lat., *avunculus*) and his sisters' children, particularly his nephews, prevails in many societies, notably those characterized in the present or past by matrilineal descent. It typically involves, on the part of the uncle, a measure of authority over his nephews coupled with specific responsibilities in their upbringing, initiation and marriage. The nephew, in turn, often enjoys special rights against his uncle's property and frequently takes precedence over the latter's own children in regard to inheritance. In many matrilineal societies the nephew leaves his parental home in boyhood or adolescence and goes to live with or near his maternal uncle in an arrangement known as "avunculocal residence." This and matrilocal residence, *i.e.*, with the wife and her relatives, represent alternative modes of achieving a local organization based on matrilineal descent. The core of the local group, whether an extended family or a localized clan, consists in the former case of the men of a matrilineal lineage; in the latter case, of its women. Not infrequently a nephew has a preferential right or obligation to marry a daughter of his maternal uncle—a form of cross-cousin marriage. When this occurs, residence may be at the same time avunculocal and matrilocal, with the men of the local group belonging to one lineage, their wives to another. Although most elaborately developed in matrilineal societies with avunculocal residence, the avunculate also is prominent in most of those with matrilocal or patrilocal residence. It likewise occurs in a moderate number of patrilineal societies. In many such cases it may be derived from an earlier matrilineal system but this is by no means always its origin, for even in an old and integrated patrilineal system special roles may be assigned to a maternal uncle as the senior male member of the mother's patrilineal kin group. Preferential cross-cousin marriage between the father's sister's son and the mother's brother's daughter is, in fact, more characteristic of patrilineal than of matrilineal societies. Within the system of bilateral descent—figuring through both male and female lines—that prevails in slightly more than one third of the world's known cultures, including those of western Europe, the avunculate and associated usages have either failed to develop or have almost disappeared. (*See* also Matriliny.)

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(G. P. Mk.)

AVVAKUM PETROVICH (1620/21–1682), archpriest leader of the Old Believers (*q.v.*) and the most original and modern of Russian 17th-century writers, was born in Grigorovo near Nizhni Novgorod. From his boyhood his stormy personality and his religious fervour brought him into conflict with those around him. In 1652 he went to Moscow and quickly joined in the struggle against the reforms of the patriarch Nikon (*q.v.*). In 1653 he was banished to Tobolsk, Siberia, and was then sent farther east to the Lena and the Amur, where he suffered severe injustice. In 1663 he was recalled, but the difficult journey took him three years. Although Nikon by then had fallen, Avvakum, who vigorously took up the cudgels for the Old Believers party, was soon banished again, to Mezen, in northern Russia. The synod against the Old Believers (1666–67) sent him still farther north to Pustozersk, near Naryan-Mar. In the prison of the little fort there he wrote most of his works, the greatest of which is his *Zhitie* (*Life*), the first Russian autobiography (Eng. trans., 1941). It is distinguished for its lively description and its original colourful style and is one of the great works of early Russian literature. Avvakum was burned at the stake on April 14, 1682.

See N. K. Gudzy, *History of Early Russian Literature* (1949), Eng. trans. of 2nd Russian ed. (1941); P. Pascal, *Avvakum et les débuts du raskol* (1938).
(F. v. L.)

AWAJI-SHIMA, Japanese island with an area of 230 sq.mi. at the eastern end of the Inland sea, administratively a part of Hyōgo prefecture. Two narrow straits, Akashi strait to the north and Kii strait to the southeast, separate it from Honshu, while Naruto strait to the southwest separates it from Shikoku. Essentially mountainous (2,000 ft. the highest elevation), Awaji has one major plain which bisects it from east to west. This plain has the bulk of the population (198,808 in 1960) and agricultural land, the main city, Sumoto (48,497 in 1960), and the only railway line. Farmers specialize in dairying, vegetables, cut flowers and fruit, mainly for sale in Osaka-Kobe markets. Fishermen from small villages along the east and west coasts extract a rich haul of fish and shellfish from the Inland sea. Awaji has only a few small-scale consumer goods industries. (J. D. Ee.)

AWAN, a city of ancient Elam (*q.v.*), prominent throughout early Sumerian and Akkadian history in the second half of the 3rd millennium B.C. Although it was probably situated near Susa, its exact location is unknown. (G. G. Ca.)

AWE, LOCH, the longest fresh-water lake in Scotland, is situated in mid-Argyll, about 117 ft. above sea level. It has an area of nearly 16 sq.mi. and is 24 mi. long northeast to southwest from Kilchurn castle to Ford, its breadth varying from ½ to 3 mi. Its majestic northern end, dominated by the eastern skirts of the Ben Cruachan massif, is crescentic, one arm running toward Glen Orchy, the other to the point where the river Awe leaves the lake, reaching Loch Etive, a sea loch, by the impressive gorge of the Pass of Brander. The scenery around the southern end is much gentler. Inishail Island ("isle of rest"), burial ground of the Macarthurs, contains ruins of a church and convent.

(A. T. A. L.)

AXHOLME, ISLE OF, a rural district in the Gainsborough parliamentary division of Lincolnshire, Eng., bounded west by Yorkshire, south by Nottinghamshire and east by the river Trent. A flat, alluvial tract about 18 mi. by 5 mi., it is almost entirely under 100 ft. in elevation. The rural district consists of 13 parishes with an area of 79.9 sq.mi. and a population (1961) of 14,110.

In 1627 Charles I, then lord of the island, made a contract with Cornelius Vermuyden, a Dutchman, for reclaiming the meres and marshes. (*See* FENS.) This undertaking led to a large number of Flemish workmen settling in the district and, in spite of the violent measures adopted by the English peasantry to expel them, they retained their ground in sufficient numbers to affect the physical appearance and accent of the inhabitants to this day.

The principal towns are Epworth, the birthplace of John and Charles Wesley, and Crowle. The land is extremely fertile and produces heavy crops.

AXINITE, a mineral consisting of a complex aluminum and calcium iron borosilicate. The mineral was named from the Greek word for "ax" because of the characteristic thin wedgelike form of its crystals. The colour is usually clove-brown, but occasionally the mineral has a violet tinge. Handsome specimens are afforded by the beautifully developed transparent crystals found at Le Bourg d'Oisans in Dauphiné in France. The hardness of 6.5 to 7, combined with the colour and transparency, renders axinite applicable for use as a gem stone, the Dauphiné crystals being occasionally cut for this purpose, and it is regarded as a semi-precious stone. The specific gravity of axinite is 3.28. The chemical formula is $HCa_2(Mn,Fe)BAl_2Si_4O_{16}$. The iron may be replaced by manganese, yielding the form manganaxinite, and the aluminum by ferric iron.

AXIOM. According to Aristotle, every demonstrative science must start from indemonstrable principles. Among these first principles some are peculiar to the particular science but others are common to all sciences and are called axioms. Elsewhere the axioms are characterized as the common opinions from which all demonstration proceeds, and as those things which anyone must hold who is to learn anything at all.

In the *Elements* of Euclid the first principles are listed in two categories, the *postulates* and the *common notions*. The former are the principles peculiar to the particular science of geometry and seem to be thought of just as required assumptions since their statement opens with the word *etestho* ("let there be demanded"). The common notions are evidently the same as Aristotle's axioms, and indeed Proclus (*q.v.*), *On the First Book of Euclid*, tells us explicitly that the two terms are synonymous. However, the principle by which the division between postulates and axioms is to be made seems to have been not very certain; Proclus debates various accounts of it, but among them, that postulates are peculiar to geometric subject matter, while axioms are common, either to all sciences that are concerned with quantity or to all sciences whatever.

In modern times mathematicians have often used the words "postulate" and "axiom" as synonymous. But a distinction which recommends itself as useful, and in part historically justified, is to reserve the name "axiom" for the axioms of logic (*see* LOGIC), and to use "postulate" for those assumptions or first principles (beyond the principles of logic) by which a particular mathematical discipline is defined.

For examples of particular systems of mathematical axioms (or better, postulates) *see* the article POSTULATE.

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AXIS, OPTIC, the direction in a crystal along which the ordinary and extraordinary rays are propagated with the same velocity.

See LIGHT: *Double Refraction;* CRYSTALLOGRAPHY: *Optical Crystallography.*

AXMINSTER, a small market town in Devon, Eng., lies on the Axe river, 26 mi. E. of Exeter by road and rail. In 1953 the urban district of Axminster ceased to exist and it was transferred to the rural district. Pop. of rural district (1961) 14,350. Axminster lies at the intersection of two ancient roads, the Portway and the Fosse Way. Its history dates from about 660 when it was one of the earliest settlements in the Saxon occupation of Devon. Axminster was founded soon after 705. The parish church of St. Mary the Virgin, which stands in Trinity square, the centre of the town, has a Norman doorway and Early English and Perpendicular work; its 13th-century tower was damaged in 1644 when Roundheads from Lyme Regis attacked Cavaliers inside the church. On alternate Thursdays an agricultural market is held in the square—an ancient privilege—and nearby is the cattle market. Axminster's best-known industry is carpetmaking (*see* CARPET MANUFACTURE). The carpet factory, founded in 1755, was closed in 1835; a new factory was built in 1937.

Ashe house, 2 mi. S.W., was the home of the Drake family and was rebuilt by Sir John Drake in 1670–80. John Churchill, 1st duke of Marlborough, whose mother was Elizabeth Drake, was probably born there. Only minor fragments remain of Newenham abbey, a magnificent Cistercian monastery founded in 1246 by Reginald de Mohun and dismantled after the Dissolution.

BY COURTESY OF R. R. HUMPHREY

ADULT AXOLOTL (AMBYSTOMA MEXICANUM) RETAINING LARVAL GILLS

AXOLOTL, a permanently larval salamander from Lakes Xochimilco and Chalco in Mexico. Its scientific name is *Ambystoma* (or *Siredon*) *mexicanum.* The popular name of axolotl is applied in a broad sense to any neotenic salamander (*i.e.,* one that matures sexually in the larval stage) of the family Ambystomatidae, a group found mainly in the ancient lakes of the Mexican plateau and in the western part of the continental United States.

Ambystoma mexicanum is a

black-speckled, dark-brown salamander with weak limbs, sharply pointed digits and external gills directed forward. Axolotls grow to a larger size than ordinary larvae of the family, sometimes reaching a length of 10 inches. They eat small animals, including others of their kind. In Mexico they are sold as food, and biological laboratories use them for experimental studies.

Ambystoma mexicanum has long been of interest because in captivity it may occasionally metamorphose into a gill-less form similar to the widespread tiger salamander (*A. tigrinum*). In nature the larval state seems obligatory as a result of hereditary factors, which probably influence the thyroid and pituitary glands, and environmental features such as temperature and chemical content of the water. This neoteny presumably promotes species survival where conditions would be difficult for a terrestrial adult, as on the arid Mexican plateau.

See AMPHIBIA; METAMORPHOSIS.

See J. A. Tihen, "Comments on the Osteology and Phylogeny of Ambystomatid Salamanders," *Bulletin Florida State Museum*, 3:1–50 (1958); E. H. Taylor, "A Bibliography of Mexican Amphibiology," *Kans. Univ. Sci. Bull.*, 31, pt. ii, pp. 543–89 (1947). (G. B. R.)

AXON (AXONE), also called the axis cylinder process, neurite, neuraxis and neuraxon, is a process of the nerve cells. As a rule it has as a sheath a fatty substance called myelin. Its usual function is to conduct impulses away from the cell or neuron. *See* NERVOUS SYSTEM; SYNAPSE. (F. L. A.)

AXUM: *see* AKSUM.

AYACUCHO, a department in the highlands of south central Peru (pop. [1958 est.] 572,559; area 17,569 sq.mi.) bounded north by Junín, west by Huancavelica and Ica, south by Arequipa, east by Apurímac and Cuzco (*qq.v.*). It is largely a region of high plateau, interspersed with valleys, drained by the Apurimac and its tributaries. Lake Parinacocha, 12 mi. long and 6 mi. wide, lies in the south of the department. Cattle and sheep graze in the area, and cereals, maize, potatoes, grapes and sugar cane are cultivated there. Industries include the manufacture of woolen textiles, sugar, wine and alcohol. Silver, nickel, cobalt, copper, manganese, sulfur and asphalt are important mineral resources. The population is chiefly Indian and mestizo. The city of Ayacucho (*q.v.*) is the capital of the department. (J. L. TR.)

AYACUCHO, a city in the highland region of south central Peru (pop. [1958 est.] 26,650), capital of the department of the same name and of the province of Huamanga. Founded in 1539 by Francisco Pizarro (*q.v.*), it was known as Huamanga until 1825. The city gained its present name from the plain of Ayacucho (meaning "corner of death" in Quechua), which lies near Quinua, the scene of the decisive defeat in 1824 of the royalist forces by the revolutionaries under command of Gen. Antonio José de Sucre (*q.v.*).

Ayacucho lies in a fertile valley at 8,987 ft. above sea level in latitude 13° 6′ S. Important archaeological ruins are found near the city. The climate is pleasant and invigorating. Crops cultivated in the district include cereals, maize, potatoes, grapes and sugar cane; cattle and sheep graze in the area. Significant industrial products of Ayacucho are filigree ware, woolen textiles, wine, alcohol, pottery and leather goods. Mineral resources of the region comprise silver, nickel, cobalt, copper, manganese, sulfur and asphalt. The city, seat of a bishopric, contains a cathedral and many churches. The Colonial university that functioned in Ayacucho until the 1880s was reopened in 1958. Ayacucho is on the highway between Lima and Cuzco approximately midway between these cities in a total distance of 720 mi. Ayacucho may also be reached by air. The nearest railhead is at Huancavelica. (J. L. TR.)

AYACUCHO, BATTLE OF, won by the "patriots" on Dec. 9, 1824, freed Peru and sealed Spain's doom in the new world. The revolutionary forces numbering about 6,000 men, among them Venezuelans, Colombians, Argentines and Chileans as well as Peruvians, were under the leadership of Simón Bolívar's outstanding lieutenant, the Venezuelan Antonio José de Sucre (*q.v.*). He opened the attack with a brilliant cavalry charge led by the daring Colombian José María Córdoba, and in a short time the Spanish army of over 9,000 was nearly annihilated. The terms of surrender provided that all Spanish forces would be withdrawn from both Peru and Charcas (Bolivia). The last of the Spanish soldiers departed from Callao, the port for Lima, in Jan. 1826. *See* PERU: *History*. (J. J. J.)

AYALA, BALTASAR (1548–1584), Spanish jurist, was born in Antwerp during the subjection of the Low Countries to the throne of Spain and was auditor general in the army sent by Philip II to suppress the rebellion of the states-general. His work *De jure et officiis bellicis et disciplina militarii* ("On the Law and Duties of War and Military Discipline"), published in 1582, is devoted partly to a discussion of the law of war in general, including the conditions of a just war, and partly to the application of the law of war to actual military operations. While his principles of a just war were a contribution to greater restraint in relation to the conduct of hostilities, his conception of the rights of the monarch was reactionary and his denial of the application of the law of war to rebels is in strong contrast with the more humanitarian ideas of Francisco de Vitoria.

See *De jure et officiis bellicis et disciplina militarii*, trans. by J. P. Bate, in "Classics of International Law"; James Brown Scott, *Law, the State, and the International Community*, vol. I, ch. xxiv (1939). (C. G. FX.)

AYALA, PEDRO LÓPEZ DE: *see* LÓPEZ DE AYALA, PEDRO.

AYALA Y HERRERA, ADELARDO LÓPEZ DE (1828–1879), Spanish dramatist and politician, whose most distinctive achievement is in his comedies of contemporary manners, was born at Guadalcanal, Seville, May 1, 1828. While still young, he enjoyed success as a playwright and this led to political advancement. Being without firm political convictions, he found little difficulty in changing party. Thus he was prominent in the revolutionary movement to drive the Bourbons from the throne in 1868, but took office when they were restored, becoming eventually president of the *Cortes*.

Ayala died in Madrid, Dec. 30, 1879.

His plays are of three kinds. The earliest, notably *Un hombre de estado* (1851) and *Rioja* (1854), which are set in the royal court of 17th-century Spain, are historical verse dramas. He also wrote *zarzuelas* (musical plays), mostly with a historical background, and sometimes, *e.g.*, *El conde de Castralla* (1856), containing satirical allusions to current politics. In his later work—*El tejado de vidrio* (1856), *El tanto por ciento* (1861), *El nuevo don Juan* (1863) and *Consuelo* (1878)—the moralizing tendency, already apparent in his first plays, is more pronounced, and there is an attempt at realistic presentation of the upper and middle classes of 19th-century Spain. The realism is timid, however, and the satire is in general moral rather than specific social terms. Self-seeking and sexual licence are its conventional targets. *Consuelo*, his finest play in spite of a somewhat contrived plot, is a natural and impressive portrayal of a girl who suffers the consequences of her rejection of a worthy but poor suitor for a wealthy scoundrel. (H. B. HL.)

AYDIN (AIDIN), the centre and a chief town of the *il* (province) of the same name in southwestern Turkey, about 70 mi. E.S.E. of Izmir with which it is linked by railway. Pop. (1960) 35,671. It lies on the lower slopes of hills overlooking the fertile valley of the Buyuk Menderes (anc. Maeander) river, and on a nearby height are the ruins of the ancient Tralles (*q.v.*). It is an important trading centre for the crops grown in the neighbouring plain; the chief products are olives and olive oil, dried figs and grapes, tobacco and cotton. It also exports licorice and acorns of valonia oak used for tanning.

Aydin was taken by the Seljuks, Aidin and Mentesh late in the 13th century, and about 1390, when ruled by Isa Bey, a descendant of Aidin, acknowledged Ottoman suzerainty. In the Seljuk period it was only a secondary city. The town suffered severely in the Greco-Turkish conflict of 1919–22.

The *il* of Aydin (pop., 1960, 469,888; area 2,957 sq.mi. includes the greater part of the Buyuk Menderes valley and its mountainous borders to north and south. It is densely populated and one of the most important agricultural areas of Turkey, its chief crops being figs, olives and cotton. Nazilli, about 30 mi. E. of

Aydin, is a centre of the cotton textile industry.

(N. Tu.; S. Er.; E. Tu.)

AYE-AYE, the most remarkable of all the Malagasy lemurs. The aye-aye, *Daubentonia madagascariensis*, has a broad rounded head, short face, large eyes, large hands and long thin fingers with pointed claws, of which the third is remarkable for its extreme slenderness. The foot resembles that of the other lemurs in its large opposable great toe with a flat nail; but all the other toes have

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AYE-AYE (DAUBENTONIA MADAGASCARIENSIS)

pointed compressed claws. The tail is long and bushy. The general colour is dark brown, the outer fur being long and rather loose, with a woolly undercoat. It is nocturnal in its habits, living alone or in pairs in the bamboo forests. It feeds on juices, especially of the sugar cane, which it obtains by tearing the stalk with its strong incisor teeth; but it also devours wood-boring caterpillars, which it obtains by cutting their burrows with its teeth and picking them out of their retreat with the claw of its attenuated middle finger. It constructs large ball-like nests of dried leaves, lodged in a fork of the branches of a large tree, and with the opening on one side. *See* PRIMATES: *Lemurs: Lemuriformes.*

AYLESBURY, a municipal borough and the county town of Buckinghamshire in the Aylesbury parliamentary division, 39 mi. N.W. of London by road. Pop. (1961) 27,923. Area 5.1 sq.mi. An important market town, it stands on a low hill in the vale of Aylesbury, a rich agricultural district once renowned for its ducks. Its industries include printing, food products, rivet manufacture and light engineering.

Aylesbury (Saxon Aegelsburh) was the centre of a hundred (*q.v.*) before the Conquest and in 1239 Henry III granted it an annual fair at the feast of St. Osyth. Queen Mary's charter of 1554 constituted it a free borough but it was not until 1916 that it was incorporated. The 12th- to 13th-century church of St. Mary, built on an earlier site, crowns the hill and stands in a square of 17th- to 18th-century houses. The narrow streets of the old town converge upon the market square where stand the county hall (1720), in which the assizes, quarter and petty sessions are held, and the King's Head hotel (15th century), which belongs to the National Trust. The old building of Aylesbury grammar school (1598) is now part of the county museum. The school moved to new premises in 1906.

AYLESFORD, HENEAGE FINCH, 1ST EARL OF (1649?–1719), English lawyer prominent in the reign of James II, was the second son of Heneage Finch, 1st earl of Nottingham. Educated at Westminster school and at Christ Church, Oxford, he was appointed solicitor general in 1679, being returned to parliament that year for Oxford university, and in 1685 for Guildford. He represented the crown in the attack upon the corporation of London (1682) and the next year in the prosecution of Lord William Russell, when, according to G. Burnet, "he showed more of a vicious eloquence in turning matters with some subtlety against the prisoners than of strict or sincere reasoning." In the trial of Algernon Sidney (1684), he supported the opinion of Lord Chief Justice Jeffreys that *scribere est agere*, arguing that the unpublished treatise of the accused was an overt act. The same year he was counsel for James II in his successful action against Titus Oates for libel, and in 1685 prosecuted Oates for the crown for perjury. Finch, however, though a Tory and a crown lawyer, was a staunch churchman, and on his refusal in 1686 to defend the royal dispensing power he was summarily dismissed by the king. As leading counsel for the seven bishops (1688) he argued that such a power was "a power to abrogate law," which "is as much a part of the legislature as a power to make laws." He sat again for Oxford university in the Convention parliament of 1689–90 and in all the following assemblies, except that of 1698, until 1703.

He was one of the few who in the house of commons opposed the famous vote that James II had broken the contract between king and people and left the throne vacant. In 1689 he joined in voting for the reversal of Lord Russell's attainder and endeavoured to defend his conduct in the trial, but was refused a hearing by the house. He held no office during the reign of William III, but in 1703 he was raised to the peerage and made a privy councilor. After the accession of George I in 1714, he was created earl of Aylesford and appointed chancellor of the duchy of Lancaster. He died on July 22, 1719. (G. H. J.)

AYLESFORD, a village in the Sevenoaks parliamentary division of Kent, Eng., 3½ mi. N.W. of Maidstone. Pop. (1961) 5,278. It was the first point at which the Medway could be forded, and Bede states that Vortigern here fought Hengist and Horsa in 455. The river is crossed by a modernized 14th-century bridge. About a mile northeast are two megalithic tombs, Kit's Coty house, consisting of three upright stones and a capstone, and the Countless Stones. Aylesford cemetery bears witness to the Belgic invasions (about 75 B.C.). The church of St. Peter, on a hill above the Medway, dates from Norman times and a Carmelite friary, founded in 1242, has been restored to its original purpose. Preston hall, the ancient home of the Colepepers, is a hospital for tubercular patients and attached to it is a village settlement for their rehabilitation run by the British Legion and known as "British Legion village." The main occupations of the Aylesford people are quarrying, paper-making and agriculture.

AYLLÓN, LUCAS VAZQUEZ DE (*c.* 1475–1526), Spanish explorer and colonizer of South Carolina, was born in Toledo of a wealthy family. In 1502 he accompanied Nicolás de Ovando to the West Indies island of Hispaniola and became judge in the colonial administration of the island. In 1520 he went to Mexico with the intention of mediating the dispute between Cortés and Diego Velázquez over the observance of royal orders in New Spain. An expedition sent by him under command of Francisco Gordillo made a landfall near Cape Fear on the North American continent in 1522 and the following year Ayllón went to Spain to secure a royal charter for the exploration and settlement of that coast. He was authorized by Charles V to explore 800 leagues of territory taking special pains to find a strait to the Spice Islands. In the early summer of 1526 Ayllón sailed from Hispaniola to found a settlement, probably at the mouth of the Pee Dee river, called San Miguel de Guadalupe. (Little credence can be given to the claim that the settlement was made at Jamestown, Va.) The colony was ill-fated, however, and abandoned after Ayllón and many men had died in a fever epidemic. He left two manuscripts later used by Peter Martyr.

See W. Lowery, *The Spanish Settlements Within the Present Limits of the United States 1513–1561* (1911). (U. S. L.)

AYLMER, JOHN (1521–1594), bishop of London, distinguished by his thorough enforcement of the Elizabethan act of uniformity in his diocese, was born at Aylmer hall, in Norfolk. About 1541 he was made chaplain to the duke of Suffolk and tutor to his daughter Lady Jane Grey. He became archdeacon of Stow in 1553, but his opposition in convocation to the doctrine of transubstantiation soon led to his deprivation. From exile in Switzerland he wrote a reply to John Knox's famous *Blast Against the Monstrous Regiment of Women* under the title *An Harborowe for Faithfull and Trewe Subiectes* (1559). On the accession of Elizabeth he returned to England. He became archdeacon of Lincoln in 1562, when he was a member of the convocation that reformed and settled the doctrine and discipline of the Church of England. In 1577 he was consecrated bishop of London, and thereafter made himself notorious by his harsh treatment of all who differed from him on ecclesiastical questions, whether puritan or papist. He is attacked in the Marprelate tracts (1588; *see* MARPRELATE CONTROVERSY) and is characterized as "Morrell," the bad shepherd, in Edmund Spenser's *The Shepheardes Calender.* He died on June 3, 1594.

See the eulogistic life by J. Strype (1701). (G. Hu.)

AYMARA, a large South American Indian group living in the vast windy 12,500-ft.-high Titicaca plateau of the central Andes, between the western Maritime Cordillera and the eastern snow-capped Cordillera Real, and southward to Lake Poopó and the salt marshes of Uyuni. In colonial times the Aymara tribes were the Canchi, Colla, Lupaca, Collagua, Ubina, Pacasa, Caranga, Charca, Quillaca, Umasuya and Collahuaya, their territories corresponding largely to modern Bolivian political divisions of similar name. Additionally, Aymara was anciently spoken in the provinces of Lipes and Chichas (southern Bolivia), Arica (northern Chile), and southern portions of the departments of Cuzco, Apurímac and Ayacucho (southern Peru). Modern Aymara number 600,000 in Peru and Bolivia (*see* BOLIVIA: *The People;* PERU: *The People*).

Basically agriculturalists and herders, the Aymara live in an area of poor soil and harsh climate. Trees are rare; coarse grass gives pasturage for llama and alpaca herds; fuel is of the semi-subterranean *tola* brush or llama dung. Some fish are taken with nets in the lake and its southern outlet, the Río Desaguadero. The uncertainty of life on the harsh, raw plateau has led the Aymara to develop much magic to control natural phenomena and to assure food from crops, flocks and fishing.

The builders of the huge stone ruins at Tiahuanaco were unknown by the colonial period, though they were doubtless ancestors of the Aymara; the influence of the pre-Incan Tiahuanacan culture may be seen archaeologically as far as the Pacific coast. The pre-Incan period of the *Chullpas* (corbelled tower graves of chiefs and other important people) was one of independent, warring Aymara states, the most important being those of the Colla, capital Hatuncolla, and the Lupaca, capital Chucuito. About 1430 the Inca emperor Viracocha began conquests southward from his capital at Cuzco. Former Aymara territories ultimately formed a major part of the Inca empire, against which the Aymara continually revolted. In the Inca civil war, the Aymara supported Huascar against Atahualpa.

The Spanish conquest began in 1535 under Diego de Almagro. Seekers of gold and serfs were followed by Dominican and Jesuit friars seeking converts, present-day Aymara being nominally Catholic. The Spanish *encomienda* economy for food production, household serfs, miners and coca plantations was based on the native *ayllu*, a loosely patrilineal land-owning group or *communidad*. Exploitation reached its height under the viceroy Toledo, and the period of rebellion begun in 1780 ended with independence of the Spanish crown in 1821.

Aymara were the first cultivators of the misnamed "Irish" or white potato, of which they had over 200 named varieties, and most of which were made into frost-dried *chuñu*, an Aymara staple. They also had 10 varieties of oca (*Oxalis tuberosa*), 5 of ullucu (*Ullucus tuberosus*), 6 of the spinach-family seed-grain quinoa (*Chenopodium quinoa*), 2 of kañawa (*Chenopodium* spp.) and 6 of corn (*Zea mays*), which last they did not originate and which grows poorly in the cold dry *altiplano*. European beans (*Vicia faba*), barley and wheat have been added since the conquest. Men dig, plow, fertilize and thresh, but women plant. In ancient times there was some irrigation, manuring and crop rotation, and to a lesser extent there is today. Herding of llamas and alpacas is done by women and children; llamas are used as beasts of burden, their flesh, rarely eaten, being dried into *charqui* ("jerky"); alpacas are used for their fine wool from which Aymara women spin and weave sturdy warm clothing. Fishing is from *balsas, i.e.,* cigar-shaped, giant totora-reed rafts, poled or mat-sailed, using dragnets, dip nets and fish fences.

Aymara clothing copies in crude homespun earlier Spanish colonial models. Men wear conical, ear-flapped, knit wool *gorros;* women wear round, native-made wool derbies, with wool wimples in cold weather. Aboriginally, Aymara deformed their heads into the spectacular "sugar-loaf" form by binding in infancy. The single-room, rectangular, gabled Aymara house, about eight by ten feet in size, is made of turf, with wild grass thatching over pole rafters, with a family sleeping platform of mud at one end and a clay stove near the door.

Pottery, weaving, metal- and leatherwork are all crude even by earlier colonial, and certainly by Tiahuanacan, standards.

Aymara religion consists in alcohol and llama-blood libations to the earth goddess Pachamama, to the Spirit of the Lake and to the Pampa spirit, supernatural "owner" of the animals. Thunupa is the god of lightning, much feared by the Aymara. Their world is densely populated with other spirits also: *waka* which are either good or evil; *achachilas* or locality demons causing sickness by soul kidnaping; *supaya* or evil demons; a beautiful young woman demon causing insanity; an evil hag who brings epidemics; a three-headed water monster of Lake Titicaca; and dangerous nocturnal flying heads. The Aymara have many categories of magicians, diviners, medicine men and witches to cope with these supernaturals. Their *materia medica*, mostly of plant origin numbers over 400 items, including quinine for fever, mercury pomade for syphilis, and many others, some of which are probably effective medically.

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AYODHYA (AJODHYA), an ancient city of India on the Gogra river near Fyzabad, Uttar Pradesh, is one of the seven sacred Hindu shrines, for in antiquity it was the magnificent (96 mi. perimeter) capital of Dasharatha, king of Kosala and father of Rama, the eponymous hero of the *Ramayana*. The temple marking the site of Rama's birth was converted by the Mogul emperor Babur into a mosque, although the Hanumangarh and Kanak Bhavan temples are still in use by Ramaite Vaishnavas. Several bathing ghats are associated with the Rama legend, as are the flocks of red monkeys still ubiquitous in the town. (*See* RĀMĀYANA.)

Kosala has claims to be the birthplace of the founders of Buddhism and Jainism, and a period of Buddhist supremacy obtained in Ayodhya until its restoration by Chandra Gupta II (Vikramaditya) *c.* 57 B.C., and the revival of Hinduism; even in the 7th century the Chinese traveler Hsüan Tsang recorded 20 Buddhist temples with 3,000 monks there. Apart from the temples named above, Ayodhya is largely in ruins, and the modern town is insignificant. (J. B.-P.)

AYR, a royal and parliamentary burgh, county town of Ayrshire, Scot., and seaport at the mouth of the river Ayr, 33 mi S.S.W. of Glasgow by road. Pop. (1961) 45,276. It receives its name from the river; *ar* or *ad'har* in Gaelic signifies clear or rapid, also shelving and fordable. The burgh embraces Newton-on-Ayr, Wallacetown, Whitletts and Alloway and its boundaries stretch from Prestwick to the river Doon. Newtown is a burgh of barony with charter said to have been granted by King Robert the Bruce to 48 inhabitants who had fought at Bannockburn. Ayr was created a king's burgh (renamed royal burgh in the 15th century) by William the Lion in 1202. He built a castle (of which nothing remains) and made it a garrison town and the court town of the sheriffdom of Ayr, which it still is. During the wars of Scottish independence, the town was the scene of many of William Wallace's exploits. In the church of St. John, the Scots parliament met in 1315 after the victory of Bannockburn to confirm Bruce and his family in possession of the crown of Scotland. As a result of the Reformation, the two monasteries in Ayr were suppressed and the citizens developed strong Presbyterian tendencies. Later when Cromwell subdued Scotland he built a fort, including the tower of St. John near the harbour, known as Cromwell's fort. In the 18th century Ayr was a small town congregating round the High street, the Sandgate and the adjoining Vennels. By the mid-19th century it had become a social centre and watering place for the Scottish gentry. The establishment of new industries, stimulated by the opening of the Glasgow-Ayr railway in 1840, did not completely alter its appearance, as they were sited north of the river, in Newton-on-Ayr and Wallacetown. The oldest among them are metalworking and engineering, which have been carried on for more than a century. Others include drop-stamping and stamping works; light engineering; the making of agricultural implements, chemicals, fertilizers; textiles and carpets; boots and shoes; and furniture. In 1935 the burgh was extended to include Whitletts and Alloway.

Ayr proper lies on the south bank of the river, which is crossed by three road bridges and two railway bridges. Between the Sandgate and the harbour is Loudoun hall (16th century, restored), the town house of the Loudouns, for long sheriffs of Ayr. Near the town centre is the beach where the Low green is fronted by a 2½-mi.-long esplanade.

In the middle ages Ayr was the chief Scottish port on the west coast, but was later superseded by the new ports farther up the Clyde. The harbour has 36,000 ft. of wharves and can take vessels with a draught of 21 ft. Port equipment includes a coaling conveyor and electric cranes and steam cranes up to 40 tons capacity. A slipway 850 ft. long capable of handling vessels up to 2,000 tons is within the harbour area. Coal is exported, mainly to the Irish ports. Facilities are also available on the south quay for the landing and marketing of fish. Ayr is an important market centre and large cattle sales are held weekly. The Ayrshire Agricultural show is held annually in April on the racecourse, near Whitletts, and lasts two days. Ayr is also reckoned as the Newmarket of Scotland and many meetings are held on the new racecourse.

Two local weekly newspapers are published, the *Ayrshire Post,* established in 1880, and the *Ayr Advertiser,* which first appeared in 1803. Of the 12 schools accommodating 7,000 pupils, Ayr academy, dating from 1233, is the most notable, with approximately 1,000 pupils. Robert Burns was born at Alloway (*q.v.*) and spent most of his life in the vicinity. The corporation owns two scenic estates at Belleisle and Craigie park which are administered for the benefit of the public. (W. R. W.)

AYRE, SIR AMOS LOWREY (1885–1952), British shipbuilder who enjoyed international prestige, combining fullest technical knowledge with practical experience, was born at South Shields, Durham, on July 23, 1885. He was educated at Armstrong college, Newcastle upon Tyne, where he distinguished himself in naval architecture. After World War I he joined his brother in founding the successful Burntisland Shipbuilding company, of which he was chairman until 1936. Ayre showed keen interest in international work for the industry, and in 1928 represented British shipbuilding and acted as chairman at the League of Nations committee on international shipbuilding statistics. During 1930–31 he was president of the Shipbuilding Employers' federation, and subsequently left his firm to become permanent chairman of the industry's national commercial organization, the Shipbuilding conference. During World War II he was director of merchant shipbuilding at the admiralty. Knighted in 1937, Ayre was made a knight of the British Empire in 1943. He died in London on Jan. 13, 1952. (R. B. Sh.)

AYRER, JAKOB (1544?–1605), prolific German dramatist of minor talents, was probably born in Nürnberg. The date is uncertain, but it may have been in March 1544. He moved to Bamberg in 1570, returning to Nürnberg in 1593. A lawyer by profession, by the time he died (at Nürnberg, March 24 or 26, 1605) he was a member of the city council and an imperial notary.

Apart from his *Bamberg Chronicle* and a version of the Psalter, both on traditional lines, Ayrer wrote over 100 plays; 30 tragedies and comedies and 36 *Fastnachtsspiele* (Shrovetide farces) and *Singspiele* are printed in his *Opus theatricum* (1618). As a dramatist he is the successor of Hans Sachs, resembling him in versification and diction, in the simplicity of his character-drawing, his moralistic attitude and the undramatic, narrative quality of his dialogue. But unlike Sachs at his best, his plots tend to lose themselves in endless episodic detail. The Englische Komödianten (troupes of English actors who performed crude but theatrically effective versions of Elizabethan plays in Germany in the late 16th and early 17th centuries) taught Ayrer to concentrate on outward action, sensational incidents and spectacular effect; the "English" clown replaced the traditional fool and appeared even in serious plays. English jigs were models for his *Singspiele,* with strophic texts sung to traditional tunes, while the "English" repertory provided new subjects. Other subjects range from Germanic legend, Livy and Boccaccio to comic anecdotes of daily life. Despite some new features, Ayrer essentially represented the end of an older tradition and had no direct successors.

Bibliography.—*Ayrers Dramen,* ed. by A. von Keller, 5 vol. (1865). *See* also W. Wodick, *Jakob Ayrers Dramen* (1912); G. Höfer, *Die Bildung Jakob Ayrers* (1929); W. Stammler, *Von der Mystik zum Barock,* 2nd ed. (1950). (J. R. We.)

AYRSHIRE, a southwestern county of Scotland, is bounded on the north by Renfrewshire, on the east by Lanarkshire, Dumfriesshire and Kirkcudbrightshire, on the south by Wigtownshire and on the west by the Firth of Clyde. Area 1,132 sq.mi.; pop. (1961) 342,855.

Physical Features.—The shore curves southward from Wemyss Bay on the narrow, middle part of the Clyde estuary and then in a great bight to the mouth of Loch Ryan. The land rises from a coastal plain to an eastern boundary linking hill groups of from 1,200 to 2,000 ft. Thus the county roughly resembles a crescent-shaped piece of saucer, concave to the west around Ayr bay and Irvine bay. To these bays flow most of the rivers along roughly radial courses. From north to south they are the Garnock, Irvine, Ayr (the longest, 38 mi.), Doon, Girvan and Stinchar. Rivers divide Ayrshire into three districts (former baileries, see *History* below)—Cunninghame north of the Irvine, Kyle between Irvine and Doon and Carrick south of the Doon. The many lochs, the chief being Doon, Finlas and Bradan, provide water for the whole area. There are three islands, including Ailsa Craig (*q.v.*), a large inhabited rock of intrusive riebeckite-microdiorite reaching 1,114 ft. above mean sea level.

On the eastern rim, high moorland comprises about one-third of the county. This is wind-swept country of curlew and grouse with large farms and wide views across the lowlands to the firth and the hills beyond. The mean annual rainfall is commonly 60–100 in. The vegetation varies with slope, etc., between acid grasslands (fescue and purple moor grasses with matgrass, heather and bracken), wet grass moor (*Molinia,* sedges, etc.) and peat mosses with cotton grass, deer grass and sphagnum. The highest moors lie in the southern uplands (southeast of the main and branch faults running from New Cumnock to Girvan), mostly over Ordovician shales and grits, lightly metamorphosed in the Caledonian orogenesis; Shalloch on Minnoch (2,520 ft.) and Kirriereoch (2,565 ft.) are part of the metamorphic aureole around the Merrick granite boss in Kirkcudbrightshire. Outliers of these high plateaus in eastern Kyle and Cunninghame, and in the Kilbirnie hills farther north, are separated by valleys leading through to Glasgow and Clydesdale. Much of this country consists of Carboniferous basalts, with some Silurian inliers.

More than half of Ayrshire is rolling lowland between 100 and 1,000 ft. above sea level. Plateau surfaces are planed across a synclinal structure, including important coal-yielding Carboniferous rocks, complicated by faulting and igneous intrusions which make mining difficult. In the centre are productive Coal Measures, overlain in places by barren Red Measures and by red Permian sandstone, much used for building. Rolling boulder clay cover gives light but fertile soils in Cunninghame, derived largely from Old Red Sandstone and basalts, but colder and heavier soils in Kyle, including much Carboniferous material. A mean annual rainfall of 40–50 in. in a mild, drizzly climate gives luxuriant growth. This is a soft, gentle landscape of whitewashed houses, sometimes still thatched, amid trim fields of fodder crops and ley, interrupted by the large manufacturing town of Kilmarnock or industrialized valleys like that of the upper Irvine.

Fringing the shore are, first, sand dunes with bent grass, attractive to vacationers, then turfy "links" on the sand-apron, largely turned into golf links, and inland postglacial raised beaches mainly at about 25 and 100 ft. above sea level, which yield well-drained easily warmed soils, responding to intensive cultivation for early potatoes, strawberries, etc., if well fertilized. The climate is mild (January mean 40°–42° F.) and fairly sunny (January mean more than 1 hr. per day, August 4½ hr.), with moderate rainfall (largely less than 35 in. mean annual). The low incidence of fog (less than 5 days per year on the average) is of importance to Prestwick airfield. (A. T. A. L.)

History.—Various small prehistoric finds show that the county has been continuously inhabited for 6,000 years. The only trace

of Roman penetration against the tribe of the Damnonii is the site of a fort, built during Agricola's invasion of Caledonia (A.D. 79–84), near Loudoun hill. During the dark ages the tribal kingdom of the Strathclyde Britons occupied southwestern Scotland. In 1034 it was included in the rudimentary kingdom of Scotland and its king Duncan became the first king of all Scotland. Norman infiltration is visible in the still used parish church of Symington, first built in 1160, and in the great ruined castle at Dundonald, first built in 1135. Crossraguel abbey, 2 mi. S.W. of Maybole, founded in 1244, is the best preserved of the ruined monasteries.

Rudimentary royal administration of the shire began in the 12th century. Prestwick became a burgh of barony in 1165. By 1207 the sheriffdom of Ayr included the baileries of Cunninghame, Kyle (Kyle Stewart and King's Kyle) and Carrick. Between 1203 and 1206 Ayr and in 1372 Irvine became king's (later royal) burghs. The invading Norwegians were defeated at the battle of Largs (1263) by Alexander III. In 1297, at Ayr, William Wallace began the struggle to regain Scotland's independence from England. Robert Bruce, earl of Carrick, began his successful fight for the Scottish throne at his home, Turnberry castle, in 1307; he held a parliament at the church of St. John the Baptist, Ayr, in 1315. During the middle ages the great baronial families, such as the Kennedys of Dunure castle (now in ruins) and the Mures of Rowallan castle (still occupied), held sway. The Reformation (1560), including visits by John Knox, was accepted quietly and the monasteries were dissolved. To control southwestern Scotland, Oliver Cromwell built a citadel at Ayr in 1654. After the Covenanters' brief victory at the battle of Drumclog (1679), near Loudoun hill, their martyrs' graves show their suppression.

With the industrial revolution, Scotland's first deep coal mines were sunk at Stevenston in 1780; iron works were opened at Muirkirk in 1787; and factory textile production began at Catrine in 1787. The agricultural revolution brought enclosures, draining and crop rotation. In 1812 the duke of Portland built a horse-drawn tramway from his Riccarton (Kilmarnock) coalpits to his newly built harbour at Troon; and four years later he introduced on to it the first steam locomotive in Scotland.

Among notable men native to Ayrshire are: Robert Burns, the poet, born at Alloway (*q.v.*) in 1759; John Galt, the novelist; William Murdock, the inventor of coal gas; John Loudon McAdam, originator of the "macadamizing" of roads; John Boyd Dunlop, pioneer of the pneumatic rubber tire; and Sir Alexander Fleming, who discovered penicillin. Culzean (*q.v.*) castle, designed by Robert Adam in 1775, which is the home of the marquis of Ailsa and contains a flat given for life to former Pres. Dwight D. Eisenhower to commemorate his services in World War II, was presented to the National Trust for Scotland.

Population and Administration.—The population of Ayrshire in 1961 was 342,822; 57,552 more than in 1931. Ayr (45,276), the county town, and Kilmarnock (47,509) (*qq.v.*) are large burghs. The small burghs include Ardrossan (9,573), Irvine (16,911), Largs (9,104), Troon (9,927), Prestwick (*qq.v.*) (12,562) and Saltcoats (14,182). There are five parliamentary constituencies: Ayr and Kilmarnock burghs, and South, Central and North Ayrshire, the latter including Buteshire.

In each burgh the magistrates court deals with minor offences at common law, but serious offences are remitted to the sheriff court at Ayr. The lord lieutenant of the county has only the high ceremonial prestige of being the sovereign's personal representative. Local public services are administered by the town councils of the burghs and district councils of the country areas. County public services are organized by the county council from Ayr, though Ayr and Kilmarnock burghs maintain some of their own, *e.g.*, police and libraries.

Industries and Communications.—Ayrshire is one of the most important and best-developed agricultural counties in Scotland though farming employs less than 6% of the population. The lowland's lush meadows have the heaviest stock-carrying capacity in Scotland. In the early 1960s its numerous dairy farms with about 150,000 dairy cattle produced about one-fifth of Scotland's milk supply, all from T.T. or attested herds of the world-famous Ayrshire breed (*see* CATTLE) whose pedigree records are in Ayr, the main stock market. At Auchincruive, near Ayr, the West of Scotland Agricultural college's practical department, the Hannah Dairy Research institute and the Scottish Horticultural Research institute ensure scientific progress. There were about 30,000 beef cattle in the early 1960s. The raising of poultry and pigs is also significant. Tractors had all but replaced the Clydesdale draft horses by the early 1960s. There were about 450,000 mutton Blackface hill sheep and Border Leicester marginal land sheep. About 25% of the arable land is devoted to crops, mainly oats and turnips. The almost frost-free sandy soil near the coast produces large crops of Epicure potatoes, Scotland's earliest, and market gardens supply the industrial areas. Industries connected with agriculture include: butter, cheese, cream and powdered milk processing at Mauchline and Kilmaurs; the canning of vegetables at Kilwinning; one of Scotland's largest fertilizer plants at Ayr; the processing of seaweed into many commodities at Girvan; and the production of 90% of Great Britain's output of self-propelled combine harvesters at Kilmarnock.

The main industrial areas are the Irvine and Garnock valleys. The chief textile industry is woolen hosiery, with about 60 factories in Kilmarnock, Ayr, Irvine, Stewarton and Dalry, while carpets are made at Kilmarnock and Ayr, nylon at Kilmarnock and Stewarton, cotton at Catrine, linen at Kilbirnie, balmorals and Glengarries for Scottish regiments at Kilmarnock, blankets at Galston, Hollybush and Dunlop. Two-thirds of Great Britain's lace comes from Galston, Newmilns and Darvel. Kilmarnock, the industrial centre, has the largest hydraulic engineering plant in the commonwealth and makes ball bearings and agricultural machinery. Ayr also makes agricultural machinery and has one of Great Britain's largest drop forges and the country's only manufacturers of mounted hammer mills. Prestwick has aircraft engineering and construction works, Glengarnock steel mills and Ardeer (Stevenston) commercial explosive and chemical works, while Ardrossan petroleum refinery produces the biggest output of bitumen in Scotland. Ships are built at Ardrossan and Troon, repaired at Ardrossan, Troon and Ayr, and broken up at Troon. Mauchline (*q.v.*) makes curling stones, importing the rough material from Ailsa Craig, for export. Whisky is blended at Kilmarnock. Ayr, Kilmarnock and Maybole produce footwear, Beith furniture, and Kilmarnock and Hurlford earthenware.

Coal is exported from Ayr to Northern Ireland and from Troon to the western coastal areas of Scotland. The Central Ayrshire coal field, which provides the main occupation for many villages, has reserves estimated at 1,000,000,000 tons. The estimated annual production for the mid-1960s was more than 6,000,000 tons (about one-fifth of the total for Scotland), including 1,500,000 tons from each of the new mines near Ochiltree, at Killoch colliery and the Barony colliery, beside which is a 60-megawatt electricity generating station burning slurry. By the mid-1960s the Hunterston (West Kilbride) atomic power station was expected to produce 300 megawatts annually for the national grid. Bauxite and limestone are mined at Beith, whinstone at Dundonald, fire clay at Dalry and brick clay at Annbank, Dreghorn and Dalry.

The formerly important fishing industry was declining in the 1960s, though harbour facilities were improved at Ayr, Maidens, Girvan and Dunure. Popular seaside and golfing resorts are Largs, Saltcoats, Troon and Prestwick (championship courses), Ayr and Girvan. There is a modern holiday camp at the Heads of Ayr and there are racecourses at Bogside, near Irvine, which has the Scottish Grand National steeplechase, and Ayr, the "Newmarket of Scotland" with seven meetings annually.

Bus services cover many of the 1,500 mi. of roads. In the 1950s and 1960s new fast diesel trains served the main railway lines, which were to be electrified. The chief harbours are at Ardrossan, which can take vessels up to 14,000 tons, Ayr and Troon. Prestwick's almost fog-free international airport is the largest in Scotland and the second largest and busiest in Great Britain after London. (S. R. W.)

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Ayrshire Archaeological and Natural History Society, *Ayrshire at the Time of Burns* (1959); W. Boyd, *Education in Ayrshire Through Seven Centuries* (1961).

AYRTON, HERTHA (née MARKS) (1854–1923), English scientist, is best known for her work with the electric arc. She was born at Portsea, April 25, 1854. She enrolled in Girton college in 1876, and when she returned, studied science in London and married W. E. Ayrton, whose pupil she had been. W. E. Ayrton is known for his work in association with John Perry on electrical measuring devices, particularly the dynamometer (*q.v.*) and wattmeter. The work on the electric arc, which made Mrs. Ayrton famous, began in 1883, and her book, *The Electric Arc*, appeared in 1902. In 1903 Ayrton was asked by the admiralty to elucidate some of the problems connected with the electric searchlight. The four reports (1904–08) were largely, and the last one entirely, the work of Mrs. Ayrton. She continued to work on the problem after her husband's death in 1908, continuing at the same time her researches on ripples in water. Her discoveries in this connection she utilized in the invention of the Ayrton antigas fan for the repulsion of noxious gases in war. The first installment of these fans was sent to the front in France in May 1916. She was then asked by the war office to investigate the ventilation of gun emplacements. Toward the end of her life she experimented with the transmission of coal gas to obviate the necessity of separate gasworks in each district. She died Aug. 26, 1923.

See Evelyn Sharp, *Hertha Ayrton* (1926).

AYSÉN (AISÉN), a province of southern Chile created in 1929, when it was elevated from territorial status. The territory was formed in 1927 from parts of the present Chiloé, Llanquihue and Magallanes provinces. Pop. (1960) 37,803. Its area, 39,994 sq.mi., includes two-thirds of the Chonos archipelago (island clusters north of lat. 45° 45′ S.), the Taitao peninsula and the mainland between the Palena river and Lake San Martín (Lake O'Higgins). The Taitao peninsula-Chonos group and the Moraleda-Elephant channels, respectively, are the southern end of the submerged Chilean coastal range and longitudinal depression. To the south, as to the east, Andean structure prevails. The series of volcanoes associated with the Andes south of Santiago's latitude terminates northwest of Puerto Aysén. The mountains, which rise 3,000 to 9,000 ft., appear as rugged blocks separated by glaciated valleys and fiords. Perennial snowfields cap most elevations above 3,000 or 3,500 ft.; glaciers extend into the valleys and, in some cases, to the sea. One of the Cerro San Valentín glaciers provides an impressive spectacle at its terminus on Lake San Rafael, northeast of the Isthmus of Ofqui. The rough land at lower elevations is forested, chiefly with broadleaf evergreens. Heavy, all-year rains and uniformly cool but not cold temperatures prevail. The rivers, many of which rise to the east of the main cordillera and cross to the Pacific side, are among the most turbulent in Chile.

The few primitive nonfarming Indians who once lived in this area have all but disappeared. Replacing the coastal Indians are emigrants from Chiloé (*q.v.*) who farm patches of potatoes and wheat and comprise the labour force. On the drier Patagonian side of the province, where brush and grass vegetation is general, colonists are operating larger and more diversified farms. Sheep and cattle are numerous, many of them being raised on three large pastoral concessions which were granted by the government in 1900. Coyhaique, the largest town (pop. [1960] 8,782), Balmaceda (founded 1917) and Chile Chico are trading centres in the developing interior. The latter two have air service to Puerto Montt. The former two are joined by all-weather road to Puerto Aysén (pop. [1960] 5,488), provincial capital and port of call for the small steamers which run between Puerto Montt and Punta Arenas. Lumber, and lead, zinc and silver concentrates are produced. (J. T.)

AYTON (AYTOUN), **SIR ROBERT** (1570–1638), one of the earliest Scottish poets to use southern standard English as a literary medium, was the son of Andrew Ayton of Kinaldie, Fifeshire, and was born in 1570. He was educated at the University of St. Andrews. On the accession of James VI to the English throne he wrote in Paris a Latin panegyric which brought him into immediate favour at court. He was knighted in 1612. He held various lucrative offices, and was private secretary to the queens of James I and Charles I. He died in London, and was buried in Westminster abbey on Feb. 28, 1638. Ayton's contemporary literary reputation was considerable, although he never considered himself as a poet, but his poetry seems stilted and artificial to modern readers.

BIBLIOGRAPHY.—Ayton's Latin poems are printed in *Delitiae Poetarum Scotorum*, i, pp. 40–75 (1637). They are reprinted with his English poems and a memoir in Charles Rogers' edition of *The Poems of Sir Robert Aytoun*, 2nd ed. (privately printed, 1871). For further details of his life, *see* A. B. Grosart in the *Dictionary of National Biography*.

AYTOUN, WILLIAM EDMONDSTOUNE (1813–1865), Scottish poet and humorist whose parodies and light verse make him a forerunner of W. S. Gilbert (*q.v.*), was born at Edinburgh on June 21, 1813. He was a descendant of Sir Robert Aytoun, and his mother, who knew Sir Walter Scott well, gave him his love of ballads and Scottish history. Educated at Edinburgh academy and university and at Aschaffenburg, Ger., where he began to translate Goethe, Aytoun became a writer to the signet in 1835 and in 1840 was called to the Scottish bar. He remained a barrister in spite of his confession that "I followed the Law diligently; but, somehow or other, I never could overtake it."

His early poems, *Poland, Homer and Other Poems* (1832) were serious, and so were his first contributions to *Blackwood's Magazine* (1836); in fact he always regarded himself as primarily a serious poet. In 1849, however, he began to collaborate with Theodore Martin in a series of humorous and satirical papers for Blackwood's, in which first appeared the verses republished separately as *The Bon Gaultier Ballads* (1845). These were models for later writers, especially for Gilbert in the *Bab Ballads*. Aytoun excels in parody (*e.g.*, "The Queen in France," based on "Sir Patrick Spens," and "The Massacre of the Macpherson.")

Aytoun joined the staff of *Blackwood's Magazine* in 1844, contributing political as well as miscellaneous articles for the rest of his life. In 1845 he was appointed professor of rhetoric and belles lettres at Edinburgh university; the number of his students rose from 30 to 1,850 in a few years. Shortly afterward he published *Lays of the Cavaliers* (1848), a set of Jacobite ballads which achieved wide popularity; some, such as "The Execution of Montrose," have a grave beauty. In 1854, reverting to light verse, he published *Firmilian, a Spasmodic Tragedy*, in which the writings of Philip James Bailey, Sydney Dobell (*qq.v.*) and Alexander Smith were brilliantly ridiculed. In 1852 his services to the Tory party, especially in defense of protection, had been recognized by his appointment as sheriff of Orkney.

In 1858 Aytoun published his collection of the *Ballads of Scotland*, 2 vol., and a translation made with Theodore (then Sir Theodore) Martin of the *Poems and Ballads of Goethe* (1858). His novel, *Norman Sinclair* (1861), pictures Scottish manners in the early 19th century. He died at Elgin on Aug. 4, 1865.

Aytoun's poems were edited by F. Page (1921).

See Sir Theodore Martin, *Memoirs of W. E. Aytoun* (1867).

AYUB KHAN, MOHAMMED (1907–), president of Pakistan since 1958, was born on May 14, 1907, in Rihana village, Hazara district, North-West Frontier Province, India (now West Pakistan). His father was Rissaldar-Major (Senior Cavalry Officer) Mir Dad Khan. The family comes of ancient frontier landholding stock with a strong military tradition, and Ayub Khan claims that his background gives him an understanding of the needs and outlook of the rural masses. After attending Aligarh Muslim University he joined the army, passed out from the (British) Royal Military Academy at Sandhurst, and served with the Royal Fusiliers before joining the 14th Punjab Regiment. He saw much active service, commanding a battalion on the Burma front in World War II, before becoming president of the Services Selection Board. After independence (1947), his skilful handling of a difficult situation in Waziristan gave him promotion as major general. In 1951 he became the first Pakistani commander in chief and a national figure. In the face of great difficulties he remodeled the defense forces and improved their status, at a time when ministerial instability and rumours of widespread corrup-

tion had discredited many politicians.

In 1958, after Pres. Iskander Mirza had abrogated the constitution on Oct. 7, Ayub Khan became supreme commander and chief martial law administrator. Shortly afterward, on Oct. 27, 1958, he assumed office as president. He did much to stamp out corruption, with the help of army officers who were temporarily attached to different ministries. He thought that Pakistan needed a strong executive and that it was unfit for the party politics that had weakened previous administrations. The "basic democracies," or local elected bodies, that he established in 1960 were intended to associate the rural population more closely with the government and to exclude the politicians of the former regime, many of whom were disqualified from public office on charges of corruption. He received an overwhelming vote of confidence in 1960 and was re-elected president in 1965. *See* also PAKISTAN: *History.*

AYYUBIDS, the dynasty which ruled over Egypt, upper Iraq, most of Syria and Yemen in the late 12th and early 13th centuries. It took its name from Ayyub (d. 1172), a Kurdish chieftain from Armenia who served a vassal of the Seljuk sultan Alp Arslan and rose to be governor of Damascus. Saladin (*q.v.*), Ayyub's son, was the real founder of the dynasty. It was he who mobilized Muslim enthusiasm to build up a united front against the crusaders and made Egypt the most powerful Muslim state in the world at that time. The death of Kamil I, Saladin's gifted nephew, in 1238, marked the virtual end of the line.

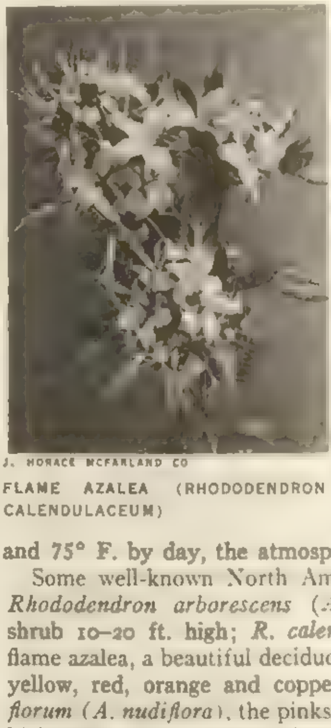
The Ayyubid regime was a decentralized, semifeudal family federation. Under a sovereign to whom all owed allegiance, territories were distributed among vassal relations who enjoyed autonomy in the internal administration of their provinces. The sultan directed the policy of the central government, which was transacted by divans of state. The most important divans were those of war, finance and public security and the chancery which was responsible for the conduct of correspondence and the drafting of treaties. Christians and Jews, who alone possessed the requisite secretarial training and who were generally well treated, carried out much of the administrative routine. The Ayyubids were zealous Sunnite Muslims who warred against Muslim Shi'ites and Christians with missionary enthusiasm and sought to convert them by means of education. The madrasah, an academy of religious sciences in which each of the four schools of Sunnite Islamic law had its own teachers, was introduced by them into Egypt and Jerusalem from eastern Islam. They treated the caliphs of Baghdad with deference and frequently invited their advice and mediation. Yet they showed a certain tolerance to non-Muslims, as when they allowed Dominicans and Franciscans to enter their dominions. Despite the ideological differences which separated the Ayyubids from their Shi'ite Fatimid predecessors, Ayyubid culture may be regarded as an extension and development of the Fatimid. Architecturally, the Ayyubids were great military engineers, as the citadel of Cairo and the defenses of Aleppo testify. The metal work of the period, inspired by craftsmen from Mosul, is excellent.

See C. Cahen, *La Syrie du Nord à l'époque des croisades* (1940) and article "Ayyubids" in *Encyclopaedia of Islam*, 2nd ed. (1958); also G. Wiet, "Les Ayyoubides," *Histoire de la nation égyptienne*, ed. by G. Hanotaux, vol. iv (1937). (R. L. HL.)

AZAÏS, PIERRE HYACINTHE (1766–1845), French philosopher remembered for the visionary optimism of his system, was born on March 1, 1766, at Sorèze in Languedoc, the son of a composer. A friendship with Sophie Cottin, the novelist, brought him into literary society under Napoleon I, and he made his name with *Des Compensations dans les destinées humaines*, 3 vol. (1809), in which he argued that happiness and misery alternate and produce a natural balance in the total of human experience. This was followed by his *Système universel*, 8 vol. (1809–12), a cosmological work in which everything—past, present and future—is "explained" in terms of expansive and compressive forces interacting harmoniously. He was given minor administrative posts and a pension, but lost these at the restoration of the Bourbons and lived in penury until the duc Decazes granted him a government pension again. Meanwhile, in collaboration with his wife, he had published *L'Ami des enfants*, 12 vol. (1816), a continuation of Arnaud Berquin's tales for children. Eventually his theory of compensations, which had proved agreeable to Bonapartist and to Bourbon regimes alike in so far as it discouraged political agitation, became the subject of ridicule. Azaïs also wrote on freemasonry (1834) and on phrenology and magnetism (1839) and published numerous analyses of political trends during the reigns of Charles X and Louis Philippe. He died at St. Émilion on Jan. 22, 1845.

AZALEA, the name still commonly used by most gardeners for certain species of *Rhododendron* (*q.v.*) that were formerly given the generic designation of *Azalea*. The azaleas are commonly described as deciduous shrubs, and this is true of the native North American species, but the Indian azaleas and others are evergreen, while some rhododendrons are deciduous. Neither the shape of the corolla nor other characters are sufficiently constant to serve as means of separating these plants into two distinct genera, although typically azaleas are deciduous while rhododendrons are evergreen, their flowers are funnel-shaped, somewhat two-lipped and often fragrant, rather than campanulate and usually inodorous as in rhododendrons, and possess typically five, rather than ten or more, long-exserted stamens. However, intermediates or intergrades occur.

The beautiful varieties in cultivation have been bred from a few originals, natives of the hilly regions of Asia and the United States. They are perhaps unequaled as indoor decorative plants. Propagation is usually done by grafting the half-ripened shoots on the stronger-growing kinds, the shoots of the stock and the grafts being in a similar half-ripened condition, and the plants then being placed in a moist temperature of 65° F. A rich and fibrous peat soil, with sufficient sand to prevent waterlogging, is required. The best time to pot azaleas is three to four weeks after the blooming is over. To produce handsome specimens, the young plants must be cut back whenever necessary.


J. HORACE MCFARLAND CO

FLAME AZALEA (RHODODENDRON CALENDULACEUM)

Specimens that have grown stringy may be pruned back just before growth commences. The lowest temperature for them during the winter is about 35° F., and during their season of growth from 55° F. to 65° F. at night, and 75° F. by day, the atmosphere being kept relatively humid.

Some well-known North American species are the following: *Rhododendron arborescens* (*Azalea arborescens*), a deciduous shrub 10–20 ft. high; *R. calendulaceum* (*A. calendulacea*), the flame azalea, a beautiful deciduous shrub two to six feet high, with yellow, red, orange and copper-coloured flowers; and *R. nudiflorum* (*A. nudiflora*), the pinkster flower, a shrub three to six feet high, with pink to nearly white flowers. *R. canadense* (*Rhodora canadensis, A. canadensis*), the rhodora, is a much-branched deciduous shrub, one to three feet high, with rose- or pinkish-purple flowers.

The Ghent azalea, *R. gandavense* (*A. gandavensis*), the Korean azalea, *R. yedoense* (*A. yedoensis*), and the Kurume azalea, *R. japonicum* (*A. kurume*), have been the parents of hundreds of named horticultural forms, which, with the North American species, are among the finest hardy shrubs in cultivation. (J. M. BL.)

AZAMGARH, a town in Uttar Pradesh, India, the headquarters of Azamgarh district, is on the Tons river, a tributary of the Gogra (*q.v.*), 53 mi. N.N.E. of Varanasi (Benares). Pop. (1961) 32,391. The Tons encloses the town on east, south and west, a danger to it in times of flood. Azamgarh was founded in 1665 by Azam Khan, a local Rajput chief, feudatory to the Mogul. The only monument of note is the dilapidated remnant of Azam's fort. Azamgarh is now a compact settlement of narrow streets, flanked by both *kucha* (mud, tile-roofed) and *pukka* (masonry)

houses. It is on the Northeastern railway metre-gauge system.

Azamgarh District is bordered on the north by the Gogra river, which is flanked by a low-lying tract varying considerably in width. South of this the ground rises slightly, then slopes away gently toward the southeast. Drainage is in general inadequate to deal with the annual average rainfall of 45 in. brought by the monsoon-type climate. The soil is alluvial and fertile; about 73% of the district's area of 2,222 sq.mi. is cultivated and most of the population (2,408,052 in 1961) depends on agriculture. Rice, sugar cane, wheat, pulses and millets are the main crops. During the rainy season malaria is prevalent, affecting the work of rice cultivation.

Road communications are confined to dry-weather unmetalled roads, apart from the Fyzabad-Gorakhpur-Varanasi main road which passes through the east of the district. The main industries are sugar refining and hand loom weaving. Mau, 25 mi. S.E. of Azamgarh, is noted for fine hand loom cloth, which is exported from the district. Mau is at the junction of the Azamgarh metre-gauge line with that running north from Varanasi. (M. N. K.)

AZAN (Adhan or Ezan), an Arabic word meaning "announcement," is the call to public worship on Friday and to the five daily hours of prayer (*salat*) in Muslim countries. The *azan* is proclaimed by the muezzin, a servant of the mosque chosen for good character, who stands at the door or at the side of a small mosque, or on the minaret (*q.v.*) of a large one. Many mosques have installed electronic recordings of the *azan*, and amplifiers have displaced the muezzin on the parapet.

The *azan* translated runs: "God is most great. I testify there is no god but God. I testify that Mohammed is the apostle of God. Come to prayer. Come to salvation. God is most great. There is no god but God." The first phrase is proclaimed four times, and the rest twice, save for the last. To the morning *azan* is added twice: "Prayer is better than sleep." The worshiper makes a set response to each phrase.

The *azan* was at first simply: "Come to prayer," but according to tradition Mohammed consulted his followers with a view to investing the call with dignity. Some advised using the Jewish trumpet, others the Christian bell, but the matter was finally settled by the dream of a certain Abdullah, which suggested summoning the faithful by the voice of a crier proclaiming: "God is most great, etc."

See K. Cragg, *The Call of the Minaret* (1956). (A. K. Cr.)

AZAÑA, MANUEL (1880–1940), Spanish statesman prominent in the politics of the second republic, of which he became president in 1936, was born on Jan. 10, 1880, at Alcalá de Henares. He was educated at the Augustinian Colegio María Cristina at the Escorial, but left it with strongly anticlerical opinions. Afterward he studied law in Paris, but his early career was mainly literary. He dabbled in journalism, translated George Borrow's *The Bible in Spain* and works by Bertrand Russell and wrote an autobiographical and anticlerical novel *El Jardín de los frailes* (1927). A biography of Juan Valera gained him the national prize for literature in 1926.

His political career began toward the end of the dictatorship of Primo de Rivera. In 1930 he was elected president of the Ateneo, a celebrated literary and political club in Madrid, from which he began to organize a republican movement. He was a member of the revolutionary committee which signed the pact of San Sebastián in Aug. 1930 and which in April 1931 became the provisional government of the second republic (*see* Spain: *History*). Azaña was the dominant figure in the constituent *Cortes* of 1931. As minister for war in the provisional government he conducted a thorough purge in the army; and during the discussions on the new constitution he was the driving force behind the articles restricting the freedom of the religious orders and permitting the suppression of the Society of Jesus. When the adoption of these articles caused the resignation of Niceto Alcalá Zamora (*q.v.*) as prime minister in Oct. 1931, Azaña became his successor.

The government soon became predominantly Socialist (though by political sentiment its members would more properly be termed Liberals), not from choice but because of the defection of the Radical leader Alejandro Lerroux. Azaña's premiership, which lasted until Sept. 1933, has been much criticized, especially for the Law for the Defense of the Republic (1931) and for the severity with which the government acted during the civil disturbances in Jan. and Aug. 1932 and in Jan. 1933. However, during a period which abounded with both Anarchist and Monarchist plots, Azaña's chief merit lay in the provision of firm government. The enthusiastic innovations of his inexperienced ministers made the years 1931–33 the most fruitful in internal reforms in the history of the second republic.

In the autumn of 1933 Azaña was driven from office by a combination of centre and right-wing parties under Lerroux. He was arrested in 1934 on suspicion of having abetted a rising in Catalonia, but the charges against him failed and he was increasingly looked to as the "strong man" who might save the republic. His decision to stand for president after the popular front's victory (Feb. 1936) and the deposition of Alcalá Zamora was therefore surprising. He was elected president on May 10, 1936. The motive for his candidature may have been a desire to prevent the left-wing parties under Francisco Largo Caballero from gaining complete control, but he was able to do little before the outbreak of civil war. His reaction to the nationalist rising—the appointment of the moderate Diego Martínez Barrio as prime minister in an attempt to widen support for the republic—was typical, but unsuccessful. Control of policy passed from his hands, and though he remained in office he was merely a figurehead. After the victory of the nationalist forces he went into exile in France, where he died, at Montauban, on Nov. 4, 1940.

AZANDE (Zande), often referred to in early travel literature as Niam-Niam, are one of the best-known Sudanic-speaking peoples of central Africa. They straddle the Nile-Congo divide, living partly in the Sudan, partly in the Republic of the (former Belgian) Congo and partly in the Central African Republic. An estimate of their population in the late 1960s put it at about 750,000. Their country, savannah in the north and rain forest in the south, is for the most part suitable for agriculture and hunting, which they diligently pursue. Eleusine (a cultivated grass, *Eleusine coracana*) is their staple crop, but they also cultivate much maize, peanuts, sweet potatoes, sesame, peas and beans, manioc, and bananas. Oil crushed from termites is an important article in their diet. They had a reputation for cannibalism in the past. The Azande are fine craftsmen in iron, clay and wood.

The Azande are ethnically very mixed. In the 18th century a people calling themselves Ambomu and living on the Mbomu river began, under the leadership of their ruling Avongara clan, to conquer vast stretches of territory to the south and east, and overcame many peoples, some of whom have preserved their languages while others have been completely assimilated. This amalgam is the Azande people of today. During their conquests also, scions of the royal clan carved out kingdoms for themselves. The king's court—in the province he ruled over directly himself—was in the centre of the kingdom, and paths ran from it to the courts of provincial governors, mostly members of the royal clan. These governors were appointed by the king and they paid him tribute and were obliged to mobilize their subjects for war at his command. For war the male population was organized into companies, which were also summoned by the king and his governors to clear their cultivations. There were frequent full-scale wars between kingdom and kingdom and border raids took place every year.

The traditional distribution of the Azande is in widely scattered homesteads, each the residence of a family. Polygyny is practised, and in the past many men, especially the nobles, had so many wives that it was difficult for the younger men to marry. Adultery could be heavily punished. Marriage was contracted by the gift of about 20 spears by the bridegroom to the family of the bride. Girls were married very young and sometimes affianced a few hours after birth. While the commoners will not marry into their own clans, the nobles often marry kinswomen, even their paternal half sisters and their own daughters. Patri-

lineal clans are numerous but widely dispersed and have only very general social functions. These clans are totemic, and it is believed that at a man's death the body-soul, one of the two souls the Azande credit themselves with, becomes a totemic animal of his clan.

Zande religion is an ancestor cult, the conception of a god being vague and relatively unimportant. More significant for them, however, than the cult of ancestors, is witchcraft. They devote much time, when they have suffered misfortunes, to discovering who is bewitching them. In their view misfortunes, especially sickness and death, are caused by witches motivated by malice; and the witch responsible is discovered by administering poison to fowls and, in the past, sometimes to human beings also, and putting the names of suspected persons before the poison, asking it to declare their guilt or innocence by killing or sparing the fowls. In the past a witch who killed a man was either speared or made to pay compensation, or magic was made by the dead man's kin to destroy him. Only the last method of exacting vengeance is used today.

Bibliography.—C. R. Lagae, *Les Azande ou Niam-Niam* (1926); E. E. Evans-Pritchard, *Witchcraft, Oracles and Magic Among the Azande* (1937) and *Essays in Social Anthropology* (1963); P. T. W. Baxter and A. J. Butt, *The Azande and Related Peoples of the Anglo-Egyptian Sudan and Belgian Congo* (1954). (E. E. E.-P.)

AZARIAH (Azarias): *see* Uzziah.

AZARIAH, VEDANAYAKAM SAMUEL (1874–1945), the first Indian bishop of the Anglican Church in India, was born on Aug. 17, 1874, at Vellalanvilai in the Tinnevelly district of south India, where his father was the parish priest. He worked with the Young Men's Christian association and with the Indian Missionary society of Tinnevelly, which he had helped to found in 1903. He was ordained in 1909, and on Dec. 29, 1912, earlier opposition having been overcome, he was consecrated bishop of Dornakal. At first he had charge only of the small area of the Indian Missionary society; but, as he grew in experience and power, his area was increased until it included all the Telugu-speaking districts of the Madras presidency in which the Anglican missions were at work, an area containing 100,000 Christians by 1930. As bishop, Azariah developed remarkable powers as writer, preacher, teacher and organizer.

For many years he played a great part in wider Christian movements. At the World Missionary conference in Edinburgh in 1910, he delivered a memorable address on relations between missionaries and national workers. He was chairman of the National Christian Council of India, Burma and Ceylon from 1929 to 1945. For more than 20 years he was a leader on the Joint Committee on Church Union in South India, but died on Jan. 1, 1945, at Dornakal, too early to see the inauguration of the Church of South India in 1947.

See C. Graham, *Azariah of Dornakal* (1946); introduction by S. C. Neill to V. S. Azariah, *Christian Giving* (1955). (S. C. N.)

AZAY-LE-RIDEAU, a town of central France in the *département* of Indre-et-Loire, lies a few miles above the confluence of the Indre with the Loire rivers 15 mi. S.W. of Tours. Pop. (1962) 1,661. The château, built in 1518–27 by Gilles Berthelot the financier as his country house, is partly constructed on piles and projects out over the Indre river. Surrounded by a wooded park, it is an elegant Renaissance building, two stories high, forming two sides of a square; the other sides were never built. Turrets with sharply pointed roofs mark the three corners. The main façade was sculptured by Pierre Maupoint and its chief features are two emblems—the salamander of Francis I and the ermine of Claude of France—accompanied by mottoes. Inside there is a beautiful staircase in Italian style and the rooms contain 17th-century furniture and many works of art. The spectacle of *Son et Lumière* is presented in the grounds in the summer. The town is built at the foot of a hill by the Indre, and its old streets are narrow and tortuous. The parish church, at one corner of the park, dates from about 1000. Azay-le-Rideau is in a fertile district which produces white wine, pears and, particularly, apples. Veneer work, panelling, and boxes for dairy produce are made. Originally the site of a Roman villa, the town was known in the 12th century as Azayum and in 1213 the chatelain was Hugues-le-Ridel. Burned down in 1418, it was called Azay-le-Brûlé (burned) until the 16th century. Since about 1885 the château has belonged to the state.

(O. S.; P. So.)

AZEGLIO, MASSIMO TAPARELLI, Marchese d' (1798–1866), Italian statesman, painter and author, an honest patriot of the Risorgimento and a good example of the best type of Piedmontese aristocrat, was born in Turin on Oct. 24, 1798. In Rome, where his father was special envoy from the kingdom of Sardinia to the Vatican, he acquired a love of art and music and became an artist, even holding exhibitions in Paris and London. From 1831 to 1843 he lived in Milan in order to escape the authoritarian and philistine atmosphere of Turin. There he married a daughter of Alessandro Manzoni and turned to literature. His writings, whether novels or pamphlets, aimed at exposing the evils of foreign domination in Italy and awakening the national consciousness. They also had a considerable impact in France and England.

D'Azeglio fought in the first war of Italian independence in 1848 with the papal forces against Austria. In 1849, in Turin, he formed the first cabinet under Victor Emmanuel II and concluded peace with Austria. He remained in office for three years. He conducted the affairs of Piedmont with tact and ability, improving its diplomatic relations and introducing the important Siccardi laws of 1850 which abolished ecclesiastical courts and immunities. He invited Cavour, then a rising young politician, to enter the ministry in 1850. Cavour made certain declarations in the chamber (May 1852) which led the ministry in the direction of an alliance with Urbano Rattazzi and the left. D'Azeglio disapproved of this and therefore resigned office, but on the king's request he formed a new ministry, excluding Cavour. In Oct. 1852, however, he retired into private life. For the next four years he lived modestly in Turin, devoting himself once more to art, although Cavour treated him as an elder statesman and sometimes, because of D'Azeglio's fine reputation abroad, consulted him on matters of moment. In 1855 he was appointed director of the Turin art gallery. In 1859 he was given various political missions, including one to Paris and London to prepare the basis for a general congress of the powers on the Italian question. When war between Piedmont and Austria appeared inevitable he returned to Italy and was sent as royal commissioner by Cavour to the Romagna, whence the papal troops had been expelled. After the armistice of Villafranca, D'Azeglio was recalled with orders to withdraw the Piedmontese garrisons, but he saw the danger of allowing the papal troops to reoccupy the Romagna and after a severe inner struggle left the Piedmontese troops in Bologna. The king approved of this and explained that his orders had not been accurately expressed; thus Piedmontese influence continued to prevail in the Romagna, and the ultimate annexation of this area was prepared. Early in 1860 Cavour appointed D'Azeglio governor of Milan after the annexation of Lombardy. D'Azeglio disapproved, however, of the government's policy with regard to Garibaldi's Sicilian expedition and of the occupation by Piedmont of the kingdom of Naples (which he regarded as inopportune) and so resigned office. He subsequently led a comparatively retired life. As deputy and as writer, he occupied himself chiefly with the Roman question. In his opinion Italy should be unified by the Piedmontese and French armies, all connection with Mazzini and the Italian nationalist conspirators being eschewed. The pope should enjoy nominal sovereignty over Rome, with full spiritual independence, the capital of Italy being established elsewhere but the Romans being Italian citizens. Naples and Sicily, he thought did not want Italian unity and should be given their independence.

D'Azeglio died at his villa of Cannero on Jan. 15, 1866, leaving his memoirs, *I miei ricordi*, unfinished. He was cautious and conservative and was to some extent an amateur in politics, but of his sincerity there is no doubt. His political writings are trenchant and clear, but his novels, *Ettore Fieramosca* (1833) and *Niccolò dei Lapi* (1841), are somewhat heavy and are interesting only if one understands their political allusions.

See A. Vismara, *Bibliografia di Massimo d'Azeglio* (1878); N. Vac-

calluzzo, *Massimo d'Azeglio* (1925). (D. M. Sh.)

AZERBAIJAN (Āzarbāījān), formerly the Northwestern province of Iran, was subdivided in 1938 to form the Third and Fourth *ostans* (provinces), later East and West Azerbaijan, with capitals at Tabriz (*q.v.*) and Rezaiyeh respectively. With a combined area of 44,108 sq.mi., it is bounded north by the Aras river separating it from the Soviet republics of Azerbaijan and Armenia; west by Turkey and Iraq; east and south by the Iranian First (Gilan), Fifth (Kermanshah) and Kurdistan *ostans*. The region has high ranges and ancient volcanoes, like Savalan (Sabalan) (15,784 ft.) and Sahand (12,138 ft.), dominating extended plateaus and fertile depressions ranging from 3,000 to 5,000 ft. above sea level. The climate is extreme, hot, relatively dry summers alternating with cold, snowy winters. Annual precipitation varies from 12 to 35 in., permitting dry farming. There are no natural forests preserved except on the Caspian slope near Astara.

Modern excavations have shown that Azerbaijan was a centre of early civilization. It formed part of Urartu and later of Media (*qq.v.*). It was conquered by Alexander the Great and named Atropatene after Atropates, one of his generals who founded a dynasty. It returned to Persian control under the Sassanians (A.D. 226). Invaded by Arabs, Turks and Mongols it was the cradle of the Safawid dynasty. During early Qajar times (18th–19th centuries) the Russians gradually encroached on the Transcaucasian dependencies and before World War I and again during World War II (when the province was occupied by Soviet troops) virtually dominated the province. In Nov. 1945 a communist-led revolt resulted in an autonomous republic's being established in Tabriz and a Kurdish one at Mahabad. On Dec. 11, 1946, Iranian control was re-established.

The population was 2,112,134 (East) and 878,797 (West) in 1961, chiefly Iranian Turks, Kurds, some Armenians, Assyrians, Jews and Persians. Azeri-Turkish, the language of the majority, differs from the idiom of Turkey. The Turks of Azerbaijan are Shi'ites and the Kurds are Sunnis. There are still nomadic groups among the Turks and Kurds, the largest being the Shahseven, who are believed to number more than 100,000 and migrate between the Moghan steppe and Mt. Sabalan.

The best agricultural lands are around Lake Rezaiyeh (Urmia), a shallow, highly saline lake covering from 1,750 to 2,300 sq.mi. according to the season. Cereals, fruits, cotton, tobacco and sugar beets are grown and dried fruits are exported. Azerbaijan sheep are famous for their wool. There are scattered deposits of copper, lead, iron, coal, salt and orpiment, and traces of petroleum. The commercial centre is Tabriz which once rivaled Teheran. Famous for its carpets, it is now linked by rail with Teheran and, through Jolfa, with the Soviet system. Regional centres are Maragheh, Urmia (Rezaiyeh), Ardabil, Khoi (Khvoy) and Mahabad (Saujbulagh). (H. Bo.)

AZERBAIJAN SOVIET SOCIALIST REPUBLIC (Azerbaidzhan), one of the three soviet socialist republics in Transcaucasia (Georgia, Armenia, Azerbaijan), covers the extreme southern part of European U.S.S.R. lying beyond the Greater Caucasus (Bolshoi Kavkaz) mountain range. Azerbaijan is 33,436 sq.mi. in area and had (1959) 3,697,717 inhabitants. The republic is of special importance to the Soviet Union, both for its cotton and oil and because of its position at the gateway to Iran and southwest Asia.

Geographical Characteristics.—Azerbaijan may be divided into four major physical regions from north to south. The north comprises the eastern end of the Great Caucasus range, exceeding 14,000 ft. in the peak Bazar-Dyuzi but dropping steeply southeastward into the Caspian to form the Apsheron peninsula (Apsheronski Poluostrov). The southern flank of the Caucasus overlooks the second main region of Azerbaijan, the Kura-Aras lowland (Kura-Araksinskaya Nizmennost). This is the eastern end of an almost continuous depression drained in Azerbaijan by the Kura river and its tributaries. It extends from the Black sea to the Caspian between the Greater and Lesser Caucasus (Malyy Kavkaz). Toward the southeast the lowland widens and levels out, ending at the Caspian sea in the Kura delta. In the south-

AZERBAIJAN SOVIET SOCIALIST REPUBLIC, INCLUDING THE NAKHICHEVAN AUTONOMOUS SOVIET SOCIALIST REPUBLIC AND THE NAGORNO-KARABAKH AUTONOMOUS OBLAST

west of the republic the Kura lowland is limited by the third region, the ranges and plateaus of the Lesser Caucasus, with many small areas exceeding 10,000 ft. The Nakhichevan Autonomous Soviet Socialist Republic, U.S.S.R., separated from the rest of Azerbaijan by part of Armenia, comes within this region and is drained by the Aras (Araks) river. The fourth region is the small, narrow Lenkoran lowland (Lenkoranskaya Nizmennost) squeezed between high mountains and the Caspian sea.

Partly because of the great range of altitude in the republic, there is a great variety of climate, vegetation and soil conditions. It lies mainly between latitude 42° and 39° N. and is officially classified as dry subtropical. There is a considerable range of temperature between summer and winter, Baku having a mean January temperature of 39° F. and a mean July temperature of 78°. Mean annual temperatures decrease with altitude in the mountain regions. Mean annual precipitation tends to increase with altitude, being less than 10 in. at the mouth of the Kura, 10–15 in. in the Kura valley, but more than 40 in. in the highest part of the Greater Caucasus. The small Lenkoran lowland has the exceptionally high figure of 40–50 in. Natural vegetation and soil zones vary according to altitude, with steppe and even semidesert conditions in the lowland and foothills of the mountain regions and an intermediate zone of broadleaf forest below the high zone of Alpine meadows. The luxuriant vegetation of the Lenkoran lowland contrasts with the generally thin cover of vegetation elsewhere in the republic.

Wild animals abound in the Greater Caucasus range including, in the forest zone, the Caucasian deer (*Cervus elaphus maral*), wild boar (*Sus scrofa attila*), bears, wolves, foxes, leopards and the lynx (*Felix lynx orientalis*), wild cats and jackals. Above the forest the chief fauna are wild goats and eagles. In the lowland there are porcupines, antelopes, hyenas and tigers, as well as many rodents. In the humid Lenkoran lowlands waterfowl are numerous.

Population.—The Azerbaijan S.S.R. includes two smaller administrative units, the Nakhichevan A.S.S.R. (*q.v.*) and the Nagorno-Karabakh autonomous *oblast* (A.O.) (*q.v.*). Results of the population census in 1959 were as follows:

Urban and Rural Population (1959)

Administrative unit	Total	Urban	Rural	% Urban
Azerbaijan S.S.R.	3,697,717	1,767,270	1,930,447	47.8
Nakhichevan A.S.S.R.	141,361	38,274	103,087	27.1
Nagorno-Karabakh A.O.	130,406	26,973	103,433	20.7

Only 67.1% of the population of the republic is made up of Azerbaijanis (Azers or Azerbaijani Turks) and these are con-

centrated in the Kura lowland. Russians, Belorussians and Ukrainians make up 10.3% of the total and are most numerous in Baku (*q.v.*). Armenians are another large element (12% of total population) and account for about 90% of the population of the Nagorno-Karabakh A.O. The Talyshy and Taty are other minority groups. Density of population varies from a few persons per square mile in the higher mountain areas to about 100 per sq.mi. in irrigated areas of the lowland and 200 per sq.mi. around Baku.

Of the total population of Azerbaijan, 47.8% lives in urban types of settlement, a proportion about the same as the national average. Greater Baku, with 971,058 inhabitants (1959), has more than half of the urban population and is among the largest towns in the U.S.S.R. Kirovabad (*q.v.;* 116,122) is the only other town with more than 100,000 inhabitants, but Sumgait, Mingechaur and Dashkesan are growing rapidly. Nakhichevan (25,340) and Stepanakert (19,703) are the capitals of the two small units within Azerbaijan.

About 40% of the employed population of Azerbaijan is engaged in agriculture, while the mining and industrial side of the economy is dominated by the oil industry and associated activities. Baku is the administrative and commercial capital of the republic. It is also the cultural centre, with the state university (1950) and a number of technical and cultural institutes. Kirovabad is the main urban centre of the interior.

The Economy.—There is a single Council of National Economy for the whole of Azerbaijan. Agriculture may be divided into two types: that which produces for regional consumption or Transcaucasia as a whole, and that which specializes in the production of crops, not widely grown in the U.S.S.R., for national distribution. Of the total area of the republic, about one-seventh or 3,150,000 ac. is sown, while much of the remainder is lowland or mountain pasture. Part of the sown area is irrigated (*see* map), mainly by the Kura and its tributaries. Azerbaijan produces wheat (1,340,000 ac.), barley, maize and potatoes largely for its own use. These are grown mainly on nonirrigated land on the lower slopes of the mountain regions. Cotton for use in the textile mills of the Moscow industrial region is the chief special crop. It occupies a considerable part of the irrigated land, which is also used for rice cultivation (only a small part of the area indicated on the map is actually irrigated). Other special crops of Azerbaijan are tea and citrus fruits cultivated in the Lenkoran lowlands and vines, fruits, tobacco and vegetables on the lower slopes of the Caucasus. Pastoral activities dominate the nonirrigated steppe and semidesert lands of the Kura lowlands and a certain amount of transhumance takes place between winter pastures in these lowlands and adjoining high mountain summer pastures.

In the early 1960s the republic had more than 1,370,000 cattle and 4,280,000 sheep. Meat and wool are among products sent outside the republic. In the vicinity of Baku emphasis is on the production of milk and vegetables for the large urban market.

Oil is by far the most important single commodity in the economy of Azerbaijan. Around 1900 the Baku area together with smaller oil fields in the Caucasus accounted for about half of the world's oil output; most was exported to foreign countries. It remained the chief producing area of the U.S.S.R. until the early 1950s, but since then with the growth of the Soviet economy has been largely eclipsed by the new Volga-Ural oil field known as Second Baku (*q.v.*), in which production costs are claimed to be three or four times lower than around Baku. Oil production in 1913 was 8,453,539 short tons or 75% of the national total. From a peak figure of 24,405,231 (68% of the Soviet output) in 1940, production by the late 1950s had steadily declined to below 20,000,000 short tons which compared with the output of other Soviet oil fields and represented less than 15% of the national total.

The main producing area in Azerbaijan is the Apsheron peninsula but there are smaller fields at the mouth of the Kura and near Kirovabad.

Oil is the principal source of energy in Azerbaijan, but in 1954 a large hydroelectric power station was opened at Mingechaur on the Kura. Other minerals include copper (Kedabek and Dostafyur), alunite (Zaglik), cement rocks (near Tauz) and rock salt (Nakhichevan). Baku has a wide range of industries, oil refining remaining the most important. The opening of steel, aluminum and rubber works at Sumgait near Baku after World War II stimulated the manufacture of industrial equipment especially for use in the oil industry. Other branches of industry represented in Azerbaijan are food processing, cotton ginning and the manufacture of cotton and woolen textiles, but the republic accounts for only 1%–2% of the total Soviet output of the last items. Iron ore from Dashkesan is sent to the Rustavi iron and steel works (in the Georgian S.S.R., about 20 mi. beyond the republic boundary), which serves all three Transcaucasian republics. Fisheries centred on the Caspian sea (*q.v.*) are important.

Rail is the main form of transport within Azerbaijan. Most of the oil sent from Azerbaijan to other parts of the U.S.S.R. goes across Transcaucasia by pipeline to Batumi (*q.v.*) on the Black sea or direct by water from the port of Baku to the Volga for distribution over a large part of European U.S.S.R. (J. P. Co.)

History.—The Azerbaijan S.S.R. and the Persian province of Azerbaijan adjoin each other and the origin of the peoples of both regions is broadly the same. Yet they have never been united politically except in the sense that from the 11th century up to 1723 and again from 1735 to 1813 the whole territory was either under Persian suzerainty or actually part of the Persian empire. Known to the Romans as Albania and to the Arabs as Aran, Azerbaijan was conquered by the Arabs in A.D. 642. The population had originally been Iranian but became turkicized by the 9th century (*see* TURKIC PEOPLES). Under the Arabs the various khanates—Shirvan, Aran and Mughan—became prosperous, but they deteriorated after the collapse of the Arab empire. During the Mongol domination (1236–1498) and the Safawid dynasty of Persia, the khanates, especially that of Shirvan (Shemakha), recovered some of their former prosperity. The 18th century saw the military rise of Russia and its territorial expansion at the expense of Turkey and Persia. As a result of long wars of aggression Russia acquired by the Treaty of Gulistan (1813) the khanates of Derbent, Baku, Shirvan, Sheki (Nukha), Ganja or Gandzha (now Kirovabad) and Lenkoran, and by the Treaty of Turkmanchai (1828) Nakhichevan and the southern part of Talish. Thenceforward Azerbaijan was divided between Russia and Persia by the present-day frontier, the majority of the Azerbaijanis remaining in Persia. Under Russian rule the Azerbaijanis were called Tatars or Musulmans and they were administered in the guberniyas of Baku and Elizavetpol.

After the 1905 revolution some political activity developed and the Musavat (Equality) party was formed in 1911. The March 1917 revolution and the presence of the Turkish army in Transcaucasia brought about an alliance between the Musavat and Turkey. At the same time an attempt was made to found an independent Transcaucasian federation consisting of Azerbaijan, Georgia and Armenia. Racial and religious animosity caused this to fail and an independent republic of Azerbaijan was formed in May 1918, its capital being at Gandzha until Baku, which had been under the control of a Communist council, was captured with the help of the Turkish army in 1918. A small British force which had originally occupied Baku in Aug. 1918, but withdrew on the arrival of the Turks, returned after the collapse of Turkey in November and was virtually in control of the republic's affairs until it was finally evacuated in Aug. 1919. The new republic was recognized *de facto* by the Allied powers on Jan. 15, 1920. In April 1920 Azerbaijan was invaded by the Red army and the government surrendered to the Communist authorities. The Azerbaijan S.S.R. was created in the same month. In 1922 it was incorporated in the Transcaucasian Soviet Federated Socialist Republic until 1936 when it became a union republic.

Under the Soviet regime the economy of the republic was greatly developed. Of its political stability it is difficult to speak with

precision. In 1951 M. D. Bagirov, the first secretary of the Communist party of Azerbaijan, spoke of the existence of "political deviations" and "secret anti-government activities by enemies of the people." He was executed in April 1956.

(G. E. Wr.)

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AZHARI, ISMAIL AL- (1900–), Sudanese statesman, prime minister of Sudan from 1954 to 1956, was born at Omdurman on Oct. 30, 1900, of a family originally from Kordofan, a grandson of Sheikh Ismail al-Azhari, a former mufti of the Sudan. After an education in Sudanese schools he graduated at the American University of Beirut and from 1921 to 1946 served in the Sudanese department of education. Soon after the signature of the Anglo-Egyptian treaty of 1936, the disappointment of many articulate Sudanese at their exclusion from a voice in determining the future status of their country found expression in political organization, and al-Azhari, who in 1939 had been appointed first secretary to the Graduates' General congress, became its president in 1940.

Al-Azhari was later president of the Ashigga party, a body favourable to unity with Egypt, and in 1952 was made president of the broader-based National Unionist party. In Nov. 1953 he was elected to the house of representatives and in Jan. 1954 was chosen prime minister, thus becoming leader of the first all-Sudanese cabinet. His term of office was marked by the end of the Anglo-Egyptian condominium on Jan. 1, 1956, and the assumption of Sudanese sovereignty.

A realignment of political forces, the withdrawal of the support of the Khatmiyya religious brotherhood and the resignation of three ministers, however, precipitated the fall of al-Azhari's ministry in July 1956, when he was succeeded as prime minister by Abdullah Khalil. (R. L. Hl.)

AZIMUTH, the angular distance from the north or south point of the horizon to the foot of the vertical circle through a heavenly body. The azimuth of a horizontal direction is its deviation from the north or south.

See Altitude and Azimuth; Surveying: *Units of Measure Used in Surveying.*

AZO (Azzo, latinized as Azolinus Porcius) (*c.* 1150–1230), Italian jurist, was born at Bologna, studied under Johannes Bassianus and became professor of civil law at Bologna. Azo is occasionally described as Azo Soldanus or as Azzo Porcius. He is to be distinguished from the 13th-century canonist, Azo Lambertaccius, and the 14th-century canonist, Azo de Ramenghis. Azo occupied a very important position among the glossators. His *Summa codicis* and *Summa institutionum*, completed by the additions of Hugolinus Presbyteri and Odofredus, formed a methodical exposition of Roman law and were of such weight before the tribunals that it used to be said, "*Chi non ha Azzo, non vada al Palazzo*" ("He who has not learnt Azzo does not go to the palace [of justice]," *i.e.*, does not become a judge). Azo numbered among his pupils Franciscus Accursius and Jacobus Balduinus.

The extent to which Azo plagiarized the works of his predecessors, Placentinus and Bassanius, is disputed. Azo's work was more complete and had a more enduring reputation. In England, most of the Roman material used by Henry de Bracton (*q.v.*) in his *De legibus et consuetudinibus Angliæ* was derived from the *Summae* of Azo. (Rl. P.)

AZO COMPOUND. "Azo" is an abbreviated form of *azote*, an early name coined by Antoine Lavoisier for nitrogen. Azo compounds as outlined in this article are the organic chemical compounds which contain the group —N:N— attached to two hydrocarbon radicals and have the general formula RN:NR′, where R and R′ can be either an alkyl or a substituted or unsubstituted aryl group. Among the most important members of the family are the azo dyestuffs, which form an enormous class of chemical compounds; literally thousands of them have been made, and at least a thousand, each with a peculiar and valuable property, have come into world commerce. (*See* Dyes and Dyeing.)

Azo compounds are distinguished from the diazo compounds (*q.v.*), which also contain doubly linked nitrogen, in that each of the nitrogen atoms contained in the —N:N— grouping is bound to a carbon atom in the alkyl or aryl radical. For the most part, also, the azo compounds are much more stable and unreactive than the diazo compounds.

Nomenclature and Classification.—The simpler members of the azo class of compounds are readily named. Where R and R′ are unsubstituted and alike, the name used is that of the compound from which the radicals are derived with the prefix "azo"; thus CH_3—N:N—CH_3 is called azomethane, and C_6H_5—N:N—C_6H_5 azobenzene. If R and R′ are different the term "azo" is placed between the names of the compounds from which they are derived; thus C_6H_5—N:N—CH_3 is called benzeneazomethane. When R and R′ are both substituted aryl residues, and when the —N:N— group occurs more than once in the molecule, the naming of the compounds becomes very complicated, and systematic chemical nomenclature gives way to the use of trademarks, especially for the numerous members of this class which are used as dyestuffs.

From this consideration of the nomenclature of these compounds, it becomes apparent at once that they can be divided into three classes: (1) the aliphatic azo compounds where both R and R′ are alkyl residues; (2) the mixed aliphatic-aromatic azo compounds where R is an alkyl and R′ is an aryl residue; and (3) the aromatic azo compounds where both R and R′ are aryl residues. The third class is by far the most numerous and important of the azo compounds.

Aliphatic Azo Compounds.—Of the aliphatic azo compounds, azomethane, prepared by oxidizing *sym*-dimethylhydrazine hydrochloride with chromic acid, is best known. A gas at ordinary temperatures, it is readily condensed to a yellow liquid having a boiling point of 1.5° C. In no way does it behave as a base. At 200° C. it is thermally decomposed by a unimolecular reaction into nitrogen and free methyl radicals, the latter being detected in the usual manner by the use of metal mirrors. However, the free methyl radicals combine at once to form ethane, so that the whole equation may be written thus:

$$CH_3\text{—N:N—}CH_3 \rightarrow 2CH_3\cdot + N_2 \rightarrow CH_3.CH_3 + N_2$$

From a consideration of the first part of this reaction it would appear that azomethane should be an excellent methylating agent. Such is found to be the case. The other aliphatic azo compounds are prepared in a similar manner and react the same as azomethane. Chemically, they are of little importance.

Mixed Aliphatic-Aromatic Azo Compounds.—Of little importance, too, are the mixed aliphatic-aromatic azo compounds, of which benzeneazomethane and benzeneazoethane are best known. They are yellow liquids and can be prepared by oxidizing the corresponding hydrazo compounds in ether solutions by means of mercuric oxide. The first boils at 150° C., the second at 175°–185° C., with some decomposition. Both are readily steam distilled. The most interesting reaction of these products is that they are readily converted isomerically into hydrazones by the action of either 60% sulfuric acid or alcoholic sodium ethylate, as follows:

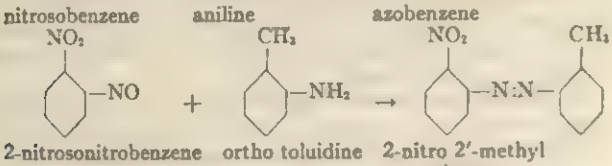
$$\underset{\text{benzeneazoethane}}{C_6H_5N\text{:N—}C_2H_5} \rightarrow \underset{\text{acetaldehyde phenylhydrazone}}{C_6H_5.NH.N\text{:}CH.CH_3}$$

Aromatic Azo Compounds.—The parent substance of the aromatic azo compounds is azobenzene, $C_6H_5.N\text{:}N.C_6H_5$, discovered in 1834 by Eilhardt Mitscherlich. It forms orange-red crystals melting at 66°–68° C. (*see* melting point of isomers below), and it boils without decomposition at 295° C. As in the case of many of its closely related compounds, it can be prepared by a wide variety of methods based primarily on four reactions. Thus azobenzene itself can be made (1) by the reduction of nitrobenzene, (2) by the reduction of azoxybenzene, (3) by the mild oxidation of hydrazobenzene, and (4) by the reaction of nitrosobenzene and aniline. The latter reaction, giving rather good yields,

and most useful in preparing substituted aromatic azo compounds, definitely establishes the chemical constitution of azobenzene and of its substituted products.

$$C_6H_5NO + C_6H_5NH_2 \rightarrow C_6H_5-N:N-C_6H_5+H_2O$$

nitrosobenzene aniline azobenzene



2-nitrosonitrobenzene ortho toluidine 2-nitro 2′-methyl azobenzene

A fifth method for making aromatic azo compounds, but not applicable in the case of azobenzene, is by "coupling" an aromatic diazo compound to a phenol or an aromatic amine. The coupling reaction is very difficult, if not entirely impossible, when a hydroxy or an amino group is not present in the aromatic molecule to which the diazo compound is to be coupled.

Oxidation of the aromatic azo compounds with mild oxidizing agents gives the azoxy compounds, while reduction gives first the hydrazo compounds and then the primary amines.

$$2Ar.N:N.Ar+O_2 \rightarrow 2Ar.\underset{\underset{O}{|}}{N}:N.Ar$$

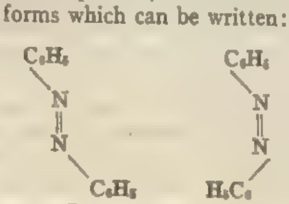
$$Ar.N:N.Ar+2H_2 \rightarrow Ar.NH.NH.Ar \rightarrow 2ArNH_2$$

The reduction reaction is of great technical importance, for by the use of reducing agents such as stannous or titanous salts, or sodium hydrosulfite, $Na_2S_2O_4$, the azo dyestuffs, which may contain from one to four —N:N— groupings, are broken down into primary amines, thus giving the structure of the dyes under examination. Moreover, this reaction is so exact that it is useful in the quantitative determination of the azo grouping.

Azo dyestuffs are primarily hydroxy- and amino-substituted aromatic azo compounds, and by far the greater number also contain one or more sulfonic acid groups. Almost invariably they are made by coupling aromatic diazo compounds with phenols and aromatic amines.

With the addition of the hydroxy and amino groups the colour of the azo compounds is much deeper than with azobenzene itself, and as the molecules become more complex, with more than one azo group present and with each aromatic residue containing additional OH or NH_2 groups, the absorption of light moves toward the red end of the spectrum, so that dyestuffs of every shade of colour, from light yellow to deep black, can be obtained.

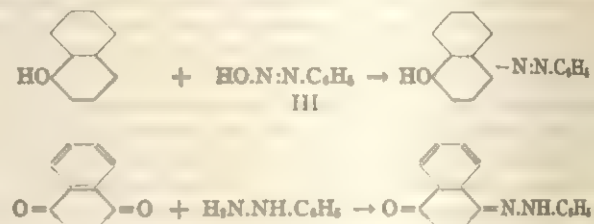
Azobenzene itself is of considerable theoretical interest. Because of the space arrangement of the groups attached to the doubly bound nitrogen atoms there is the possibility of stereoisomerism in these compounds, and thus azobenzene should exist in two isomeric forms which can be written:



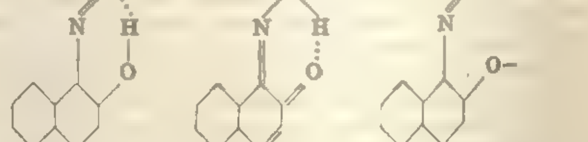
I II

Azobenzene, melting at 68° C., and made by the reduction of nitrobenzene or azoxybenzene is the *trans*-compound (I), as shown by X-ray crystallographic examination. In 1937, G. S. Hartley published the results of work which indicated that when solutions of this material were exposed to sunlight, parts of the *trans*-compound were converted to the *cis*-form (II). Studying the rate and extent of conversion in various solvents, he and his coworkers found that as much as 40% of the *cis*-isomer could be obtained in certain solvents such as acetone. He also determined that the two isomers could be separated from each other by their different solubilities in water and other solvents or by chromatographic means. He also established the fact that *cis*-azobenzene melts at 71.4° C., being converted at this temperature into the *trans*-form. Later, other investigators studied this conversion and the chromatographic separation not only of azobenzene but also of other azo compounds. It has been found in general that on alumina the *cis*-form is more readily absorbed than the *trans*-form, especially from petroleum ether solutions, the reverse being true on charcoal from methyl alcoholic solutions.

In another direction, too, these azo compounds are of considerable theoretical interest, particularly as to the structure of the hydroxy substituted products. In 1870, Friedrich Kekulé prepared *p*-hydroxyazobenzene, and for a time it was generally agreed that it was a true azophenol. In 1883, however, T. Zincke found that the compound formed by coupling phenyl diazonium ion with *α*-naphthol is identical with the one formed by condensing phenylhydrazine and *α*-naphthoquinone.



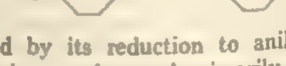
Investigation of this problem, whether the compounds have the azophenol (III) or the quinone-hydrazone structure (IV), has continued almost without a break since Zincke's discovery, and it is not yet solved. It now seems clear that the *p*-hydroxy compounds resemble the *meta* derivatives which can be prepared by an indirect method. Since the *meta* compounds cannot change into quinones but must be phenols, this is strong evidence that the *para* compounds are also true phenols. The *ortho* compounds differ from them in several ways. They are insoluble in alkalies and are not methylated even by such a vigorous agent as diazomethane. On the other hand, the *ortho* compounds cannot satisfactorily be allotted a quinone structure analogous to IV; *e.g.*, they are brominated and nitrated in a typically phenolic way. The anomalous behaviour of the *ortho* compounds must be connected with the proximity in space between the azo and hydroxyl groups. One result of this proximity is that hydrogen bonds can be formed either in the azo or hydrazone structure, as in V and VI.



V VI VII

There is the further possibility that the molecule may be the internal salt VII. Hence, there is strong presumption that the actual state of the molecule is that of a resonance hybrid of these three structures and that the *ortho* compounds cannot be said to have the simple structure either of an azophenol or of a quinone hydrazone. In the *para* series, structures analogous to V and VI are impossible, and thus the differences between the two series can be theoretically explained.

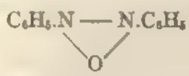
Aminoazo Compounds.—These are the normal products of coupling diazo compounds with aromatic amines. They are red, yellow, brown or deep-brown solids. Aminoazobenzene, known also under the trade name of Aniline Yellow, melts at 127° C. and can be distilled without decomposition under reduced pressures. Its structure,



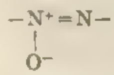
is clearly indicated by its reduction to aniline and *p*-phenylenediamine, and it is manufactured primarily as an intermediate for certain azo and induline dyes. The compound 2,4-diamino

azobenzene, $(NH_2)_2C_6H_3-N:N-C_6H_5$, made by coupling a mole of benzene diazonium chloride with a mole of *meta*-phenylenediamine, is sold in large quantities in world commerce as its hydrochloride under the name of Chrysoidine. Bismarck brown (Manchester brown), discovered in 1865, a mixture of tri- and tetraamino azobenzenes, being primarily benzene-meta-diazo-bis-metaphenylenediamine dihydrochloride, and made by the action of nitrous acid on *meta*-phenylenediamine in dilute hydrochloric acid, is well known in every industrial nation in the world as a brown dyestuff and stain.

Azoxy Compounds.—These form a small class of nonbasic substances produced, often very readily, in the reduction of aromatic nitro compounds. In this reaction they arise from the condensation of the nitroso compound and the substituted hydroxylamine, which are direct products of the reduction; this condensation takes place most readily in alkaline solution, so that with mild alkaline reducing agents azoxy compounds result in good yield. The first member of the class known was azoxybenzene, prepared in 1841 by N. Zinin by reducing nitrobenzene with alcoholic potash. Obtained by this method it forms yellowish crystals melting at 36° C. The molecular formula is $(C_6H_5)_2.N_2O$, and since it is readily reduced to azobenzene by heating with zinc dust, Kekulé suggested this structure:



This was accepted for many years, but in a series of investigations during the years 1910 to 20 A. Angeli showed that the azoxy group is not symmetrical, since oxidation of an azo compound with dissimilar radicals, $R-N:N-R'$, gives two isomeric azoxy compounds, $R-NO:N-R'$ and $R-N:NO-R'$. Hence, the structure of the group must be



a view supported by the fact that when azoxybenzene is nitrated or brominated only one ring is attacked, showing that the two rings are not linked to similar nitrogen atoms.

Since the azoxy group contains doubly linked nitrogen atoms, stereo-isomerism should occur as in the azo compounds (*see* above) even when the two attached aryl groups are identical. Such has been found to be the case.

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AZOIMIDE: *see* Hydrazoic Acid.

AZORES (Açôres), an archipelago in the north Atlantic ocean comprising part of metropolitan Portugal. Area 894 sq.mi. Pop. (1960) 327,806. The islands extend from northwest to southeast, between 36° 55′ and 39° 43′ N., and between 25° and 31° 16′ W. They are divided into three widely separated groups, rising from a depth of more than 2½ mi. The southeastern group consists of São Miguel and Santa Maria, with Formigas; the central, of Faial, Pico, São Jorge, Terceira and Graciosa; the northwestern, of Flores and Corvo. The nearest continental land is Cape Roca in Portugal, which lies 740 mi. E. of São Miguel. Thus the Azores are farther from the mainland than any group of Atlantic islands. In general characteristics all the component islands are similar, rising steeply from scree- or talus-lined shores to heights reaching 7,713 ft. (in Pico). Their volcanic nature has been shown by the numerous earthquakes and basaltic eruptions that have taken place since their discovery. In 1522 the town of Vila Franca, at that time capital of São Miguel, was buried during a violent convulsion.

Climate.—The climate is very mild; the temperature ranges from 48° F. in January, to 82° F. in July, near sea level. West to northwest winds, sometimes stormy, prevail in winter; mild northeasters in summer. Meteorological data compiled and transmitted from the Azores are essential to European weather forecasting.

Vegetation and Animal Life.—The general character of the flora is decidedly European. Vegetation in most of the islands is remarkably rich, especially in grasses, mosses and ferns, heath, juniper and a variety of shrubs. There were almost no tall-growing trees until the 19th century when the Bordeaux pine, European poplar, African palm, Australian eucalyptus, chestnut, cryptomeria, elm, oak and many others were successfully introduced. The orange, apricot, banana, lemon, citron, Japanese medlar, apple and fig are the common fruits. Pineapples are cultivated extensively in greenhouses in São Miguel. Grapes and melons are abundant.

The mammals of the Azores are limited to the rabbit, weasel, ferret, rat (brown and black), mouse and bat, in addition to domestic animals. The game includes the woodcock, red partridge (introduced in the 16th century), quail and snipe. There are valuable fisheries of tunny, mullet and bonito. The porpoise, dolphin and whale are also common. Whale fishing is a profitable

THE AZORES, SHOWING THE CENTRAL GROUP AND SÃO MIGUEL OF THE SOUTHEASTERN GROUP. INSETS SHOW (LEFT) THE NORTHWESTERN GROUP AND (RIGHT) SANTA MARIA AND FORMIGAS ROCKS OF THE SOUTHEASTERN GROUP

District	Area (sq. mi.)	Population (1960)	Component islands
Ponta Delgada	326	181,792	São Miguel Santa Maria
Angra do Heroísmo	272	96,820	Terceira Graciosa São Jorge
Horta	296	49,194	Faial Pico Flores Corvo

industry throughout the islands whence the sperm oil is exported.

Economy and Communications.—The trade of the Azores was long a Portuguese monopoly, but later, before World War II, it was shared by Great Britain, the United States and Germany; textiles are imported from Portugal, coal from Great Britain. Other main imports are automobiles, mineral oils and machinery. Exports consist chiefly of hand embroideries, pineapples, canned fish and sperm oil.

In addition to regular mail services there are cables to both sides of the Atlantic, radio (telegraph and telephone) between the islands and to Europe. In 1939 a regular transatlantic air service was begun via the Azores. Civil aircraft use the airport at Santa Maria and military air traffic the air base at Lajes, Terceira.

Population and Administration.—The inhabitants of the islands are mostly of Portuguese origin. The predominant religion is Roman Catholic. The diocese of the Azores, founded in 1529, has its see at Angra. Two line regiments of infantry and two brigades of artillery as well as a regiment of the Portuguese air force are stationed in the islands. The most important island is São Miguel, noteworthy for scenery.

The Azores have no central government. The islands are grouped in three administrative districts with the same status as those of continental Portugal, but with special autonomous prerogatives exercised in each by a *junta geral.*

The principal seaports, which give their names to the districts, are Angra do Heroísmo, or Angra (pop. [1960] 13,929), Ponta Delgada (*q.v.*) (22,740) and Horta (7,250).

History.—The earliest notice of the existence of the Azores is found in some Italian and Catalonian maps of the 14th century, though the position of the islands was marked inaccurately. Claims that Carthaginian or other coins were found at Corvo have been dismissed as unfounded. According to the most reliable information the islands were discovered about 1427 by a pilot of the king of Portugal whose name was Diogo de Silves. No traces of human beings were found in any of them, nor even of their having been visited before. Settlement began in Santa Maria about 1432, under the guidance of Gonçalo Velho Cabral (not to be confounded with Pedro Alvares Cabral, who discovered Brazil in 1500). São Miguel was settled in 1444 and Terceira some years later. A few Flemings, under Jobs van Hurtere, were allowed to settle in Faial at the request of Isabella, duchess of Burgundy, who was the sister of Prince Henry the Navigator. The Flemings were absorbed by the Portuguese settlers and left no trace either in the language or customs of the population. By the end of the 15th century all the islands were inhabited and trade with Portugal became well established. When Philip II of Spain took possession of Portugal in 1580, the people of Terceira fiercely resisted the Spaniards and were only subdued two years later by a great Spanish fleet under the marquess of Santa Cruz. From then until 1640 the Azores, like the rest of Portugal, were subject to Spain. The Azores were the grand rendezvous for the fleets on their voyage home from the Indies; and hence they became a theatre of the maritime warfare between the English under Elizabeth I and the peninsular powers. One such expedition, which took place in 1591, led to the famous sea fight off Flores, between the English ship "Revenge," commanded by Sir Richard Grenville, and a Spanish fleet of 53 ships. Except for some time during the Spanish occupation there was no central government in the Azores until 1766 when the marquess of Pombal (1699–1782) established a governor and captain-general for the whole group at Angra, Terceira, to repress the abuses of the local administrators. When civil war broke out in Portugal, after Miguel had been proclaimed king in 1828, the constitutionalists in Terceira supported Pedro, the eldest brother of Miguel, and after an attack by the whole Portuguese fleet on the island was repelled at Praia, they succeeded with the aid of British mercenaries in entering Portugal and defeating Miguel. Maria da Glória, daughter of Pedro, was then acclaimed queen of Portugal. A new constitution was established in 1832 and the islands were grouped in three administrative districts (Ponta Delgada, Angra and Horta) which in 1895 were given autonomous administration within certain limits. In World War I the only incident in the islands was the attack on Ponta Delgada by a German submarine in 1917. A U.S. naval base was established at Ponta Delgada in World War I. In World War II Great Britain was allowed to establish an air base at Lajes airfield (Oct. 1943). Lajes and Santa Maria became important centres of military communications between the United States and Europe during World War II. Santa Maria airport was constructed for the U.S. air force in 1944 and the lease extended under the United States-Portuguese Defense pact, 1951. It was later transferred to Lajes.

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AZORÍN (pseudonym of José Martínez Ruiz) (1874–1967), Spanish essayist, critic and novelist, remarkable for the subtle simplicity of his style, was born at Monóvar, Alicante, on June 8, 1874. As a member of the disillusioned "generation of 1898," which deliberately shunned the imposing and the obvious, he pursued his inspiration through half tones, muted colours and the subtleties of atmosphere. His early novels *La Voluntad* ("Volition"; 1902) and *Las confesiones de un pequeño filósofo* ("Confessions of a minor philosopher"; 1904) are tentative. But his most successful medium, both for critical and artistic purposes, proved to be the short essay in which, apparently artlessly, he creates the atmosphere of scene and leads his readers on by suggestion. Thus the spirit of old Castile is reconstructed in *El alma castellana* ("The Castilian soul"; 1900), the mind and environment of Cervantes' protagonist in *La ruta de Don Quijote* (1905) and literary criticism is conveyed obliquely through the seemingly inconsequent impressions of *Al margen de los clásicos* ("Marginal notes to the classics"; 1915) and *Rivas y Larra* (1916). The simplicity of his style attracted innumerable imitators almost all of whom failed to achieve Azorín's ideological subtlety, vitality and poetic rhythm. His later works include *De Granada a Castelar* (1922), *Una hora de España* (1924; Eng. trans., *An Hour of Spain*, 1931), the more abstract *Superrealismo* (1929) and numerous articles in periodicals. Azorín died in Madrid on March 2, 1967. (I. L. Mc C.)

AZOTUS: *see* Ashdod.

AZOV, a town and ancient fortress in Rostov *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., lies on the left bank of the main (southern) distributary of the Don, 20 mi. upstream from its mouth. It is a fishing port with fish canning, textile and agricultural machinery industries. Pop. (1959) 39,931.

The town was of great importance as a trading centre and fortress after its establishment in the 6th century B.C. as the Greek colony Tanais. Later a Genoese factory, Tana, it became a Turkish fortress, falling to Peter the Great in 1696 and finally being secured by the tsaritsa Anne in 1739. Since then, the port has silted and lost its functions to Rostov-on-Don, 16 mi. N.E. (R. A. F.)

AZOV, SEA OF (Azovskoye More), an inland sea off the southern coast of European Russia, forms an extension of the Black sea to which it is linked by the Kerch strait. Its area is 14,517 sq.mi., excluding the Sivash, or Putrid sea, which divides the Crimea from the mainland and which itself is separated from the Sea of Azov by a 66-mi.-long sand bar, the Arabatskaya Strelka. Its greatest length is 230 mi. and its greatest breadth 106 mi. The sea is shallow, with a maximum depth of 46 ft. Vast quantities of silt are brought down by the rivers Don and Kuban, and in the Taganrog gulf in the northeast depth is 3 ft. or less and deep draft vessels for Rostov and Taganrog have to transship in open roads. Depth varies markedly with wind force and direction, par-

ticularly in the Taganrog gulf. Salinity in the sea is low (1.1%) but in the Sivash it is very high (up to 10%). There is an anti-clockwise circular current along the coasts but this may be affected by winds. Fierce storms can occur and winds up to 65 m.p.h. have been recorded. The period of freeze up is variable but there is normally stationary ice along the northern coasts from the end of December to early March. With northeast and north winds the ice often breaks loose, to drift in the open sea. Coasts are low and characterized by long sandspits, shallow gulfs and lagoons in various stages of silting up. Fishing is extremely important, chiefly for sturgeon, bream, grey mullet, herring, Crimean anchovy and others. The major ports are Rostov-on-Don, Taganrog, Zhdanov, Osipenko, Genichesk and Temryuk. On the shores of the Sea of Azov, which was known in the ancient world as Palus Meotis, stood the Greek colony of Tanais, now Azov (*q.v.*). In the 19th century, the wheat trade was of great importance. Expeditions surveyed the sea in 1874, 1891, 1913 and 1922–28.

See *The Mediterranean Pilot* (Admiralty, London); V. I. Borisov and Y. I. Kapitonov, *Azovskoye More* (1957); D. Karelin, *Morya Nashey Rodiny* (1954). (R. A. F.)

AZTEC, one of the most important Indian groups of the new world. The word *Azteca* is derived from Aztlán ("white land"), where, according to the Aztec traditions, their tribe originated. Aztlán probably is merely a general reference to the northwestern region of Mexico. The Aztecs are also known as Tenochca, a name derived from a legendary patriarch called Tenoch. Tenoch, or Tenochca, gave its name to Tenochtitlán ("stone rising in the water"), a city founded by the Aztecs on an island in Lake Texcoco, in the Valley of Mexico. The Aztecs or Tenochcas were also known as Mexica, probably derived from Meztliapan ("moon lake"), the mystical name for Lake Texcoco. The Aztecs themselves usually added the prefix *Culhua* to *Mexica* (Culhua-Mexica) in order to show their relationship to the most civilized peoples in the Valley of Mexico, whose centre was the city of Culhuacán. Mexica came to be applied not only to the ancient city of Tenochtitlán but also to the modern Mexican nation and its inhabitants (Mexico, Mexicans).

The language of the Aztecs was Nahua, part of the Uto-Aztecan linguistic family which, at the time of the discovery of America, was making its influence felt intermittently from western United States to Panamá. Once the Aztecs achieved political ascendancy, their language gained currency in an area almost as large as present-day Mexico. The Spanish conquerors, using Nahua as one of the principal means of communicating with Indians of other tongues, further extended the influence of the language. Approximately 1,000,000 people still speak Nahua in Mexico.

The empire the Aztecs established was equaled in the new world only by that of the Incas of Peru, and the brilliance of their civilization is comparable to that of other great ancient cultures of America and the old world. The story of their rapid rise and their dramatic fall has come down to us through the oral traditions preserved by the Aztecs and transcribed by the Spanish historians and ethnographers, through the Indian codices and through archeological testimony.

From their legendary land of Aztlán, the Aztecs came into contact with the highly developed Toltec (*q.v.*) civilization located in central Mexico and having as its capital the city of Tula (Hidalgo). The appearance of the Aztecs is linked, however, not to the splendour of Tula and of the Toltecs but to their decline. For reasons not yet fully known but having to do with internal social, political and religious conflicts, a tremendous cultural catastrophe, which has been compared to the fall of the Roman empire, occurred at the beginning of the 12th century A.D. The city of Tula was attacked and destroyed, as were other important Toltec centres. Tribes of less-developed cultures—hunters and gatherers—took advantage of the situation and added to the chaos, traveling from the arid plateau of northern Mexico toward the fertile, civilized central zone, pursuing and hastening the retreat of the more advanced agricultural peoples. In their legends the Aztecs like to portray themselves as part of that wave of barbarian invaders known by the general term Chichimecas ("sons of the dog"). The fact is, however, that the Aztecs were ancient "Toltequized" farmers, who for a long period had probably served as military aids to the Toltecs, precisely along the border which had separated them from the uncivilized Chichimecs and which had given way with the fall of Tula.

Throughout a century (from the beginning of the 12th century to the beginning of the 13th), the Aztecs wandered about in search of a new place to settle. During that time, a group of Chichimecs, under the leadership of Xólotl, succeeded in gaining power in the Valley of Mexico, establishing their centre first in Tenayuca and later in Texcoco. Xólotl's Chichimecs joined forces with the remaining Toltecs, who were firmly entrenched in Culhuacán. The combination of strong Chichimec power in rapid process of assimilating a higher culture and the restoration of Toltec power in Culhuacán led to a period of relative peace and cultural progress in the Valley of Mexico. The stabilization of this new situation attracted immigrants from all parts of the disturbed country, among them the Aztecs, who by then had established a precarious home near the ruins of Tula.

The Aztecs' stay in Tula was extremely eventful. On the one hand, they perfected their technological knowledge, especially with regard to agriculture. According to their traditions, it was there that they undertook irrigation cultivation and built *chinampas* (the famous and misnamed "floating gardens"); these techniques were to become essential in the foundation and survival of Tenochtitlán. On the other hand, the Aztec religion took definite form, with its god Huitzilopochtli ("Hummingbird-on-the-left"), its sun worship and its human sacrifice. Aztec tradition has it that Huitzilopochtli ordered them to take leave again in search of a permanent home.

The Aztecs' "pilgrimage" did not end with their arrival at the Valley of Mexico. For another century (until the beginning of the 14th) they were forced to wander about in unfriendly territory, suspected by their neighbours and harassed by their powerful opponents. Taking refuge in Chapultepec (modern Mexico City's main park), they fortified the hill for protection. Yet, after a battle that proved disastrous for them, the Aztecs were expelled from Chapultepec by a coalition of their neighbours, the Culhua-Toltecs of Culhuacán and the Tepanecs of Azcapotzalco. They then sought the protection of their Culhuacán conquerors and, in exchange for military service, received some land in Tizapán. It was not long before the ferocity shown by the Aztecs in war and their bloodthirsty religious rites alarmed the Culhuas, and once again the tribe was forced to take flight.

The pilgrimage was, however, nearly at an end. In the year of "two house," according to their calendar (A.D. 1325), the wanderers found the land spoken of in their prophecies. On a small island in Lake Texcoco, the elder members of the tribe spotted an eagle, symbol of the sun and of Huitzilopochtli, resting on a nopal. There they built the temple of their tribal god and, around it, the first dwellings of what was to become the powerful city of Tenochtitlán, the capital of the Mexica empire, of the viceroyalty of New Spain, and of the modern Mexican nation. Alongside, another Mexica group founded the twin city of Tlatelolco, which in time was to be absorbed by Tenochtitlán.

The swamp-surrounded island on which the Aztecs were forced to take refuge was so uninviting that none of the powers in the Valley of Mexico had claimed it. Tenochtitlán was thus located at the edge of the lands occupied by the valley's three powers: the Chichimecs of Texcoco, the Toltecs of Culhuacán and the Tepanecs of Azcapotzalco. It was not long before the Aztecs used their strategic position to advantage, placing their forces at the service of the Tepanecs, who proclaimed themselves heirs to the pre-Toltec civilization of Teotihuacán and who were emerging as the strongest power in the valley. It was as mercenaries and tribute-payers in the service of Azcapotzalco that the first three Aztec kings (Acamapichtli, Huitzilihuitl and Chimalpopoca) waged war against Culhuacán and Texcoco, thereby helping to establish the supremacy of the Tepanec king Tezozomoc. It was also as vassals of Azcapotzalco that the Aztecs participated in the campaigns that took them to what are now the states of Mexico, Morelos, Puebla, Hidalgo and Veracruz. In this way, the tribe began its apprenticeship as empire builders. Meanwhile, the city

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AZTEC CALENDAR STONE SHOWING THE 20-DAY SIGNS IN INNER CIRCLE

of Tenochtitlán and the Aztecs were becoming prosperous through the spoils of war, trade and the acquisition of lands from conquered tribes.

During the reign of Itzcoatl, the fourth Aztec king (1427–40), a century after the founding of Tenochtitlán, dynastic differences were dividing the Tepanecs. Netzahualcoyotl, the legitimate king of Texcoco who had been dispossessed by the Tepanecs, returned to claim his rights, with the support of the powers of what are today the states of Puebla and Tlaxcala (Cholula, Huejotzingo, Tlaxcala). Aware of their newly gained strength and chafing under their dependence upon Azcapotzalco, the Aztecs allied themselves with the Tepanecs' enemies and helped bring about the fall of Azcapotzalco.

With the defeat of the Tepanecs by Itzcoatl and Netzahualcoyotl, hegemony over the Valley of Mexico was established by Tenochtitlán and Texcoco, with Tlacopan (Tacuba), a Tepanec city opposed to Azcapotzalco, holding the position of junior party in what has come to be known as the triple alliance. The agreement among the three powers provided for a five-way division of the spoils of war, two shares going to Texcoco, two to Tenochtitlán and one to Tacuba.

Mexica expansion was under way. As the military leaders of the triple alliance, the Aztecs consolidated their domination over the Valley of Mexico and over neighbouring areas in what are now the states of Morelos and Mexico. Under Huehue Moctezuma (Montezuma I), the fifth Aztec king (1440–69), the conquests were extended to the modern states of Guerrero, Hidalgo, Puebla and Oaxaca and, in another series of campaigns, to the Veracruz coast on the Gulf of Mexico. Moctezuma seems to have been a strong military leader and a weak political organizer. His successor, Axayacatl (1469–81), devoted most of his time as sovereign to putting down rebellions of recently conquered tribes, save for one invasion to the Pacific coast of the modern state of Oaxaca. The most important contribution made by Axayacatl to Mexica hegemony was the conquest of Tlatelolco, Tenochtitlán's twin city. The brief reign of Tizoc, the seventh Aztec king (1481–86), was merely a continuation of Axayacatl's efforts to preserve the empire.

Ahuitzotl, another great military leader and eighth king of the Aztecs (1486–1502), gave new impetus to Mexica expansion. His people not only consolidated their former territorial gains but extended their domain along the Pacific coast, from the mouth of the Balsas river to the present-day border between Mexico and Guatemala, and along the Gulf of Mexico, from the Tuxpan river to what is now the state of Tabasco. All the territory between these two coast lines fell to the triple alliance, whether by conquest or submission through fear of Ahuizotl's ferocious campaigns. Only two powers dared resist him: Tlaxcala, which was encircled by the Aztecs, and the Tarascan "kingdom," in the present-day state of Michoacán.

Ahuizotl's success as a military leader was not matched, however, by skill as an organizer. His campaigns seem to have been aimed less at extending the empire than at acquiring booty and tribute, capturing victims for sacrifice at Tenochtitlán and ruling by terror. The task of attempting to organize the empire along lines other than mere Aztec military strength and Ahuizotl-type terrorism was left to Moctezuma Xocoyotzin (Montezuma II, *q.v.*), the ninth Aztec king (1502–20). It was the reign of this second Moctezuma that produced the codices in which Aztec officials recorded the organization of the empire into provinces and the payment of tribute according to the production of each region. A gigantic political, military and religious bureaucracy was built up, with governors, tax collectors, courts of justice, military garrisons, mail and messenger services, etc. Despite their feverish efforts at political organization, the Aztecs still had the strength to subjugate their allies, Texcoco and Tacuba, and to undertake new campaigns. It is extremely probable that in this period Aztec troops pushed as far as Central America, into Guatemala and Nicaragua, just as Aztec merchants had done earlier.

But the days of the Aztecs' greatest glory were also their last. Since 1517, Spanish expeditions led by Hernández de Córdoba, Grijalva and Hernán Cortés (*q.v.*) had been exploring the coasts along the Gulf of Mexico. Rumours of ships as large as houses (*acalli*) reached the city of Tenochtitlán, and to them were added prophecies of the imminent return of the benign deity and cultural hero Quetzalcoatl; they could mean only disaster for the Aztecs and their god Huitzilopochtli. Cortés' bold march against Tenochtitlán set the stage for the final scene of the Aztec empire. Spanish might, combined with a general revolt of the peoples under Tenochtitlán domination, proved superior to the Aztecs' strength. Under the last two Aztec kings, Cuitláhuac and Cuauhtémoc, Tenochtitlán was besieged and destroyed, but only after a heroic Aztec defense. Over the still-smoldering ruins of Tenochtitlán a new city began to rise. Symbolizing the future Mexico, the Christian cathedral built there was erected on the stones of Huitzilopochtli's temple.

The almost incredible story of a small wandering tribe that was able to build an empire in one century (from the beginning of the 14th century to the beginning of the 15th) can be largely explained by three main factors: the Aztec religion, the economy of the Valley of Mexico and the sociopolitical organization of Mexica.

The Aztec religion was centred around the cult of Huitzilopochtli, a young warrior and symbol of the sun, who died every evening, to be born anew the following day. At dawn, Huitzilopochtli would begin his daily struggle against the stars and the moon, driving them away with a shaft of light. At sunset, he would die and return to the bosom of the earth, his mother (Coatlicue), where he would renew his strength in order to take up the fight against darkness, which was symbolized by his brothers, the stars, and his sister, the moon. If he was to permit this daily cycle to occur and guarantee human existence, Huitzilopochtli had to be well nourished, vigorous and healthy. His sustenance was human blood, life's precious liquid (*chalchiuatl*). The Aztecs were people of the sun, chosen by Huitzilopochtli to provide him nourishment. War was, therefore, their favourite occupation and religious obligation. In war they captured their enemies and sacrificed them to the sun, opening their chests and tearing out their hearts barehanded. As the Aztec power grew, the number of human sacrifices increased. Prisoners from all parts of the country were put to death in Tenochtitlán so that the universe and man might survive. The Aztecs' cult of the sun was not to go unrewarded; Huitzilopochtli therefore promised them no less than domination of the world. The Aztec empire was given the name *Cem-Anáhuac Tenochca tlalpan*, that is, "the world, land of Tenochca," and their king was called *Cem-Anáhuac tlatoani*, that is, "ruler of the

world."

If the Aztecs' religious conception and their belief in predestination were factors behind Mexica imperialism, the sacrificial rites of sun worship were an instrument of terrorism which the Aztecs wielded with unmerciful relentlessness. The chroniclers report that at the festivities inaugurating the reign of Ahuizotl, the most warlike of the Mexica leaders, 80,000 prisoners were sacrificed at Tenochtitlán, their hearts placed before the sun, their limbs served at ritual banquets and their mutilated bodies thrown to wild beasts. When there was no war and victims were scarce, the Aztecs organized a *xochiyaóyotl* ("war of the flowers") in order to capture prisoners for sacrifice to the sun.

The economic basis of the Aztec hegemony was the Valley of Mexico's agriculture, characterized by *chinampas* cultivation and irrigation systems. It was mainly from the Toltecs that the Aztecs had learned these techniques. Nevertheless, these methods date even further back in Mexican history; almost certainly they were in existence in the 6th century B.C. The high productivity of the systems resulted in a heavy density of population in the Valley of Mexico and the development of large urban centres. In the early 16th century the total population of the valley fluctuated around 2,000,000, cities like Tenochtitlán, Texcoco, Tacuba and Xochimilco approaching or exceeding the 100,000 mark.

Because of this enormous concentration of population and economic resources, the Valley of Mexico became the pivotal key to power in the central part of the country. The group successful in uniting the valley under a single authority could go on to conquer the neighbouring valleys of Morelos, Mexico, Puebla and Hidalgo, and, thence, the rest of the country. This seems to have been the cycle of unification of the valley, conquest of its outlying areas and expansion to the rest of Mexico that had been followed by the Teotihuacans and the Toltecs, who preceded the Aztecs in quest of empire.

From very early times, another factor contributed to the strategic importance of the Valley of Mexico and to the realization of its potential in terms of power: a system of lakes (Texcoco, Chalco, Xochimilco, Xaltoca and Zumpango) that were connected naturally and by means of artificial canals (*acalotes*). The transport facilities provided by the lakes and canals compensated for the difficulties resulting from the nonexistence of the wheel and of domesticated animals and, in no small measure, furthered the early economic and political unification of the valley. According to Spanish chroniclers of the time, there were no less than 200,000 watercraft in existence in the 16th century.

The concentration of population in the Valley of Mexico, the urban development, the possibilities of water transport and the geographical diversity of the neighbouring areas all served as powerful stimuli to trade. Probably in keeping with an ancient tradition, the merchants (*pochteca*) of Aztec society were organized in very powerful guilds, which even started wars on their own and sent trading expeditions to remote places. It was on the basis of the geographical data collected by their merchants that the Aztecs drew up maps not only of what is now Mexico but also of Central America. It is virtually impossible to separate the Aztecs' trade policy from their military and expansionist policy. In fact, the coming of the merchants announced the arrival of the Aztec warriors, and the trade system was not long in being replaced, in the event of conquest, by a system of taxation and control that channeled toward the Valley of Mexico part of the products of the region and the benefits of its trade.

The third essential factor in Aztec imperialism, one that was closely linked to the religious ideology and the economic conditions of the Valley of Mexico, was the sociopolitical organization of the tribe. Aztec society in the early 16th century displayed many features described as "primitive," together with manifestations of a highly advanced civilization. For example, the division of the tribe into *calpulli* ("big houses"), pseudo-family units established in Tenochtitlán, has sometimes been interpreted as proof of a classical equalitarian organization. Yet, evidence of social stratification is indisputable. Possibly the Aztecs retained the *calpulli* mainly because of their usefulness in military and political organization, at the same time as a system of social stratification was developing. The *calpulli* may, in fact, be defined as localized units of fictitious kinship, of ambilateral descent, having an endogamous tendency and showing true social stratification.

Aztec society has also been interpreted as "feudal." This assertion is based on the existence of an Aztec hereditary "nobility" (*tlatoque*), behind which was a group of knighted commoners (*tecuhtin*) with access to land rights. Nevertheless, the relation of these noble groups to the Aztec kings, to the rest of society and to land ownership cannot be compared with old world feudalism. At the time it came into contact with the Spaniards, Aztec society was characterized by an oriental-type political organization, in which the king was an absolute or autocratic despot in the process of deification. Particularly during the reign of the second Moctezuma, Aztec society and the empire itself were being vigorously reorganized, following a pattern that seems to be traditional in the Valley of Mexico. A gigantic bureaucracy, completely dominated by the king, was charged with administering the immense Aztec empire, its tributaries and its trade. The imperial bureaucracy gradually absorbed the old social groups of "nobles," "knights" and merchants.

See also Index references under "Aztec" in the Index volume.

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AZUA, a province in southern Dominican Republic, crossed by the Sierra de Ocoa. Area 938 sq.mi.; pop. (1960) 75,147. In spite of low rainfall, agricultural production is abundant because of irrigation. The most important cultivations are coffee in the wetter mountainous areas, maize, plantains, bananas, peanuts and some sugar cane and tobacco. Lumbering of hardwoods and stock raising are significant. The province was established in 1845 and formerly had a larger area. The capital, Azua de Compostela (pop. [1960] 12,350), was founded in 1504 on the coast but was moved three miles inland after being destroyed by earthquake. (D. R. D.)

AZUAY, a province in southern Ecuador, bounded north by Cañar, east by Oriente, south by Loja and west by El Oro and Guayas. Its area is 3,011 sq.mi., and its population (1960 est.) was 329,900. The population is concentrated in the Basin of Cuenca (about 8,500 ft. above sea level) where farmers grow highland crops such as wheat, barley, potatoes and maize. Sugar cane, coffee and cotton are grown in the lower valleys. There is also a considerable amount of land used for the pasture of dairy cattle and, at higher elevations, of sheep. In the bordering mountains there are marble quarries and small-scale mining of gold, silver, mercury and platinum. Cuenca (*q.v.*), third largest city of Ecuador, is the capital of the province, and is the commercial centre of a large part of southern Ecuador. The manufacture of Panama hats from straw sent up from the lowlands is an important industry. (P. E. J.)

AZUELA, MARIANO (1873–1952), Mexican novelist, best known for his novels of the Mexican revolution, was born in Lagos de Moreno, Jalisco, on Jan. 1, 1873. He received an M.D. in Guadalajara in 1899, and practised medicine first in his native town and after 1916 in Mexico City. He wrote over 20 novels, mostly about the social effects of the Mexican revolution throughout its 30-year course. The most famous of these, *Los de abajo*, depicting the horrors of the revolution, resulted from his service as army doctor with Francisco Villa in 1915. Forced to flee across the border to El Paso, Tex., he first published the novel as a newspaper serial (Oct.–Dec. 1915). Hardly noted, the novel was "discovered" in 1924. It widely influenced other Mexican novelists of social protest, and was translated into most major languages, including English (*The Under Dogs*, trans. by E. Munguía, illus. by J. C. Orozco, 1929).

Returning from Texas to Mexico City in 1916, Azuela, disillusioned with the revolutionary struggle, wrote novels critical of the new regime: *Las moscas* (1918) and *Los caciques* (1917; Eng. trans. by L. B. Simpson, *Two Novels of Mexico: The Flies, The Bosses*, 1956); *Las tribulaciones de una familia decente* (1918).

His complete works in three volumes, edited by F. Monterde, appeared in 1959.

Azuela died in Mexico City, March 1, 1952.

See John E. Englekirk and L. B. Kiddle, Introduction and bibliographies in *Los de abajo*, pp. xi–lviii (1939). (L. Ll.)

AZURARA, GOMES EANES DE: *see* Zurara, Gomes Eanes De.

AZURITE or Chessylite, a basic copper carbonate, is found in nearly all copper mines, and is one of the ores of copper (*q.v.*). Its vivid blue colour contrasts strikingly with the emerald-green malachite, which it usually accompanies. It was known to Pliny as *caeruleum*. Azurite occurs with malachite in the oxidized portions of copper lodes, being due to alteration of copper sulfides by meteoric waters. It is often formed also by reaction between copper-bearing solutions and limestone and is a corrosion product of bronze.

The name chessylite is taken from Chessy, near Lyon, where many fine crystals belonging to the monoclinic system have been found. The formula is $2CuCO_3.Cu(OH)_2$. Hardness is 3.5 to 4 on Mohs' scale (*q.v.*) and specific gravity 3.8.

B THIS letter, corresponding to Semitic *beth* and Greek *beta*, has from earliest times retained the second place in all the European alphabets except the Cyrillic. Its form in the writing of the Moabite Stone, dating from the 9th century B.C., was . Early Greek forms were , and . The usual Greek form was or B, and in Latin the last two forms appear unchanged, giving the modern B. An uncial form occurs in the 6th century A.D. strangely resembling the early Greek forms from the island of Thera, but there can scarcely be a direct connection, the two similar forms having developed independently. (*See* ALPHABET.)

The equivalent Hebrew letter is thought to derive from an earlier symbol resembling the floor plan of a house; hence, the letter was named *beth*, the Hebrew word for "house."

The English minuscule form *b* is a descendant of Latin cursive . In this form the upper loop is extremely elongated and has almost disappeared. The early Irish form was ; the Carolingian (9th or 10th century) . The sound represented by the letter is the voiced bilabial stop. It stood for this sound in the Semitic languages and in Greek and Latin. From the 2nd century A.D. the sound in Latin tended to become a bilabial spirant for there is evidence of confusion in spelling between *b* and *u*. The letter, however, did not fall into disuse and was used in the Romance languages to represent the voiced labial stop in those situations where it was preserved, including the double *bb* and, in many of the languages, the initial *b*. The sound was always present in English, where it was derived from an original Indo-European **bh*.

The systems of phonetic changes involving the letter *b* in words of Germanic origin are discussed in GERMANIC LANGUAGES.

The Cyrillic alphabet was based on medieval Greek, in which the phonetic value of B had become *v*. A new form, , was therefore devised as the phonetic equivalent of *b*, and this letter appears in the second position of the Cyrillic alphabet.

In music, B is the second note of the musical alphabet and the seventh degree of the "natural scale" of C. In Germany, however, the alphabetical name for this note is, not B, but H, while B stands for B flat, a fact which is important to remember in dealing with German music, German writings on music and so on. Thus in German nomenclature Schubert's *Unfinished Symphony* is not in B minor but in H moll (minor), while Brahms's Second Pianoforte Concerto stands as being not in B flat but in B.

In chemistry, B is used as a symbol for boron. (J. W. P.)

BAADE, WALTER (1893–1960), German astronomer who became a resident in the United States in 1931, had a strong influence on galactic and extragalactic research. Born at Schröttinghausen on March 24, 1893, he was educated at the universities of Münster and Göttingen. During 1919–31 he was a member of the staff at Hamburg observatory. From 1931 to 1938 he was astronomer at Mount Wilson observatory in California. He returned to Göttingen as Gauss professor in 1959, and died there on June 25, 1960. The greater part of his observational and theoretical work is concerned with extragalactic nebulae as stellar systems. His main subjects are: variable stars in our galaxy, in globular clusters and in the Andromeda nebula; galactic and extragalactic novae; the investigation of the new star class of supernovae; the observation of the galactic nucleus through "galactic windows" (regions of low interstellar absorption near the galactic belt); the revision of the zero point of the period-luminosity curve of δ Cephei stars and the change in the cosmic distance scale by a factor two; the emission and absorption nebulae along the arms of spiral systems; the resolution of central parts of the Andromeda nebula; and the evidence for existence of two essentially different stellar populations of older and younger stars. Baade immensely stimulated the theory of stellar interiors as the basis of theoretical interpretation of stellar evolution. (O. H. L. H.)

BAADER, FRANZ XAVER VON (1765–1841), German theologian, was born at Munich on March 27, 1765. In 1826 he was appointed professor of philosophy and speculative theology at the new University of Munich, but in 1838 he ceased to lecture owing to a ministerial order prohibiting laymen from lecturing on philosophy and theology. He died at Munich on May 23, 1841.

The facts that Baader left no systematic works and that he usually expressed himself in obscure aphorisms or mystical symbols make it difficult to summarize his philosophy. He believes that reason must be supplemented by faith and church tradition and that it must clarify the truths given by authority and revelation. But in his attempt to correlate the two realms he approaches the mysticism of Eckhart, Paracelsus and Böhme. Human knowledge is never mere *scientia*, it is invariably *con-scientia*—a knowing with a consciousness of God whose knowledge compenetrates ours. God is not to be conceived as mere abstract Being, but as an everlasting process of activity, which is distinguishable under two aspects—the immanent or esoteric, and the emanent or exoteric. As regards ethics, Baader rejects the Kantian or any autonomic system of morals. Not obedience to a moral law, but realization in ourselves of the divine life is the true ethical end. But because man has alienated himself from God no ethical theory that neglects the facts of sin and redemption (and the necessity of prayer and the sacraments) is satisfactory. The history of man and of humanity is the history of the redeeming love of God. Man in his social relations is under two great institutions. One is temporal, natural and limited—the state; the other is eternal, cosmopolitan and universal—the church. In the state two things are requisite: first, common submission to the ruler, which can be secured or given only when the state is Christian, for God alone is the true ruler of men; and, second, inequality of rank, without which there can be no organization. A despotism of mere power and liberalism, which naturally produces socialism, is equally objectionable. The ideal state is a civil community ruled by a universal or Catholic church, the principles of which are equally distinct from mere passive pietism, or faith that will *know* nothing, and from the Protestant doctrine, which is the very radicalism of reason.

Baader's *Sämtliche Werke* were published in 16 volumes (1851–60). Some of his lectures at Munich were published under the title *Spekulative Dogmatik* (1827).

BIBLIOGRAPHY.—The most complete account of his thought is Eugene Susini, *Franz von Baader et le romantisme mystique*, 3 vol. (1942). A brief biography is that of Josef Siegl, *Franz von Baader* (1957). *See* also F. P. Siegfried in *Catholic Encyclopaedia*, vol. ii, pp. 173–175.

(J. J. PN.)

BAAL, the name of a god in many ancient near eastern communities, especially among the Canaanites, who apparently considered him the most important god in the pantheon. His name is common to the Semitic languages and means "lord" or "owner," but it could be used more generally: a *baal* of hair is an owner of hair, a hairy man (II Kings i, 8), and a *baal* of wings is a winged creature; in the plural, *baalim* of arrows is archers (Gen. xlix, 23) and *baalim* of oaths means conspirators (Neh. vi, 18). His name might be used to refer to a god bearing another name, even Yahweh himself, as is indicated by the occurrence of such names as Jerubbaal (Gideon), Ishbaal (one of Saul's sons) and Beeliada (a son of David, I Chron. xiv, 7). The last name appears in II Sam. v, 16 as Eliada, showing that El (God) was regarded as equivalent to Baal; *cf.* also the name Bealiah, "Yahweh is *baal*," which survives in I Chron. xii, 5. Yet such fluidity in the use of the term *baal* did not preclude its being attached to a god of distinct character, not only among other peoples but even by the Israelites.

Knowledge of Baal's personality and functions derives chiefly from a number of tablets uncovered in 1929 and later at Ugarit (*q.v.;* modern Ras Shamra) in northern Syria and dating from the middle of the 2nd millennium B.C. These tablets, although closely attached to the worship of Baal at his local temple, probably represent Canaanite belief generally. To them he was the god of the fertility of field and cattle who fought several enemies, died and was reborn. He was the Rider of the Clouds, deity of rain and storm, associated with the goddesses Little Lightning (the daughter of Light), Little Dew (the daughter of Distillation) and Little Earth. These divinities apparently have little individuality of their own and merely express aspects of Baal's power; of far greater importance is Anat, the warrior-goddess, who is Baal's consort and sister. His chief enemy is Mot, god of the rainless season and the nether world. By obvious symbolism the ascendancy of Mot on earth follows upon the death of Baal, who is buried together with huge sacrifices of all sorts of animals, and all activity on earth ceases. Anat, however, slaughters Mot, cuts him to pieces, burns, grinds and sows him in the fields. By this act she is doing what the farmer does to restore life to the earth; and as the farmer, his work over, prays for the return of the rain-god, so Anat, by the destruction and sowing of Mot, encompasses Baal's rebirth.

Other Ugaritic myths tell of the defeat by Baal of Yamm, a god of the sea, following a motif found in other near eastern stories in which a hero or younger god in the course of his adventures must defeat a sea monster. The myths tell also of Baal's struggle to obtain a palace comparable in grandeur with those of the other gods. He is opposed in this by El, chief of an older divine generation, and apparently also by El's wife Asherah. This myth must refer in part to the construction of Baal's own temple in the city of Ugarit, and may have been regularly recited in ritual commemoration of the temple's dedication. Near Baal's temple was that of Dagon, given in the tablets as Baal's father. Baal bears an alternate name, Hadad, taken from an old Semitic storm-god from whom Baal of Ugarit probably acquired much of his individuality.

Baal's worship was popular from the 14th century on in Egypt, where he was considered the counterpart of Setekh; through the influence of the Aramaeans, who borrowed the Babylonian spelling Bel, he ultimately became known as the Greek Belos, identified with Zeus. Of the worship of the Tyrian Baal, also called Melkart (King of the City) and often identified with the Greek Heracles but sometimes with Zeus, there are many accounts in ancient writers, from Herodotus on. He had a magnificent temple to which gifts streamed from all countries, especially at the great feasts; noteworthy is the annual feast of his awakening after the winter solstice. At Tyre, as among the Hebrews, Baal had his symbolical pillars, one of gold and one of smaragd (emerald), which, transported by fantasy to the farthest west, apparently gave rise to the familiar Pillars of Hercules. His name occurs as an element in Carthaginian proper names (Hanni*bal*, Hasdru*bal*, etc.), and a tablet found at Marseilles describes the charges made by the priests of the temple of Baal for offering sacrifices.

The Old Testament frequently speaks of the Baal of a given place, or refers to Baalim in the plural, suggesting the existence of local deities, distinct from one another, "lords" of the various locales. Yet these cannot have been merely vegetation spirits whose power extended no farther than the immediate vicinity. It is not known to what extent the Canaanites considered their various Baalim identical, but the Baal of Ugarit scarcely confined his activities to the town, and doubtless other communities agreed in giving him cosmic scope. Regarding Baal's importance the Old Testament may therefore be somewhat misleading, but concerning his functions it agrees fairly closely with the Ugaritic tablets. He is the source of all the gifts of nature; as the god of fertility, all the produce of the soil is his, and he receives tribute of the first fruits. Joined with the Baalim there are found corresponding female figures known as Ashtaroth, plural of Ashtoreth; here the Ugaritic and Hebrew sources apparently diverge, with Ashtoreth in the latter taking the place of Anat (*see* ASTARTE). The cult of the Baalim and Ashtaroth was characterized, in the eyes of hostile witnesses at any rate, by gross sensuality and licentiousness. On the summits of hills and mountains and "under every green tree" flourished the cult of the givers of increase. Human sacrifice (Jer. xix, 5), the burning of incense (Jer. vii, 9), violent and ecstatic exercises, ceremonial acts of bowing and kissing and the preparing of sacred mystic cakes appear among the offenses denounced by the Jewish prophets and suggest that the cult of Baal (and Ashtoreth) included characteristic features of worship which recur in various parts of the Semitic world.

The history of Baalism among the Israelites is obscured by the difficulty of determining whether the worship stigmatized by the prophets is the worship of Yahweh under a conception, and often with rites, which treated him as a local nature god; or whether Baalism was consciously recognized from the first to be distinct from Yahwism. The earliest certain reaction to Baalism is ascribed to the reign of Ahab, whose marriage with Jezebel led him to worship Baal and erect a temple to him in Samaria. This, however, did not prevent him from remaining a follower of Yahweh, whose prophets he still consulted, and whose protection he still cherished when he named his sons Ahaziah and Jehoram ("Yah [weh] holds" and "Yahweh is high"). Elijah, in crusading against this introduction to Israel of Baal's worship, certainly regarded him as no local vegetation spirit; his priests claimed for him the same power as Elijah for Yahweh. (*See* ELIJAH.) By the time of Hosea the antagonism to Baalism had so deepened that the use of the term "Baal" was felt to be dangerous to true religion. Thus there grew up the tendency to replace it by the contemptuous *bosheth* ("shame") in accordance with the idea of Ex. xxiii, 13; in compound proper names, for instance, may be found Ishbosheth for the earlier Ishbaal. Nonetheless, the books of Deuteronomy and Jeremiah afford complete testimony for the prevalence of Baalism as late as the exile, but prove that the Jews regarded it as debased as compared with the pure worship of Yahweh, the god of Israel. *See* BEL; *see* also references under "Baal" in the Index.

See A. S. Kapelrud, *Baal in the Ras Shamra Texts* (1952), with further bibliography. (W. M. SE.)

BAALBEK (BA'LABAKK), ancient Heliopolis (Greek "city of the sun"), is the principal town and agricultural centre of the rich plain of the Beka' the eastern district of the Republic of Lebanon. It stands at 3,850 ft., on the watershed separating the Litani (Leontes) and the Asi (Orontes), at the foot of Anti-Lebanon. Pop. (1956 est.) 11,700. Two-thirds are Mutawilis and one-third Christians and there are a few Sunnite Muslims. It is the seat of a Uniate Greek bishop. Baalbek is connected by railway and road with Beirut (40 mi. E.N.E.) and Damascus (35 mi. N.N.W.) via Riyaq (Rayaq), and with Aleppo, Syr. The main activities are agricultural, but there is some tourist trade.

History.—The name has given rise to conjecture; it was possibly connected with the worship of Baal (*q.v.*), the lord of the Beka' (R. Kittel, O. Eissfeldt). No remains or testimonies are earlier than the Greek conquest of Syria (333 B.C.). After the death of Alexander, the Beka' fell to Ptolemy and his descendants, under whom, presumably, the town was named Heliopolis after its Egyptian namesake. In 200 B.C. it was conquered by Antiochus the Great and remained a Seleucid possession until the fall of that dynasty. Around 65 B.C. it appears to have been

KAHOUS FROM YERVANT SARRAFIAN, BEIRUT

RUINS OF THE TEMPLE OF JUPITER, BAALBEK: COMPLETED 3RD CENTURY A.D.

under the sway of an Arab (Ituraean) chieftain, Ptolemy (son of Mennaeus), whom Pompey, when he occupied Heliopolis in 63 B.C. on his way from Antioch to Damascus, confirmed as a vassal prince against payment of a large sum. In 36 B.C. it belonged to the Syrian territories donated by Marcus Antonius to Cleopatra. About 16 B.C., Augustus settled veterans of two legions in Baalbek under the name Colonia Iulia Augusta Felix Heliopolis.

The two huge temples could only have been built on imperial initiative and with imperial funds, probably to provide a common religious centre for the colonists and the native population. The temple of Jupiter was erected under the Julio-Claudian dynasty, but it took about two centuries to complete its elaborate courtyards. Trajan, on his way to the Parthian War, consulted the oracle of Jupiter Heliopolitanus, who is said to have foretold his death in terms that were only understood after the event. The temple of Bacchus was probably built around A.D. 150. The eviction of pagan by Christian religion seems to have been a gradual one; Constantine (d. 337) is supposed to have closed the temples; Theodosius I (379–395) is said to have established a church in the temple, but the great basilica that was built over the altars in the courtyard cannot be earlier than the 6th century. Baalbek passed under Arab domination in 637 ('Omar I) and remained under the caliphs until 1075, when it fell under the rule of the Seljuks. From 1110 it was subject to their vassals, the Burids; in 1136 it fell into the hands of Zangi, prince of Aleppo. In 1157 it was conquered by Nureddin, who, in 1170, rebuilt its walls after a destructive earthquake, and in 1174 it came under Saladin. The Mongols occupied the town in 1260 for a few months, and Baalbek became a possession of the Egyptian Mamelukes under whom it remained until the Ottoman conquest in 1517. After World War I the French mandatory authorities included Baalbek in the State of Lebanon, the present Republic of Lebanon.

Archaeology.—Although European attention was first directed to the ruins in the 16th century (Martin von Baumgarten 1507; Pierre Belon du Mans 1553), Robert Wood was the first to publish a good survey of the temples, with many plates (1757). From 1898 to 1905 a German expedition under Otto Puchstein excavated the temples. Extensive clearings and repairs were accomplished under the French mandate and the Lebanese government has undertaken considerable restoration work. The so-called acropolis includes the temples of Jupiter and Bacchus, with their entirely separate precincts. Access to the temple of Jupiter is gained by the propylaea (early 3rd century) leading to a hexagonal forecourt (middle 3rd century). The worshipers were then admitted to the main court (2nd century). There, flanked by two basins for lustral purposes, stood two huge altars (the larger one was 60 ft. high) erected in the 1st century and designed to allow people to worship from a height. The rectangular court, 343 × 338 ft., is surrounded by elaborately decorated exedrae (semicircular benches), opening on a portico whose 84 granite columns were brought from Aswan in upper Egypt. In the 6th century A.D. a Christian basilica, now removed, was built over the altars. At the western end of the court, on a high artificial terrace, preceded by an imposing stairway, stood the temple, a Corinthian building with 10 columns on each front and 19 on each flank. The terrace probably goes back to pre-Roman days; the temple, according to an inscription, was near completion in A.D. 60. Only six columns of the south side, with their beautifully carved entablature, are still standing (height 62 ft., diameter 7½ ft.). A more ambitious project of the early empire was to raise a high platform round the temple, but it had to be abandoned and its only remains are the formidable foundations to which belonged the famous trilithon of ancient writers (three blocks, each roughly 62 × 14 × 11 ft.). The temple was dedicated to the Heliopolitan triad which included (1) the Syrian thunder-god Hadad, equated with Jupiter; (2) the Syrian nature-goddess Atargatis, equated with Venus; and (3) a youthful god, probably a vegetation spirit, a protector of the crops and cattle, equated by the Greeks with Hermes the shepherd, hence by the Romans with Mercury. Originally the cult was purely agricultural. Like many such cults, however, and probably under Greek influence, it seems to have developed a mystic aspect, and the youthful god, in many respects not unlike Adonis, seems to have acquired some bacchic features. The cult was spread over the whole Roman empire, mainly by merchants and soldiers (*e.g.*, dedications found in Northumberland, Eng., along Hadrian's wall at Carvoran).

The Temple of Bacchus (middle of 2nd century A.D.), not so large, but almost entirely preserved, is also Corinthian, with 8 × 15 columns. Its symbolic decoration shows that it was dedicated to the same triad as the great temple, but the prevalence of bacchic symbols in the interior probably points to a mystic destination. Other ruins include (1) a round temple (3rd century), of unknown destination, near the acropolis; (2) remains of the city walls; (3) on the hill of Sheikh Abdullah, traces of a temple dedicated to Hermes; (4) important Roman mosaics from private houses, now in Beirut museum; (5) a ruined mosque with re-employed antique material; (6) extensive Arab fortifications, including a mosque, in the acropolis.

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BAB (Mirza 'Ali Mohammed of Shiraz) (1820–1850), became the founder of a Muslim religious sect in 1844 when he claimed for himself the title of Bab ("gate") to the truth. The concept of a Bab who affords access to divine guidance is a familiar one from Shi'ite Islam, and Mirza 'Ali Mohammed was not the first to appropriate the title. The Shi'ites believe that the last of their great leaders or Imams, upon which they are dependent for spiritual direction, became invisible to his followers about A.D. 874. It is expected that he will return at some future time, but in the meanwhile contact with him is possible only through an intermediary known as the Bab (*see* Imam; Shi'ism). In the latter portion of his brief career, Mirza 'Ali Mohammed dropped the title Bab and proclaimed himself the Imam Mahdi whose coming the Shi'ites so long had expected. Many were willing to accept his claims, and a strong religious movement grew up about him. The movement met with sharp opposition from both orthodox Muslims and the Persian government. The founder was arrested on suspicion of insurrection, and there ensued a series of bloody clashes. The Babis were subject to persecution by the authorities, about 28 of them being executed after an attempt on the life of the Shah in 1852. Mirza 'Ali Mohammed was executed in 1850 after a career of only six years and passed his spiritual authority on to a young disciple, Mirza Yahya, known as Subh-i-Azal. *See* also Babism. (C. J. A.)

BABBAGE, CHARLES (1791–1871), English mathematician and mechanician, the originator of the modern automatic computer, was born at Totnes, Devon, on Dec. 26, 1791. He went up to Trinity college, Cambridge, in 1810. There, instead of taking the tripos, he founded, with Sir John Herschel and George Peacock, the Analytical society, whose object was to introduce continental developments into English mathematics, in particular by replacing the Newtonian *Dot* notation in the calculus by the Leibnizian *D* notation. In the years 1815–17 he contributed three papers on the "Calculus of Functions" to the *Philosophical Transactions*, and in 1816 was elected a fellow of the Royal society. He first had the idea of mechanical calculation of tables in the rooms of the Analytical society in 1812 or 1813. He later made a small machine which would tabulate to eight decimals a function whose second differences were constant, and in 1823 he obtained government support for a projected difference engine with 20 decimals working up to seventh differences. The design was sound, but its practical realization required much development of engineering techniques to which Babbage devoted himself. In 1826 he invented a new notation for drawings of machinery. But in 1842, after more than ten years' indecision, the government of Sir Robert Peel refused the further support which had been recommended by the Royal society, and Babbage's difference engine was never finished. A machine based on Babbage's ideas was made in 1855 by Scheutz, a Stockholm firm. Meanwhile, in 1834, Babbage invented the principle of the analytical engine, the automatic computer of the 20th century. He devoted many years of his life to the construction of this also, but it was never finished. From 1828 to 1839 Babbage was Lucasian professor of mathematics at Cambridge. He was instrumental in founding the Astronomical (1820) and Statistical (1834) societies, and published papers on mathematics, statistics, physics, machine design and geology.

Babbage's books include a translation of part I of *An Elementary Treatise on the Differential and Integral Calculus* by S. F. Lacroix (1816); *Reflections on the Decline of Science in England* (1830); *On the Economy of Machinery and Manufactures* (1832); the *Ninth Bridgewater Treatise* (1837); *Thoughts on the Principles of Taxation* (1848); and *Passages From the Life of a Philosopher* (1864).
See also H. P. Babbage, *Babbage's Calculating Engines* (1889). (G. A. B.)

BABBITT, IRVING (1865–1933), U.S. critic and teacher, was best known as the leader of the 20th-century movement in literary criticism known as the "new humanism," or neohumanism. Born in Dayton, O., on Aug. 2, 1865, he was educated at Harvard and at the Sorbonne in Paris. He was a teacher of French and comparative literature at Harvard from 1894 until his death on July 15, 1933.

A vigorous teacher, lecturer and essayist, Babbitt was the unrestrained foe of romanticism and its offshoots, realism and naturalism, opposing to these the classical virtues of restraint and moderation. Allied with Babbitt were Paul Elmer More, Norman Foerster and, for a time, Stuart P. Sherman. Such earlier followers as T. S. Eliot and George Santayana later criticized him adversely. (For other opposition, *see* also American Literature: *From 1914 to 1945*.)

Babbitt extended his views beyond literary criticism: *Literature and the American College* (1908) opposes vocationalism in education and calls for a return to the study of classical literatures; *The New Laokoön* (1910) deplores the confusion in the arts created by romanticism; *Rousseau and Romanticism* (1919) criticizes the effects of Rousseau's thought in the 20th century; *Democracy and Leadership* (1924) studies social and political problems; *On Being Creative* (1932) compares the romantic concept of spontaneity adversely with classic theories of imitation. The humanist and antihumanist controversy reached its peak shortly before the depression of the 1930s.

Bibliography.—Frederick Manchester and Odell Shepard (eds.), *Irving Babbitt, Man and Teacher* (1941); Frederick Manchester (ed.), *Spanish Character*, Babbit's posthumous volume of essays (1940), contains a bibliography.

BABBITT, ISAAC (1799–1862), U.S. inventor, was born in Taunton, Mass., on July 26, 1799. He was trained to be a goldsmith and thus had some opportunity to experiment with metals, in which work he succeeded in making the first britannia ware produced in the United States (1824). Ten years later he went to Boston and while employed there by the South Boston Iron Co., in 1839, he made one of the types of alloy known as Babbitt's metals, or white metals. They are hard compositions of tin with antimony and copper, and are used for bearings. For this invention he received a gold medal from the Massachusetts Charitable Mechanics' association and an award of $20,000 from congress. He became a manufacturer of this metal and of soap. He died in Somerville, Mass., on May 26, 1862.

BABBITT'S METAL, an alloy invented in 1839 by Isaac Babbitt for the special purpose of providing a suitable bearing material for steam engines. Babbitt's patent covered only the principle of using a soft conformable alloy supported by a stronger shell; the alloy mentioned in the patent contained 89 parts of tin, 9 of antimony and 2 of copper. Babbitt's metal had a two-phase structure consisting of hard particles in a soft matrix. It was theorized that the hard particles form a "pavement" which supports the load while the soft matrix is worn down to a level slightly below that of the hard "pavement" and thus provides a series of channels for supply of lubricant. The antimony strengthens the matrix by dissolving in the tin and by forming hard cubic particles of tin-antimony (SnSb) compound. Copper additions form hard needle-shaped particles of copper-tin (Cu_6Sn_5) compound which entrain the tin-antimony cubes and ensure uniform distribution.

The term Babbitt is widely used to include three groups of bearing alloys: high-tin alloys (substantially lead-free) containing 90% or more tin, high-lead alloys containing 70% or more lead and intermediate alloys containing tin and lead in the matrix. *See* Bearing Metals; Alloys.

See P. G. Forrester, *Babbitt Alloys for Plain Bearings*, Tin Research Institute Publication No. 149 (1950); C. H. Mathewson, *Modern Uses of Non-Ferrous Alloys*, "A.I.M.E. Series" (1953). (R. M. MacI.)

BABBLER, the general name applied to members of a large old-world family of birds (Timaliidae), the babbling thrushes. There are sometimes united with the thrush family (Turdidae). There are about 260 species, ranging in size from warbler to jay, some dull, some gaily clad. They are abundant in China and Malaysia, about 50 species being found in forests of the Malay peninsula. The best known are the Chinese robin (*Liothrix lutea*), the coachwhip bird (*Psophodes*) and the red-capped babbler (*Timalia pileata*) of southeastern Asia. (G. F. Ss.)

BABCOCK, STEPHEN MOULTON (1843–1931), U.S. agricultural research chemist, called the father of scientific dairying, was born Oct. 22, 1843, near Bridgewater, N.Y. He is best known for development of a simple method to measure the butterfat content of milk by mixing sulfuric acid with a measured sample of milk to liberate the fat globules, which, in a graduated container, indicate the percentage of butterfat at a glance. The Babcock test, introduced in 1890, discouraged watering and adulteration practices and enabled farmers to realize profits from milk according to the intrinsic fat richness of the product; it also gave major stimulus to improvement of dairy production through improvement of herds. Babcock studied at Tufts college, Medford, Mass., and Rensselaer Polytechnic institute, Troy, N.Y., and at the University of Göttingen, Ger. (Ph.D., 1879). After several years of working as a teacher and chemist in New York, Babcock joined the University of Wisconsin staff in 1888, remaining there 43 years. Pioneer nutritional studies, specifically vitamin research, for which the University of Wisconsin became famous, are credited to the Babcock laboratory, and at least ten other notable inventions and discoveries in his field were made by Babcock alone or with fellow workers. He repeatedly refused to patent his discoveries, preferring that the world benefit freely by them. He died July 2, 1931, in Madison, Wis.

See E. T. Dies, "Jolly Scientist," *Land*, 8:193–196 (1949).

BABEL, TOWER OF, according to Gen. xi a structure erected in the plain (or valley) of Shinar. Because of its builders' presumption in erecting a tower that reached the heavens—symbolizing human self-sufficiency and pride—the Lord confused their tongues. The myth on which the building of the tower rests may have developed as an attempt to account for the diversity of man's languages. Use of the word Babel perhaps indicates that the story was inspired by the Babylonian ziggurat of Etemenanki, north of the Marduk temple Esangila (*see* BABYLON). The "confusion" of tongues would be correctly indicated by *balal*, Heb. "to confuse."

See H. Gressmann, *The Tower of Babel* (1928); A. Parrot, *Ziggurats et tour de Babel* (1949).

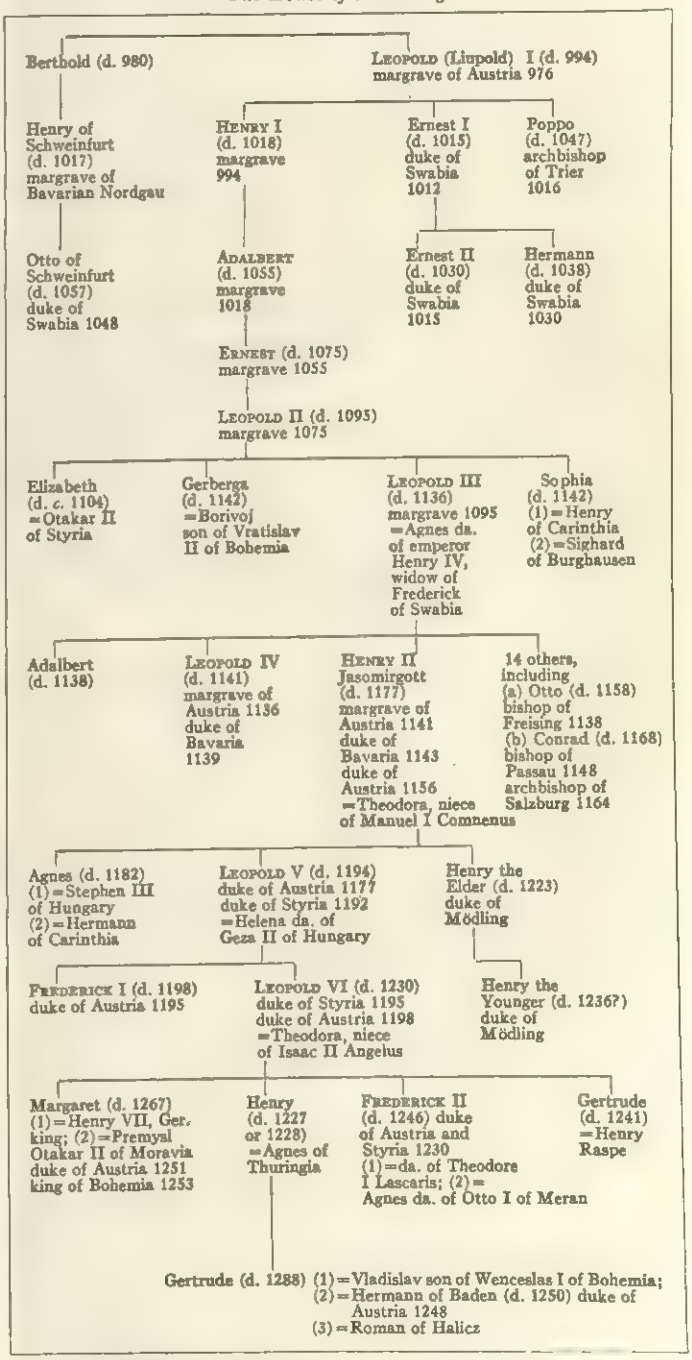
BABELL, WILLIAM (*c.* 1690–1723), English composer, known in his time as a keyboard executant of outstanding brilliance. Born about 1690, probably in London, he was taught music by his father (a bassoonist) and the eminent theoretician Dr. Pepusch, and he held appointments as organist of All Hallows, Bread street, and as an orchestral violinist. He is chiefly remembered for his virtuoso transcriptions for harpsichord of popular operatic excerpts, especially those based on arias from Handel's *Rinaldo*. His reputation as a performer was widespread and according to one German critic, he was said to surpass even Handel himself. He died on Sept. 23, 1723, in London. About two years later his friends arranged the publication of some of his compositions, comprising two sets of solo sonatas for violin, oboe or flute and *continuo*; though rather variable in quality and of no great originality, they often disclose a pleasing melodic gift and are of interest in that the ornamentation of the slow movements—usually left to the performer's discretion—is fully written out.

(S. J. SA.)

BABENBERG, the name of the first Austrian dynasty (976–1246), derived from the castle of Babenberg, first mention of which is made in 902 and which later became the bishopric and town of Bamberg in Franconia. The historian Otto of Freising reports that the family of Babenberg, of which he himself was a member, was descended from Count Adalbert (executed in 906). This would indicate that the family stemmed from the East Frankish family of the Poppones and that their ancestor was Poppo I, who in 819 was a count in the parts of Franconia bordering on Hesse. This Poppo's grandsons were probably the brothers Adalhart, Henry and the aforementioned Adalbert, who in the struggle for supremacy in Franconia against the Conradines (ancestors of the German king Conrad I) concentrated their forces on the castle of Babenberg. The conflict, however, ended in their defeat and death (for the first two in 902, for Adalbert in 906), and all their possessions were confiscated by the king, Louis the Child.

Modern research, however, has cast doubts on the descent of the Austrian margraves from this older Babenberg family; there are also grounds for supposing connections between the later Austrian dynasty and the Bavarian ducal house of the Arnulfings. But reliable information only becomes available in the Ottonian period. Berthold of Babenberg (*see* table) owned the northern countships of eastern Franconia by the time of the reign of the emperor Otto I, and his younger brother Leopold I (Liupold) received the Austrian mark in 976. At the borders of the Bavarian dukedom the brothers had to hold in check the supporters of Duke Henry the Quarrelsome, who had been deposed by Otto II. The accession to the German kingdom of Henry II (1002), son of the Quarrelsome, led to a rising under Berthold's son Henry of Schweinfurt, which cost him all his lands except his personal property in eastern Franconia. The last of this elder line, Otto of Schweinfurt, in recognition of services to the German king Henry III, received the dukedom of Swabia (1048–57), which had previously (1012–38) been held by Leopold's descendants. From

The House of Babenberg



(1) (2)=Indicates order of marriage.

1036 to 1038 the Babenberg duke Hermann of Swabia had extended his rule to the mark of Turin, through marriage with the daughter of its margrave, Manfred II (d. 1035).

Although the position of the house of Babenberg in the Austrian mark was for long only a modest one, they enjoyed a considerable standing as a result of their family connections. The wife of Leopold I was probably a niece of the emperor Otto II, and his grandson the margrave Adalbert is reported to have married a sister of King Peter of Hungary. Leopold II's daughters married the dukes of Carinthia and Bohemia and the margrave of Styria. Leopold III was the brother-in-law of the emperor Henry V and after the latter's death (1125) was a candidate for the German crown. He was the most important of the Babenberg margraves and was soon venerated by his people as a saint (canonized in 1485).

Among the sons of Leopold III, Henry II Jasomirgott and the historian Otto of Freising are the most notable. They were half brothers of King Conrad III, and in their generation a number of marriages forged connections between the house of Babenberg and the Welfs, Hungary, Bohemia, Poland, Montferrat (Piedmont) and Byzantium. Leopold IV and Henry were both dukes of Bavaria, and in 1156 Austria was raised to a dukedom (*see* AUSTRIA, EMPIRE OF). In 1192 Leopold V succeeded to the dukedom of Styria; his part in the third crusade brought him into conflict with Richard I of England and led to the unlawful imprisonment of the king, whose niece Eleanor it was intended should marry one of Leopold's sons (1193). The ransom for Richard's liberation was used partly for the foundation of Wiener Neustadt (1194) and its fortification against the Hungarians, and partly for the reform of the Austrian currency.

In the 12th century the Babenbergs were in fact the rulers of the country, far overshadowing the rest of the Austrian nobility, whose political powers they steadily reduced. The period of their greatest power was under Leopold VI. Leopold's son Frederick II engaged in conflicts with the Bavarians, Bohemians and Hungarians and, after the fall of his brother-in-law the German king Henry VII (the emperor Frederick II's son), was temporarily dispossessed of his lands. The duke's two marriages remained childless; in 1245 it was arranged that his niece Gertrude should marry the emperor Frederick II and that Austria should be raised to a kingdom, but these plans were not realized. Duke Frederick was killed on June 15, 1246, fighting against the Hungarians on the Leitha river. For Margaret, his sister, and for Gertrude, who both survived him, *see* AUSTRIA, EMPIRE OF.

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BABEUF, FRANÇOIS NOEL (GRACCHUS BABEUF) (1760–1797), French political agitator who attempted to overthrow the Directory and to set up a communist "republic of equals," was born at St. Quentin on Nov. 23, 1760. From 1785 until the outbreak of the French Revolution he was employed as *commissaire à terrier* at Roye, with the invidious duty of assisting landlords to assert their feudal rights over the peasants. In 1789, however, he drew up the first article of the *cahier* of the electors of the *bailliage* of Roye, demanding the abolition of feudal rights (*see* FRENCH REVOLUTION).

During the earlier period of the Revolution Babeuf served in various minor posts in Paris or in the provinces. In 1794, however, he settled in Paris and on Sept. 3 published the first number of his *Journal de la liberté de la presse*, renamed *Le Tribun du peuple* in the following October. In this paper he vehemently attacked the men of the Terror, who had been overthrown by the *coup d'état* of Thermidor, and at first defended the Thermidorians. But he also attacked the economic outcome of the Revolution and later the Thermidorians themselves. As a result of this Babeuf was arrested in Feb. 1795 and sent to prison at Arras. There he came under the influence of certain terrorist prisoners, notably R. F. Lebois, editor of the *Journal de l'égalité*. He emerged from prison a confirmed communist, convinced that his utopia could only be realized through the restoration of the constitution of 1793.

The misery due to the fall in value of the *assignats* gained Babeuf a hearing. He gathered round him a small circle of his immediate followers, known as the Société des Égaux. This was soon merged with discontented Jacobins who met near the Panthéon. After the club of the Panthéon had been closed by Bonaparte (Feb. 29, 1796), Babeuf's activity increased, and on April 11, 1796, Paris was placarded with posters headed *Analyse de la doctrine de Baboeuf*, inciting people to revolt against the Directory. The Babouvist song "Mourant de faim, mourant de froid" ("Dying of hunger, dying of cold") began to be sung in the *cafés* with great applause, and reports were current that the disaffected troops in the camp of Grenelle were ready to join a rising against the government.

The Directory thought it time to act. Its agents, notably the former captain Georges Grisel, who had been initiated into Babeuf's society, had produced complete evidence of a Babouvist and Jacobin conspiracy for an armed rising fixed for 22 Floréal year IV (May 11, 1796). On May 10, 1796, Babeuf was arrested with many of his associates, including A. Darthe, P. M. Buonarroti and L. Taffoureau, together with four former members of the Convention, Robert Lindet, J. A. B. Amar, M. G. A. Vadier and J. B. Drouet. The trial of Babeuf and his accomplices was fixed to take place before the newly constituted high court of justice at Vendôme. On 7 Prairial year V (May 27, 1797), Babeuf and Darthé were condemned to death, while the rest were either exiled or acquitted. Babeuf and Darthe, on hearing the verdict, attempted to commit suicide, but were nevertheless executed at Vendôme on 8 Prairial.

Babeuf and his followers wanted the return of the constitution of 1793 because it had been a democratic constitution established by the vote of the French people and as such could provide a rallying point for all parties among the discontented revolutionaries. They regarded the arbitrary destruction of this constitution in 1795 as illegal and those who supported its destruction as traitors. Yet the Babouvists attacked the right to property which had been reaffirmed in the constitution of 1793. The opening sentences of the *Analyse de la doctrine de Baboeuf* declared that: "Nature has given to every man the right to the enjoyment of an equal share in all property." Babeuf moreover maintained that a true state should contain neither rich nor poor, but imposed upon every man an obligation to work. The Babouvists' disappointment at the outcome of the Revolution is made clear in another sentence from the *Analyse*: "The Revolution is not yet complete, because all the good things of life are taken by the rich, who rule as dictators, while the poor toil in misery like slaves and are considered of no account in the state."

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BABIES, CARE OF: *see* INFANTS, CARE OF; MATERNAL AND CHILD HEALTH.

BABINGTON, ANTHONY (1561–1586), English conspirator, was one of the principals in a plot to assassinate Elizabeth I, secure the release of Mary Stuart and promote a general rising of Roman Catholics in England. The son of Henry Babington of Dethick in Derbyshire and of Mary, daughter of Lord Darcy, he was born in Oct. 1561 and was brought up secretly a Roman Catholic. As a youth he served at Sheffield as page to the earl of Shrewsbury, keeper of Mary Stuart, for whom he early felt an ardent devotion. In 1580 he went to London, attended the court of Elizabeth I and joined the secret society supporting the Jesuit missionaries. In 1582, after the execution of Edmund Campion, he withdrew to Dethick, and later went abroad. He became associated at Paris with Mary's supporters, who were planning her release with the help of Spain, and on his return he was entrusted with letters for her. In May 1586 he was joined by the priest John Ballard in the plot which generally bears his name. The conspiracy, in its general purpose of destroying the government, included many Roman Catholics and had ramifications all over the country. Philip II of Spain promised immediate assistance with an expedition after the assassination of the queen was effected. Babington wrote to Mary explaining his plans, but his

letters and her reply were intercepted by the spies of Sir Francis Walsingham. On Aug. 4 Ballard was seized and betrayed his comrades, probably under torture. Babington had already applied for a passport abroad, for the ostensible purpose of spying upon the refugees, but in reality to organize the foreign expedition and secure his own safety. The passport being delayed, he offered to reveal to Walsingham a dangerous conspiracy, but the latter sent no reply, and meanwhile the ports were closed.

Shortly afterward, Babington is said to have observed a memorandum of Walsingham's concerning himself while in the company of the minister's servants. Thereupon he fled to St. John's Wood and after disguising himself succeeded in reaching Harrow, where he was sheltered by a Roman Catholic convert. Toward the end of August he was discovered and imprisoned in the Tower of London. On Sept. 13–14 he was tried with Ballard and five others by a special commission; he confessed his guilt but strove to place all the blame upon Ballard. All were condemned to death for high treason. On Sept. 19 he wrote to Elizabeth praying for mercy, and the same day offered £1,000 for procuring his pardon; the next day he was executed in Lincoln's Inn Fields.

The historical significance of the Babington plot lies in its implication of Mary Stuart. The only positive documentary proof that Mary had knowledge of the intended assassination of Elizabeth is in a postscript to her final answer to Babington. The authenticity of this postscript has been challenged, but it is argued that Mary's circumstances, together with the tenor of her correspondence with Babington, place her complicity beyond all reasonable doubt. *See* also MARY (Mary Stuart).

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BABIRUSA, the wild East Indian swine of the Celebes and Buru (*Babirussa babyrussa*). Its stout body is covered with a rough gray hide, almost devoid of hair. The peculiarity of this hoofed mammal is the exaggerated development of the canines, or tusks, of the male. Those of the upper jaw are directed upward from their bases, so that they never enter the mouth, but pierce the skin of the face and curve backward, eventually almost touching the forehead. Alfred Russel Wallace remarks that "it is conceivable that these tusks were once useful, and were then worn down as fast as they grew, but that changed conditions of life have rendered them unnecessary, and they now develop into a monstrous form. . . ."

W. SUSCHITZKY

BABIRUSA (BABIRUSSA BABYRUSSA)

The babirusa is a docile, timid, night-hunting animal of the dense jungle. They root in soft soil near rivers and in swamps, the male usually going ahead while the mother and young follow, foraging on upturned tidbits of animal and plant matter. *See* also ARTIODACTYL.

BABISM (BABIISM), the religion founded by Mirza 'Ali Mohammed of Shiraz, who in 1844 declared himself to be the Bab (*q.v.*; Arabic "gate") through whom a renewed divine revelation should come. The title Bab originated with the Shi'ite sect of Muslims (*see* SHI'ISM), who believe that the spiritual authority of Mohammed at his death was transmitted to Ali (*q.v.*), his cousin and son-in-law, from whom it passed to his descendants, the 12 divinely chosen Imams (leaders) of the Shi'ite sect (*see* IMAM). The 12th and last Imam disappeared from human view *c.* A.D. 874 but the Shi'ites believe him still alive, though hidden. For a short time after disappearing, the Imam kept contact with his followers through agents, called by the title Bab, who acted as his spokesmen. By assuming the title, Mirza 'Ali Mohammed thus claimed to renew the broken communication with the occluded Imam.

Shi'ites also believe that at the end of time the 12th Imam (Imam Mahdi) will reappear to establish justice on earth. Abandoning the title Bab, Mirza 'Ali Mohammed soon proclaimed himself this expected Imam Mahdi. His followers consequently began to call him Qa'im, "He who shall arise," a traditional name for the coming Imam.

Still later he was called "His Holiness the Highest Point" and "His Holiness the Lord Most High." These two titles and other evidence show that he was looked upon as a divine figure in the fullest sense. Use of the term "Point" is explained by an alleged tradition from 'Ali that the meaning of the entire Koran is contained in its first chapter, the meaning of the chapter in the invocation, the meaning of the invocation in the first letter and the meaning of the whole in the dot or point that distinguishes that letter from others of similar form. In the "Point" is found the summation of all wisdom, the fullness of divine knowledge and power.

Babi doctrine holds that God in himself, in his essential divine nature, is unknowable, beyond the possibility of human comprehension. He is known, however, through a series of manifestations of himself, the great prophets who have appeared in the past. Among these manifestations the Babis list the Jewish prophets, Christ and Mohammed, and the Baha'is have added to the series the founders of other, non-Semitic religions (*see* BAHA'I FAITH). Each of the divine manifestations came with a teaching appropriate to the needs of those whom he addressed. When his teaching was no longer useful, a new manifestation appeared to further human spiritual enlightenment. Altogether this body of teachings evidences a divine plan for the continued and progressive spiritual education of man. Unlike the Muslims, the Babis do not believe in the end of prophecy but consider that it shall continue eternally for the duration of the universe itself. Denial of the finality of Mohammed's prophethood has brought them into serious conflict with Muslims in many countries. Babis also believe that each divine manifestation has foretold his successor. The Bab was prefigured in Jewish expectations of the Messiah, Christ's promise of the Comforter and Muslim teaching of the return of the Imam. The Bab also pointed to one who would come after him, his successor, "Him whom God should manifest." Baha'is have taken this prediction to refer to Baha'ullah (*q.v.*), but it is not certain that the Bab so intended.

One important Babi belief has to do with numbers and the equivalence of names in terms of numerical value. Each letter of the Arabic alphabet traditionally has a numerical value, and it is common in Muslim literature to find dates and numbers represented through the numerical values of words. For the Bab the number 19 was of particular significance since it was the "number of unity"; *i.e.*, the total of the values of the separate letters of the Arabic word for unity (*wahid*) when added together. The mystic significance of numbers was decisive in the Bab's appointment of his successor and the limitation of the number of his major disciples (there were 18 of these plus himself for a total of 19). The number 19 was also the basis of the system of reckoning time and the monetary system proposed by the Bab.

Most of the Bab's life after his "manifestation" (1844) was spent in prison. He was executed at Tabriz by government order in 1850. During his lifetime and after his followers were subjected to cruel persecutions that persist to the present day. The chief reasons for the opposition to the Bab and his religion were probably three: (1) the lightninglike spread of his new doctrines; (2) the offense to Muslim religious beliefs posed by his claims; and (3) the political implications of claiming the title Imam.

When the Bab died, his followers soon split into two sects. The Bab had nominated as his successor one Mirza Yahya, known as Subh-i-Azal (Dawn of Eternity). The group split when Baha'ullah (Subh-i-Azal's half-brother) publicly proclaimed himself "Him whom God should manifest," as foretold by the Bab. The majority of Babis soon accepted this claim as authentic and became Baha'is. Some, however, remained loyal to Subh-i-Azal, and strife resulted between the factions, causing the death of several persons. To prevent public disorder the Turkish authorities banished both Baha'ullah and Subh-i-Azal, to Palestine and Cyprus, respectively; conflict, nevertheless, continued between the two parties. There are today very few Babis, the Baha'is having become of vastly

greater importance. It is the latter whose world-wide organization and ethical teachings have saved the Bab from oblivion. *See* BAHA'I FAITH.

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(C. J. A.)

BABITS, MIHÁLY (1883–1941), Hungarian poet, novelist and essay writer, who played an important part in the literary life of his country in the early 20th century, was born in Szekszárd on Nov. 26, 1883, of a middle-class family (his father was a judge). He read Hungarian and classics at the University of Budapest and then taught in various secondary schools. His first volume of poetry appeared in 1909. During World War I he had to resign from his teaching post because of his pacifism and thereafter devoted all his energies to literature. Babits belonged to the group of writers and poets which included also Endre Ady, Zsigmond Móricz and Dezső Kosztolányi, whose principal organ was *Nyugat*, one of the most important reviews in Hungarian literary history, of which he later became editor. A shy, reticent man, Babits found himself charged with responsibilities he had not sought. Thus, in 1929, he became the "curator" of the important Baumgarten prize, awarded annually to a writer "who had remained faithful to his principles." He died in Budapest, Aug. 4, 1941.

Babits is an intellectual poet, difficult to understand, imbued with the spirit of antiquity. His style is remarkable for its compression. Self-centred and withdrawn in his early period, he later left his "ivory tower," and turned to deal with the pains and problems of his fellows. He wrote several novels. In some such as *Halálfiai* ("The Children of Death"; 1927) he gave a poignant picture of the decaying middle classes. A prolific essay writer and a brilliant translator, he translated, among other works, the plays of Sophocles, Dante's *Divina Commedia*, medieval Latin hymns and works by Shakespeare and Goethe. (Ds. SR.)

BABOL (BABUL, formerly BARFURUSH), the chief town of a populous district in Mazanderan, the Second *ostan* (province) of Iran, lies on the eastern side of the Babol river about 15 mi. from the Caspian sea. The river is bridged there by the old highway built by Shah Abbas I to cross the Caspian provinces from east to west. Pop. (1956) 36,194. The town gained importance during the reign of Fath Ali Shah, although Abbas I had previously laid out a pleasure garden and summer palace there, the remains of which are known as Bagh-i-Shah. It is still a lively regional centre with large and crowded bazaars, well-built houses in burnt brick and tilted and tiled roofs, paved streets and handsome little mosques and funeral towers. There are some manufacturing activities but bigger developments have occurred at the nearby town of Shahi (pop. 23,055), a former village which profited greatly because of the Trans-Iranian railway joining the Mazanderan plain there.

Meshed-i-sar, now called Babol Sar, was formerly the port of Babol at the mouth of its river on the Caspian, but has completely lost its function since the level of the sea dropped about 6½ ft. leaving the riverside quays dry and the undredged sand bar impassable even for native lighters. However, Babol Sar developed into a fashionable seaside resort, frequented by well-to-do people from Teheran. It is reached through Babol by the main motor road and an airport has been constructed there. Its population was 7,237 in 1956. (H. Bo.)

BABOON. The early English naturalist John Ray (1627–1705) defined baboons as short-tailed quadrupedal monkeys, but no such natural group exists. Scientifically the term is restricted to five species constituting the genus *Papio* but in a wider sense includes two related stump-tailed species, the drill and mandrill. The name has also been applied to a stump-tailed monkey from Celebes (*Cynopithecus*) and certain other large macaques (*e.g.*, the pig-tailed *Macaca nemestrina*), and sometimes also to the gelada (*Theropithecus*); in Guiana it is colloquially applied to the red howler (*Alouatta seniculus*).

Typical baboons, as above restricted, are heavy-bodied terrestrial quadrupeds with large heads, large cheek pouches and long, truncated, naked muzzles with the nostrils at the tip. Their tails are carried in a characteristic arched manner. Because of their enormous canines and powerful limbs, they can be very destructive to crops and are dangerous adversaries, especially since they associate in large troops. Remarkable for their degree of social cohesion, the members of a troop are subservient to the whims of a dominant male leader who guards his harem and other adherents on the understanding that his personal dietetic and sexual demands receive prior consideration.

Baboons are confined to the drier savanna and rocky districts in Africa south of the Sahara and in Arabia, being rarely found in forest and then only marginally. Almost omnivorous, they favour roots, peanuts, fruit, insects, birds' eggs and even larger creatures, which they catch and tear apart by hand. They are noisy, emitting alarm notes resembling a dog's bark besides feebler calls; *e.g.*, grunts, squeals, chatterings, each with a definite meaning. Communication between individuals is also effected by posturings and tail signaling. They are highly intelligent and educable.

Coat colour varies considerably, but coat texture is always harsh. Over the shoulders in adult males, the coat tends to be lengthened, forming a cape; the underparts, hands, feet, face and buttocks are naked, and the last-mentioned site often is vividly coloured. Males greatly exceed the females in size. The latter, at the midpoint of the menstrual cycle, present an unsightly appearance because of the high degree of swelling around the genital region. Normally only one young is born at a time, gestation lasting seven months.

Of the known species the largest is the darkly coloured South African chacma (*P. ursinus*) and the smallest the bright rusty Guinea baboon (*P. papio*). The most spectacular is the sacred, or Arabian, baboon (*P. hamadryas*) of northeast Africa and Arabia, sacred to the ancient Egyptians and characterized by the enormously elongated hairs of the neck and shoulders of the adult males and the bright red naked sitting pads. Others are the olive baboon (*P. anubis*) ranging over west, central and eastern Africa and the long-limbed yellow baboon (*P. cynocephalus*) of Rhodesia. *See* PRIMATES: *Old World Monkeys* (*Catarrhines*): *Baboons and Mandrills*; CHACMA; DRILL; GELADA; MANDRILL.

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(W. C. O. H.)

BABRIUS, the author of a collection of verse fables written in Greek not later than the 3rd century A.D., was probably a Hellenized Roman, but nothing is known of his life. The fables are versions of Aesopic fables, with some additional stories, rendered into the scazon, or choliambic, metre. But the metre follows Roman rather than Greek practice, both in the use of resolved feet and in the attention paid to ictus and accent, above all at the end of the line. The fables were very popular in antiquity and originally comprised ten books. The extant collection is in two books, the second being incomplete. Many are beast fables, and almost all are short and simply written. But there is a definite satirical element which suggests urban sophistication, and there is often a pointed conclusion in the last two lines.

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(G. B. Ko.)

BABUR (ZAHIR UD-DIN MOHAMMED) (1483–1530), first Mogul ruler in India, poet, diarist and military adventurer, was born on Feb. 14, 1483. A Barlas Turk, he was descended on the male side in the fifth generation from Timur (*q.v.*) and on the female side in the 15th degree from Genghis Khan (*q.v.*). In succeeding his father as ruler of Fergana (*q.v.*) in 1494, Babur inherited a share in the interminable family struggle among the descendants of Timur for the towns and fertile zones of Transoxiana, an area enriched by the caravan and entrepôt trade with China, India and Iraq. Important in the power struggle was an ability to attract an armed following and to draw revenue from

herdsmen, cultivators, artisans and traders. The weapons were adroitness in managing the allegiances and antagonisms of an unruly but not uncouth military elite, united or divided by close family ties, and personal address and ability to inspire affection among men unsusceptible to the appeal of more impersonal loyalties of language, race or state. The young Babur owed his survival and his success in the political tournament to his winning personal qualities and the swift opportunism that drew him later to conquer the plains of northern India.

From 1494 to 1504 Babur struggled to retain Fergana and to establish himself at Samarkand, Timur's old capital, in face of more powerful Mogul relatives and Shaibani Khan, ruler of the Uzbek tribes to the northeast of the Jaxartes (Syr Darya) river. Brief occupations of the city in 1497 and 1501 were followed by a decisive defeat by Shaibani Khan at Sar-i-pul in April–May 1501 which left Babur bereft of both Samarkand and his own principality. Seeking a headquarters beyond Uzbek power, in 1504 he settled at Kabul and shortly after the failure in 1511–12 of a last attempt to re-establish himself in central Asia and Samarkand he turned to exploiting the political possibilities to the east and south of Kabul. After probing raids toward India and the occupation of Kandahar in 1522 Babur was invited by Daulat Khan Lodi of Lahore and 'Alam Khan, an uncle of Ibrahim Lodi, the sultan of Delhi, to help them against Ibrahim. Northern India, divided among the largely autonomous and quarreling Afghan chiefs under the weak suzerainty of Delhi and the Rajputs under the paramountcy of Rana Sanga of Mewar, was in no state to resist him. In April 1526 Babur defeated and killed Ibrahim Lodi at Panipat and occupied Delhi and Agra. In March 1527 he defeated Rana Sanga at Khanua and in May 1529, at the battle of the Gogra, near Patna, he overthrew the Afghan chiefs settled in Bihar and Bengal. When he died, however, at Agra on Dec. 26, 1530, Babur had only succeeded in staking a military claim to empire in India, a claim which was to be consolidated by his grandson Akbar (*q.v.*).

BIBLIOGRAPHY.—Babur's frank and engaging memoirs, the *Baburnama*, have been translated from the Turki by A. S. Beveridge, 2 vol. (1921–22). *See* also L. F. Rushbrook Williams, *An Empire Builder of the Sixteenth Century* (1918); F. Grenard, *Baber* (1930); *Cambridge History of India*, vol. iv, *The Mughul Period* (1937). For a full bibliography on Babur's career and place in literature *see* the article "Babur," *The Encyclopaedia of Islam*, vol. i, 2nd ed. (1958–59).

(P. H.)

BABUREN, DIRK (THEODOR or DIRCK) **VAN** (*c.* 1590–*c.* 1624), Dutch painter, was born at Utrecht in about 1590 and died apparently soon after 1623, the latest date on any known work. Baburen was a pupil of Paulus Moreelse and worked in Rome from 1617–20. Like other painters of the Utrecht school, such as Gerard van Honthorst and H. Terbrugghen, with whom his art has much in common, he was profoundly influenced by the powerful and dramatic chiaroscuro style of Caravaggio. His own manner is broad and forceful, but compared with the greater Caravaggesque masters betrays a certain coarseness in conception and weakness in draftsmanship and modeling. All his known works are figure compositions, and these include, besides a number of religious subjects, genre pieces of the Utrecht school type, with half-length, life-size figures. Among notable pictures are the "Entombment" in the church of S. Pietro in Montorio, Rome; "Christ Among the Doctors" in the National gallery, Oslo; and the "Procuress" in the Museum of Fine Arts, Boston.

(R. E. W. J.)

BABY BLUE-EYES (*Nemophila menziesii*), a small North American plant of the waterleaf family, Hydrophyllaceae, a popular wild flower of California, native to moist places in valleys and mountains. It is a low, usually diffuse, annual, with stems about six inches long and minutely hairy divided leaves. The bell-shaped light-to-deep-blue flowers, one-half inch to one and one-half inches across, often veined with purple and dotted toward the centre, are borne in one-sided clusters. It is cultivated as an annual; seeds should be sown one-fourth inch deep in any ordinary garden soil, in full sunlight, as soon as warm weather is assured. Thinned out to three to six inch intervals, they will bloom from July to frost. *See* NEMOPHILA. (N. TR.)

BABYLON, one of the most famous cities of antiquity, is situated on a branch of the Euphrates river just north of the modern town of Hillah in southern Iraq. At this latitude there is only a narrow strip of land between the Euphrates and the Tigris, and the city thus stood at a nodal point that enabled it to intercept traffic between Syria and the Persian gulf on the one hand, and between the two rivers on the other. In the first half of the 18th century B.C., under Hammurabi (*q.v.*), who overcame Rim-Sin of Larsa, Babylon succeeded to suzerainty over the great part of Mesopotamia. (*See* BABYLONIA AND ASSYRIA.)

It was, however, as a religious centre that the city attracted both power and prestige, and from the time of Hammurabi onward an established priesthood fostered the cult of Marduk there. Even the kings of Assyria found it politic to receive what was practically a coronation rite in Babylon. The priests did not fail to take advantage of the murder of Sennacherib (*q.v.*) and to proclaim that this misfortune was due to the failure of that prince to submit to Marduk. As S. Langdon showed, it is significant that there was "consistent reference to the great temple of Marduk on the very bricks employed in the reconstruction of older and far more famous sanctuaries throughout Babylonia."

Old Babylon, the capital of Hammurabi and his successors, was sacked as the result of a Hittite raid at the beginning of the 16th century B.C., but the statue of Marduk that was removed was restored to it by the Kassite king Agum II, *c.* 1570 B.C., after an absence of 24 years. Thereafter Babylon's career was checkered, although more than one monarch between that time and the 8th century B.C. endeavoured to impart to it something of its former glory. The city again suffered in the wars with Assyria, particularly at the time when the Chaldean soldier of fortune Merodach-baladan established his throne there. Sargon II (722–705 B.C.) recorded in a prism discovered at Nimrud that he found it wasted and ruined, a jungle infested with jackals. His attempt to rebuild the city was frustrated by the Aramaean tribes, and Sennacherib consequently leveled it to the ground in 689 B.C. Esarhaddon built a new town on the same site, but after his death one of his sons, Shamash-shum-ukin, who succeeded to Babylonia, revolted against Assyria. Babylon suffered the horrors of a siege and was eventually captured by Ashurbanipal (648 B.C.).

During the decline and fall of the Assyrian empire Babylon was ruled by an independent line of kings. In the late 7th and early 6th centuries B.C. Nabopolassar and his son Nebuchadrezzar rebuilt the city whose remains have survived until today; and it was at this time that Babylon attained its greatest fame. Nabonidus (*q.v.*), a heretic, the last of the Neo-Babylonian kings, earned unpopularity with the priests of Marduk and was succeeded by the Persian king Cyrus, who in 539 B.C. was allowed to invest Babylon without resistance. Under Cyrus' successors Darius I and Xerxes I, however, the city was plundered and punished for revolting against Achaemenid rule, and its defenses were demolished. Alexander the Great, who died in the palace of Nebuchadrezzar in 323 B.C., had intended to rebuild the ziggurat, but his successors established a new capital in Seleucia. Nonetheless the city was not deserted, as the remains of a Greek theatre testify, and as late as the Parthian period a school of learned astronomers flourished within it.

Topography, Buildings and Antiquities.—In spite of the statements of classical writers and the work of German excavators the topography of Babylon is far from clear. The earliest Greek writer on the city is Herodotus, who describes the town as standing on a broad plain and forming an exact square, with a total circuit of about 60 mi. Other Greek writers, Ctesias, Strabo and Cleitarchus, give a different estimate amounting to about 42 mi. Various attempts have been made to correlate these statements with the remains that can be observed, for the actual walls of the city have an extent of only about 11 mi. It has been suggested that Herodotus included the towns of Borsippa, Kish and Sippar within his total circuit. In fact, however, these discrepancies, which are due to hearsay and to imperfect observation in ancient times and to incomplete geographical and archaeological surveys in modern, remain unresolved. Changes in the course of the river and the destruction wrought by medieval and modern canals as well as

the rise in the level of the water table have obliterated the evidence or so effectively concealed it as to make it practically impossible to reconstitute the ancient circuit. Since the earliest times the Euphrates has frequently shifted its course, and though the greater part of the city down to the Neo-Babylonian period lay on its eastern bank, during the Persian and Greek periods an arm of the river had, according to R. Koldewey (*see* Bibliography, below), shifted to the east of the citadel. Transverse canals with sluice gates ran in an east-west direction north and south of the citadel; the burnt-brick piers of a Neo-Babylonian bridge that spanned the Euphrates provide important evidence of the hydrography.

Herodotus' defective account of the temples and the town walls and his unverifiable measurements have led many authorities to doubt if he ever visited the site, but one of his remarks about the ziggurat, popularly known as the "tower of Babel," bears the authentic imprint of an eyewitness: "when one is about half-way up, one finds a resting-place and seats, where persons are wont to sit some time on their way to the summit" (Herodotus i, 181; Eng. trans. by G. Rawlinson revised by A. W. Lawrence, 1935). Any traveler, ancient or modern, would have found it beyond his powers to describe this complex site without making a prolonged stay. It seems reasonable to conclude that Herodotus made a brief halt in the course of a caravan journey, that he listened to the tales of garrulous guides and perhaps filled out his notes from some earlier author. His understanding that the town was laid out on a rectangular grid is approximately correct, and his references to moat, ditch, embankment and towers, streets and houses, while unsatisfactory in detail, have more than a touch of verisimilitude.

What in fact is known about the topography, buildings and antiquities of Babylon is mainly due to the work of R. Koldewey, who conducted excavations there on behalf of the Deutsche-Orient Gesellschaft between 1899 and 1917. There were double inner and outer walls on the left bank of the river, composed of sun-dried and burnt brick, reinforced with towers at intervals and further strengthened by an escarpment and fosse. The outer double walls reached a maximum of 7.1 m. in width.

The most impressive monument on the site is the great Ishtar gate, an enormous burnt-brick structure more than 12 m. high, decorated with brick reliefs, in tiers, of dragons (the *shirrush*) and young bulls. The gate was a double one, and on its south side there was a vast antechamber. Through the gate ran the famous stone- and brick-paved procession street that has been traced over a length of more than half a mile. The sides of the streets were decorated with brick lions *passant*. It has been estimated that there were 120 lions along the street and 575 dragons and bulls, in 13 rows, on the gate. Not all of these reliefs were visible at the same time, however, for the level of the street was raised more than once and even originally the lowest rows, which were irregularly laid, may have been treated as foundation deposits. The Iraq antiquities department has reconstructed this thoroughfare at one of the higher levels. The upper courses of the friezes were composed of polychrome glazed bricks; stylized floral designs on the top give a brilliant final touch to this spectacular façade. The procession street, which entered the city from its northern side, flanked the great palace area and the sacred enclosure or ziggurat, known as Etemenanki, where it turned west and led up to a bridge across the Euphrates. Not far to the south of this section of the road was Esangila, the principal temple of Marduk, patron god of the city.

West of the procession street and southwest of the Ishtar gate lay the palace area, which covered more than 13 ac. of ground and where the pomp and majesty of Babylon were concentrated. There were five blocks of annexed buildings, each of which centred around a vast courtyard. The central block contained a throne room measuring 60 by 55 m. and decorated with blue glazed bricks, some of which were incorporated in columns surmounted by double capitals of Ionic type with half rosettes and palmettes. The roofing of this great chamber presents a technical problem; it may have been achieved by means of overlapping beams laid diagonally from the corners of the room, a device known to the Parthians later on. Hundreds of smaller rooms within this area housed the royal family and court officials and must have served for the storage of royal treasure as well as for transacting business. This vast throne room can be associated with the scene of Belshazzar's feast and the writing on the wall, which foretold the doom of Babylon at the hands of the Medes and the Persians (Dan. v; the statement in verse 2 that Nebuchadrezzar was Belshazzar's father has to be emended in the light of the cuneiform records, which state that Belshazzar was in fact the son of Nabonidus, the last king of Babylon). On the other hand the tradition that associates the series of magazines in the northeast corner of the palace area as the site of the "hanging gardens" can be dismissed as fiction. From tablets discovered therein it is now known that this was the place where Jehoiachin, king of Judah, was held in captivity by Nebuchadrezzar in 597 B.C. together with his court and craftsmen and smiths, among whom there were Philistines, Phoenicians, Elamites, Medes and Persians, Egyptians and Ionian carpenters. The whole of this palace area or *Qasr* as it is now locally known was strongly defended: on the west by an enormous bastion (*halsu rabitu*) on the river bank; on the north by a huge buttressed wall, *Imgur Bel*; and on the south side by a canal, as well as by powerful buttresses, which also flanked the eastern wall. While traces of the handiwork of Assyrian monarchs, notably Esarhaddon, have been found, it is to Nebuchadrezzar (605–562 B.C.) that credit must be given for the greatest architectural achievements out of the many Neo-Babylonian monarchs who had a hand in the embellishment of the city during the last century of its lifetime.

BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

STONE BAS-RELIEF FROM THE ESANGILA, SHOWING ASHURBANIPAL CARRYING BASKET IN THE REBUILDING OF THE TEMPLE

Many well-built and spacious temples were found in the course of the excavations, including those of Ninmah, Marduk (the Esangila), Ninurta and Ishtar of Agade, but a fraction of the total named in the records. Every temple had an oblong cella with podium for the god's statue against the middle of the long wall at the far end of the sanctuary, opposite the door; the other rooms were grouped around a square or oblong courtyard. Spacious houses, notably the "great house" of Merkes, were characterized by a sawtoothed façade repeated in various buildings at Ur. The ziggurat or staged temple tower known as Etemenanki had a special *temenos* or walled enclosure that ensured its privacy. It was dismantled by Alexander the Great, who died before he could rebuild it: his successors the Seleucids erected a Greek theatre.

After the conquest of Babylon by Cyrus the Persians took over the capital, which for a time prospered, as is known from many Achaemenid economic documents. A hypostyle building (*apadanna*), including a black limestone plinth inscribed with the name of Darius I and ornamented glazed brickwork, may be contemporary. His successor Xerxes I destroyed the statue of Marduk as punishment for a nationalist uprising. Large numbers of small artifacts as well as some sculpture were found, notably a basalt monument known as the "Lion of Babylon," which depicts a man supine under the beast's belly, a traditional formula for illustrating the king's triumph. There are now reasons for assigning this to the Neo-Babylonian period.

With the death of Alexander the Great, Babylon, although still a religious centre, ceased to have any political significance, for the new capital of Mesopotamia was transferred by his successors to Seleucia on the Tigris. A large part of the old city buried under a deep bed of silt remains to be found, and the Babylon of Hammurabi, of which only the slenderest traces have been detected, now lies beneath the water table.

See also references under "Babylon" in the Index.

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BABYLONIA AND ASSYRIA, the two ancient kingdoms of Mesopotamia (*q.v.*) or modern Iraq. Of these, Babylonia roughly corresponds to the southern plain between Baghdad and the Persian gulf, while Assyria is the northern region around present-day Mosul. Their names are derived from those of their capitals, Babylon and Ashur, respectively. A high civilization was developed in Babylonia around 3000 B.C., and Babylonia remained the cultural centre of the region until the Persian conquest in 539 B.C. Political power, however, shifted back and forth between Babylonia and Assyria. Although recorded history begins in Assyria about one millennium later than in Babylonia, the Assyrians became the leading power, especially between 900 and 600 B.C., owing to their military and administrative skills.

Babylonia and Assyria shared a common Semitic language called Assyro-Babylonian or Akkadian. In Babylonia this language superseded that of an earlier population, Sumerian, and it was the Sumerian people that first developed the high civilization of Babylonia.

Until the 19th century the knowledge of Babylonia and Assyria was based on the Old Testament and a few Greek writers. Not until after the discovery of ancient monuments and written documents in the two countries, and especially after the decipherment of the cuneiform script and the languages written in this script, did the history and civilization of Babylonia and Assyria become known. Covering, as it does, three millenniums, this civilization underwent many changes, although it retained certain main characteristics. The sources are unevenly distributed over this long time span, being abundant for some periods but scarce or entirely lacking for others. Therefore there remain gaps in our knowledge of the political history as well as of the development of institutions, social structure, religion, art and literature, as will be shown below. (H. G. Gk.)

This article is organized as follows:

I. GEOGRAPHY

While the political boundaries of Babylonia and Assyria varied greatly from period to period, these two countries are customarily considered to comprise all the lands situated between the Tigris and Euphrates rivers, as well as the long stretch of land extending from the Tigris eastward toward the Iranian plateau. In modern usage this area is often called Mesopotamia, a term used by ancient Greek historians and geographers. It corresponds roughly to the region enclosed within the political boundaries of the present-day state of Iraq. Divided by a line drawn between the two rivers where they come closest to each other (near the modern city of Baghdad), two areas are distinguished: the southern area, identified with Babylonia, and the northern area, identified with Assyria.

1. Physical Geography.—The southern area is formed mainly by the alluvial deposits of the Tigris (Sumerian Idigna; Akkadian Idiglat), the Euphrates (Sum. Puranun; Akk. Purattu) and the many canals between. In its central part there is a slight elevation, called Edin in ancient times, while the southern part, close to the Persian gulf, extends into a full marshland. The main rivers are the Diyala (ancient Turnat), the Kerkha (anc. Uqnu) and the Qarun (anc. Ulay), all left-bank tributaries of the Tigris. In two important respects the ancient courses of the Tigris and Euphrates differed greatly from those followed by these rivers in modern times: in ancient times, the main course of the Tigris ran southward from Kut, following the course of the modern Shatt al Hay; and the course of the Euphrates ran past the ancient Babylon along a line 15–30 mi. E. of the present course of the river.

The higher-lying northern area consists of a plateau broken up by the ridges of Karaja Dag (anc. Izala), Tur 'Abdin (anc. Kasiyari) and Sinjar (anc. Singara), and the rivers Khabur (anc. Haburu), Balikh (anc. Balihu) and the largely dry Wadi Tartar

(anc. Tartara), all situated between the Tigris and the Euphrates. The main mountain chain east of the Tigris is Jabal Hamrin (anc. Epih), and the main rivers there are the Great and Little Zab (anc. Zabu) and the 'Adem (anc. Radanu).

2. Babylonia.—Originally the name of the provincial city of Babylon (anc. Babili, misinterpreted in ancient times as Bab-ili, "the Gate of Gods"), the name of the country of Babylonia begins to appear in the Old Babylonian period, when the rulers of Babylon, especially the great conqueror and lawgiver Hammurabi, succeeded in uniting the southern half of the Land of the Two Rivers. Politically, Babylonia extended in that period northward along the Tigris toward Ashur, and along the Euphrates toward Mari. Babylonia reached its highest political expansion in the Neo-Babylonian period when its conquered territories included all of Mesopotamia, Syria and Palestine. Babylonia proper was known also under the term "Kardunias," introduced in the Middle Babylonian period, and "Kaldu," "the land of the Chaldeans," known in the Neo-Babylonian period.

The main cities of Babylonia, from south to north, are: Eridu (modern Abu Shahrain), Ur(im) (mod. Tell el Muqayyar), Larsa(m) (mod. Tell Sankarah), Erech or Uruk (mod. Warka), Lagash-Girsu (mod. area of Telloh), Umma (mod. Jokhah), Shuruppak (mod. Tell Fa'rah) and Adab (mod. Bismayah), in the southern part; Nippur (mod. Nuffar), Marad (mod. Wannat Sa'dun) and Isin (mod. Bahriyyat), in the central part; Borsippa or Barsipa (mod. Birs Nimrud), Babylon (mod. Hillah), Kish (mod. Uhaymir), Cuthah, Kutua, Kutha or Kutu (mod. Tell Ibrahim), Sippar (mod. Abu Habbah) and Upi-Akshak (unlocated), in the northern part. East of the Tigris are situated Eshnunna or Ishnun (mod. Tell Asmar), Tutub (mod. Khafajah) and Der (mod. Badrah).

3. Assyria.—The name of the country of Assyria, derived from the name of the city of Ashur (Ashshur), originally designated a stretch of land situated between the Tigris river and the mountains of Iran. In its further expansion Assyria included all the lands situated between the Tigris and the Euphrates, called Hanigalbat in ancient times. The Assyrian empire reached its greatest expansion in the New Assyrian period with the conquest of Mesopotamia, Syria, Cyprus, Palestine and Egypt and of large areas in Iran, Armenia and Anatolia.

The main cities of Assyria, outside Ashur (mod. Qal'at Sharqat), the most ancient capital of Assyria, are: Nineveh or Ninua (mod. Quyunjiq), the later capital Kalakh or Kalhu (mod. Nimrud), Arba'ilu (mod. Irbil), Kakzu (mod. Sadawah) and Arrapkha (mod. Kirkuk), all situated east of the Tigris; and Mari (mod. Tell el Hariri), Harran (mod. Harran) and Nasibina (mod. Nesibin), situated between the Tigris and the Euphrates.

(I. J. G.)

II. ARCHAEOLOGY, ARCHITECTURE AND ART

The term "Babylonia and Assyria" is here used synonymously with "Mesopotamia." The area under consideration is not determined by the political boundaries of the kingdoms of Babylonia and Assyria, and periods much earlier than those that witnessed the appearance of Babylonia and Assyria as political entities are covered.

A summary of the history of Mesopotamian archaeology, its division into periods and the methods of establishing relative and absolute chronology are given elsewhere (*see* ARCHAEOLOGY: *Egypt and Western Asia*). This article surveys the material that has accumulated as a result of over a century of archaeological activities in Mesopotamia. The wealth of this material is such that it is very difficult to do it justice in a relatively short article. Some aspects of Mesopotamian archaeology are consequently omitted, while the neighbouring regions of Elam, to the east, and Mari, to the northwest, are mentioned only exceptionally.

A. ARCHITECTURE

1. Prehistoric Periods.—The earliest manifestations of architecture in Mesopotamia probably remain unknown. At Jarmo (*q.v.*), the earliest village known, the several layers of houses excavated have thin walls made of packed mud and, occasionally, stone foundations. The buildings consisted of agglomerations of rather small quadrangular rooms, with no apparent principle guiding their arrangement. Since few doorways were found it is difficult to recognize individual houses. Considering the very small area excavated, the seeming lack of planning does not preclude the existence of structures of a more orderly plan in this village or on contemporary sites yet unknown. At the somewhat later sites of Hassuna and Matarrah, where larger areas were excavated, fairly well-planned buildings were found alongside a jumble of rooms not greatly different from those at Jarmo. Of special interest are two: one house in Hassuna and another at Matarrah. Both seem to be organized on the same principle, namely that of a central room or court flanked by smaller rooms. These represent modest rudiments of the tripartite plan that finds monumental expression in much larger buildings of later periods.

Of the next, Tell Halaf, period fairly substantial and regular buildings consisting of quadrangular rooms are known. There are also round structures, of which the tholoi at Arpachiyah are the best examples.

Buildings possessing features that characterize temples throughout many later periods were found in the lower levels at Tepe Gawra. Though they are poorly preserved, the plan is clearly tripartite, with a relatively large oblong central room or court flanked more or less symmetrically on two sides by smaller rooms. The central room contained such structures as a small "offering table" and an altar or podium, which regularly occur in later temples. In addition to quadrangular buildings, round houses were found at Tepe Gawra in an early Ubaid period stratum.

Alongside such structures, whether secular or religious, occur a number of less articulate plans. Indeed, at no time is a single type of plan of house, temple or palace used exclusively. The earliest large architecture at Tepe Gawra is represented by stone foundations of a large structure assigned to stratum XIV. Though it differs in plan from identified temples, the possibility that it was a temple cannot be excluded, but it may have been an exceptionally large house or palace.

A group of three temples of monumental character was discovered in stratum XIII of the Ubaid period at Tepe Gawra, but the plan of only one was well preserved. Its façade faced an open space to the southeast and consisted of a large central double niche flanked by two symmetrical projections. The walls were elaborately decorated with buttresses and recesses, a feature that survived in Mesopotamian temple architecture for more than 3,000 years. The entrance was not through the central niche but between two double buttresses to the left of it. Within the temple were two parallel walls (about four metres apart) that did not run the whole length of the building but allowed wide openings on either end. They too were decorated with double buttresses. The centre of the northeast wall was the focal point of the temple. The plan of this temple clearly manifests the peculiarly early Mesopotamian (Sumerian?) bent-axis approach to the focal point of a temple.

The series of temples of the Ubaid period discovered at Eridu beneath the great ziggurat show unmistakable affinities with the temples of the north. The tripartite scheme and the elaborate decoration with recesses and buttresses are present.

2. Protoliterate and Early Dynastic Periods.—The tripartite temple plan found monumental expression in the Protoliterate period. Several such temples, some built on a truly monumental scale, were discovered at Warka (Uruk; biblical Erech). They were erected at ground level or on a low socle, but the so-called White temple, of which several rebuildings could be traced, was built on a high platform and approached through a series of stairways or ramps. A very similar temple built on a platform subsequently was discovered at 'Uqair.

The temples of the Early Dynastic (E.D.) period generally were built according to plans different from those common in earlier periods. The successive rebuildings of a relatively small temple, dedicated to the moon-god Sin, at Khafajah, provide the only known example of a gradual transition from a tripartite to a typically Early Dynastic plan. In such temples, in contrast to

the earlier ones, the cult chamber is located not in the centre but at the end of the building complex. It is approached through a single main entrance by way of a series of rooms or courts. This plan resembles more that of a dwelling, and the outside presents a less monumental appearance. Although the temples of the Early Dynastic period vary considerably, they all have the same type of cult chamber. This is an oblong room containing such features as an offering table, a hearth and, nearly always, a structure against one of the short walls, usually called an altar. Indeed, some temples consist only of such a room decorated with buttresses on the outside and with an entrance through one of its long walls. Occasionally there is more than one cult room in a temple. Sometimes the "altar," which was the focal point of the sanctum, was placed in front of a shallow niche. Occasionally it was separated from the rest of the sanctum either by two piers projecting from the longer walls or by a series of low rectangular columns with rounded tops. It has been suggested that this separation led to the development of the wide inner sanctum of later periods.

There also appeared in the Early Dynastic period a type of temple in which the sanctuary and its ancillary architectural elements were contained in a large enclosure. The one most thoroughly investigated and recorded is the Temple Oval at Khafajah. Its double enclosure contained a high platform upon which the sanctuary stood.

A relatively small number of private houses of the Early Dynastic period are known, most of them from Khafajah. It is difficult to recognize a definite architectural type for the Early Dynastic I phase. While some rooms are large enough to have been open courts, the arrangement of smaller rooms in relation to them does not follow any clear pattern. Such houses often have more than one entrance.

In the Early Dynastic II phase the houses at Khafajah were larger, their walls were thicker, and a distinctive plan that survived into much later times appeared. This type of house is planned around a sizable central court. The number of rooms varies. Now and throughout later Mesopotamian history there is but a single entrance from the outside. Usually the central court is reached through an antechamber, often flanked by a second room. The other rooms are reached through the court. There is usually one room, larger than the others, which probably was the "reception room" or "master's room." Such features as ovens, storage bins, drains, grinding stones and storage jars occasionally suggest the functions of different rooms.

A large building excavated at Kish and dated to the last phase of the Early Dynastic period was apparently a palace. It had an elaborate entrance, with external buttresses developed into projecting towers, and a colonnade that apparently supported the roof of a portico. An Early Dynastic building at Eridu that is very similar in plan consisted of two almost identical units, which suggests a twin palace. A much simpler Early Dynastic III "palace" (probably a "women's house") was found at Tell Asmar (ancient Eshnunna). It was rebuilt on a larger scale in the Protoimperial period, when it contained a large number of ablution places and toilets, all connected to a vaulted sewer under the adjoining street.

3. Historical Periods.—A fairly large area at Tell Asmar, excavated throughout a number of building levels, proved that plans of private dwellings did not change radically from the Early Dynastic through the Protoimperial and into the Akkadian period. Indeed, it is possible to follow the history of a single fairly large house throughout these periods and learn how it was modified, contracted or enlarged while still retaining its major features. The building material, however, did change. While at the end of the Early Dynastic period normal plano-convex bricks were still in use, during the Protoimperial period the plano-convex bricks became nearly flat but retained their oblong proportions. In the Akkadian period flat bricks were used almost exclusively and, though the oblong shape continued in use, square or nearly square bricks became predominant.

The few public buildings that are dated to the Akkadian period (for instance, the temples at Nuzi) closely follow Early Dynastic types. During the rule of the Guti apparently no monumental architecture was undertaken in areas under their domination. At almost the same time Lagash, under Gudea, had a period of great architectural and cultural achievement.

With the advent of the 3rd dynasty of Ur a great expansion of architectural activity took place all over southern Mesopotamia. The founder of this dynasty—Ur-Nammu—was one of the most active builders in Mesopotamian history, and his temples and temple towers (ziggurats) survive on several major sites. Vassal rulers of lesser kingdoms shared in this architectural activity. At Tell Asmar a temple dedicated to Shu-Sin (formerly read Gimil-Sin), a deified king of that dynasty, though relatively small, is one of the clearest examples of a new temple plan that thereafter became the predominant type in Babylonia. An axial approach from the entrance through an antechamber leads into a square court and thence to a broad cella with the focal point in the form of a niche containing the "altar" still on the same axis. A single series of rooms, all of about the same width, surrounds the court.

The outstanding architectural monuments of the Ur III period are undoubtedly the ziggurats or temple towers, the best preserved of which is the ziggurat at Ur. It measured 190 by 130 ft. at the base, and its outer face was decorated with shallow buttresses. The building consisted of a solid mass of sun-dried bricks alternating with layers of matting inserted to strengthen the cohesion between the bricks while the mortar was still wet. The outer surface was protected with a revetment of kiln-baked bricks. On the northeast side three stairways gave access to the first stage. Two of these were built against the structure while the third was perpendicular to it. Apparently a gatehouse existed where the three stairways met at the first stage. The central stairway continued to the top of the second stage. From the incline of the stairway it has been calculated that the second stage was about 17 ft. above the first. It is generally assumed that a third stage originally existed and that a shrine of some sort stood upon it.

Of the Isin-Larsa period, which followed that of Ur III, relatively few original architectural monuments are known. A number of houses at Ur show close affinities with earlier houses, going back to the Early Dynastic and Akkadian periods. One feature of the Isin-Larsa period is a strongly fortified, relatively small town area that may be called a citadel. One such citadel was found on Mound D at Khafajah (ancient Tutub) and a second at Tell Harmal only a few miles away, across the Diyala river. The existence of such strongly fortified citadels may reflect the military threat created by the advent of the 1st dynasty of Babylon, for apparently neither of the two survived into the Old Babylonian period.

The building activities of the 1st dynasty of Babylon, in contrast to those of the 3rd dynasty of Ur, appear rather insignificant. Apparently the rulers were now mainly concerned with the pious upkeep of earlier monuments, especially the temples and the ziggurats.

Excavations at Dur-Kurigalzu revealed some important buildings of the Kassite period. A contemporary temple at Warka shows a plan greatly different from traditional temple plans in both the south and the north. It may go back to an architectural tradition represented by temples found in strata IX–VIII at Tepe Gawra.

With the emergence of Ashur as the capital city of Assyria in the middle of the 14th century B.C., great building activity began. In the course of time a large number of temples dedicated to various deities were erected, some with ziggurats attached. At Ashur, too, was found a double temple with a double ziggurat.

In the New Assyrian period, in the first half of the 1st millennium B.C., great architectural monuments were erected not only in Ashur but also in Nineveh, Nimrud (ancient Kalakh) and Khorsabad (ancient Dur-Sharrukin). The last, built by Sargon II, is of special interest as a planned town unhindered by considerations of space or the presence of earlier ruins. The town was a near square, its corners oriented to the cardinal points of the compass, surrounded by a thick fortification wall with seven forti-

fied gateways. It covered an area of about 740 ac. Two palaces were placed astride the northwestern and southwestern walls respectively. The first was the main palace, built on an artificial platform about 45 ft. high and covering an area of about 25 ac. In front of it a strongly fortified citadel extended into the town. This palace was planned not only as the king's residence but also as an administrative and religious centre. Within its confines were a number of temples and a ziggurat. Architecturally the palace consists of a large number of units, each planned for its specific function, its rooms usually grouped around a court. The two largest courts cover areas of about 1.7 and 2.2 ac. respectively and may be considered "squares" rather than courts. The other palace is not fully excavated, and its function remains obscure. The new capital was never fully occupied and parts of the main palace seem never to have been finished. On the death of Sargon II, his son and successor Sennacherib returned to Ashur and then to the old capital of Nineveh.

With the fall of Assyria and the transfer of central power once more to the south during the Neo-Babylonian period, architectural activity was renewed in the south. Outstanding are the monuments found in the capital—Babylon—where tremendous fortification walls, numerous temples and palaces and a large ziggurat were erected. The temples on the whole differed from those in the north, maintaining the tradition established in the south as early as the 3rd dynasty of Ur. The palaces, like those in Assyria, consisted of an agglomeration of units within the confines of retaining walls. Kiln-fired bricks were used on an unprecedented scale, and molded glazed bricks, known also in Assyria, covered huge areas of exterior walls and decorated monumental gateways. The rather limited decorative motifs consisted of lions, bulls and monsters, often bordered with floral and geometric patterns. (*See* also BABYLON; PRE-HELLENIC ARCHITECTURE.)

B. ART AND ART OBJECTS

1. Sculpture.—Numerous human and animal figurines, modeled in clay, were found at Jarmo, and though hardly deserving to be called sculpture in comparison with later achievements in Mesopotamian art, some of these are very well shaped. Various species of animals are clearly recognizable. The great majority of the human figurines represent very markedly steatopygous nude females. In some the facial features as well as the arms, hands and legs are indicated; others consist only of the lower part of the body and the legs. They are nearly always represented in a seated or squatting position. This type of female figurine is found also in the somewhat later Hassuna and Halaf cultures. During the Ubaiḍ period a different type of human figurine appears, representing a standing nude female of rather slender proportions. The heads are well molded but in most cases look reptilian rather than human; there is no doubt that this was the modeler's intent. Sometimes the figure is depicted as holding and nursing a child, and some scholars identify it as the "mother goddess," while others see in it the female demon Lamashtu, the abductor of children. Clay figurines continued to be made throughout Mesopotamian history.

From prehistoric times there also survive miniature stone pendants and amulets, the excellence of workmanship of which is an evidence of the high degree of the stonecutters' skill, also manifest in contemporary glyptic.

The earliest examples of true sculpture in the round come from the Protoliterate period, outstanding among them being a magnificent though incomplete head from Warka, which may be male rather than female. Missing are the back part, the inlaid eyes and eyebrows and the hair. A lesser piece from the Protoliterate period is a stone statuette from the Sin temple at Khafajah.

No sculpture in the round is known from Early Dynastic I, but large numbers of stone statuettes date from E.D. II and E.D. III. The majority are from southern Mesopotamia, though some were found to the north, at Ashur on the Tigris and Mari on the Euphrates. These statuettes, representing both men and women, vary from a few inches to about three feet in height. Most of them are standing, but seated figures are not uncommon. They exhibit a great variety of dress and, in the female statuettes, coiffure. Though they show a great range of the sculptor's skill and of style, nearly all of them have one common feature: the arms are folded and the hands clasped in front of the body in an attitude of reverence. Sometimes the hands hold a cup and sometimes, especially in the seated figures, one hand holds a branch. The attitude of worship and the fact that nearly all the statuettes were found in temples leave no doubt that they represent the devout in the presence of the deity, as explicitly confirmed in later times by inscriptions carved on statues. The fact that an image could represent the worshiper may explain the surprisingly small dimensions of some of the sanctuaries, which apparently were intended neither for a congregation of worshipers nor for the performance of elaborate rites but rather as a depository where the worshiper, represented by the statuette, was forever in the presence of the deity. This function of the statuettes suggests that the deity as well as the worshiper was present in the cult chamber. A terra-cotta painted relief from the Ishtar temple at Ashur and two statues (male and female) from the Abu temple at Tell Asmar may represent deities. The Tell Asmar statues are in the worshiper's attitude, with hands in front of the body and holding a cup. They are larger than any of the statuettes found with them and have uniquely enormous eyes. They also have unusually carved bases, showing the emblem of the god of vegetation. Two distinct styles of Early Dynastic sculpture are recognized: in one the human features and body are stylized to form geometric planes and shapes; in the other the body and features are more naturalistic.

In the Akkadian period sculpture in the round, as well as other art forms, both continues earlier tradition and introduces a distinctive new style. A turbaned head from Adab and a magnificent copper head from Nineveh demonstrate the contrast in style with Early Dynastic sculptures, as represented by, for example, the figures of a god and a priest from Tell Asmar.

Numerous statues of Gudea and of his successors are known from Lagash. Some are carved of diorite, a hard stone that requires special skill in working and that had to be imported from distant sources. The traditional gesture of reverence, the clasped hands, is in evidence. The ruler is shown either standing or seated, bareheaded or wearing an elaborate turban. The dress is a simple garment thrown over the left shoulder, leaving the right shoulder and arm bare.

The 3rd dynasty of Ur is represented by very few stone sculptures. From the Isin-Larsa period there survive a number of life-size or nearly life-size statues of rulers of Eshnunna, which were carried away to Elam as booty and discovered by French excavators at Susa. Statues of several rulers of Mari also are known.

Of the Old Babylonian period rare examples of sculpture in the round are preserved. Hard stone such as diorite still was used. In contrast to the clean-shaven face represented on statues of Gudea, a head from this period, presumably of Hammurabi, shows an elaborately curled beard. From Old Babylonian times to the fall of Babylon, a period of over 1,000 years, only a few statues, of Assyrian kings, are known.

2. Small Sculpture and Amulets.—Even in prehistoric times animals or parts of animals occasionally were carved out of stone. In the Protoliterate period such small sculptures, beautifully carved, became very popular. They represent subjects that were of interest to the Mesopotamians throughout the ages—lions, panthers, domesticated and wild cattle, sheep, goats, pigs, birds, fishes, scorpions, etc. Occasionally the animals are depicted standing, but usually the domesticated animals are recumbent with their heads turned sideways. Such animal figures often have a flat surface at the back, and this is commonly engraved with holes forming outlines of quadrupeds or scorpions. The birds depicted in amulets are mostly ducklike. In addition to natural creatures there occur among the Protoliterate amulets examples of the lion-headed bird later known in Sumerian as Imdugud. Fishes occur either single or joined at the abdomen. Many of the amulets are perforated horizontally through the body but some are perforated vertically; the manner in which the latter type was used was ascertained when two such amulets were found

in situ at both ends of a string of beads.

Many of the great variety of amulets of the Protoliterate period continued into Early Dynastic times, when new popular forms also were added, among them stags, frogs, doves, fruits and leaves, and the representation of a bull or cow with an artificial beard. Occasionally such bearded heads were fashioned in couples in stone or gold. Outstanding examples of small sculptures in the historical periods are weights in the form of birds with their heads turned backward (duck weights), frogs, snails, boar's heads, etc.

3. Relief Sculpture.—No proper sculpture in relief is known from the prehistoric periods. A basalt stele from Warka shows hunting scenes, with figures whose garments and hairdress are characteristic of the Protoliterate period.

A more complex scheme of decoration in relief, on an alabaster vase from Warka, clearly depicts scenes of ritual character. The ritual has been interpreted as part of the wedding ceremony in which the goddess Inanna is offered bridal gifts by her consort Dumuzi (Tammuz). On other stone vessels of the Protoliterate period a common motif shows lions attacking bulls. The bodies of the animals usually are in low relief, with the heads often in high relief, sometimes approaching sculpture in the round. The body of a spouted vase from Warka bears this motif, while the spout is flanked by two lions sculptured in the round. Another common motif shows a naked hero between lions that attack cattle or sheep.

Numerous square or nearly square plaques decorated with reliefs are known from E.D. II and III. They usually are divided into three registers and have a hole in the centre. The upper register almost invariably depicts a banqueting scene in which a seated man and woman are attended by servants, musicians, dancers and gift bearers. The middle register usually shows bearers of gifts of various kinds. The theme on the lower register varies considerably, but a war chariot drawn by horselike animals (onagers?) often is depicted. The uniformity of certain aspects of culture over a wide area of Mesopotamia during the Early Dynastic period is illustrated by an incomplete plaque from Khafajah whose decoration could be completed by a fragment of a similar plaque from Ur.

The chief personages on E.D. plaques are human in most cases, but the fact that nearly all examples were found in temples indicates a religious significance. Some depict ritual scenes, such as libation offered by a naked priest in front of a seated god. A plaque from Telloh depicts the ruler Ur-Nanshe and his family. The ruler carries a basket on his head, presumably having assumed the humble and pious role of a labourer carrying material for the building of a temple.

The monumental "Stele of the Vultures" from Lagash commemorates the victory of the ruler, E-anna-tum, over Umma. One fragment shows E-anna-tum on foot, leading a phalanx of helmeted soldiers, and again in a chariot at the head of his army. The other side of the same fragment shows part of a large figure, probably the god Ningirsu, drawing a net filled with the bodies of the enemy, as the fowler draws a net around the trapped birds.

Sculptured stone vessels likewise continued to be made during the Early Dynastic period. One class, made mostly of steatite, is found in two forms: a low cylindrical cup with flat bottom, and a taller vase with incurving wall and a mouth somewhat narrower than the flat base. The earlier examples are of the E.D. II period. Several specimens bear a representation of a wattle structure, sometimes in combination with other motifs. On other specimens the decoration consists of more or less complex compositions of human beings, animals and plants.

From the Akkadian period has survived the magnificent and unique victory stele of King Naramsin. The king stands alone before a high mountain with heavenly bodies above. His army, represented by a small group of standard and weapon carriers, strides upward, while the enemy is represented by a few limp corpses, some of the enemy warriors in the agony of dying, and the still living asking for mercy. The whole expresses most concisely and eloquently the dramatic moment of victory. Fragments of other stelae and rock carvings of the Akkadian period, unlike the Naramsin stele, seem to have been composed in horizontal registers in the tradition of the Early Dynastic period.

The surviving fragments of a stele erected by Ur-Nammu, the founder of the 3rd dynasty of Ur, indicate that this monument commemorated the king's piety rather than his prowess. The best-preserved register shows the king approaching a seated god on the right and a goddess on the left. He is followed in each case by a female deity, presumably his personal goddess. This is the so-called presentation scene, which occurs in innumerable versions on cylinder seals of the Ur III and later periods.

Of the Old Babylonian period, the relief carved at the top of the stele inscribed with the code of Hammurabi should be mentioned. No ritual, indeed no action of any kind, is depicted. The king simply faces his god in testimony of divine sanction of his pious deeds.

During the Ur III, Isin-Larsa and Old Babylonian periods, a large number of clay plaques were made in molds. The commonest subject is the very old one of a nude female, usually with the arms under the breasts and occasionally with a child nursing, but gods and goddesses, bull-men, heroes fighting lions, hunters, wild and domesticated animals and various activities also are depicted. Some subjects are obviously of religious character, some have mythological connotations and others seem to be of secular nature. The manufacture of plaques in a mold had the obvious advantage of "mass production," which can turn out large numbers of a product while the artist concentrates on a single object, the original mold. Indeed, some of the molds are of exceedingly fine workmanship. While stone sculptures could be afforded only by a small segment of the society, the clay plaques represent a most important aspect of popular art.

Of the Kassite period a large number of boundary stones (*kudurru*) carved with reliefs are known. They usually show emblems of deities and often bear an inscription and sometimes also the representation of the king who granted title to the land or guaranteed the boundaries. Another type of relief, which occurs first in the Kassite period, is assembled from bricks, each brick being made in a special mold and forming part of a decorative motif or figure. The advantage of mass production is obvious here also.

Of the earliest independent Assyrian kingdom, in the 18th century B.C., very little is known. With the establishment of the Middle Assyrian state in the 14th century, a distinctive culture begins to emerge, blending western and northern influences with the cultural traditions of Babylonia. There is an essential difference between such ritual scenes as that shown in relief on an altar of Tukulti-Ninurta I, where the king first approaches and then kneels before an altar bearing the emblem of a god, and earlier works such as the relief carved above the code of Hammurabi, where the king confronts his god directly.

The major achievements of Assyrian art are the innumerable reliefs that covered the walls of the Assyrian palaces at Nineveh, Nimrud (Kalakh) and Khorsabad (Dur-Sharrukin). They provide an almost inexhaustible source not only for art studies but also for archaeological research, since the Assyrian artist delighted in depicting lifelike details of dress, weapons, chariots, horse trappings, buildings, cities, landscape features, etc. In contrast to early Babylonian reliefs, which are either explicitly ritual or have religious connotations, the Assyrian reliefs are mostly secular, constituting a pictorial testimony to the prowess and military might of the monarch. Even a peaceful scene showing the king banqueting with his queen to the sound of music bears a gruesome reminder of a recent victory in the form of the severed head of the enemy king hanging from a branch of a tree. The frequently shown symbols of deity, however, clearly imply that all the activity depicted takes place under the auspices and with the blessing of the gods.

During the *floruit* of late Assyrian art, between the 9th and 7th centuries B.C., there were appreciable variations in subject matter and style between the earlier and the later works as well as among reliefs from various locations. In spite of such differences, however, the whole of the late Assyrian bas-relief art is an entity in itself, individual and distinguishable from other major

classes of art in the near east.

In the relatively short time between the fall of the Assyrian empire, when the south regained predominance, and the fall of Babylon to the Achaemenids, a great cultural revival took place in the south and especially in Babylon itself. Glazed-brick decoration was lavishly used during Neo-Babylonian times to ornament important buildings. However, the very advantage of this technique for mass-producing colourful decorative motifs tended to reduce the number of such motifs and to make the whole decoration rather uninspiringly repetitious. Thus there was endless repetition of separate figures of the lion, the bull and the monster (each a symbol of a deity), framed with simple geometric motifs such as rows of rosettes or palmettes, but with no interaction between them.

4. Glyptic.—Buttonlike stone objects engraved with distinctive designs were commonly used as stamp seals in prehistoric periods. Many such stamps and also their impressions in clay are known. The designs are usually geometric motifs, though plants, animals and human figures begin to appear in the later prehistoric periods in northern Mesopotamia.

During the Protoliterate period in southern Mesopotamia engraved cylinder seals were introduced. Numerous impressions of such seals, made by rolling them on wet clay, have been found in excavations; indeed, some of the most interesting seals are known only from their impressions. Cylinder seals continued in use in Mesopotamia for over three millenniums and spread into other parts of the ancient world, where they sometimes assumed new iconographic and stylistic features characteristic of a particular region and period.

The earliest cylinder seals reveal a surprisingly high standard of glyptic art, rarely equaled in later times. A great variety of iconographic and stylistic beginnings were made. Plants, animals, human beings and monsters are depicted, together with man-made objects such as buildings, boats, symbols, utensils, etc. Sometimes the elements are arranged in symmetrical decorative motifs; often coherent action is depicted. Several iconographic elements are common to glyptic and other art forms. The scenes are on the whole ritual, though some impressions seem to show secular activity. Cylinder seals characteristic of the later phases of the Protoliterate period have been found outside Mesopotamia as far away as Egypt, providing important evidence for correlating certain phases of early Egyptian and Mesopotamian cultures.

The glyptic of E.D. I shows clear affinities in style and subject matter with that of the late phases of the Protoliterate period. Distinctive of E.D. I are seals of the "brocade style," in which the artist's aim was not to depict any scene or action but rather to produce an evenly decorated surface. The usual motif on such seals consists of horned animals.

The glyptic of E.D. II is distinguished by action scenes in which the decorative effect of the composition is of primary concern. Most of the scenes show conflicts between beasts, monsters and human beings in various combinations. The bull-man makes his appearance, usually siding with human beings in protecting cattle or sheep, and occasionally wildlife, from lions. Short inscriptions also appear. The composition makes use of antithetical groups and crossing bodies. The spaces between the contestants are filled with elements such as weapons, plants, separate heads and inscriptions, to produce an evenly filled surface.

E.D. III glyptic continues the subject matter tradition of E.D. II. The struggle between man and hero and lions attacking other animals is still a major subject, but a large variety of scenes depicting banquets (such as are shown on plaques), food and drink offerings, musicians, chariots, boats, etc., appear. Sometimes a deity, distinguished by the horned headdress, is depicted. Other seals show the building of a temple, apparently with the king participating as a humble labourer.

During the Akkadian period glyptic art reached a peak of perfection comparable only with that of the early stages of the Protoliterate period. The old theme of struggle between hero, bull-man and beasts is still popular, but it is rendered in an entirely new style. The figures are often articulate and finely modeled to render the actuality of musculature, hair, horns, etc. Very often the composition is heraldic, with a framed inscription as the central feature. A great variety of new subjects was introduced, many obviously mythological, though the specific myths to which they allude often are unknown.

With the fall of the dynasty of Akkad there was a marked decline in glyptic art. The Gutian occupation is represented by a few very poor specimens. From Lagash, under Gudea, and from many sites in southern Mesopotamia, which was reunited under the 3rd dynasty of Ur, there are numerous cylinder seals reflecting the mood of piety that so deeply permeates the other works of art of that time. Many specimens show a high standard of technical perfection, but there is a drastic limitation of subject matter during Ur III, with the so-called presentation scene predominating. This shows a worshiper being introduced to a god by another deity, usually a female, presumably his personal goddess. A short inscription frequently identifies the owner of the seal and the god to whom it is dedicated, but the god depicted on the seal is not necessarily the one to whom it is dedicated.

The glyptic of the Isin-Larsa and Old Babylonian periods continues the tradition of Ur III, with the presentation scene as its predominant subject. There are some variations, however; the god may be standing rather than seated, and the worshiper often is shown carrying an offering (usually a lamb or kid). The introduction of secondary elements in the spaces between the figures is characteristic. These elements, such as dragons, animals, nude females, monkeys, dwarfs and man-made objects, were apparently of amuletic significance.

In the Kassite period the subject matter of the cylinder seals is further impoverished. Very often only two figures, a god and a worshiper, are depicted, while the rest of the surface is devoted to a relatively long inscription—a prayer. Secondary elements occur between the inscription and the figures, most characteristically the Maltese cross. The Kassite seals are somewhat larger and longer than those of the Old Babylonian period, and instead of the previously popular hematite other, usually coloured, stones were used.

Contemporaneously with the later phase of the Kassite rule in the south, glyptic of the so-called Mitannian style appears in the north. In these seals an artificial material, glazed paste, often replaces stone. The Mitannian style is a peripheral development that penetrated certain areas of Mesopotamia and influenced Assyrian glyptic.

Middle Assyrian glyptic took over many of the earlier elements, but they are arranged with more balance and clarity. Many designs are known only from impressions. Scenes with human participants show not only ritual but also secular activities. Inscriptions often give the name of the seal's owner. Whether the seals depict fantastic creatures or a secular scene such as hunting there is a vigour of composition and a fine modeling of details that is comparable to the best specimens of Protoliterate and Akkadian glyptic. From this new peak Mesopotamian glyptic deteriorated in artistic quality, though some outstanding pieces were still produced during the New Assyrian and Neo-Babylonian periods. Ritual scenes, in which emblems often replace deities are predominant. There are also amuletic elements and undoubtedly astrological symbols. Hard stones such as rock crystal and chalcedony are commonly used, and the drill is employed in addition to the engraving tool.

5. Wall Paintings.—The earliest-known wall paintings were discovered in a temple of the Protoliterate period at Tell Uqair. Most of the motifs are geometric, consisting of rectangles and lozenges in various combinations. There are two leopards on the sides of the altar and traces of other quadrupeds and humans. The lower part of a human figure shows a colourfully decorated garment with tassels at the back.

Only a few indications of wall painting during the Early Dynastic period have been found.

For wall paintings dating to the first half of the 2nd millennium B.C. it is necessary to go outside Babylonia and Assyria proper to Mari on the middle Euphrates. These paintings are on the whole, in the tradition of Mesopotamian art, though they contain certain undoubtedly local elements. Painted presentation

scenes similar to those shown on the Ur-Nammu stele and on cylinder seals give some idea of the colourfulness of contemporary garments.

Numerous traces of wall paintings were found in the so-called "painted palace" in the Kassite city of Dur-Kurigalzu, near Babylon. They consist chiefly of processions of human figures placed, curiously enough, inside the doorways that cut through the thick walls of the palace. It may be assumed that other scenes were painted in other parts of the building. Approximately contemporary wall paintings were found at Nuzi, consisting of panels filled chiefly with geometric elements but including also stylized palmettes, bull heads and heads of the Egyptian goddess Hathor. These frescoes clearly show influences from farther west.

Nearly all the wall paintings known from Assyria come from palaces. Traces of both decorative motifs and representational design were found at Kar-Tukulti-Ninurta, of the Middle Assyrian period, located on the Tigris across from Ashur. The predominant colours are white, black, deep red and bright blue. Stylized flower motifs that originated in the regions west of Mesopotamia are common; the very old Mesopotamian motifs of rosettes and of animals placed symmetrically on each side of the "tree of life" also occur. The motifs are arranged in panels with more or less elaborate borders, the whole effect being that of tapestry. In later Assyrian towns similar motifs using the same colour schemes have been found. In addition, at Khorsabad (Dur-Sharrukin) traces of a huge panel depicting the king and perhaps one of his ministers before the god Ashur were found in the citadel that adjoined the main palace of Sargon II. This panel is placed above three rows of conventional designs showing bulls and winged genii in alternating rows. The uniformity of the elements suggests that the Assyrian painters may have used mechanical devices, such as templates. At Til Barsib, on the middle Euphrates, in addition to the normal decorative Assyrian motifs there were "narrative" scenes that parallel the stone bas-reliefs of the Assyrian palaces. Possibly wall paintings were only a cheaper substitute for reliefs.

6. Metalwork.—There are traces of worked metal, especially copper, from the late prehistoric periods. From the Ubaid period there survive copper beads, pins and needles as well as larger objects such as chisels and axes that seem to have been made in open molds and to imitate polished stone tools. In the Protoliterate period, copper, gold, silver and lead are known, though relatively few metal objects have survived.

The extraordinary variety and high technical perfection of the metallurgy of the Early Dynastic period are impressive. In addition to a great variety of tools and weapons, vessels, jewelry and ornaments, there are solidly cast (apparently by the lost wax or cire-perdue process) human and animal figures comparable in quality to the best examples of stone sculpture. The unique treasures from the royal cemetery at Ur illustrate the opulence of the early Sumerian civilization. Exquisite vessels, jewelry, a ceremonial helmet, weapons and animal heads were fashioned of gold and silver. Precious metals were combined with coloured stone, wood, engraved shell and mother-of-pearl inlays to produce highly complex and colourful creations. While copper was plentiful and often used to cast solid objects, large sculptures such as the lion heads from El 'Ubaid were made of bitumen cores covered with thin copper sheet on which the minor details were chased and engraved. A large copper relief from El 'Ubaid, depicting the lion-headed bird Imdugud gripping two stags, also combines bas-relief with heads fashioned in the round. A silver vase from Lagash is engraved on the body with a representation of Imdugud attacking lions and on the shoulder with recumbent bulls.

Outstanding among the surprisingly small number of major metal sculptures that have survived from later periods is a magnificent bronze head from Nineveh, assigned to the Akkadian period on stylistic grounds.

Small human and animal figures made especially for foundation deposits were sometimes accompanied by inscribed copper tablets identifying the builder and the building. In the human figures the lower part of the body was often replaced by a peg. Another type of metal figure used in foundation deposits is a kneeling deity holding a peg. The custom of using metal figures in foundation deposits, observed at the end of Early Dynastic III, was followed by Gudea and by kings of the 3rd dynasty of Ur. Statuettes of Ur-Nammu and Shulgi represent the king as a labourer carrying a basketful of building material on his head. Ur-Nammu's statuettes usually have a long flaring skirt, but Shulgi's statuettes are of the peg type. Two unique four-faced copper statuettes represent a standing god and a seated goddess. They were found at Ishchali and date from the Isin-Larsa period.

Of the subsequent periods in Babylonian history little sculpture in metal is known, but from the Assyrian empire period major works of art have survived. Most important are reliefs in bronze that decorated some of the Assyrian palace gates. The subject matter of the reliefs from Balawat, near Nimrud, parallel that of stone bas-reliefs portraying military campaigns. Fragments found at Khorsabad show motifs that appear also on panels of glazed bricks—the bull, the eagle, the plow and the fig tree. Whether these elements are astrological symbols or a peculiar rendering of the king's name is uncertain.

Iron was used in Mesopotamia after about the middle of the 2nd millennium B.C., and large quantities of iron objects were found in the Assyrian palaces when they were first excavated in the middle of the 19th century. Isolated finds indicate that blades made of terrestrial iron occurred as early as the middle of the 3rd millennium B.C.

7. Inlays and Engravings.—As early as the Protoliterate period stone vases were embellished with multicoloured inlays, the motifs being rosettes in which petals of two colours alternated (usually red and white); concentric circles, also of alternating colours; and geometric motifs consisting of rows of triangles and lozenges. The inlay pieces were held in place by bitumen or red paste, which occasionally formed part of the colour scheme. For architectural decoration, so-called "cone mosaic" was used in the Protoliterate period. The heads of small terra-cotta cones coloured white, black, red and occasionally yellow produced geometric patterns on walls and columns that were similar to the geometric patterns of the inlays and also to the patterns of the contemporary painted pottery. To circumvent the difficulties that arise in applying cone mosaics in corners and quoins, terra-cotta tiles impressed with circles to imitate the cone heads were employed. Tiles with representations of animals, also impressed with circles, were combined with cone mosaics.

Though the use of cone mosaic apparently was confined to the Protoliterate period, other types of inlaid decoration continued in the Early Dynastic period. Inlays of coloured stone, shell, mother-of-pearl and occasionally paste were applied to stone vessels, musical instruments and a variety of other objects. Dark-coloured stone plaques were inlaid with figures of light-coloured stone, shell and mother-of-pearl. Almost invariably the eyebrows and eyes of statues also were inlaid. The details on the inlays themselves often were engraved and the lines filled with red or black pigment. On the so-called standard from Ur both the background and the figures consist of inlays. On the obverse are three registers of battle scenes, while the reverse depicts a victory banquet in three registers. The Ur standard apparently is a secular monument, but inlaid decoration also was inspired by rituals, myths and, perhaps, fables. No comparable mosaic monuments are known from later periods.

8. Ivories.—Ivory carvings are found only occasionally in Mesopotamia. Early ivory objects may have been made out of wild boars' horns. Few small ivory carvings are known from the Early Dynastic period, and ivory seems to have disappeared until the 2nd millennium. A great wealth of ivory objects is known from the Assyrian imperial period from practically all the major sites but especially from Nimrud. While the character and origins of the prehistoric ivory are uncertain, there is no doubt that in historic times true ivory was imported, possibly first by the southern sea route (the Persian gulf) and later, into Assyria, from the west (mostly, perhaps, by way of the Mediterranean). Plant motifs of the west are recognizable in Assyrian ivories. Indeed, a large proportion of the carved ivories found in Assyria are non-Assyrian in style and are the product of western craftsmen.

C. Utilitarian Objects

1. Tools and Weapons.—In the earliest village cultures of Mesopotamia flint and obsidian blades and core tools are numerous, as are ground or polished stone implements. Stone bowls and cups of rather sophisticated shape were found in Jarmo at levels in which pottery was yet unknown. Bone tools also are found in the earliest excavated settlements, occasionally hafted in a lump of clay or bitumen. Of exceptional interest among the Jarmo finds are very delicate small bone spoons with elaborate handles. Bone tools continue without much change even into historical periods.

Traces of metal were found in the early village remains, but not until the Ubaid period do substantial copper tools such as chisels and axes appear. Likewise characteristic of the Ubaid period are terra-cotta sickles and fairly elaborate stone hammers or hammer axes. Rounded stone objects perforated through the long axis, which are referred to as mace heads or club heads, also appear in the prehistoric periods. Use of the bow and arrow and the spear in the Protoliterate period is attested by representations on monuments.

In the Early Dynastic period, chipped and polished stone tools continued, as did simple bone tools. Sickles consisting of several serrated flint blades set in wood with bitumen have been found *in situ*. The rapid development of metallurgy is reflected in the great variety of copper tools and weapons. In addition to battle-axes there were many types of adzes, daggers, knives, swords, spear points, harpoons, etc. Ceremonial weapons, a number of which were found in the royal tombs of Ur, were made of precious metals. Shields and helmets are depicted on monuments.

During the Akkadian period stone tools and weapons were still used. The metal objects were inferior to those of the Early Dynastic period, being made of relatively thin sheet metal bent and hammered to the desired shape. Representations of the bow and arrow reappear on monuments, though the battle-ax, mace, sword and spear continued in use. A laurel-leaf-shaped flint arrowhead is characteristic of the Akkadian period. The plow is often depicted on Akkadian cylinder seals, and copper parts of plows, as well as hoes and shovels, are known from later periods.

After the Akkadian period the bent scimitar was introduced. The figure of a four-headed god from Ishchali holds such a weapon, which is often depicted also on terra-cotta plaques and cylinder seals.

Assyrian reliefs show individual armour as well as large shields for protecting battering rams. The straight sword replaced the curved scimitar.

2. Personal Ornaments, Cosmetic Articles and Dress.—Simple beads of stone and shell were used in all periods. In Early Dynastic times gold and silver ornaments must have been very abundant, to judge, for example, by the great number discovered in the royal tombs at Ur. In addition to the softer stones, rock crystal, lapis lazuli, agate and carnelian were employed for beads of various shapes. Carnelian beads occasionally were etched to produce a white design. This technique also was used in the Indus valley, and it provides one of several links between the Indus and Mesopotamia at the end of the Early Dynastic period.

Relatively little jewelry has survived from later periods, and most of the information derives from representations. Clay plaques of the Isin-Larsa and later periods show that strings of beads were worn by both men and women. Occasionally bracelets are shown. In Assyrian art deities and monsters as well as men and women are shown wearing earrings, beads, armlets and bracelets.

Stone palettes with traces of paint indicate the use of cosmetics in the earliest village communities. Surprisingly modern-looking ivory combs and an ivory hairpin inlaid with lapis lazuli, turquoise and gold bands were found in early tombs at Tepe Gawra. The royal tombs at Ur yielded a large number of cosmetic containers and toilet articles. Gold and silver toilet sets consisted of a ring to which were usually attached one pointed and one chisellike object, a pair of tweezers and a minute spoon, perhaps an ear scoop. Such sets were kept in elaborately decorated conical cases. Similar toilet sets of copper come from Early Dynastic levels at other sites. Lumps of black, red and orange paint used as cosmetics have been found in sea shells, in miniature stone vessels and in copper, gold and silver containers imitating shells. Copper razors also are known. Fewer cosmetic and toilet articles are known from later periods, but on the whole they seem to be of types similar to those of the Early Dynastic period.

No clear representations of dress are known from the prehistoric periods. Paint lines on terra-cotta figurines may indicate either garments or tattoo marks. The large number of spindle whorls recovered from prehistoric sites would indicate that spinning and weaving were known.

Garments are clearly depicted on reliefs and glyptic of the Protoliterate period. Some men, usually beardless (perhaps young adults), are represented as bare to the waist and wearing a short skirt. A diaphanous skirt reaching to the knees or the ankles is worn by a dignitary who invariably has a beard, long hair falling to the shoulders and a fillet on the head. The typical female costume is a beltless garment covering the left shoulder and fastened under the right arm, leaving it free; this garment, which shows a finished hem, continues into much later times. In Early Dynastic times a garment that leaves only the right arm and shoulder uncovered is worn also by male dignitaries and deities.

Sculpture and glyptic of the Early Dynastic period frequently depict a skirt reaching below the knees and held by an elaborately tied and fairly thick girdle. Female figurines invariably wear a long garment that covers the left shoulder. The representations of the Protoliterate period show smooth, loosely woven textiles, whereas those of the Early Dynastic period show mostly tufted materials. Apparently no outer garments were worn normally. Soldiers are represented as wearing capes of a heavier material (leather) for protection. No shoes are represented before the Akkadian period.

Gudea statues show the early type of costume in its severe simplicity. The right arm is uncovered, and two or three folds hang from the left arm. Occasionally the hems are decorated. In the Isin-Larsa period garments covering both shoulders appear. The royal statues from Mari show either the old-fashioned dress with the right arm and shoulder uncovered, but with more elaborately tasseled and fringed edges, or a garment covering both arms and shoulders.

Glyptic of the Akkadian and subsequent periods shows a great variety of garments, differing mainly in the decoration of the edges and in the vertical folds. Some have tiers, which indicate either that the dress was sewn from a number of horizontal bands or that such bands were wound and fastened to an undergarment.

Assyrian bas-reliefs of the 9th to 7th centuries B.C. also show a great variety of garments of king, courtiers, soldiers and foreigners. In keeping with the earliest traditions, the king's garment often reaches to his feet; similar garments are worn sometimes also by deities and demons. They are often shown as worn over a short skirt which would allow freedom of action when the long garment is open. The soldiers usually wear short skirts. Sandals are very commonly depicted on Assyrian reliefs.

3. Pottery.—Apparently the earliest-known pottery in Mesopotamia is that from the sixth level at Jarmo, but even at this early stage there was considerable variety in the forms as well as in the decoration with red paint.

In the Hassuna period the number of shapes increased, and incised and painted decorations were used. Toward the end of this period appeared a class of pottery known as Samarra ware, the sophisticated monochrome-painted decoration of which has considerable artistic merit.

Pottery of the Halaf period is distinguished by characteristic forms, some of them recalling metal types. The decoration is polychrome, with black and red paint used on a buff or white background. The motifs are mainly geometric. In contrast to the Samarra ware, the designs are symmetrical and often crowded. Even the representational motifs, such as bucrania (*i.e.*, ox skulls), were gradually reduced to abstract patterns.

Pottery of the Ubaid period has been found not only throughout Mesopotamia but also in western Iran and the Mediterranean area. The decoration is usually monochrome, with dark paint on a light background. A great variety of forms and painted patterns was

used.

Following the Ubaid period in southern Mesopotamia, new types of pottery emerged along with other classes of objects that represent the earliest phase of the distinctively Babylonian culture. After a relatively short phase characterized by burnished black, gray and red pottery, the so-called Jamdat Nasr ware appeared, having both monochrome and polychrome painted decoration, each type applied to specific forms. Following the Jamdat Nasr ware there appears in E.D. I a new class of polychrome painted pottery known as Scarlet ware. In addition to geometric patterns such as are seen on Jamdat Nasr pottery, the Scarlet ware has a large variety of representational motifs depicting plants, animals and human beings, occasionally grouped so as to form a coherent scene. This type of pottery apparently continued into E.D. II. A vase in the British museum that depicts a chariot, musicians and a banqueting scene probably dates from the early part of E.D. III.

Alongside painted pottery there was in every period a large variety of plain vessels and others with plastic, incised or engraved decoration. Typical of E.D. III are jars with upright handles on which the features of a nude female are usually indicated, either in relief or by engraving.

With minor exceptions, Mesopotamian pottery remained unpainted until glazing was introduced in the beginning of the 1st millennium B.C. However, distinct groups of decorated pottery occasionally appear. Gray jars decorated with white-filled engravings in the Isin-Larsa period show simple geometric designs alongside birds, quadrupeds, boats and human figures. Other groups of pottery, found in the north, are the Habur ware of the Old Assyrian period and the white-painted Mitannian ware that originated farther to the west.

All through Mesopotamian history new shapes were being developed and, in turn, abandoned to be replaced by other forms, and these forms, though undecorated, are invaluable for the dating of the material remains among which they are found.

4. Musical Instruments.—It is possible that musical instruments made of perishable materials (reeds) were used in prehistoric times, but the earliest preserved musical instruments are bone pipes of the Ubaid period from Tepe Gawra.

The earliest representation of an "orchestra"—that is, musicians playing simultaneously string, percussion and wind instruments—is preserved on a fragment of a steatite vase from Adab. Musical instruments are depicted on plaques and cylinder seals of the Early Dynastic period. The actual musical instruments discovered in the royal tombs at Ur show the lavishness with which such instruments were decorated. The animal heads at the end of the sound boxes were made of gold or silver and decorated with semiprecious stones. The sound boxes and the uprights of the instruments were inlaid with multicoloured mosaics of semiprecious stones, shell and mother-of-pearl. The inlaid plaques themselves were engraved with delicate designs filled with black or red paste.

Some of the mold-made terra-cotta plaques, which represent the popular art of Mesopotamia in later periods, depict musicians playing various instruments (large and small harps, lyres, lutes, cymbals, etc.). On the Assyrian reliefs musicians and musical instruments are often represented as part of a ritual (king pouring libation over lions), during processions (capture of Susa by Ashurbanipal) and, naturally, in banqueting scenes. Frequently the musicians are foreigners or people wearing a foreign type of dress.

5. Lamps.—It is uncertain when the inhabitants of Mesopotamia thought of a special device to obtain a portable light at night. A peculiar jar with seven spouts, two specimens of which (belonging to the Protoliterate period) were found several hundred miles apart, may indeed have been used as lamps. In the Early Dynastic period large sea shells were cut lengthwise and the containers thus obtained used for lamps, the wick being laid in the channel at the narrow side of the shell. Stone, clay and metal (including gold and silver) lamps imitating the form of shell lamps were common toward the end of the Early Dynastic period. Occasionally a ring was added to the narrow end to hold the wick in place. Stone lamps often were decorated in relief with representations of an animal or bull-man. This type of lamp continued until the Old Babylonian period when a lamp with a closed wick channel was introduced. This consisted of a small jar to which a wide spout was added; in later periods it assumed a shoelike shape. Such lamps are clearly shown among the symbols of deities on boundary stones of the Kassite period. Occasionally they are depicted on top a special stand. With the introduction of glaze, lamps as well as other pottery utensils were normally covered with glaze.

6. Boats.—The two great rivers are the dominating geographical features of Mesopotamia, and the inhabitants from earliest times used them as main transportation routes. Since materials from which boats are normally made are perishable in the climate of Mesopotamia, all information about ancient boats depends on models and representations on monuments. The earliest model of a boat, from the Ubaid period at Eridu, has a hollowed shaft in the centre; this has been interpreted as a base for a mast and consequently as evidence for the use of sailing boats in prehistoric times. No sails are depicted, however, on any of the numerous representations of boats in later times. Boats represented on cylinder seals of the Protoliterate period are long and low with high upturned prow and stern, a type that persists throughout Mesopotamian history. Punting poles as well as oars with wide, leaf-shaped blades are frequently shown. Occasionally both prow and stern end in plant forms. At the stern there is sometimes an upright member that apparently is tied to the boat.

In the Early Dynastic periods, in addition to numerous representations on seals, boats are shown also on votive plaques, and actual models made of clay, bitumen and metal are known. A silver model boat, over two feet long, from the royal cemetery at Ur shows a series of oars, cross members and a loop over which a cloth could be stretched to form shelter from the sun. In many representations of boats on cylinder seals of the Akkadian period deities are shown riding. Occasionally the prow of the boat itself ends in a figure of a deity using a punting pole.

Numerous clay models and representations of boats from later periods do not differ essentially from those of earlier times. In the Assyrian reliefs innumerable representations of boats and rafts are shown, but the general character of the boat remains unchanged. Occasionally the prow ends in a horse's head. Nowhere is the contrast between the river boats of Mesopotamia and the seagoing boats of the western Mediterranean more clearly shown than on a relief of Sennacherib on which both types are depicted.

7. Chariots.—The war chariot apparently made its first appearance at the end of the Early Dynastic I period, and is frequently depicted on Early Dynastic III monuments. A copper model from the Early Dynastic II period was found at Tell Agrab. It is impossible to say whether the chariot was a Mesopotamian invention or whether it was introduced from the outside. Neither is it possible to identify with certainty the animals that were used in harness. The harness itself consisted of a yoke fastened to a central pole.

Two-wheel as well as four-wheel chariots were used, and a model of a covered-wagon-type chariot, found at Tepe Gawra, indicates a peaceful use of the chariot. Assyrian reliefs depict war chariots as well as ox carts in great detail.

D. Tombs and Burials

Disposal of the dead was a concern of the inhabitants of Babylonia and Assyria from earliest times, and inhumation was practised throughout the land in all periods. Occasionally traces of fire are discernible in burials, but there is no evidence that cremation was at any time the prevailing custom. From prehistoric times the dead were supplied with objects such as pottery and personal possessions and apparently with food and drink on a more or less lavish scale. Indeed, objects found in burials form the major part of the archaeological material from Mesopotamia; those from the royal cemetery at Ur, for example, are among the richest and most important finds ever made in the country (*see* Ur). Burials varied from simple inhumation in a hole dug in the ground to specially constructed elaborate tombs that indicate

a complex and prolonged burial ritual. The body was laid either extended on its back or in a more or less contracted position on either the right or the left side. No special orientation toward any point of the compass seems to have been preferred. Graves sometimes were located in cemeteries outside the living quarters and sometimes under the floors of houses. Similarly, burials occurred sometimes within a temple precinct, while in other instances not only were burials in temples avoided but, apparently, great effort was spent to clear the area on which a temple was to be built of earlier traces of habitation as well as of graves. What guided the preference for one custom over another cannot be ascertained. (P. P. D.)

III. HISTORY

A. Early Periods

1. Prehistory.—The foothills of the Zagros mountains in northern Iraq, the country later known as Assyria, seem to have been one of the regions where villages based on agriculture and flock raising first developed. One of the early sites is Jarmo (*q.v.*), whose first levels antedate the invention of pottery. A more advanced village culture, named after the type site Hassuna (near Mosul), is found all over upper Mesopotamia. The following still more elaborate stage, in which copper makes its first appearance, is called the Tell Halaf culture after a site near the source of the Khabur river, but its centre was in the Mosul area; it covered a large area, from Assyria to southeastern Turkey and the Mediterranean. Farther to the southeast there existed a similar but slightly older culture named after the type site Samarra on the middle Tigris. These two cultures, whose most outstanding artifacts are their beautifully painted clay vessels, were replaced by the culture called Ubaid. This name is taken from a site near Ur in southern Babylonia, but the Ubaid culture covers all of Mesopotamia as far as Cilicia and the north Syrian Amuq plain (the Turkish province of Hatay) and has relations with similar culture stages on the Iranian plateau.

In spite of certain differences in detail between northern and southern Ubaid, the over-all picture is one of great homogeneity over the entire area from the Persian gulf to the Mediterranean sea.

In Babylonia—the alluvial plain downstream of Baghdad—Ubaid was for a long time believed to be the oldest culture. Excavations in the 1930s and 1940s, however, showed that earlier settlements existed there too, especially at Eridu, a city that was credited with high antiquity also in Babylonian tradition. Whereas the exact time relation of the early settlements in the south to those of the Halaf and Samarra cultures in the north has not been established, it seems clear that on the whole human settlements appear much later in the alluvial plain than in upper Mesopotamia. (*See* Archaeology.)

2. Protoliterate Period in Babylonia.—After the widespread and fairly homogeneous Ubaid culture, the north and south underwent different development. Whereas in the north the periods following Ubaid, called Gawra (after the type site Tepe Gawra) and Ninevite, brought few innovations, the south made the decisive step to higher civilization in the next major period, for which the name Protoliterate has been introduced. According to the older terminology, in which archaeological periods are named after type sites, the period called Protoliterate corresponds to the last phases of the Warka period (Archaic level IV in Warka) and the Jamdat Nasr period (Archaic level III in Warka). The term Protoliterate was chosen because in this period writing makes its first appearance (Warka IV). The first written documents are small clay tablets inscribed with accounts and found in the precinct of Eanna, the main sanctuary of Erech, thus probably representing an early form of accounting for the type of temple economy known from later times. The writing is pictographic: pictures of various animals, parts of the human body, grain, vessels, etc., were incised with a pointed stylus in the soft clay before it was dried in the sun. Numerals were expressed by circular (for the tens) and semicircular (for the units) impressions of the round end of the stylus. Purely conventional symbols were used alongside pictures from the beginning. Although many of the pictographic signs can be identified with later cuneiform forms, the majority of the pictographic texts are not fully interpreted. Some peculiarities make it clear that the second group of pictographic texts (Warka III, Jamdat Nasr) was written in Sumerian, and the same is probably true of the first group (Warka IV). This would indicate that the Protoliterate civilization was developed by the Sumerians, the people still leading in Babylonia in the 3rd millennium. The origin of the Sumerians is unknown. Their language, of agglutinative structure, cannot be linked to any known family of languages. (*See* Cuneiform; Sumerian Language.)

That the Sumerians were not the earliest settlers of southern Babylonia is shown by linguistic analysis: the names of the oldest cities are pre-Sumerian, and so are the words for the basic crafts and agricultural activities, which were borrowed by the Sumerian language from an earlier language. From the appearance of the first Sumerian texts in the Protoliterate period it has been concluded that this period marked the arrival of the Sumerians in the country; but this conclusion is contested by some scholars who would date it still earlier.

B. First Historical Periods

1. Early Dynastic Period.—For the archaeological levels following the Protoliterate period the name Early Dynastic has been introduced. This term is based on the fact that, roughly at least, this period seems to correspond to the time in which the later Sumerians placed their first "dynasties." The word dynasty was introduced in modern times; Sumerian tradition speaks of the kingship that came down from heaven and existed in various cities, passing at different times from one city to another. Since the succession from father to son was not continuous at all times, the term dynasty is inaccurate, but it has come into general use. Furthermore, whenever the "kingship" returns to a city that had it before, modern scholars have introduced a numbering system by which they speak, *e.g.*, of the "1st, 2nd, etc., dynasties of Kish" or of other towns. The arrangement of all dynasties in one single time sequence in the Sumerian king list is fictitious; modern criticism has shown that the various royal centres existed simultaneously, so that the total time covered by the list has been considerably reduced.

The Sumerian king list, which found its final form as late as the early 2nd millennium (original composition around 2100 B.C. is debated), distinguishes between kings "before the Flood" and "after the Flood," thus linking the historical tradition to the belief in one universal "Flood" (*see* Flood [in Religion and Myth]). This tradition, which was still known to Berossus in the 3rd century B.C., seems also to have influenced the biblical account of the generations from Adam to Noah. The king list knows of ten antediluvial kings, each with a mythical reign of tens of thousands of years, who ruled successively in the cities of Eridu, Badtibira, Larak, Sippar and Shuruppak; Shuruppak was also the place where later tradition localized the advent of the Flood. Excavations led to the discovery of deposits of silt and sand overlying inhabited deeper levels, which presumably represent a flood, in various towns and in different depths. Whereas the "flood level" of Ur falls into the Ubaid period, similar "flood levels" in Kish and Shuruppak (Tell Fa'rah) separate the Protoliterate from the Early Dynastic level. It is therefore impossible to identify the antediluvian age of ancient tradition with any given archaeological period.

The first town that is said to have had the "kingship" after the Flood is Kish (1st dynasty of Kish). According to T. Jacobsen's synchronic reconstruction, the latest part of this dynasty was contemporary with the 1st dynasty of Uruk, which was founded by a son of the sun-god. Among his successors, the names Enmerkar, Lugalbanda and Gilgamesh (*q.v.*) are those of the heroes of Sumerian epics, whereas Dumuzi was known as a god (Tammuz), the lover of Inanna.

If Jacobsen's reconstruction of the data underlying the Sumerian king list is correct, the kings of Uruk just mentioned fell only a few generations before the beginning of the 1st dynasty of Ur, whose first king also is known from authentic inscriptions. Still earlier is the first preserved royal inscription, that of a certain

Me-silim, king of Kish, whose name does not appear in the list. He is said to have arbitrated a boundary dispute between the south Babylonian cities of Lagash and Umma, whereas his own capital, Kish, is situated in the north of Babylonia. The fact that he had such powers tallies with the tradition that Kish was the seat of the first postdiluvian dynasty and with the still unexplained phenomenon that the title "king of Kish" seems later to have come to mean "king of the universe."

The first rulers of the 1st dynasty of Ur (about 2550 B.C. according to a rough estimate) are known from the "royal tombs" discovered at Ur and from a temple at El 'Ubaid as well as from the king list (although some of the kings whose inscriptions were found at El 'Ubaid do not appear in the king list). This period is the first historical period of Babylonia and the latest part of the Early Dynastic period (Early Dynastic III, whereas I and II are older). The tombs and buildings attest a high level of material culture.

Roughly contemporary with these kings of Ur were local rulers of Lagash, who do not appear in the king list. The reason for this omission may be the fact that they did not bear the title *lugal* ("king") but rather called themselves *ensi*. This term (formerly read *patesi*) has been interpreted in different ways and also has different meanings in various periods. The title seems to imply subordination of its bearer under a higher authority, sometimes a king (*lugal*), so that at times *ensi* means no more than "governor," sometimes a city-god who is regarded as the real ruler while the *ensi* is his earthly representative. A long sequence of early *ensi* of Lagash is known from their own inscriptions, and at least some of them seem to have been practically independent though perhaps in theory under the suzerainty of some "king." The first known *ensi* of Lagash, datable to about the time of the first part of the 1st dynasty of Ur, is Ur-Nanshe (formerly misread Ur-Nina). His second successor, E-anna-tum, has left the famous "Stele of the Vultures" in which he commemorated his victory over the neighbouring city of Umma. Among E-anna-tum's successors, mention may be made of En-anna-tum I, En-temena and En-anna-tum II. After two more rulers, the last in the series of early *ensis* of Lagash is Uru-ka-gina, who is best known from his "reform texts." He tried to protect the poor, the widows and orphans by reducing the powers of the priests and of the royal officials.

Toward the end of Uru-ka-gina's reign (about 2375 B.C.) a certain Lugalzaggesi, *ensi* of Umma, conquered and destroyed Lagash. He then also defeated Uruk and Ur and made himself king in Uruk (he alone represents the 3rd dynasty of Uruk). According to his own inscriptions, Lugalzaggesi not only united all of Sumer including Kish but also carried his conquests as far as the coast of the Mediterranean sea. He thus was the first empire builder, and this period has therefore been called "protoimperial." After a reign of 25 years, however, Lugalzaggesi lost his empire to a still mightier conqueror—Sargon.

2. Dynasty of Akkad.—Semites must have been the neighbours of the Sumerians from very early times, as is evidenced by Semitic loan words in Sumerian. A Semitic dynasty is attested for Mari (Tell el Hariri on the middle Euphrates) for the Early Dynastic period. The questions of whether Semites were present before the arrival of the Sumerians and of their numbers in Early Dynastic times are not solved. It may be assumed that they came out of the Arabian desert and settled on the fringes of the cultivated land; they seem to have appeared first in large numbers in the north of Babylonia. By the time of Lugalzaggesi they must have been strong enough in the north so that one of their leaders could establish himself as king in the north Babylonian town of Akkad (not identified with any mound).

The Semitic ruler who thus established the dynasty of Akkad called himself Sharrum-kin, "the king is legitimate"; from the fact that a later namesake, Sharru-kin II of Assyria, appears as Sargon in the Bible, the form Sargon is used for the king of Akkad also. Sharrum-kin or Sargon of Akkad became the central figure of an extensive literature in later times, and one of these literary texts is the legend of his birth: he was an illegitimate child, was put into the river in a box by his mother, found and raised by a gardener of the king of Kish, and by the favour of the goddess Ishtar became cupbearer of that king until he finally took his throne. Although this is legend (of the type of the Moses story), the fact that in his own inscriptions Sargon never mentions his father seems to confirm his lowly birth, and the name, which claims legitimacy, may have been chosen for just that reason.

After having dethroned King Ur-Zababa of Kish, Sargon defeated Lugalzaggesi of Uruk and thereby conquered the whole of Sumer to the Persian gulf, in which he "washed his weapons." He then extended his empire in all directions, conquered Elam in the east and the western regions along the upper Euphrates to the Mediterranean. According to his own inscriptions Sargon reached the Amanus and Taurus mountains; a later literary text lets him even cross the latter and reach the Anatolian plateau, but the historicity of this event is debated. The new capital, Agade, founded by Sargon, thus became the centre of a vast empire, to which ships brought riches from distant countries across the Persian gulf and up the river. The king list gives Sargon's reign as 56 years (about 2350–2300); toward the end of his rule a revolt occurred in his own country.

Sargon was succeeded by his two sons, Rimush and Manishtusu (the total of their combined reigns is 24 years), and the latter was followed by Sargon's grandson Naramsin (37 years; the four reigns together cover 117 years, *c.* 2350–2230). Later tradition omitted Rimush and Manishtusu and made Naramsin a son (instead of grandson) of Sargon. Naramsin was another great conqueror under whom the empire reached at least the same size as under Sargon. He built a palace in Tell Brak, northwest of Mosul, and an inscribed stele of his was found near Diyarbakir on the upper Tigris. His most famous monument, however, is a stele commemorating his victory over the Lullubi, a barbarian tribe in the Zagros mountains on the border of Elam.

Although Naramsin was followed by a king with the boastful name Sharkalisharri, "king of all kings," and six other, little-known rulers, tradition links the downfall of the dynasty with Naramsin's name, and it is possible that this tradition is correct. A barbaric people from the east, the Guti, invaded Babylonia and destroyed both the kingdom and the city of Akkad.

Under the kings of Akkad, their Semitic language, known as Akkadian, became a literary language, written with the cuneiform system of writing. The Sumerian language continued in use beside Akkadian; some of the royal inscriptions are bilingual. (*See* CUNEIFORM; AKKADIAN LANGUAGE.)

There was no racial antagonism between Sumerians and Akkadians; the kings of Akkad were accepted as the legitimate rulers of Sumer (the southern part of Babylonia) as well as of Akkad (the northern part).

Art reached its peak under the dynasty of Akkad. Unfortunately nothing of the literature of the time has survived.

3. Dynasty of Guti.—As noted above, the Akkadian empire was destroyed, either at the end of Naramsin's reign or later, by the invasion of a mountain people from the east, the Guti. Tradition has kept the memory of the destruction brought by them over the entire country, and the king list gives the foreign-sounding names of their rulers, whose reigns came to a total of about one century (*c.* 2230–2130). In fact, however, they seem not to have held all of Babylonia at all times, since, apart from the last kings of Akkad who may have continued a limited rule in the north, the so-called 4th dynasty of Uruk seems also to have been contemporary with the dynasty of Guti.

Another independent ruler whose reign probably falls into the latter part of the Guti period was Gudea, *ensi* of Lagash in the south. Under him that city had its golden age. Apart from outstanding works of art (*see* above, *Archaeology, Architecture and Art: Sculpture*) he left a number of inscriptions in Sumerian on his statues and on clay cylinders. The language of his inscriptions is considered "classical" Sumerian. He describes in great detail the building and inauguration of a temple for his god Ningirsu, for which he got cedar beams from the Lebanon.

A king of Uruk by the name of Utukhegal, who is counted as the only king of the 5th dynasty of Uruk, was credited with the liberation of the country from the Gutian yoke. Under him, a certain Ur-Nammu was *ensi* of Ur, but soon Ur-Nammu dethroned

his overlord and united the whole country under the rule of the city of Ur, thus establishing the 3rd dynasty of Ur, which lasted for another century.

4. Third Dynasty of Ur.—The liberation had been the work of the Sumerian Utukhegal, and under Gudea Sumerian civilization reached its classical phase. The newly established 3rd dynasty of Ur brought the Sumerian element in the country once more into political predominance. The kings of Ur are: Ur-Nammu (18 years, beginning *c.* 2130), Shulgi (formerly misread Dungi, 48 years), Amar-Sin (also read Bur-Sin, 9 years), Shu-Sin (formerly misread Gimil-Sin, 9 years) and Ibbi-Sin (25 years; the later part of his reign, however, overlaps with other newly emerging dynasties).

Although the Sumerian language was predominant throughout the period, Akkadian remained in use, and persons bearing Akkadian names are mentioned frequently. A gradual shift from Sumerian to Akkadian also may be observed in the names of the kings, who form a real dynasty in the sense of uninterrupted father-son succession. Whereas the first two names are Sumerian, the last two are Akkadian; the third is either Akkadian (if the reading Bur-Sin is correct) or, more probably, hybrid, Amar being Sumerian and Sin being the Akkadian name of the moon-god, the city-god of Ur.

The 3rd dynasty of Ur held a real empire, firmly administered by governors (*ensi* in this period having this meaning), both in the various Babylonian cities and in outlying territories such as Elam, Eshnunna and Ashur. The kings of Ur indulged in great building activities; canals and temples were built throughout the country, and some of the ziggurats or temple towers still standing in ruins were the work of these kings, particularly the first two, Ur-Nammu and Shulgi.

The king was regarded as a god during this period. In contrast with practice in Egypt, whose Pharaoh was a god at all times, the custom of deifying the king existed in Babylonia for a limited time only. In writing, the divine determinative (*i.e.*, the word sign for "god" written in front of the name) served as an expression of this belief. In the dynasty of Akkad this determinative was used with the names of Naramsin and Sharkalisharri; under the dynasty of Ur it was applied to all kings. In addition there are hymns addressed to several kings of Ur in the style of hymns to a god, and the figure worshiped in the adoration scenes on seals also has been interpreted as the deified king. After the 3rd dynasty the custom lived on for a while (under the first kings of Isin and Larsa, *see* below), but it soon fell into disuse; beginning with the classical Old Babylonian period deification of a Babylonian or Assyrian king is no longer found.

The economy was organized by the state. Most of the arable land was the property of the crown; labourers received rations from the crops delivered to the royal storehouses. For the administration of this vast state economy a very differentiated hierarchy was developed, and records were kept of all deliveries and distributions of rations. Tens of thousands of clay tablets inscribed with such records were found in the capital Ur itself, in Lagash, Umma and in a royal dairy farm called Puzrish-Dagan (Drehem). Foreign trade also was carried out in the name of the central administration.

During the rule of Ibbi-Sin, the empire crumbled. In one city after another documents ceased to be dated with his date formulas. In Ur there was famine, prices rose and the government had to buy grain at high prices from different regions. Two former officials seem to have made themselves independent kings, Naplanum in Larsa and Ishbi-Irra in Isin. The final blow to Ibbi-Sin came through an attack from Elam; Elamites conquered Ur, where they kept a garrison for a few years.

C. Old Period (Babylonia and Assyria)

1. Dynasties of Isin and Larsa.—With the establishment of Naplanum and Ishbi-Irra *c.* 2030 there begins the split of the country into a northern kingdom of Isin and a southern kingdom of Larsa. The two dynasties existed side by side for over two centuries, until the last ruler of Larsa, Rim-Sin, conquered Isin, thus uniting the greater part of the country. He in turn was defeated (*c.* 1770) by King Hammurabi of Babylon, who thereby became the first after the 3rd dynasty of Ur to reunite the whole country.

During the Isin-Larsa period several changes took place. First, the Akkadian language gradually won out over the Sumerian; Sumerian henceforth was learned only in the schools and used for religious purposes. Second, the statist system of the 3rd dynasty of Ur was replaced by an economic system based on private enterprise. Documents of the period found at Ur show how overseas trade was financed by private capital. Third, a new wave of Semites appeared in Babylonia. Their language is known mainly from proper names; for writing they used the Akkadian language only. Their native idiom is of western Semitic type, akin to Canaanite. Scholars use various names for these newcomers, that most commonly applied being Amorites, based on the assumption that the Akkadian term *Amurrû*, which means "westerner," refers to these people (*see* Amorites). Other scholars reject the attribution of *Amurrû* to this group, taking *Amurrû* as a general term for "nomads," and call the newcomers (Eastern) Canaanites or simply western Semites. Individuals bearing names of this type first appear in Larsa, where they soon seized the throne, and a little later also in Sippar. In the north of the alluvial plain these newcomers established a dynasty of their own at Babylon, which now for the first time plays a political role. The establishment of this dynasty of Babylon and the simultaneous appearance of western Semites in Larsa can be dated approximately to 1900 B.C. From then on, the three dynasties of Babylon, Isin and Larsa coexisted for about a century until their final fusion.

2. Eshnunna and Ashur.—With the downfall of the empire of Ur, the Diyala region, or Eshnunna, became a kingdom under independent rulers. Farther north on the Tigris, Ashur now emerges from the dawn of prehistory. The Assyrian king list, now complete, begins with 30 rulers of whom there is no other knowledge; it is probable that some of these names belong to the Bedouin ancestors of the usurper Shamshi-Adad (*see* below) rather than to kings of Assyria proper. With king no. 31, Ilu-shuma, authentic royal inscriptions begin. Under his successors, Assyrian merchants founded trade colonies in Anatolia. They exported tin and textiles to Anatolia, organized some of the local copper trade there and brought home silver—that is, cash. The centre of these colonies was Kanesh, the mound called Kültepe near Kayseri (Caesarea Mazaca) in Turkey, but there were smaller settlements in many other places. The colonies lasted for some 70 years; part of this period fell into the reign of Sharrum-kin I of Assyria, the 35th king according to the Assyrian king list. King no. 37 bears the same name as a ruler of Eshnunna, Naramsin; identity of the two seems likely, whether Eshnunna ruled over Ashur or vice versa. The 38th king was dethroned by a usurper, a western Semite by the name of Shamshi-Adad, who seems to have come from Terqa on the middle Euphrates and, after a sojourn in Babylon, where the dynasty was of the same ethnic stock, conquered Ashur and became its 39th king (*c.* 1820). Even before he had seized the throne, he conquered Mari on the middle Euphrates, with whose rulers he had an old feud. After his accession he installed his second son, Yasmakh-Adad, as viceroy in Mari. Although Shamshi-Adad built temples in Ashur, he mostly resided in a new capital, Shubat-Enlil, probably to be identified with Tell Chagar Bazar in the Khabur region, where texts pertaining to his reign have been found.

3. Old Babylonian Period.—Toward the end of the Isin-Larsa period the kingdom of Larsa was conquered by a certain Kudur-Mabug, a man with an Elamite name who ruled in Yamutbal east of the Tigris. He installed as king in Larsa his son Warad-Sin, who was succeeded by his brother Rim-Sin. Rim-Sin, by uniting the former kingdoms of Isin and Larsa under his rule, became the rival of Hammurabi of Babylon, who came to the throne *c.* 1800 or about 20 years after Shamshi-Adad.

Hammurabi's kingdom thus was surrounded by powerful neighbours: Rim-Sin, Shamshi-Adad and the king of Eshnunna. Shamshi-Adad died shortly after the tenth year of Hammurabi, and after his death Assyria suffered a setback that of course was to the advantage of Hammurabi. Yasmakh-Adad was driven out

of Mari by Zimri-Lim, the son of the last local ruler before Shamshi-Adad, who had found refuge in Aleppo and now returned to his ancestral throne. The royal archives of Zimri-Lim of Mari are the main sources for the political history of the time. Zimri-Lim at times enjoyed the help of Hammurabi, who used him as a pawn in his political game. Shamshi-Adad's oldest son, Ishme-Dagan, his successor on the throne of Assyria (king no. 40), also seems to have suffered defeat from various neighbours. Hammurabi helped him on some occasions, but, from the fact that he claimed rule over Ashur toward the end of his reign, it seems that Hammurabi held some kind of suzerainty over Ishme-Dagan, at least in the end. Toward Eshnunna, too, Hammurabi's policy varied according to circumstances; it finally led to the conquest of that country. In his 30th year (*c.* 1770) Hammurabi was strong enough to defeat Rim-Sin of Larsa. Several years later he probably took Mari, putting an end to Zimri-Lim's independent rule. For the last decade of his 43-year reign, then, Hammurabi ruled over a kingdom that extended from the Persian gulf to Mari and Ashur and eastward to the Zagros mountains.

The reign of Hammurabi was the classical age of Old Babylonian civilization. From his correspondence one gets the impression of a shrewd politician and a good administrator who took pains to further the welfare of his subjects. Letters to his governors contain detailed instructions for the enforcement of justice and order. Most famous is his law code, composed in his later years. It was inscribed on a diorite stele discovered in Susa, where the Elamites carried it at a later date. Contemporary and later copies on clay tablets also exist.

Hammurabi's law was not the first codification known from ancient Mesopotamia. Fragments of a Sumerian code of King Ur-Nammu of Ur were found, also a Sumerian law code of King Lipit-Ishtar of Isin. Whereas these Sumerian laws antedate Hammurabi by 350 and 150 years, respectively, there is one in Akkadian from Eshnunna which is only about 50 years older than the famous code of Hammurabi.

A great number of legal and economic documents of the period give a lively picture of its life. The economy, as in the Isin-Larsa period, was based on private property and enterprise, and trade was flourishing. Of Hammurabi's buildings in Babylon itself nothing can be excavated because they are below ground-water level, but living quarters with private dwellings were found at Ur, and the palace of Zimri-Lim at Mari shows the high living standards of a ruler of the time.

With the rise of Babylon to the capital of a large united kingdom, its city-god Marduk became supreme, replacing the Sumerian god Enlil as head of the pantheon. Literature flourished in this classical period. The Akkadian language of this age, called Old Babylonian, was developed into a literary language in which many of the great epics and hymns were composed, among them the *Epic of Creation* which gave the mythological justification for Marduk's rise to power (*see* Creation, Myths of). Sumerian literature, too, was studied and copied in the schools; in fact almost all extant copies of Sumerian literary works were written in the Old Babylonian period, although the texts must have been composed earlier, when Sumerian was still a living language. Representative art of the period excels by quality more than by inventiveness; yet the glyptic art of the Old Babylonian period influenced that of Syria in the centuries to come.

After Hammurabi, his dynasty continued in unbroken father-son sequence for five generations: Samsu-iluna (38 years), Abi-eshukh (28 years), Ammi-ditana (37 years), Ammi-saduqa (21 years) and Samsu-ditana (31 years). These kings were not able to maintain Hammurabi's empire, although cultural and economic life went on in Babylonia along the lines developed under him. Under Samsu-iluna the region next to the Persian gulf broke away and became an independent kingdom called the Sea Land under a dynasty that tried to revive Sumerian tradition. Ashur regained independence, and in the north new peoples arose that threatened Babylonia. Then, 155 years after the death of Hammurabi, the 1st dynasty of Babylon was destroyed by an invasion of new peoples (*c.* 1600 B.C., according to the chronological system adopted here).

D. Middle Period

1. Hittites, Hurrians and Kassites.—The downfall of the 1st Babylonian dynasty is mentioned in a later chronicle with the following laconic sentence: "At the time of Samsu-ditana the Hittite went to the land of Akkad." A Hittite record reads: "He [*i.e.*, the Hittite king Mursili I] went to Aleppo and destroyed Aleppo and brought captives and goods of Aleppo to Hattusa [or Khattushash, the Hittite capital]. But afterward he went to Babylon and destroyed Babylon. Also the Hurrians he defeated, and he kept captives and goods of Babylon in Hattusa." These two sources, which obviously refer to the same event, mention two of the new peoples that appeared on the scene: the Hittites (*q.v.*), who had established a kingdom in central Anatolia two generations before the sack of Babylon; and the Hurrians (*q.v.*), whom Mursili obviously had to defeat in order to keep his Babylonian booty, and who are found throughout the 2nd millennium in north Syria and north Mesopotamia. The language of the Hittites belongs to the Indo-European family of languages, whereas the Hurrian language is not related to any known linguistic group. Though Hurrians are known from earlier times, the latter part of the 1st dynasty of Babylon is the first time they play a role on the political scene. But these are not the only new ethnic elements.

According to the Babylonian king list the dynasty following the 1st Babylonian is that of the Kassites (*q.v.*). The Kassites spoke another language that is neither Indo-European nor Semitic; it is assumed that they came from east of the Tigris. Hammurabi's son, Samsu-iluna, had to fight them, and under his successors they are mentioned again. During the two generations preceding the fall of Babylon, Kassites were in control of Hana on the middle Euphrates. The question as to whether the Kassites established their rule over part of Babylonia even before the fall of Babylon, so that the 1st Babylonian and Kassite dynasties would overlap, is still debated and is closely connected with chronological problems.

2. Chronology.—Until the 1930s a chronological system had seemed fairly well established. Then it was learned from the Mari letters that Hammurabi of Babylon was a contemporary of Shamshi-Adad of Assyria, who had been believed to have reigned about a century later than Hammurabi. At about that time an almost complete copy of the Assyrian king list was discovered by the Oriental institute expedition at Khorsabad. Since then, some scholars (W. F. Albright and most German scholars) have essentially followed the Assyrian king list, according to which Shamshi-Adad would have ruled around 1700 B.C. and the Babylonian kings from Hammurabi to the end of his dynasty would cover the period from *c.* 1700 to shortly before 1500. This contradicts the statement of the Babylonian king list, which attributes 576 years to the Kassite dynasty: since its end is fixed to 1160 B.C., that dynasty would have begun in 1736; *i.e.*, before the new date proposed for Hammurabi.

Several solutions of the problem have been proposed: reduction of the Kassite dynasty to less than 576 years, overlap of the two dynasties and a combination of the two. Astronomical observations of the heliacal rising of the planet Venus for the reign of Ammi-saduqa exist in a later copy, but since the rising of Venus repeats itself in a cycle of 56 or 64 years, these observations fit several dates and can be used only if other considerations point to a particular span of time. Some of the various solutions offered are these: F. Thureau-Dangin, immediately after the Mari discoveries, chose a Venus period according to which the fall of Babylon would be dated *c.* 1660; this was taken up in the 1950s by A. Goetze. Sidney Smith decided for the next Venus period, which puts the fall of Babylon to 1596, and this chronology has been adopted here. B. Landsberger showed that the Assyrian king list omits some kings known from other sources, so that figures based on it are demonstrably too low. He also drew attention to the fact that the period following the fall of Babylon was a dark age indeed, and that at the time when sources begin to speak again, *c.* 1500, the near east had undergone such changes that a chronology placing the fall of Babylon only a short time before 1500 B.C. (Albright) would not leave enough time for these changes to take place. Landsberger's main point is that a definite solution is impossible with the material available. Concerning the Kassites,

he avoids the overlap by slightly reducing the figure 576 and by dating the fall of Babylon around 1700. Sidney Smith accepts an overlap, since 1736 for him falls into the reign of Samsu-iluna who defeated the Kassites. Albright's system presupposes both overlap and reduction of the 576 years. (*See* also CHRONOLOGY.)

3. Feudal Age.—The new era is characterized by the appearance in most near eastern countries of a feudal system based upon an aristocracy of chariot warriors. It is found in the Hittite kingdom of Anatolia, in Syria and north Mesopotamia and in Kassite Babylonia. Most of the area settled by Hurrians was organized under the rule of an Aryan dynasty in a kingdom called Mitanni. The Mitanni, in contrast with the Hurrian population, spoke a language, known from ancient India, which was a precursor of classical Sanskrit; presumably the Mitanni represent one branch of those Aryan tribes the bulk of which finally reached India. These Aryans have been credited with the introduction of the horse-drawn light war chariot, but the evidence is insufficient. It comes from a handbook for the training of horses, found in the Hittite capital and written in Hittite, which is the work of a Mitanni and contains technical terms both in Hurrian and in the Indo-Aryan language. Whoever may have introduced the new instrument of warfare, the fact is that by 1500 it was in general use in the countries just mentioned. An Assyrian handbook of hippology and Kassite lists of chariot horses belong to the same general period.

The Mitanni kingdom included at least part of Assyria, reaching as it did to Kirkuk in the east. It is assumed that some of the Assyrian kings of the 15th century were under the overlordship of the kings of Mitanni, although the king list does not mention such a foreign rule but rather gives an uninterrupted sequence of kings of Ashur.

In Babylonia the first inscriptions after the dark age begin with the 16th Kassite king, Karaindash, *c.* 1450 B.C. Administrative documents first appear under the 20th king, Burnaburiash II. who was contemporary with Pharaoh Amenhotep IV (Ikhnaton), *c.* 1360 B.C. The correspondence of this Pharaoh, found at Tell el Amarna in Egypt, shows a system of great powers, whose rulers bear the title of "Great King" and address one another as "My Brother." These are Egypt, Mitanni, the Hittite kingdom, Babylonia and, in fact, though not at first formally recognized, Assyria. The Assyrian king of the Amarna age was Ashur-uballit I, who, together with the Hittites, annihilated the kingdom of Mitanni and thus established Assyrian rule in northern Mesopotamia again.

4. First Assyrian Empire.—The centuries following the Amarna age are characterized by the rivalry of Assyria and Babylonia. During the period from Ashur-uballit I (*c.* 1360) to about 1200 B.C. Assyria was the more powerful of the two. Ashur-uballit himself played an active role in Babylonian politics. He married his daughter to the Kassite king and later, when the son of this daughter was removed by a local rival, installed another Kassite prince, Kurigalzu II, on the throne. During the 13th century the throne of Assyria was held by three powerful kings: Adad-nirari I (1308–1275), Shalmaneser I (Shulman-asharid, 1275–45) and Tukulti-Ninurta I (1245–08). First Adad-nirari and after him again Shalmaneser conquered the western part of north Mesopotamia, which, after the destruction of the Mitanni kingdom, had been under Hittite domination.

All three kings led successful campaigns into the Zagros mountains east of Assyria, and the last two also into Armenia. Adad-nirari claims a victory over the Kassites of Babylonia; a decisive victory was won by Tukulti-Ninurta over the Kassite king Kashtiliash III, an event that became the subject of an epic poem.

Kashtiliash was taken prisoner, Babylonia was conquered and apparently ruled by Tukulti-Ninurta himself. Several years later, however, Babylonia regained its independence, and Tukulti-Ninurta's last years seem to be overshadowed by his own growing restlessness. At first he built a new palace in Ashur itself. Later he founded a new capital, across the Tigris from Ashur, which he called Kar-Tukulti-Ninurta. Finally he was killed by his own son. About the causes of this development it is possible only to speculate.

5. Relation of Assyria to Babylonia.—Both Assyrians and Babylonians spoke the same language, Akkadian, but two different dialects of it, which scholars call Assyrian and Babylonian, respectively. Higher civilization developed in Babylonia. Religious beliefs were essentially the same in both countries, except that in Assyria the city-god of Ashur, the god Ashur, was supreme instead of the Sumerian Enlil or Marduk of Babylon. As a literary language the Assyrians wrote Babylonian; the Assyrian dialect was used mainly for private documents and other nonliterary works, such as the Assyrian laws, extant copies of which date from *c.* 1100 B.C. In art, Assyria went its own way; this is evident from the cylinder seals of the Middle Assyrian period (14th to 12th centuries) and becomes even more striking with the emergence, in the 9th century, of an Assyrian relief art that has no equal in Babylonia.

About the reasons for the difference between Assyrians and Babylonians it is possible only to speculate. Different ethnic substrates or admixtures have been adduced, but the role they may have played in shaping the two nations is hard to define. For some periods there is evidence of a difference of attitude toward Babylonia prevailing in different circles or factions among the Assyrians: pro-Babylonian and anti-Babylonian. That such difference of opinion may have existed at the time of Tukulti-Ninurta has been suggested as a possible explanation for his assassination.

After the death of Tukulti-Ninurta, Assyrian power declined, while that of Babylonia rose. Around 1135 a Babylonian king was able to determine the policies of Assyria. A short time later, Nabu-kudurri-usur I reigned, a powerful Babylonian king who was successful against Elam in particular. But during his last years there arose in Assyria a new ruler, Tiglath-pileser I (Tukulti-apal-Esharra; 1116–1076), who brought Assyria back to the status it had had in the 13th century. He fought successfully against the Nairi countries (Armenia) and against such formerly Hittite places as Malatya (Milid) and Carchemish on the Euphrates (the great Hittite empire of the 14th and 13th centuries had been swept away in the Aegean migrations of *c.* 1180 B.C.); near the upper Euphrates he also defeated the Mushki, a people said to have arrived there 50 years before his time (*c.* 1165), possibly one of the tribes that came into Anatolia in connection with those migrations. In the Syrian steppe he defeated Aramaean tribes (this name appears here for the first time), and he even reached the coast of northern Syria. Later Tiglath-pileser conquered northern Babylonia, including the city of Babylon, but left it under its local king.

After Tiglath-pileser I, Assyrian power declined again, while Babylonia, too, was in a state of insignificance. The most important element in the west was now the Aramaeans, who established themselves in many of the formerly Hittite states of north Syria, founded a powerful kingdom with Damascus as capital, settled in lower Babylonia near the Persian gulf and also pressed against the borders of Assyria proper.

6. New Rise of Assyria.—Under Ashur-dan II (933–910), Adad-nirari II (910–889) and Tukulti-Ninurta II (889–884), we hear again of Assyrian successes, mainly near the border and against such Aramaean states as Laqe on the middle Euphrates. The following two kings, Ashurnasirpal II and Shalmaneser III, then led Assyria to a new expansion.

Ashurnasirpal (Ashur-nasir-apli II; 884–859) is known for the cruelty with which he conducted his wars. Enemies were impaled, flayed or beheaded in great numbers. He succeeded in subjugating the Aramaean tribes of Mesopotamia and in incorporating their territories into his kingdom. He undertook a campaign to the Mediterranean coast during which he received tribute from the Late Hittite kinglets of north Syria as well as from the Phoenician cities. Other campaigns were directed north into the Nairi countries and east into the Zagros mountains.

Ashurnasirpal built a new capital in Kalakh (modern Nimrud on the Tigris south of Nineveh), a town founded by Shalmaneser I but later abandoned. His palace was among the first monuments discovered in the 1840s and was re-excavated in the 1950s. It is the earliest Assyrian building known that is decorated with reliefs on wall slabs, the first example of the great Assyrian relief art that flourished from then on to the end of the empire in the 7th

century. (*See* also Ashurnasirpal.)

Shalmaneser (Shulman-Asharid III; 859–824) kept and enlarged his father's empire. He conquered the Aramaean kingdom of Bit-Adini and turned its capital, Til Barsib (Tell Ahmar on the Euphrates), into an Assyrian stronghold and centre of a province. In Syria he met a strong coalition led by Bar-Hadad I (biblical Ben-Hadad; throne name, Hadadezer; Akkadian, Adad-idri) of Damascus and including King Ahab of Israel. The battle of Karkar seems not to have been a victory for the Assyrians, for their army returned to Kalakh and did not come back to Syria for the next few years. Not until after the death of Ahab and Bar-Hadad was Shalmaneser able to reach his goal. Damascus was besieged, though not conquered, and its oasis was devastated. Most Syrian rulers paid tribute, among them Jehu of Israel, as depicted on Shalmaneser's obelisk. Shalmaneser then turned toward the north, where he reached the source of the Tigris. This event, together with other campaigns, is depicted on bronze bands found at Balawat (see *Archaeology, Architecture and Art,* above).

In Armenia, the region previously known as the Nairi lands, a unified kingdom under the name of Urartu (*q.v.;* biblical Ararat) emerged by this time. It remained Assyria's most active rival for the centuries to come. The kings of Urartu left inscriptions in cuneiform writing, borrowed from Assyria, in the local language (called variously by scholars Urartaean, Vannic—from the capital, modern Van in Turkey—or Khaldic), which is related to Hurrian and may be a late stage of a dialect of that language.

In Babylonia the struggle of two contestants for the throne gave Shalmaneser an opportunity to appear with his army. While in Babylon itself he contented himself with reinstituting the rightful king and making offerings to the gods; he conducted a campaign against the Aramaeans who had settled in the region near the Persian gulf, the ancient Sea Land. These south Babylonian Aramaeans, also known as Chaldeans, among them the leading tribe of Bit-Yakin, were made tributary (*see* Aramaeans; Chaldea).

Toward the end of Shalmaneser's reign there was a general revolt against him led by his eldest son. His second son, who remained loyal, succeeded him as Shamshi-Adad V (824–810) and suppressed the rebellion with the aid of the Babylonians. Under Shamshi-Adad V, the Medes of Iran are mentioned for the first time in history. After his death his widow, Sammu-ramat, known to posterity under her Graecized name Semiramis, was regent for her son Adad-nirari III (810–782) during the five years before he came of age. Under the successors of Adad-nirari III, Assyrian power suffered another setback. Inscriptions of some provincial governors of the period bespeak a decline of the royal authority. The final rise of the New Assyrian empire only came with Tiglath-pileser III.

E. Late Period

1. New Assyrian Empire.—Tukulti-apal-Esharra III (745–727), the biblical Tiglath-pileser, was a general who usurped the throne. He succeeded in establishing a real empire reaching from the Persian gulf to the Armenian mountains and including all of Syria and Palestine to the Egyptian border. By breaking up large provinces into smaller units and by the systematic deportation of the population of conquered territories—a measure already applied by earlier Assyrian kings—he established a strong centralized administration of the vast empire. Among his numerous campaigns the most important are described below.

King Sardur II of Urartu, who led a coalition of north Syrian rulers against the Assyrians, was defeated in Commagene and had to flee to his capital, Tushpa (Van). Though Tiglath-pileser was unable to conquer this fortress, he included the southern part of Armenia in his empire and severely punished Sardur's north Syrian allies. All Syrian states either submitted or were defeated. Several Israelite kings paid tribute (II Kings xv, xvi), and Damascus and Gaza were conquered.

Babylonia at first acknowledged the supremacy of Ashur. Revolts and dynastic struggles after the death of King Nabu-nasir (Nabonassar; 747–735) finally led Tiglath-pileser in 730 to a campaign into Babylonia, during which he defeated several Aramaean tribes and received their tribute; the Chaldean Marduk-apal-iddina (Merodach-baladan) was one of their tribal chiefs. In Babylon itself Tiglath-pileser "seized the hands of Marduk" and made himself king of Babylon under the name of Pulu (biblical Pul), thus for the first time uniting the two kingdoms of Assyria and Babylonia in a personal union. (*See* also Tiglath-pileser.)

His son Shalmaneser V (727–722) continued the same policy; his Babylonian throne name was Ululai. The most renowned event of his reign is the revolt of Hosea of Israel, which led to the siege of Samaria by Shalmaneser. He was removed, however, by a military revolt that brought another usurper to the throne: Sharru-kin II, the biblical Sargon.

The conquest of Samaria is attributed to Shalmaneser V in the Bible, whereas Sargon claims it as his own success during his accession year; the question is still debated. The deportation of the ten tribes of the northern kingdom is the best-known example of an old Assyrian policy.

Sargon.—With Sargon II (722–705) begins the last dynasty of Assyria, often referred to as the Sargonids, a sequence of four exceptionally gifted kings under whom the empire reached its peak. Apart from the annals of the kings and the relevant parts of the Babylonian Chronicle, an important source for the history of the period are the state letters found at Nineveh, which also give a lively picture of the administration and the cultural life.

Sargon fought many wars in order to maintain and enlarge the empire of his predecessors. In Palestine, where the northern kingdom became an Assyrian province, the southern kingdom of Judah under King Hezekiah maintained its existence by paying tribute. The Philistine towns of Gaza, Ashdod and Gath were put under Assyrian administration after an attempt of Hanun of Gaza to re-establish himself in his home town with Egyptian help had failed. Several revolts in the rest of Syria and southeastern Anatolia were put down by Sargon, who finally abandoned the policy of taking tribute from local rulers and rather turned their territories into Assyrian provinces. This was the end of the Late Hittite and Aramaean states of the region. Tabal (around Kayseri in Turkey) and Kue (the Cilician plain) became the westernmost provinces. King Midas of Phrygia, called Mita of Mushki by Sargon, was prevented from taking Cilicia and had to pay tribute, but was able to maintain his independence. Greek cities in Cyprus, where a stele of Sargon was found, acknowledged the supremacy of the Assyrian king. Urartu, weakened by attacks of the Cimmerians, who had come across the Caucasus, could not withstand Sargon's attack. In 714 Tushpa was conquered, King Rusa committed suicide, a rich booty was taken to Assyria and Rusa's successor, Argisti II, who kept only a small part of Urartu, became an ally of Assyria.

In Babylonia the Chaldean Merodach-baladan had made himself king early in Sargon's reign and secured the help of Elam. An attempt of Sargon, in his second year, to bring Babylonia under his control failed; he was defeated by the Elamites, and Merodach-baladan remained king for ten more years. Not until his 12th year (710) was Sargon able to defeat Merodach-baladan, who fled to Elam; the Chaldean tribes were punished, but in Babylonia proper Sargon took the role of a restorator. He called himself "king of Sumer and Akkad" but only "governor" of Babylon; he celebrated the New Year festival in Babylon and did much for the rebuilding of Babylon and other Babylonian towns.

In Assyria, Sargon first resided at Kalakh, but in 713 he began to build a new residence for himself, Dur-Sharrukin, "Sargon's fortress" (Khorsabad, northeast of Nineveh), where his palace with many reliefs and inscriptions has been excavated. Sargon lost his life on a campaign in Iran in 705 and was succeeded by his son Sennacherib. (*See* also Sargon.)

Sennacherib.—Sennacherib (Sin-akhkhe-eriba; 705–681) differed from his father in many respects, especially in his attitude toward Babylonia. He immediately abandoned Dur-Sharrukin and resided first in Ashur and later in Nineveh, where he built a palace and which from then on remained the real capital of Assyria. In Babylonia Merodach-baladan seized power again in 703 with the help of Elam. But only nine months later Sennacherib defeated the coalition of Elamites, Babylonians and Chaldeans;

Merodach-baladan fled again, and Sennacherib put a man of his choice on the throne of Babylonia. In the meantime, Hezekiah of Judah revolted, instigated by Merodach-baladan and the king of Egypt. In 701 Sennacherib marched into Palestine, where he conquered Lakhish (Lachish) and besieged Jerusalem. Both the Bible (II Kings xviii, 13–xix, 36; II Chron. xxxii, 1–22; Isaiah xxxvi, 1–xxxvii, 37) and Herodotus have kept the memory of how he had to give up this siege; in spite of this retreat, which was considered a miracle, Hezekiah paid tribute and thus saved his kingdom for the future.

The ill fate of the siege of Jerusalem was the signal for the Babylonians to revolt again. Sennacherib, in 700, suppressed this revolt and installed his own son Ashur-nadin-shum as king of Babylon. He then decided to punish the Elamites for the help they had given the Babylonian insurgents. For this purpose he had ships built in Syria and Assyria, which were manned with Phoenician and Ionian sailors and sailed down the Euphrates and Tigris for an attack on Elam from the Persian gulf. In 694 he landed in Elam and looted several towns, but in his rear the Elamites occupied Babylonia, captured Ashur-nadin-shum and put a man of their choice on the throne. The war went on for the following years with varying success; finally in 689 Sennacherib conquered Babylon, where a Chaldean, Mushezib-Marduk, was then king, and punished the city severely. The statue of the god Marduk was taken to Ashur, the city itself was looted and completely destroyed, even flooded by a diversion of the river. For the rest of Sennacherib's reign the city of Babylon remained a wasteland.

Sennacherib's palace in Nineveh, like the palaces of his predecessors, was adorned with reliefs. They show a considerable advance in the lively rendering of landscape and of crowded scenes. Among the latter there are pictures of the transport of huge bull colossi. The engineering skill of the period also is reflected in an aqueduct by which fresh water for the capital was led across a valley near Jerwan. In Ashur, to which the New Year festival was now transferred, trees for the garden of the new festival house were planted on a rocky plateau in holes cut into the rock and filled with earth.

The destruction of Babylon was considered by many a grave sin. In 681 Sennacherib was killed by some of his sons. The details of the event and its causes are debated, especially the question of whether his successor, who was a younger son, was involved in the plot. (*See* also SENNACHERIB.)

Esarhaddon.—At any rate, Esarhaddon (Ashur-akh-iddina; 681–669), who followed his father on the throne, represented the pro-Babylonian faction; he immediately began to rebuild Babylon and did much for the restoration of temples also in other Babylonian cities. Like Sargon he used only the title of "governor of Babylon" for himself.

In the north, the Cimmerians became more and more a menace. Another Asian people, the Scythians (Assyrian Ishkuza), appeared in the same region. Numerous oracle questions by which Esarhaddon tried to find out what these people would do show the degree to which he felt this danger; they betray a weakness that contrasts with the king's military success in other parts. In order to secure help against the Cimmerians, he even gave his own daughter as a wife to Bartatua, king of the Scythians (Herodotus renders the name as Protothyas).

Esarhaddon extended the empire farther than any Assyrian king before him by conquering Egypt. A first campaign of 673 failed. After careful preparations, another Assyrian army went out in 671. This time the Egyptians under the Ethiopian king Taharqa (Tarku, biblical Tirhakah) were defeated, Memphis, the northern capital, was taken and the land was organized in 22 districts under local rulers, each of them under the supervision of an Assyrian governor. However, revolts followed soon, both in Egypt and in Assyria. After having restored order at home, Esarhaddon set out himself to suppress the Egyptian revolt but died on the way. (*See* also ESARHADDON.)

Ashurbanipal.—Esarhaddon had designated a younger son of his, Ashurbanipal (Ashur-bani-apli), as his successor on the throne of Assyria, while his elder son, Shamash-shum-ukin, was to become king of Babylon under Ashurbanipal's overlordship. Although this decision, in which the dowager queen Nakiya (whom some believe to be the Nitokris of Greek tradition) had played a role, met with some criticism, it was accepted, and after Esarhaddon's death his two sons succeeded him as ordered.

Ashurbanipal (669–630) had an excellent education. Not only was he well trained in warfare and all manly sports but he also learned to read and write cuneiform, to read even old Sumerian texts and to solve mathematical problems. His interest in literature was a very real one as his creation of a library shows.

At the beginning of Ashurbanipal's reign the Egyptian revolt was suppressed by the general who led the army after Esarhaddon's death. The Ethiopian king Taharqa fled; the Egyptian Necho I was taken prisoner and later installed in Egypt as an Assyrian vassal, while his son Psamtik was given a province. In 664, however, a new revolt broke out, which was suppressed once more. On this occasion Thebes, the capital of Upper Egypt, was destroyed and obelisks were brought to Nineveh. All this did not secure a permanent rule. Around 655 Psamtik I was able to drive out the Assyrians and to establish a new, independent Egyptian kingdom, known as the Saite dynasty. He received help from Gyges of Lydia (Guggu, king of Luddu, in Assyrian), who sent him Carian and Ionian mercenaries. Several years earlier, Gyges had offered Ashurbanipal his alliance against the Cimmerians. When in 652 Gyges was killed in a new attack of the Cimmerians, Ashurbanipal considered this the punishment for the role he had played in Psamtik's insurrection.

In the same year, 652, Shamash-shum-ukin of Babylon revolted, having secured the help of Psamtik, the Elamites and Aramaean and Arab tribes. After four years of fighting Ashurbanipal conquered Babylon in 648; Shamash-shum-ukin died in the conflagration, and a man by the name of Kandalanu was made king of Babylon. Ashurbanipal then proceeded against Elam, which had caused so much trouble in Babylonia.

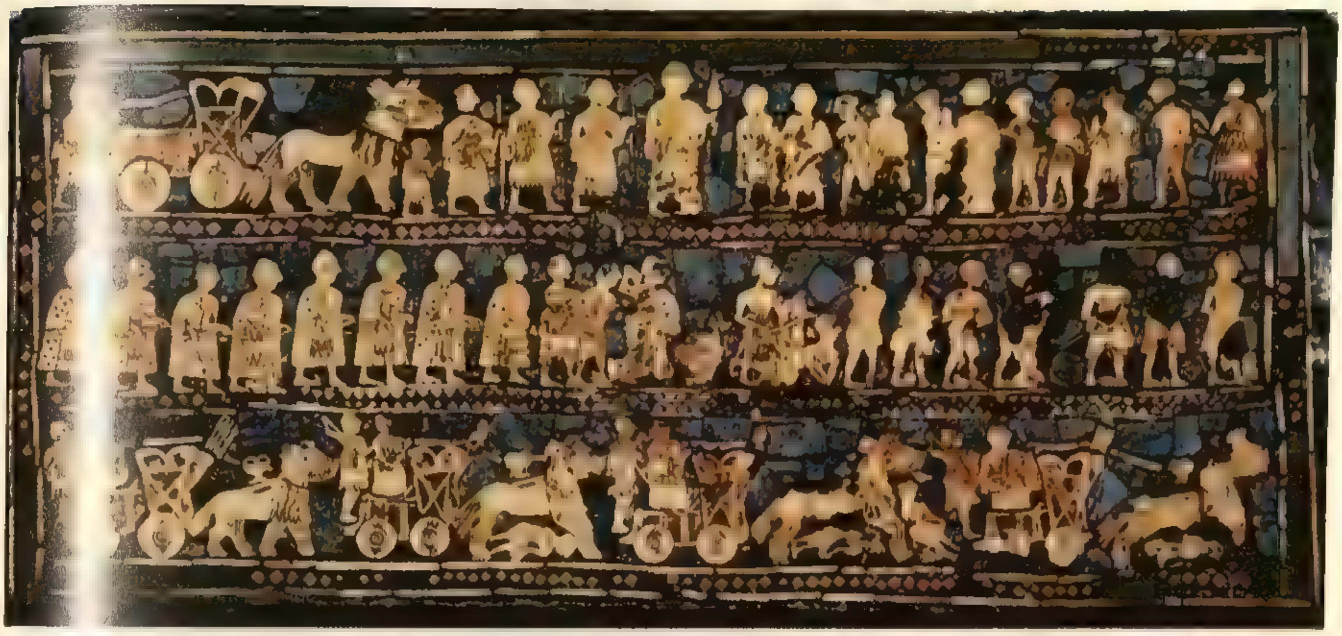
After a long war Elam was finally conquered and its capital, Susa, destroyed in 639. Ashurbanipal also fought against the Arabs who had helped Shamash-shum-ukin. Of the last years of his reign little is known; we hear only that Cyrus I of Persia, the grandfather of Cyrus the Great, once sought an alliance with Ashurbanipal, probably against the Medes.

Ashurbanipal's palace in Nineveh was decorated with elaborate reliefs that show the highest degree of artistic achievement. Especially the pictures of lions and other animals in the numerous hunting scenes are masterpieces. The victories over the camel-riding Arabs and over Elam are the subjects of other relief series, and even the hunting and garden scenes contain allusions to the king's victory over Elam.

The creation of Ashurbanipal that became most important for posterity was his library. All works of Babylonian literature were collected there in very careful copies made of originals that the king's emissaries found in Babylonian schools. That this library was discovered in one of the mounds of Nineveh as early as the 1840s was most fortunate. (*See* also ASHURBANIPAL.)

2. End of Assyria.—Ashurbanipal was succeeded by his sons Ashur-etil-ilani (*c.* 630–627) and Sin-shar-ishkun (627–612), about whom little is known. In Babylonia Kandalanu, who had been installed there by Ashurbanipal, continued on the throne until 627. After his death there was anarchy in Babylonia; Sin-shar-ishkun tried to gain control and had temporary success in part of the country, as evidenced by contracts dated according to his reign in Nippur. He was opposed by a Chaldean, Nabu-apal-usur (Nabopolassar), who was able to establish himself as king in 626 and to conquer Babylon a little later. The following years were filled with wars between Assyria and the Chaldean king, during which border regions were taken and retaken. A new enemy of Assyria was the Medes under King Cyaxares (Umakishtar in Akkadian), who came to the throne about 624. Around 620 Sin-shar-ishkun had a success against Cyaxares, but soon the war entered its final stage.

With the year 616 there begins a part of the Babylonian Chronicle that deals with the events leading to the fall of Nineveh. In that year Nabopolassar marched up the Euphrates and Khabur

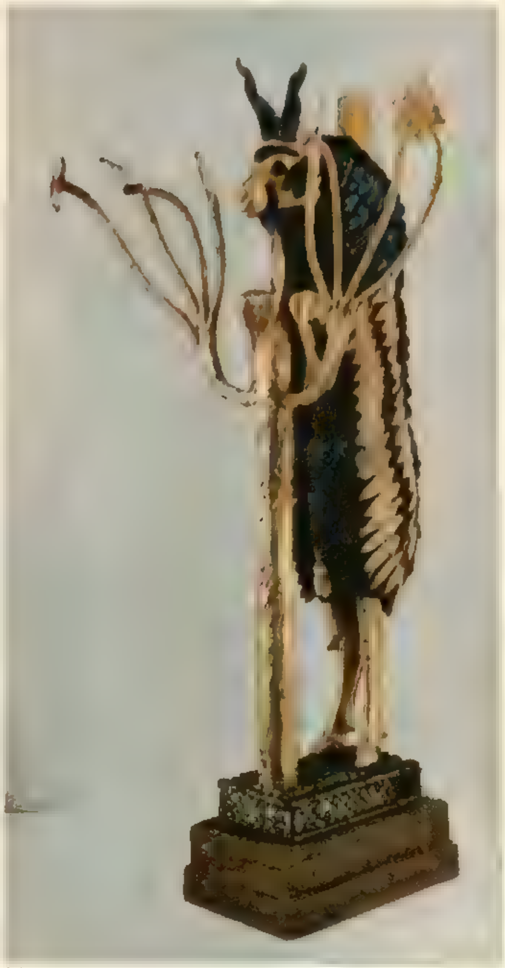


Inlaid standard showing battle and victory scene, a mosaic made of lapis lazuli, shell, coloured stones and mother-of-pearl. The reverse side depicts gift-bearers and banqueting scenes. From Ur, Early Dynastic III period

MOSAIC WORK, PAINTING, RELIEF AND METALWORK OF ANCIENT BABYLONIA AND ASSYRIA

Adoration scene from painted plaster panel found at Khorsabad (Dur-Sharrukin), representing Sargon II and (perhaps) a minister before the god Ashur. New Assyrian period

Figure of a rampant goat, made of gold and silver, lapis lazuli, red sandstone and shell, from a royal tomb at Ur. One of a pair. Height: 18½ in. Early Dynastic III period



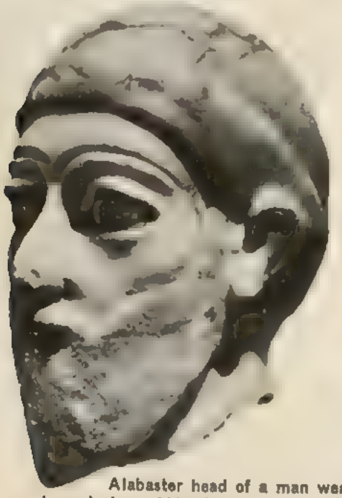
Lion relief in glazed brick, panel from wall-lined street leading from Ishtar gate to temple of Marduk, Babylon; built in reign of Nebuchadrezzar II, 605–562 B.C., Neo-Babylonian period

BABYLONIA AND ASSYRIA

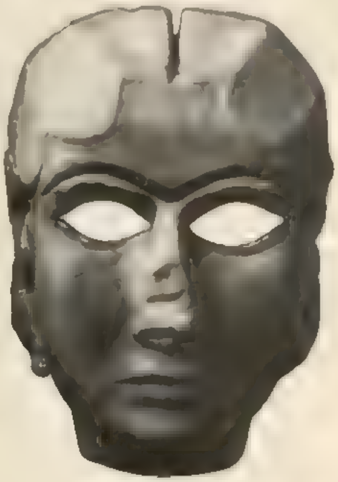
Seated female figure, terra cotta; Tell Halaf period. From Tepe Gawra

Stone statuette; Protoliterate period. From the temple of the moon-god, Sin, IV Khafajah

Inscribed statue of Puzur-Ishtar, governor of Mari, found at Babylon. Ur III period, c. 2000 B.C.



Alabaster head of a man wearing a turban; Akkadian period; c. 24th century B.C. From Adab (modern Bismayah)



One of the earliest examples of true sculpture in the round, an incomplete head from Warka (Uruk). Protoliterate period

Alabaster statue of a priest; Early Dynastic II period. From the temple of Abu at Eshnunna (Tell Asmar)

Statue of Gudea in the traditional pose of reverence; 22nd century B.C. From Lagash (modern Telloh)

Votive statue of turbaned Gudea made of diorite; 22nd century B.C. From Lagash (modern Telloh)

BABYLONIAN AND ASSYRIAN SCULPTURE IN THE ROUND

Copper goat's head from Shuruppak (modern Tell Fa'rah); Early Dynastic period

Copper statuette of nude male carrying a box on his head; Early Dynastic period

Statuette of Ur-Nammu, 3rd dynasty of Ur, shown carrying a basket. From Nippur, c. 2100 B.C.

Two-wheeled copper chariot from the Shara temple, Tell Agrab; Early Dynastic II period

Front view of bronze head, considered by some authorities to be Sargon I of Agade; from Nineveh; Akkadian period, second half of 3rd millennium B.C.

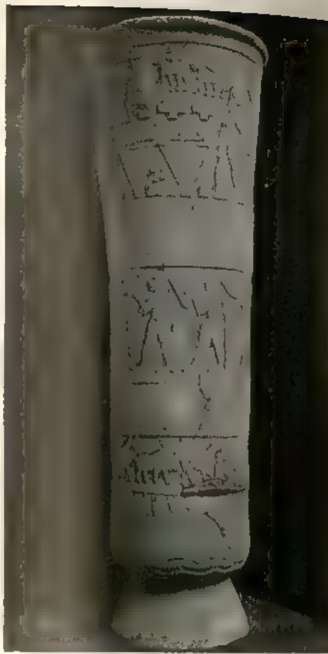
Silver vase of En-temena, king of Lagash, engraved with representation of Imdugud attacking lions; Early Dynastic III period. From Telloh

Double copper vase supported by a pair of wrestlers, from the Nintu temple, Khafajah; Early Dynastic II period

BABYLONIAN AND ASSYRIAN METALWORK

BABYLONIA AND ASSYRIA

Representation of lion-headed bird Imdugud and two stags, a copper relief from El 'Ubaid which combines bas-relief with sculpture in the round; Early Dynastic III period



Votive alabaster vase from Warka with ritual scenes; Protoliterate period

Fragment of square plaque from Khafajah, to which a fragment of a similar plaque from Ur has been added (lower left corner); Early Dynastic II period

Spouted vase with stone inlays; Protoliterate period

Sculptured steatite cup in a low cylindrical shape with a flat bottom; Early Dynastic II period. From Khafajah

Vase from Warka with spout flanked by two lions sculptured in the round; Protoliterate period

Basalt stele depicting a lion hunt, with figures in dress characteristic of the Protoliterate period. From Warka

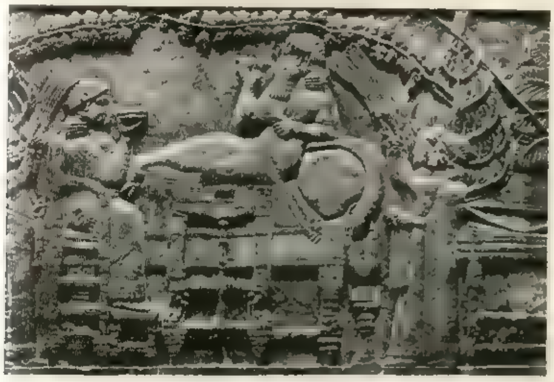
Two fragments from obverse side of "Stele of the Vultures" of E-anna-tum, ruler of Lagash; Early Dynastic III period

BABYLONIAN AND ASSYRIAN RELIEF SCULPTURE

Victory stele of King Naramsin, commemorating his triumph over the Lullubi; Akkadian period. 23rd century B.C. From Susa

Bas-relief on top of the stele inscribed with Hammurabi's code, showing the king before sun god Shamash; Old Babylonian period. 18th century B.C. From Susa

Monumental stone relief of a winged human-headed bull (*lamassu*) from the palace of Sargon II, king of Assyria, (722–705 B.C.). From Khorsabad



Assyrian relief from the palace of Ashurbanipal, king of Assyria (669–630 B.C.), showing the king and queen dining in the garden. From Nineveh

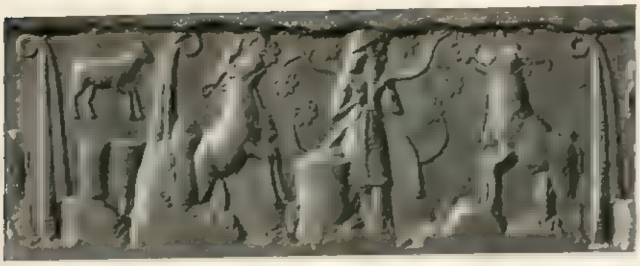
Altar of Tukulti-Ninurta I (1245–1208 B.C.) showing the king approaching and kneeling before altar bearing emblem of the fire god Nasku. From Ashur

Assyrian relief from the palace of Ashurnasirpal II, king of Assyria (884–859 B.C.), showing the king hunting lions. From Nimrud

BABYLONIAN AND ASSYRIAN RELIEF SCULPTURE

BY COURTESY OF (TOP RIGHT) THE ORIENTAL INSTITUTE, (BOTTOM) THE TRUSTEES OF THE BRITISH MUSEUM; PHOTOGRAPHS, (TOP LEFT AND CENTRE) ARCHIVES PHOTOGRAPHIQUES, (CENTRE RIGHT) BILDARCHIV FOTO MARBURG, (CENTRE LEFT) MANSELL COLLECTION

BABYLONIA AND ASSYRIA



Feeding the sacred herd, impression from a seal from Warka: Protoliterate period

Horned animals engraved in the "brocade style" from a seal found at Tell Asmar; Early Dynastic I period

Contest scene of human and superhuman beings in conflict with animals and monsters; Early Dynastic II period

Struggle between human-headed animal[illegible] beasts, including lions, from seal of the Early Dynastic III period

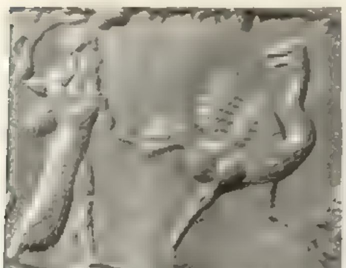
Combat scene showing bearded hero and bull-man struggling with beasts; Akkadian period

Presentation scene showing two go[illegible] horned hats leading a worshiper to meet a seated god; Ur III per[illegible]

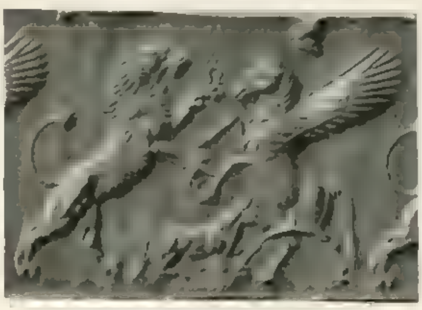
Presentation scene with worshiper bringing an offering; Old Babylonian

Seal impression from the Kassite period with seated deity and inscribed prayer

Cylinder seal impression of the Mitannian style



Hunting scene with winged hero pursuing an ostrich; Middle Assyrian period



Middle Assyrian cylinder seal impression showing a lion and winged horse in combat

Cylinder seal impression of the New Assyrian period with a winged genius gripping two winged bulls

BABYLONIAN AND ASSYRIAN CYLINDER SEAL IMPRESSIONS

valleys, defeated the Assyrians near Harran and received tribute from the north Mesopotamian tribes. In this situation Sin-shar-ishkun concluded an alliance with Psamtik of Egypt. In 615 Nabopolassar besieged Ashur but had to retreat upon the approach of an Assyrian army; in the autumn of the same year the Medes marched against Arrapkha (Kirkuk). In 614 the Medes advanced from there via Kalakh to Nineveh, but for unknown reasons they did not begin a siege of the capital but rather took the town of Tarbisu, northwest of it; from there they turned south against Ashur, which they besieged and conquered. Nabopolassar came to their help but arrived at Ashur only after the city was taken; he then concluded a formal treaty of alliance with Cyaxares, after which both kings returned home.

During 613 Nabopolassar operated on the middle Euphrates, where he met the resistance of an Assyrian army. In the following year, 612, both the Chaldeans and Medes besieged Nineveh, which they took in the month of Ab (August) of that year. The city was looted and completely destroyed, never to be rebuilt again. The chronicle has a broken sentence about Sin-shar-ishkun in this connection; if one is to believe the later tradition about "Sardanapalus" one may restore it to mean that the king died in the flames of his palace. Following the conquest of Nineveh, Cyaxares went home, while Nabopolassar continued his military operations in the direction of Nisibin (Nusaybin), west of Nineveh. Still farther west, an Assyrian named Ashur-uballit II set up a last Assyrian kingdom in Harran. Against him Nabopolassar operated during the next years. In 611 he reached Til Barsib on the Euphrates but did not attack Harran itself yet. But in 610 Nabopolassar was able to take Harran, although an Egyptian army had now appeared on the scene. Ashur-uballit abandoned Harran. In 609 he and Necho II of Egypt tried to recapture it but had to give up that plan upon the approach of Nabopolassar. While Ashur-uballit is no longer heard of after this unsuccessful attempt, Nabopolassar continued his campaign northward into Urartu, where he returned also in 608. Thus, after the fall of Nineveh in 612, the fall of Harran in 610 and Ashur-uballit's attempt at reconquering the latter in 609, Assyria ceased to exist.

3. Neo-Babylonian Kingdom.—The Chaldean dynasty that came to rule over Babylonia with Nabopolassar (626–605) remained in power for a little less than one century and brought about a last period of flourishing. The Assyrian empire was divided between the Medes and the Chaldeans: northern Assyria and Anatolia were taken by the Medes, whereas the south became Babylonian. In Syria the Egyptian army that had helped Ashur-uballit remained, and Nabopolassar turned against it. Fighting went on during 607 and 606, mainly in the region near the bend of the Euphrates; in these campaigns Nabopolassar's son, the crown prince Nabu-kudurri-usur, took part with his father. With the year 605 a new tablet of the chronicle begins. In that year Nabopolassar stayed at home and sent his son against the Egyptians. They were defeated by the crown prince in the battle of Carchemish (*q.v.*). The remnants of the Egyptian army were pursued and annihilated near Hamath on the Orontes, and subsequently Nabu-kudurri-usur conquered "all of Hatti"; *i.e.*, Syria. On the 8th of Ab Nabopolassar died, and his son hurried home to succeed him on the 1st of Elul.

Nabu-kudurri-usur II (605–562; the biblical Nebuchadnezzar or, according to a better reading, Nebuchadrezzar) ruled for 44 years and marks the peak of the Chaldean or Neo-Babylonian kingdom. During the first years of his reign he continued the pacification of Syria, where the chronicle reports his activities for all the years from 604 to 595 (the end of the extant text). For 601 it lists an indecisive battle against an Egyptian army in Palestine. The siege and first conquest of Jerusalem in 597 is also mentioned in this chronicle; the story is known from the Bible. King Jehoiachin was taken to Babylon as prisoner; accounts listing the rations he received there during his captivity were found in Nebuchadrezzar's palace. In Jerusalem, Nebuchadrezzar installed a new king, Zedekiah, who paid him tribute. About Nebuchadrezzar's later years we are not so well informed. For 595 the chronicle mentions the suppression of a revolt in Babylonia. The second and final conquest of Jerusalem in 587, following a revolt of Zedekiah, who had the help of Apries (Hophra) of Egypt, is known from the Bible, while the letters found at Lachish illustrate one episode of this last struggle of Judah. The Babylonian captivity (*q.v.*) was the result of this historic event. (*See* also NEBUCHADREZZAR.)

In Babylonia the reign of Nebuchadrezzar was a period of prosperity and restoration. Almost all the palaces and temples excavated in Babylon date from his reign. The rebuilding of the famous ziggurat of Babylon, which became known as the tower of Babel, was begun by Nabopolassar and completed by Nebuchadrezzar. Found in excavation was the processional street that led from the Ishtar gate to the main temple of Marduk, Esangila; both the gate and the walls of the street were decorated with reliefs of lions, bulls and dragons in colourful glazed bricks. (*See* also BABYLON.) Similar glazed bricks also adorned the front of the throne room facing the courtyard in one of Nebuchadrezzar's palaces. In one palace, a very strong vaulted substructure was found which is believed to have carried what the Greeks later called the hanging garden of Semiramis.

Literature flourished and texts were copied in the schools. Marduk, in this period mostly called Bel, "the lord," superseded most other gods, so that in this period Babylonian religion moved toward some kind of henotheism. Simultaneously the different gods or manifestations of Bel were equated with astral bodies, and astrology was further developed. This Neo-Babylonian civilization is the one that became known to the Greeks and Jews. Writing, even of private documents, went on in Akkadian, although Aramaean was the language spoken by the majority of the people.

The successors of Nebuchadrezzar were short lived and insignificant. Of Amel-Marduk (Evil-Merodach; 562–560) hardly more is known than the fact, attested by the Bible, that he pardoned Jehoiachin. His brother-in-law and successor Nergal-shar-usur (559–556; Neriglissar according to Berossus) tells of building activities in his own inscriptions; a chronicle text mentions a campaign of his in Cilicia. The lawful heir, Labashi-Marduk, a minor, was assassinated in 556, and in his stead a usurper, Nabu-na'id, seized the throne.

Nabonidus (Nabu-na'id; 556–539), the last Babylonian king, is one of the most enigmatic figures. His mother was from Harran, and he himself had strong ties with that city and particularly with its moon-god. A derogatory poem, written after his end, blames him for having made the moon-god, Sin of Harran, the supreme god of Babylon instead of Bel-Marduk, and the chronicle also states that under him the New Year festival, the great festival of Marduk, was not celebrated for several years. For 12 years Nabonidus stayed in Arabia, where he conquered the oasis of Tema (Taimah) and then used it as a base for further conquests in the Arabian peninsula. During his absence, he installed his son Bel-shar-ushur as viceroy in Babylon; the Bible (Dan. v) knows him as "King" Belshazzar (*q.v.*). (*See* NABONIDUS.)

The most dangerous enemies of the Neo-Babylonian kingdom were the Persians. A Persian ruler, Cyrus II the Great, had shaken off the overlordship of the Medes by defeating their king, Astyages, in Nabonidus' first year (555). Harran, which the Medes had held since 610, was taken by Nabonidus as a consequence of their defeat, and he immediately began the rebuilding of its moon temple. But Cyrus went on to enlarge his realm. After having taken Ecbatana (Hamadan), the old capital of the Medes (550), Assyria and all of Anatolia, where he defeated Croesus of Lydia and conquered Sardis (547), he brought the rest of Iran under his rule, thus replacing the kingdom of the Medes by his own Persian empire.

To take Babylonia and with it Syria was the logical next step. Nabonidus finally returned home to defend his country. Historians still puzzle whether his sojourn in Arabia was a sign of unawareness of the Persian danger, or whether he tried to secure the resources of the Arabs against this danger. At any rate it was too late. After a short war Babylon was taken without fighting in 539. There Cyrus acted as the restorer of the old order, and the above-mentioned poem duly praises him as the legitimate king who returned Marduk to his old rule. Syria automatically fell to Cyrus once Babylonia was his, and the two regions became one

satrapy of the Persian empire. This is the end of the history of Babylonia.

4. Persian and Seleucid Eras.—Under the Persian kings Babylonia remained a province of their empire and seems on the whole to have been prosperous. The Achaemenid kings used the Akkadian language for their royal inscriptions alongside Old Persian and Elamite (these trilingual inscriptions were the first to be deciphered in modern times; *see* CUNEIFORM). Legal and business documents continued to be written in Akkadian; they were dated after the regnal years of the Persian kings. Some Babylonian firms transacted business with the "great kings"; in the administrative documents Persian terms appear as loan words. Revolts occurred at the accession of Darius and later and were suppressed. When Alexander the Great conquered Babylon in 330 B.C. he found the ziggurat or temple tower, which Herodotus had seen still standing about 100 years earlier, completely destroyed. This destruction has been explained as due to Zoroastrian fanaticism under the later Achaemenids. Alexander ordered the site to be cleared, but the work of reconstruction was never completed. A theatre and other Hellenistic buildings were found in Babylon by the excavators. Gradually, however, the founding of new cities for the Macedonian soldiers, and especially the foundation of Seleucia on the Tigris, led to the desertion of Babylon while other cities continued to exist. Especially the scribal school at Erech remained active all through the Seleucid period, collecting ritual texts and developing astrology. From the Seleucid period comes the compilation in Greek of a work on Babylonian history, ascribed to a certain Berossus, parts of which are preserved through quotations in the books of later Greek writers. (H. G. GK.)

IV. CIVILIZATION

A. ECOLOGY, ETHNOLOGY AND TECHNOLOGY

1. Ecology.—The lower valleys of the Zagros region, the piedmont and the banks of the rivers of Mesopotamia proper lend themselves readily to agriculture and offer ample pasture. The main cereal crop of the region was barley, dependent on rainfall in the northwestern part of the country and on irrigation in the southeast, while wheat was grown to a smaller extent, and millet still less. Equally important with barley were sesame, with its oily seeds; several leguminous plants; and fibre-yielding flax. A considerable variety of domesticated savorys (garlic, onion, leek, etc.) and other spice plants were known. In gardens, dates, which provided an essential part of the diet, were cultivated according to techniques learned very early, while such fruits as figs, apples, pears and pomegranates were of less importance. Wine likewise was produced, though beer made of barley was a much more popular alcoholic beverage. Herds of goats and several breeds of sheep provided a supply of meat and milk (used for butter and cheese); the hides, hair and especially wool were of great economic importance. Cattle, needing seasonal transhumance, were kept mainly by the palace and the temple. River, lake and sea fish were used widely as food only up to the middle of the 2nd millennium B.C. and that with constantly decreasing frequency; after that time, fish seems hardly to have formed a part of Mesopotamian diet. Fowlers caught and tended ducks, geese and a number of other birds difficult to identify. The chief object of hunting was to decrease the number of wild animals preying on the flocks rather than to obtain food.

The region lacked timber suitable for building, and stone was available only in the northwest, apart from an outcrop in the far south. The commonest building materials were clay (used in pisée technique, but mainly in brick form) and, in the southwest, reeds, which grew to a great height in the extensive canebrakes. Metals could be obtained only through trade or war.

Under such conditions, communities of barley farmers sprang up in villages situated at first in the fertile valleys, and later spreading into the alluvial land, where at first small-scale agricultural engineering (dikes, drainage and distribution canals) was practised and then, gradually, constructions developed to serve larger sections. Farmers got their water from the crest of the annually flooding rivers; mechanical lifting devices were relied on only for gardens. The settlements seem to have been small, unfortified villages, which, in Babylonia proper, tended to cluster along navigable waterways. During the entire history of the irrigated region, flood catastrophes and gradual salination of the over-used soil forced constant shifting of settlements. When the phenomenon of urbanization took place in the southwest, these same factors contributed toward repeated dislocation of political power from city to city. In contrast to the agglomerations of cities along the several courses of the Euphrates and possibly along the large canals fed by that river, urban settlements were rare in the northwest, where only the stimulus of political, administrative or military needs could cause them to start and to flourish.

The northwest was the habitat of small farmers living in villages, of nomadic shepherds who moved slowly but continuously with their flocks, a region that had to be forced by a central authority into accepting urbanization and what it exacted in taxes and services. There any weakening of the executive power of the central authority led immediately to a collapse of communications and of the services needed to support the political integration of the region and thus to the return to the type of fragmentation that constituted the natural political organization of northwest Mesopotamia and a number of adjacent regions to the west.

Characteristic features of Mesopotamian cities were the large and often doubled crenelated brick walls sweeping around the settlement in straight or curving lines, studded with cavalier towers and interrupted by monumental gates. In the south the temples were placed by themselves within an *enceinte* inside the city walls, while in the north a citadellike interior fortification guarded palace, temple, treasury and the barracks of the soldiery as an "inner city" that, quite often, was located astride the main wall. The multiple-staged temple tower (ziggurat), often decorated with coloured glazed bricks, was a characteristic of the silhouette of the Mesopotamian city. Outside the walls was a fringe of gardens, fields and scattered houses that, as a rule, grew into suburbs (for which the Sumerian and the Akkadian languages have special designations). The harbour was likewise beyond the walls; its function was to link the originally quite autarchic city to the economic life of the outside world, and it enjoyed for this very purpose a special legal and administrative status.

2. Ethnic Composition.—A series of invasions and intrusions, either from the semidesert regions to the west or from across the mountain barriers to the north and the northeast, characterize the entire history of Mesopotamia. They are reflected in the culture sequences of the preliterate period as well as in the historic records of the subsequent three and more millenniums. At an undatable point in the late preliterate period there seems to have occurred a fusion of several distinct ethnic and cultural assemblages that produced a *sui generis* Mesopotamian civilization. To this civilization Sumerians and early Semites contributed essentially, and a complex substratum must be assumed, but the extent of the contributions of this to the general culture is a moot question. This composite Mesopotamian civilization is known, first, up to the beginning of the 2nd millennium, through Sumerian texts, and then, after a transition period, through texts written in the dialects of the Semitic Akkadian language. As to material remains—such as works of art, pottery, tools and traces of buildings—the evidence dating up to the end of the 3rd millennium is richer, more varied and more impressive than that of the subsequent periods with the exception of certain remnants of the Neo-Babylonian age. This seems to be due to the frequent shifting of the seat of political power, which often spared the artifacts and buildings of the earlier settlements of the south the wear, tear and loss concomitant with continuous habitation; in contrast, in the north, where this power remained stationary often for very long periods, settlements are less well preserved.

The Mesopotamian civilization that arose in the densely urbanized stretches along the lower Euphrates, to conquer and to influence vast regions of the near east, remained itself characteristically open to foreign impulses and seems to have been able repeatedly to learn and to derive increased vigour from contacts with conquerors. Understanding of the culture development in the northwest, in Assyria, is still far from clear, but it

seems that a more or less coherent body of foreign mores (usually referred to as Hurrian; *see* HURRIANS) was instrumental in endowing certain essentially Assyrian culture traits (such as the status of the city of Ashur, the position of the Assyrian king, etc.) with enough strength to create there an important variant of Mesopotamian civilization. The decline in vigour of this civilization can be observed as early as the beginning of the 1st millennium B.C. This decline is evidenced chiefly by the introduction of a new system of writing, whose slow but irresistible spread severely restricted the expansion of the Akkadian literary tradition and divorced it gradually from contact with the spiritual life of the community. The ever-increasing linguistic barrier between the Aramaic-speaking population and the Sumero-Akkadian scribal tradition, rather than the loss of political independence through the Persian and eventually the Greek conquest, brought the long-lived Mesopotamian civilization to an end.

3. Technology.—Technologically, Mesopotamia in the 4th and 3rd millenniums was part of that chain of civilization foci that stretched from India to northern Africa between the zones of mountain forest and tropical forest, savannah and desert. It shared with them a stock of domesticated food plants and animals to which it seemed to have contributed of its own such essential cereals as barley and possibly wheat, as well as the wool-bearing sheep. Moreover, Mesopotamia repeatedly transmitted such plants and animals from the eastern to the western members of that chain. A common fund of techniques connected with these animals and plants was in evidence even in the formative stages of all these civilizations. These techniques pertain to farming and horticulture, to simple metallurgy and weaving, to rather advanced potterymaking and working of stone for ornaments and tools, to tanning and to the use of clay (in brick form) and wood for building.

In Mesopotamia proper may be observed an energetic development in some of these techniques—as architecture on a monumental scale and the sophisticated use of metals and stone for works of art—as well as an increase in the quantity of production of foodstuffs and raw materials under the pressure of urbanization. This early bloom was soon replaced, however, by technological stagnation and even impoverishment. The arrest in the development of Mesopotamian technology was to some degree counteracted by its readiness to accept foreign techniques and even sometimes to improve upon them. The glazed-brick wall decorations in relief, the few extant products of the late (New Assyrian and Neo-Babylonian) metallurgy (if not the work of imported craftsmen) and the architecture of the later periods (which surpasses earlier achievements not merely in size) are instances of such development. The arts of the seal cutters and jewelers, however, could not reach the levels of earlier achievement; and pottery, agriculture and animal husbandry show progressive stagnation. In such arts as metallurgy, shipbuilding and weaving the later periods openly acknowledged foreign supremacy.

Nevertheless, seen from the point of view of the world history of technology, the Assyrian conquests and the subsequent short flowering of the Chaldean empire contributed essentially toward an intensification of technological contacts within the ancient near east, including the adjacent regions to the north, the west and the east, and these contacts came to exercise long-lasting influences and stimulated diffusion of technical knowledge far beyond the frontiers of Mesopotamia. (*See* also above, *Archaeology, Architecture and Art.*)

B. Social Structure

Any reconstruction of the nature and temper of Mesopotamian social structure depends necessarily on the nature and content of the available evidence, particularly the written evidence. A complex and only vaguely known internal development and a wide range of important regional differences make it difficult to present this topic in other than general terms.

A primary characteristic of Mesopotamian social structure is the absence of any status stratification, if the unique status of the king and the always small slave population are excluded from consideration. No warrior class arose as a result of the conquests, nor did the special status of the priests create any tensions between them and the rest of society. The social structure was dominated (1) by the contrast between city dwellers and those who lived outside the walls, and (2) by the contrast between those elements of the population that were incorporated in the socio-economic organizations of temple and palace as against those who lived on small-scale agriculture, on the skill of their hands, etc., in cities, villages and encampments of all kinds. These two contrasts are the more important as the family played only a rather limited role in the social structure.

1. Family.—The family was small and restricted, though there are indications that it was more extended and complex in the Sumerian period and in certain marginal regions of Mesopotamia. In both instances are found traces of what may be termed tribal or clanlike organizations, which seem to recur again in the late period as an expression of foreign mores. The family could be enlarged by the adoption of small children or manumitted slaves who were to provide care for childless old persons, but these practices disappear or become extremely rare after the middle of the 2nd millennium B.C. Later periods show a measure of family consciousness by the use of ancestral as "family names" (for identification purposes), and also by a certain emphasis on gentility in general and on descent for certain professions. The head of the household had one wife; only in the Old Babylonian period are references made to a second wife, of lesser rank, though the social status of women was at that time higher than in the later period. The first-born son received a preference share in the paternal estate, and provisions were made to ensure the daughters' dowries and the younger brothers' marriage expenses. Normally, brothers held the inherited fields in common to avoid their division into small lots; they often lived with their families in the father's house. In the peripheral regions, as Elam and northern Assyria, some foreign influence on the family structure is clearly in evidence, just as certain vestiges of earlier customs maintain themselves (*e.g.*, the position of the mother's brother) in the early Babylonian tradition.

2. Slavery.—Outside the family stood slaves, persons with restricted freedom and isolated individuals. Documents dealing with the division of property show that there were never more than a few slaves in private possession. Those born in the house seem to have enjoyed a special status, as compared with those acquired from outside, at least in the Old Babylonian period. Later, slaves were allowed to work for their own living under the obligation of making monthly silver payments to their masters. The latter often had them articled out to learn profitable crafts in order to increase their earnings and, consequently, the master's share. Originally slaves were either debtors or their children, also foreigners who were imported for their special skills and services. Only rarely were they prisoners of war. The institutional slaves owned by the palace or temple had a somewhat different status but seem to have been recruited similarly, though many more prisoners of war must have been among them. They were utilized for all types of work and apparently could reach important positions.

Persons of restricted freedom (*i.e.*, neither free nor slaves) were attached exclusively to temples and palaces. They received food rations (according to age and sex) for work in fields and shops, but their exact social and legal status remains uncertain. They were numerous in the early periods, but little is known of their ethnic or social provenience. In the later periods (Erech of the Neo-Babylonian and Persian kings) they belonged mainly to the temple and seem to have enjoyed the same liberties as the privately owned slaves of that time.

Isolated individuals are rare, since slaves were normally manumitted into the family and foreigners had to have royal protection (as envoys or refugees) or to live in special quarters as merchants or craftsmen. Still, the name of a number of persons in the Old Babylonian period is Refugee; they may have been runaway debtors or displaced persons.

3. Associations.—Since family ties were ineffective throughout the region and clan relationships were not in evidence in cities and villages, other forms of associations assumed the function of

providing status and security for their members. These associations were professional, religious or political, using the last term loosely and generally.

Professional.—Guildlike associations of craftsmen and merchants under foremen disappeared after the Old Babylonian period, though a number of later family names may indicate some survival of such institutions. Certain craftsmen, such as tanners, fullers and smiths, however, continued to live together in special quarters of the city, to which they seem to have been restricted. In the Nippur of the late Persian period are found, perhaps as a survival, indications that suggest the existence of guildlike structures. Special circumstances contributed to the formation of associations among certain trained experts in exorcism and divination techniques. These professionals were sophisticatedly organized; candidates for membership had to be acquainted with a number of reference texts, pass what seem to have been competitive examinations and meet certain physical and status requirements. Scribes likewise seem to have undergone extensive formal training in order to preserve the traditions of their craft and apparently were organized in families (natural or artificial).

Religious.—Religious associations were rare, existing only in the Old Babylonian period. The concerns that normally give rise to such associations—for the souls of the dead and for the maintenance of specific cults—are conspicuously absent from Mesopotamian culture.

Political.—Political associations were of two types, understanding of which is essential for gauging the characteristic temper of the social structure. One type was centred in the city, the other in the palace and the temple. Thus, the former is ecologically conditioned, the latter economically, with slightly differing ideological superstructures.

Within the confines of the city walls the consciousness of belonging was shared by the community of persons of equal status, mainly farmers who lived off fields and gardens that extended in a green belt around the city. They ran their affairs through an assembly in which, under a presiding officer, some kind of consensus was reached on communal matters. Very little is known about the functioning of this type of government, but the absence of all those complex and elaborate practices that in the Greek *polis* served to control the ambitions of individuals to exercise power over their fellow citizens may be noted. The deeply agonistic mood of the Greek city is in strong contrast to the situation in the Mesopotamian city, which resembles, if anything, a tribal group in which the superiority of the richer, the older or otherwise influential members is willingly accepted.

The city harboured as the divine guarantee of its continuity and identity the house of the deity, in which was centred its religious life as a community. From the earliest period, some kind of coexistence seems to have been reached in the Mesopotamian city between, on the one hand, the self-governed community and, on the other, the temple with its personnel living in its own economic world, as well as the palace of the king, whose sway extended beyond the city walls. Throughout its entire history, the Mesopotamian city had to come to terms with these two essential institutions: temple and palace. A flourishing temple and a palace full of the spoils of war or tribute cannot have failed to affect the city economically and politically. Such conditions must have produced widely differing relationships in individual cities and in specific periods. Often the economic basis of the city was affected by the impoverishment of the arable soil, while, on other occasions, the citizens succeeded in shifting their capital investments from agricultural holdings to manufacture and export trade, which could create accumulations of capital that influenced the city's relation to the royal power. At a time when the economic importance of the temple gradually declined and the palace's influence correspondingly rose, royal officials, with functions that cannot be determined, were put into the city. Beginning with the end of the 2nd millennium, more and more is heard about the struggle of the old cities Nippur, Sippar and Babylon in Babylonia and Ashur and Harran in Assyria for the preservation of specific exemptions and privileges upon which the royal authority tended to infringe. These were mainly exemptions from military service and forced labour, freedom from taxation of all kinds, protection against military intervention within the city limits and security for overland caravans. It seems that the Assyrian kings had to grant to individual cities charters that specified these privileges, yet it is clear that political conditions rather than a well-established tradition determined their extent. The loss in revenues that occurred whenever these exemptions were respected seems to have been severely felt, and the constant endeavours of the Assyrian kings to build new cities in order to force displaced and unsettled segments of the population into urban living and hence into payment of taxes and rendering of services clearly were meant to remedy this situation.

Entirely different in structure and temper from the community of citizens were the two organizations that coexisted within the city: temple and palace. Both shared the characteristics of closed economic systems, in which goods and services are channeled into and circulated through a strict hierarchic structure. Income from agricultural holdings, taxation, trade or war was directed to a central administration that in a well-regulated pattern disposed of it to support, by means of rations and special shares, the administrators and workmen that served and directed the system. These systems differed little as between palace and temple. Both were basically households, the palace that of the king and the temple that of the deity, the latter conceived of as residing in its cella, to be fed, clothed and cared for as was the king on his dais. The status of the members of these households differed essentially from that of the city community; they were either slaves of the god or the king, or persons of restricted freedom, or attached in some other way to the lord of the manor. Their number varied according to the importance of the household and was easily increased by prisoners and by free persons who attached themselves to the household, either because of famine or because their talents (as those of certain craftsmen and artists) could best serve them within the organization of temple and palace.

Notwithstanding the many common features, important differences separated the temple, on the one hand, and the palace, on the other, and there was, furthermore, a wide range of variation among the palaces and among the temples. The military and political power and ambition of the ruler determined the size and composition of the palace organization needed to administer the realm, to organize warfare and to build and to rebuild cities and temples. Important local differences, mainly those between Babylonia and Assyria, and differences due to outside influences and specific historical developments also made themselves felt. Such qualifications likewise apply to the sanctuaries, where the requirements of certain cult practices cannot have failed to influence the internal organization of the temple, and where the degree of royal largess, rather than the returns on agricultural investment and the pious generosity of worshipers, eventually came to determine the wealth and splendour of the god's household.

This latter development is part of the complex history of the relations between the palace and the temple during the three millenniums of Mesopotamian documentation. It is characterized by the continuous rise in importance of the palace, from the manor of the Sumerian *lugal* to the splendour of the extensive structures of the New Assyrian and Neo-Babylonian kings (in Nineveh and Babylon), and the corresponding decrease in economic strength and importance of the temple, down from the vast organizations of the Sumerian period with their armies of slaves and serfs. The riches and world-wide fame of the late temples must not make us forget that the influence of the sanctuaries was socially and economically on the decline from the time of Hammurabi.

The redistributive organizations of temple and palace, emphasizing personal achievement and talent in spite of the necessarily hierarchic organization, allowed the individual more mobility than the city did. Individuals could and did move into temple and palace from the static and quasi-tribal realm of the city, where status and wealth stabilized the social structure and where it apparently was impossible for a person not born a citizen to become one, except, perhaps, by adoption.

Theologically, the temple's function was to ensure adequate materialization of the divine presence within a human-shaped image that lived in its cella and was maintained by offerings and served by the staff of the sanctuary. This organization aimed at economic independence secured by agricultural holdings and manpower. The output of the temple's textile workshops was used to obtain by barter from the mountain regions the stone, metal and timber needed to adorn the house of the god. From victorious kings, the temple expected the dedication of prisoners of war, of a part of the booty, and votive offerings. In the course of time, the kings were made to see in the restoration and embellishment of existing sanctuaries and in the building of new and larger temples and temple towers a royal privilege and duty toward the gods. In the late periods, though, royal commissaries are found on the administrative boards of the most famous temples to ensure the payment of taxes due to the king.

The cultic relation of the king to the city's deity found expression in certain functions of the ruler within the annual cycle of festivals that served to display the essential importance of the deity for the entire community. With the rise of the royal power and the wider scope of its political ambitions, the king's cultic functions ceased to be carried out in actuality and were maintained only in the references to them in the solemn royal titularies. The situation in Assyria that may be seen in documents of the turn of the 2nd millennium and later was different, inasmuch as the Assyrian king was the high priest and representative of the national god Ashur; this endows the Assyrian kingship with theocratic connotations that are conspicuously absent in the Babylonia of the 2nd and 1st millenniums.

It should be stressed that the influence of religion on the individual, as well as on the mood and temper of the society as a functioning whole, was at all times small in Mesopotamia. Ritual and ideological requirements made few demands on the individual's physiological appetites or psychological preferences. They laid no claims on his body or on his time and caused no conflicts of loyalties. Death was accepted in a matter-of-fact way, and the individual's participation in the temple's cult was extremely restricted, mainly to participation as an onlooker in certain public ceremonies. Private piety is little in evidence.

The temple was run by a priestly college (well attested for the later periods) under a chief priest. The priests derived their income from the temple's animals and staples "offered" to the image in prescribed forms and quantities and thereafter distributed among them according to a fixed rate. These priestly incomes were inherited, given as dowries and generally negotiable. This practice contributed effectively to keeping the divine repasts and essential aspect of the cult in the sanctuary.

The position of the king in Mesopotamia was in war that of the leader of the army, while his responsibilities in peacetime were social rather than cultic, although the latter aspect is, as stated above, in evidence as a special development in Assyria. The king was the guarantor for proper legal procedures and the protection of the underprivileged; he discharged these duties by hearing appeals, by regulating the rates of interest and maintaining the standards of measures, and by regulating the prices of staples and the wages and fees for essential services. Traditionally, the king promulgated laws and price regulations, both meant to correct abuses and to adjust practices to the needs of those whom they affected, and showed new ways to judge responsibilities in conflicts of interests. Still, the Code of Hammurabi and a number of similar extant Sumerian and Akkadian codifications do not show any direct relationship to actual legal practices; they rather present themselves as a traditional literary expression of the king's social responsibility and his awareness of the gap that separated existing conditions from those that were considered desirable. As such, these codes represent an interesting formulation of social criticism, but they should not be considered normative directions in the nature of the postbiblical and the Roman law.

C. Economic Conditions

Economically, Mesopotamia suffered under the blight that besets cereal farmers everywhere: the burden of debt that ruins the farmer relying on barley as a main crop, the tax claims of the administration and the practice of farming out the actual work on the land. In addition, Mesopotamia had to contend with soil deterioration and the economic disequilibrium caused by the large domains of the temples and palaces. The kings of the dynasties up to the end of the Old Babylonian period combated the continuous crisis with repeated releases of all noncommercial debts, with redistribution of ameliorated land, with regulations concerning rates of interest, etc., all apparently without much success.

Accumulation of wealth in precious metals, cattle or real estate normally was restricted to the two institutions of palace and temple. Only exceptionally is evidence found that private initiative was successful in that respect. Such an instance is offered by the Old Assyrian merchants in their overland trade dealings (for which nearly all evidence comes from Asia Minor) at the beginning of the 2nd millennium, and, most likely, by the merchants of Ur, a little later, who seem to have imported copper from overseas. Then, in texts of the Old Babylonian period there are certain indications of accumulation of wealth in the hands of merchants (in Eshnunna, Larsa and Sippar) who also worked for the palace and under the protection of the latter. For a merchant to operate under the protection of the palace became the rule from the middle of the 2nd millennium onward all over the ancient near east. With the end of this millennium, evidence for overland trade becomes rare and indirect.

In the Old Babylonian period, silver was used as a standard rather than as a means of payment, staples being handled for that purpose, while in the later periods of Babylonia and Assyria, silver actually was weighed out, coins (only in small denominations) being used solely in the last century of the Assyrian empire.

Although in Mesopotamia nearly all power and wealth were always in the hands of those connected with temple and palace, there are hardly any allusions in literary, historical or other texts to discontent with or rebellion against this situation, which must be taken to indicate a satisfactory functioning of the socioeconomic structure. The well-known passages from the Bible and contemporary Egyptian sources expressing social criticism put the Mesopotamian acceptance of the *status quo* in relief. The sizable body of Sumerian and Akkadian texts that attest to far-reaching social changes and economic reorientation all seem to suggest that they were introduced by royal initiative.

D. Intellectual Achievements

An essential if not the main achievement of Mesopotamian civilization was the early development of an effective system of writing that was put to several uses. The administrations of temples and palaces left records of large transactions and dispositions and, to a lesser extent, communications. Religious, historical and literary texts appeared early and blossomed quickly into a variety impressive in form and content. After several centuries of intense flowering, a process of fossilization set in that affected a large section of Mesopotamian literary production. It seems to have been furthered by the scribal practice of preserving by constant copying and recopying an extensive body of texts containing the numerous essential handbooks and reference works of the diviners and other professionals, including the textbooks (dictionaries, grammars, etc.) necessary for the correct training of the scribes, and, eventually, such purely literary tablets as epics and wisdom texts. This practice contributed toward maintaining a tradition that securely welded content and style to the system of writing and even the writing material, protecting the tradition against the effects of time and changing realities. However, it created a fateful gap between the static body of traditional texts and those writings that were the products of individual creativity and of specific cultural situations. These were set down only in a few or even single copies and have to a great extent disappeared, robbing us of the possibility of directly observing intellectual development in Mesopotamia. This situation and the effects of the changes in language (Aramaic for Akkadian), the system of writing and, especially, the writing technique (ink on leather and parchment) caused a progressive shrinkage of the literary tradition. (*See* below, *Literature.*)

If the achievements of Mesopotamia are judged in their effect on neighbouring and later civilizations, astrology and mathematical astronomy would have to be mentioned in the first place. Both spread toward the west as well as toward the east. Astronomy represents a very late development in Mesopotamian intellectual history that came to fruition in spite of a vigorous and persistent interest in astrology. Mention also should be made of the diffusion of administrative techniques and court ceremonial from Mesopotamia via the Sassanid court to Byzantium (and eventually to medieval Europe), and the far-reaching influences exercised directly, or by stimulus or osmosis of technological practices, iconographic motifs, the characteristic metrology, etc. (A. L. O.)

V. RELIGION

A. Growth and Development of Religious Thought

1. Wills to Natural Phenomena.—The basic characteristic of ancient Mesopotamian religion was a tendency to a pluralistic view of the numinous (*i.e.*, the mysterious element in the holy and the feelings of awe or fear it elicits): many different numina (or divine powers) were seen in many different phenomena, each such numen being the life force and will of its particular phenomenon, namable from the phenomenon and wearing the external form of the phenomenon. As an example of the last, representations from the Protoliterate period show that the numinous power in the rain cloud, Imdugud, was given form as an enormous lion-headed black bird, floating on outstretched wings and roaring its thunder cry.

With the numina that constituted the will of phenomena vital to human survival, especially those phenomena that were essential to the economy—as flocks and herds, grain, the earth, etc.—man felt a sense of solidarity that found its expression in endeavours to ensure the "presence" of the numen by such means as cult images, temples, service and the ritual drama. The earliest Mesopotamian religion appears to have been one of solidarity with nature and its powers, upon which man depended.

This early tendency to give situationally determined, nonhuman form to the numinous, however, probably at no time excluded attribution also of human form. Thus the Erech vase, which dates to Protoliterate time, shows the sacred marriage between two deities in human form, and so do numerous representations on seals from this period. The fact that human agents could embody the gods and take on their identity in the ritual drama also indicates that the human form as such must have been considered possible and appropriate for divinity.

Nonetheless, attribution of human form to the divine did not come to dominate religious thought until Early Dynastic times. From the latter half of that period onward it is the form under which gods and goddesses ordinarily are represented. The older nonhuman forms, with their close ties to natural phenomena, tended to recede into the background as divine emblems (*shu-nir*) associated with the anthropomorphic god—the sun disk next to the human figure of the sun-god Utu, the lion-headed bird accompanying Ningirsu/Ninurta, the ibex accompanying Enki and the dog associated with Nininsina. At times animosity against the now unpopular older form even seems to have made of it an enemy vanquished by the human-shaped god; in later mythology, for example, the lion-headed bird develops into the chief opponent of the god Ningirsu/Ninurta whose older form it is. Parallel to this process of divorcement of the older nonhuman form from the human form of the god there seems to go a similar general tendency to divorce phenomenon from god and to see it as a distinct, not divine entity. The god comes to own or control the phenomenon, becomes a power behind it rather than in it and of it.

2. Anthropomorphic Ruler Gods.—The victory of the human form was not easy or rapid and for long periods not complete. Enanna-tum I at the end of the Early Dynastic period still was depicted in attitude of worship before Ningirsu's old form of lion-headed bird. As late as Old Babylonian times the goddess Nininsina was still imagined with the head of a dog, and over and over again nonhuman features vie with human ones in monumental representations: rays flare from the body of the sun-god, serpent heads peep out from the shoulders of Ningishzida next to his human head, grain sprouts from the body of the grain-goddess.

The approach to understanding of the numinous that led during the Early Dynastic period to attribution of external human form to divinity paralleled a similar new understanding of activity and function of the numinous in a human pattern, that of the "ruler." The growth and the progressive differentiation of society during Protoliterate times, and the accompanying development of governmental forms, had created a type of human ruler vastly more powerful than the early chiefs and village headmen, and hence the object of feelings of distance, reverence, dependence and awe. This evolving concept of the ruler made possible a new metaphor for understanding and expressing central elements in the numinous, its awesomeness and majesty. The term *en*, "lord," with implications of "manager who causes to thrive," is attested from the early part of the Protoliterate; its application to a god is first known from the late Protoliterate in the divine name En-lil, "Lord Wind." It soon came to be an integral part of many such names (Enlil, Enki, Enamash, Engara, Enduku, etc.). The term *lugal*, "king," especially leader in war, first occurs in the middle of the Early Dynastic period. It too was used as title for deities and forms part of divine names such as Lugalbanda, Lugalgirra, Lugalkisaa, Lugalmarada, etc.

The gods became a divine landed aristocracy with great manors (the temples), managed by a vast retinue of divine and human servants; as rulers of cities they became responsible for the social and political as well as the economic welfare of the community. At the end of the Early Dynastic period, at the word of Enlil, Ningirsu of Girsu agreed with Shara of Umma on their mutual boundary line, and later on, when Umma violated the line, Ningirsu declared war. The politically active gods were organized in a "primitive democracy" in which the highest authority was a general assembly meeting at Nippur under the presidium of An and Enlil to elect "lords" and "kings" from among the member gods, and to decide on the rise and downfall of dynasties and cities. The gods who were powers in nature had become powers in history: the numinous power in the phenomenon of birth, the "Lady Birth-giver," Nintu, became an officeholder endowed with the office (*garza*) of furthering birthgiving, an office conferred upon her by Enki; Dumuzi, the mysterious power in the ewe of begetting and of giving milk, became a divine shepherd whose office was to manage and look after cattle pens and sheepfolds, and so forth.

The full realization of distance between human and divine that flowed from the ruler metaphor, as well as the living sense of a mighty power of nature still inherent in the god, is shown in Gudea's prayer to Ningirsu:

> O my master Ningirsu, lord who sends the awesome waters,
> Potent lord, engendered by the Great Mountain,
> Warrior whom none can challenge,
> Ningirsu, I am to build you your house, but have no sign!
> Warrior, you have called for what is fitting
> But, son of Enlil lord Ningirsu,
> I cannot know what that means!
> Your heart, which lifts like the swell in midocean,
> Comes crashing down like great ebony trees,
> Which roars like the waters of a breech in a dike,
> Destroys cities like a flood,
> Which rushes at the enemy country like a storm,
> O my master, your heart, the onrushing waters of a breech in a dike,
> not to be restrained,
> Warrior, your heart, remote like the Heavens,
> How can I know it?

It affected deeply man's place in the scheme of things. Ruled by the gods, working on their estates as servant or field hand, he became the serf of the god, who might be harshly treated but could not be abandoned. As lord of the manor (the temple) the god was tied to his lands and people; hence the greatest crisis life could know was destruction of the temple, the threat of breaking forever the bond between god and man. Around this direst of all calamities centre the most important, most fervent and perhaps most profound expressions of Sumerian religious feeling, the public laments, designed to strengthen and repair the bonds that had become severed, to calm the god and induce him to undertake the task of reconstruction.

3. National Gods.—The last phase of ancient Mesopotamian

religion may be counted as beginning late in the Old Babylonian period and lasting to the end of Babylonian and Assyrian civilization. It is marked by the rise of two national gods, Marduk and Ashur, to positions of supreme power in the world of the gods, and reflects the eventual crystallization of Mesopotamia into the two rival national states, each under an absolute monarch. The old pantheon and religious framework generally remained relatively unchanged, but the emphasis had subtly shifted; power and decision were now centred in Marduk or in Ashur, the other gods acting as their agents or as intercessors with them. The strong feeling of unified central power found its expression in henotheistic tendencies; the various gods were seen as in essence one with aspects of a supreme god. We are told that Enlil is Marduk (as god) of lordship and counsel, Nabu is Marduk (as god) of accounting, Sin is Marduk (as god) illuminating the night, Shamash is Marduk (as god) of justice, Adad is Marduk (as god) of rain, etc. Similarly the other gods may be identified with parts of the body of Ninurta: his eyes are Enlil and Ninlil, the iris of his eyes Sin, his lips Anu and Antum, and so on. There is a recognizable drive to see the forces that govern the cosmos as basically one and unified.

The classical image of the god as ruler, responsible for defense against external enemies and for prosperity and order internally, sharpened in the late phase. The national character of Marduk and Ashur as supreme gods identified them closely with external national interests; through signs and omens they actively guided the policies of their countries, so that religion and politics became more inextricably linked than ever before. In the struggle of the Sargonids to subdue Babylon, cult and ritual were in the centre of the fray; Sennacherib even appears to have tried to transplant the New Year festival of Babylon bodily to Assyria, with Ashur as the chief figure rather than Marduk, and groups of fragmentary Assyrian texts testify to the use of astoundingly virulent religious political propaganda.

In internal affairs, divine concern with social order, questions of morality and ethics were prominent, dominating the image of the gods. The concept of the god as ruler—now given its special colour from the everyday experience of absolute monarchy—tended to produce a piety bordering at times on subservience and anxious avoidance of even the semblance of independent initiative: "Take not to heart matters of strength and power, seek Nabu and Marduk and let them kill your foes" is the advice Nabopolassar hands on to later rulers. In the private prayers that have survived the penitent crawls before the god in veritable orgies of self-abasement, pleading for mercy for sins he is not aware he has committed.

The utter dependence of man on the gods in all matters raises the question of the righteous sufferer. By Old Babylonian times it became general belief that all men had personal gods who watched over them and that—in contrast to what had been thought earlier—the personal god was easily capable of withstanding all demons and evil forces. Sickness or other ills meant therefore that the protective deity had turned away from his ward in anger or disgust, leaving him a prey to evil, and that the ward must have committed a ritual or moral sin to alienate his god. With time the emphasis shifted more and more to the latter type of sin, and elaborate rituals with penitential psalms were used to regain the good graces of the angered god or goddess. Out of this literature grew attempts to deal with the paradox of the righteous sinner, the pious and upright man who was yet allowed to suffer. The solution found was a humble realization of the limitation of human insight and human judgment; man lacks the larger perspective of the eternal gods.

B. Sumerian Pantheon

The Sumerian pantheon was exceedingly numerous—it seems to have contained some 3,000 to 4,000 deities—hence only a few of the more prominent gods can be considered here. This article concentrates on such as ranked as chief deity of a city and lists them in regional arrangement according to the location of their cult city.

1. Southeastern Marshes.—The marshes and lakes that in ancient times separated the inhabited areas of Sumer from the Persian gulf seem to have begun southeast of a line from Eridu (Abu Shahrain) in the desert west of Ur up to Nina (Surghul) in the southern part of the Lagash region. The deities worshiped in the cities located there all appear to represent powers vital to men who derived their livelihood from the marshes; they are powers in the waters and the reeds, in the birds and fishes, and they are seen in shapes drawn from the familiar forms of animal and vegetal life in the marshes. They belong to a single family, that of Enki in Eridu, and Enki himself was the figure among them who gave rise to stories and myths about how he organized the country and its economy, how he outwitted the goddess of the gravelly desert lands in the west, always with creative results. The deities of this group of cities, the early pantheon of the marshlanders, are:

1. Enki (Ea; *q.v.*), the city-god of Eridu, situated in antiquity on a lake or lagoon. He was god of the fresh water of rivers, lakes and marshes, was known for great wisdom, and the power of water to cleanse made him god of ablution and lustration magic. His earliest name and form seems to have been Abzu, "the Watery Deep," later seen as an opponent vanquished by him. His name Enki, "Lord of the Earth," probably has reference to the fertilizing power of the irrigation waters. As creator god his name was Nudimmud; as god of ablution magic he was usually called En-uru, "Lord Reed Bundle," after the reed bundles out of which was constructed the reed hut in which the rites were performed. In historical times he was generally envisaged in human form, but an earlier nonhuman form of the god survives in his emblem, the ibex, which often is depicted under his feet. Other emblems, also seemingly older nonhuman forms of the god, were a goat the body of which tapers into that of a fish, and a ram-headed curved stick. The Akkadians identified Enki with their god Ea, and in later times a variety of gods of special crafts were identified with him.

As father of Enki the texts mention the god of the wind, Enlil of Nippur; his mother was Enlil's housekeeper, Nammu. As Enki's father, perhaps to be understood as his grandfather, occurs sometimes also the god of the sky, An. Enki's spouse was Damgalnunna, "The Great Spouse of the Prince," whom the Akkadians called Damkina. The Janus-faced god Sha (Akkadian Usmu) served as his vizier.

Of the more noteworthy myths dealing with Enki may be mentioned the Tilmun myth, which tells how he engendered a great variety of deities, among them Uttu, the spider, goddess of weaving; the "Myth of Enki and Ninmah," which tells about the creation of man and of how human freaks came into the world through a contest between these two creator gods; and "Enki Organizes Sumer," which tells how Enki blessed the major cities of Sumer, arranged for the rivers, marsh and sea, and instituted agriculture and husbandry and other important features of the economic life of the country.

2. Asalluhe (Marduk), city-god of Ku'ar, in the general vicinity of Eridu. Asalluhe was active with Enki in rituals of lustration magic and was considered his son. His name, "Man-Drenching Asal," suggests that he was originally a god of thundershowers and corresponded in the marshman's pantheon to Ishkur in the herder's and Ninurta in the farmer's. His epithet *lu-he*, "man-drenching," also is applied to Ishkur. In the incantations he is regularly the one who first observes and calls Enki's attention to existing evils, perhaps in his role of thundercloud surveying the world from on high. He was later identified with Marduk of Babylon.

3. Dumuzi-abzu, city-goddess of Kinirsha in the southeastern part of the Lagash region. Dumuzi-abzu was the power for fertility and new life in the marshes. Her name means "the Quickener [of] the Young [in mother's womb] of the Deep," and she corresponds in the marshman's pantheon to Dumuzi in the herder's. She was considered a goddess in the Lagash region, but in the region around Eridu she was viewed as male—possibly due to influence from Dumuzi of the herder's pantheon—and as son of Enki.

4. Nanshe (or perhaps better Nazi), city-goddess of Nina (Surghul) in the southeastern part of the Lagash region. Goddess of fish and fishing, Nanshe was envisaged as dressed altogether in fish. Among her accomplishments was skill in interpreting

dreams, and an important hymn to Nanshe and many references in other texts stress her concern for equity and social justice. Her father was Enki, her husband Nindara, called the "tax-gatherer" of the sea.

5. Ninmar, city-goddess of Guabba, situated on the shore of a lake or lagoon in the southeastern part of the Lagash region. She seems to have been a bird-goddess, and her emblem, a bird, probably represents her original nonhuman form. She was the daughter of Nanshe and thus granddaughter of Enki.

2. Southern Orchards.—In the south, the region along the lower course of the ancient Euphrates from Erech past Ur, three different early economies and their gods came together. Cities of the marshlander's family of gods descended from Enki can be followed from Eridu and Ku'ar in this region over toward Nina in the east; cities of the herdsman's family of gods descended from Nanna in Ur show connection northward to cities in the central grasslands; and lastly there is a group of cities that have city-gods belonging to still a third family of gods descended from Ninazu. The gods of this group all have pronounced chthonian character as powers of the nether world, and several of them appear closely connected with trees and vegetation. Since the region in which their cities lie is one of the chief centres of date cultivation in the country, and seems to have been equally so in antiquity, it is perhaps not unlikely that they represent the pantheon of the early fruit growers and their settlements along the riverbanks, dependent on the powers for growth in the earth. To this group of deities belonged probably originally also Inanna in Erech as goddess of the storehouse of dates and her bridegroom Dumuzi-Amaushumgalana, the power for growth and new life in the date palm, both of whom were later absorbed in large measure into the pantheon of the herders. Inanna seems to have been the figure that gave rise to the major myths in the fruit growers' pantheon, such as the myth of Inanna and Shukallituda, which tells of the origins of shade-tree gardening, and the myth of Inanna's descent to the nether world, which seems to be a mythopoeic elaboration of the partly subterranean character of the storehouse. The gods of this group of cities are:

1. Ninazu, the city-god of Enegir, located on the lower ancient Euphrates between Larsa and Ur. Another city of his was Eshnunna (Tell Asmar) in the Diyala region. Ninazu was an underworld deity whose precise nature is not clear; the name seems to mean "Water Knower." He counted in Enegir as son of the queen of the nether world, Ereshkigal; a variant tradition made him a son of Enlil and Ninlil. His spouse, Ningirda, was a daughter of Enki.

2. Ningishzida, city-god of Gishbanda in the vicinity of Ur. Ningishzida was likewise a power of the nether world, where he held the office of "throne-bearer." Originally he seems to have been a tree-god, for his name appears to mean "Lord Productive Tree," specifically perhaps god of the winding tree roots, as he was originally envisaged in serpent shape. When he is pictured in human form, two serpent heads grow from his shoulders in addition to the human one, and he rides on a dragon. He was a son of Ninazu and Ningirda and was married to Ninazimua, "Lady Productively Grown Branch."

3. Damu, city-god of Girsu on the Euphrates in the general vicinity of Ur. Damu, son of Ningishzida and Ninazimua, was a vegetation god, especially, it seems, god of the sap that rises in trees and plants in the spring. His name means "the Child," and his cult—which seems to have been preponderantly a woman's cult—centred in rites of lamentation and search for the god, who had lain under the bark of his nurse, the cedar tree, and had disappeared. The search ended in the finding of the god, who reappeared out of the river. A particularly interesting feature of the Damu cult is that it recognized as incarnations of the disappearing and sleeping god all the dead kings of the 3rd dynasty of Ur and the early kings of the following dynasty of Isin. The cult of Damu influenced and in time blended with the very similar cult of Dumuzi the shepherd, at home farther north among the shepherds of the central grasslands.

3. Herding Regions.—In the south around the lower ancient Euphrates was a group of cities—Ur, Gaesh, Kiabrig, Larsa and Kullab—the chief gods of which seem to have been herdsmen's gods belonging to the family of Nanna. Farther north, in the centre of Sumer between the Iturungal and the ancient Euphrates, lay grasslands ringed around by the ancient cities of Erech, Bad-tibira, Umma, Zabalam and Bitkarkara, which likewise have city-gods connected with herding and belonging to the family of Nanna. The gods of these cities, however, especially Inanna and her young husband Dumuzi the shepherd, seem to be shepherds' rather than cowherds' gods. Lastly may be noted the two cities of Adab on the northern edge of the grasslands and Kesh, probably to be identified with Ishan Abu Salabikh, north of Nippur on the edge of the gravelly western desert, both cities of Ninhursaga, whose connections were with asses (onagers) and ass herding.

These groups of city-gods form, as it were, a herdsman's pantheon, a family of gods headed by Nanna of Ur—cowherds' gods in the south, shepherds' in the central grasslands. More loosely connected is the separate family of Ninhursaga to the north of them, the ass herders' gods. Characteristic for this pantheon of the herdsmen is a prominence of astral deities: Nanna, the moon; Utu, the sun; Inanna, the morning and evening star; and seemingly An, the sky. Deities of this group have forms derived from the world familiar and particularly meaningful to the herdsman: the animal of the herd or flock, the herdsman himself.

Southern Cowherds' Gods.—1. Nanna (Sin; *q.v.*), city-god of Ur and of the neighbouring Gaesh and god of the moon. His name Nanna may have designated him particularly as the full moon; another of his names, Ensun, "Lord Wild Bull," as the half-moon; a third, Ashimbabbar, as the new light. His original form, the moon, was sometimes visualized as a boat, sometimes as the horned crown of divinity, but most characteristically it was seen with the herdsman's eye as the horns of a great bull leading the herd of stars. In human form the god became a cowherd driving his herd over the sky, and in this form the Sumerian hymns most often present him. Nanna counted as son of Enlil and Ninlil; his spouse was Ningal.

2. Ninhar, city-god of Kiabrig in the region of Ur, probably toward the south. Ninhar was god of the thunder and rainstorms that make the desert green with pasturage in the spring and was envisaged under the shape of a mighty roaring bull. He was son of Nanna and Ningal and married to Ninigara, the "Lady of Butter and Cream," goddess of the dairy.

3. Utu (Shamash; *q.v.*), city-god of Zararim (Akkadian Larsa) in the south and of Sippar in Akkad. In both cities his temple was called Ebabbar. Utu was god of the sun and of justice and equity. His name means "sun," and his original form, the sun disk, seen through the eyes of the cowherd became the round head of a bison. This form survived as the god's emblem, "the Bison's Head, the emblem of Utu," mentioned by Gudea, and in the two crossed bison-headed figures often shown under his chair. When he is depicted in human shape his solar character usually is indicated by rays issuing from his body; often he holds in his hand another of his emblems, a saw. Utu was son of Nanna and Ningal and married to Shenirda. Their son was Shakan, god of goats and goat herding and of the gazelles and wild four-legged creatures of the steppe generally. As viziers of Utu occur the personified justice, Niggina, and equity, Nigsisa. The Akkadians identified their solar deity Shamash with Utu and their goddess Aia with Shenirda.

4. Ninsun, city-goddess of Kullab, an ancient city generally assumed to have merged into Erech but perhaps more likely identical with Larsa or with a part of it. Ninsun seems to be the divine power behind, and the embodiment of, all those qualities the herdsman hoped for in his cows—she is the "good cow," a "mother of good offspring that loves the offspring." As her name Ninsun, "Lady Wild Cow," indicates, she was originally imaged in cow shape, but in human shape she could also give birth to human offspring. Thus Gudea, whose personal goddess she was, is said to have been borne by Ninsun, "the good cow in its [form as] woman." In the cowherd's pantheon the good cow that loves the offspring became the type of the mother. The "wild bull" Dumuzi of the cowherds, as distinct from Dumuzi the shepherd of the shepherds, was her son whom she lamented—often very movingly—in the yearly ritual of lament for his death. As type of the

mother, Ninhursaga in the pantheon of the ass herder and, in less degree, Ninlil in the pantheon of the farmer are counterparts to her. Her husband was Lugalbanda.

5. An (Anu; *q.v.*), worshiped in Erech but not counted as city-god. An was god of the sky and father of all the gods. His name means "sky," and he seems originally to have been envisaged under the form of a great bull, a form later disassociated from the god as a separate mythological entity, the "bull of heaven," which he owned. The bovine imagery suggests that he belonged originally to the herdsman's, specifically the cowherd's pantheon, likely enough in view of the general predilection in that pantheon for celestial powers. As father of the gods An presides in divine assemblies and grants the highest offices, kingship and lordship. He is himself, more than any other god perhaps, the embodiment of majesty and supreme authority.

Central Grassland Shepherds' Gods.—1. Inanna (Ishtar), city-goddess of Erech and Zabalam (Bzeikh), also of Hursagkalamma (Uhaimir) in Akkad. Inanna appears originally to have been a personification of the powers in the storehouse for dates and to have belonged to the pantheon of the orchardman. She lives in Eanna, "the House of the Date Clusters," her name means "the Lady of the Date Clusters," her young husband is Dumuzi-Amaushumgalana, the power in the single great bud of the date palm, and their wedding takes place in the "storehouse." The reed bundles and rolled-up screen of the gate of the storehouse served as her emblem and original nonhuman form. As goddess of the storehouse more generally—the storehouse for wool, meat and dairy products—she seems to have been received early into the pantheon of the herdsman, where she appears as bride both of Dumuzi the shepherd and of "the wild bull" Dumuzi, and as daughter of the head of the herdsman's pantheon, Nanna. From this came probably her astral aspect as goddess of the evening and morning star, which led in post-Sumerian times to a reinterpretation of her name as "Queen of the Sky." As a personification of the storehouse awaiting union with the year's produce she early became typed—although the gods Shara and Lulal (Latarak) counted as her sons—as a young marriageable girl and bride rather than as wife and mother. Since the union of storehouse and produce is not a lasting one (stores are used up), her husband dies young soon after marriage. To her typing as a young marriageable girl she probably owes her role as incarnation of the rage of battle, for in early Sumer, as still among the Bedouins, it appears to have been the accepted function of young unmarried girls to encourage and egg on the young warriors in battle with praise and taunts. To her typing as unmarried girl she may possibly owe also her role of harlot and protectress of harlots. In the process of recasting the pantheon in human aristocratic pattern she became the type of the independent, willful and spoiled young noblewoman.

Of noteworthy myths about Inanna may be mentioned "Inanna and Shukallituda," which tells how the orchardman Shukallituda invented shade-tree gardening, found Inanna asleep in the shade under one of his trees and lay with her, and how she tried to find him afterward, sending various plagues upon the country but to no avail. The end of the story is not preserved. "The Descent of Inanna" tells how she attempted to take over rule of the nether world from her sister Ereshkigal, was changed into a cut of meat and held prisoner in the nether world, but was eventually revived through the agency of Enki and released on condition that she furnish a substitute to take her place. On her return, finding that her husband Dumuzi did not appear sorrowful enough at her disappearance, she delivered him up in a fit of jealous rage to substitute for her in the nether world. The myth "Inanna and the Powers of Office" tells how Inanna journeyed to Eridu, was granted a medley of offices and powers by Enki after a banquet in her honour when he was mellowed by wine, and left next morning to take them safely to Erech. She succeeded, although Enki seven times stopped the boat and tried to get the powers back. The myth was probably a *hieros logos* of a yearly ritual journey of the image of Inanna by boat to Eridu for purification and reappointment to divine office. "Inanna and Ebeh" tells of Inanna's conquest of the mountain range Ebeh, the present Jabal Hamrin. (*See* also ISHTAR.)

2. Dumuzi (Tammuz; *q.v.*), city-god of Bad-tibira (Madinah), is god of fertility and the production of new life. His name means "the Quickener of the Young [in Mother's Womb]" and he occurs in various forms: as Dumuzi-Abzu, "Dumuzi of the Watery Deep," in the marshman's pantheon; as Dumuzi-Amaushumgalana, "Dumuzi, the One Great Source [lit. 'mother'] of the Date Clusters," a deification of the heart of palm, the single great bud of the date palm, in the orchardman's pantheon, where Damu is a related figure; as "the Wild Bull" (*am*) Dumuzi, son of Ninsun, in the cowherd's; and as Dumuzi "the shepherd" (*sibad*), son of Duttur, goddess of the ewe, in the shepherd's pantheon. It is in the latter form (as the divine power to produce lambs and milk in the ewes in springtime) that he is city-god of Bad-tibira.

The cult of Dumuzi centres around two poles, the marriage of the god to Inanna, and the lamenting of his early death. The marriage was ritually consummated in a cult drama, a *hieros gamos*, in which the king took on the identity of the god, a priestess that of the goddess. It expressed different things in the various Dumuzi cults. In Erech the marriage of Inanna as goddess of the storehouse to Dumuzi-Amaushumgalana was essentially a harvest festival. It celebrated the relief of the community in knowing itself safely provisioned for a new year under the ritual image of the young girl finding security in marriage. In the marriage of Inanna to "the wild bull Dumuzi" of the cowherds in Nippur the rite was essentially a fertility rite of spring, the king's potency in the consummation of it being coincident with the shooting up of the flax, the grain and the verdure of the steppe.

The end of spring and of new life in nature, of the milking and lambing season, heralded the death of Dumuzi, the power who had produced it. His death was variously conceived. In the herdsmen's rites it was usually brought about by an attack on the young herdsman in the desert by raiders from the nether world. In the rites he was mourned by his bereaved mother, his sister and his young widow in laments that often reach great heights of beauty and compassion.

3. Shara, city-god of Umma and son of Inanna. The precise character of this god remains obscure.

4. Ishkur (Adad; *q.v.*), city-god of Bitkarkara, a city mentioned between Zabalam and Adab and perhaps to be identified with the modern site of Tell Jidr. Ishkur was god of the rain and thunderstorms of spring, so vital to the herdsman because the pasturage in the desert depends on them. As Ninhar, whom he greatly resembles, Ishkur was imagined in the shape of a great bull and was son of Nanna. When he is depicted in human shape he often holds his symbol, the lightning fork. As god of rain and thunder he corresponds in the herdsman's pantheon to Asalluhe in the marshman's and has the epithet *lu-he*, "man-drenching," in common with him. In the farmer's pantheon his counterpart is Ninurta. Ishkur's wife was the goddess Shala. He was identified by the Akkadians with their god of thunderstorms, Adad.

Gods of the Northern Ass Herders.—Ninhursaga (Belitili), city-goddess of Adab and of Kesh, is the goddess of the stony rocky ground, the *hursag*, as it is found in the mountains to the east and as it comes out in the vast gravelly and stony desert to the west, contrasting so sharply with the alluvial soil of Sumer proper. Particularly she is the power in the foothills and in the desert to produce wildlife, and especially the wild onagers of the western desert are her offspring. Her name Ninhursaga denotes her as the "Lady of the Stony Ground." Other names for her are Dingirmah, the "Exalted Deity"; Ninmah, the "Exalted Lady"; Aruru, the "Dropper" (*i.e.*, who lets fall in birth); and Nintu, "Lady Birth-giver." As the sorrowing mother animal she appears in a lament for her son, a young colt, but as goddess of birth she is not only the goddess of animal birth but "the mother of all children." In curses on evil-doing future rulers she may be asked to stop all birthgiving in the land. Her husband is the god Shulpae. Of their children the sons Mululil and Ashshirgi and the daughter Egime may be mentioned. Mululil appears to have been a dying god, comparable with Dumuzi and Damu, whose death was lamented in yearly rites.

4. Farming Regions.—The ancient cities situated north of the central grasslands and up into Akkad, and to the east in the northern parts of the Lagash region, have city-gods most of whom

show connections with cereals or agricultural implements or otherwise indicate that they belong to the world of the farmer with its characteristic values and forms. They belong to a single divine family, that of Enlil in Nippur, and may be assumed to have constituted the farmer's pantheon. Their most distinctive features seem to be a pronounced fierceness and warlikeness in the male gods, who tend to the type of the warrior, and a stress on chthonian aspects. The figure that occupied the myth-making fantasy most centrally in the farmer's pantheon was Enlil. Late in the myth-making period, on the verge of that of the epic, interest seems to have shifted to Enlil's son Ninurta. The gods of this group are:

1. Enlil, city-god of Nippur, god of the wind. His name Enlil designates him directly as "Lord Wind," but with time the form in which he manifested himself came to be viewed more particularly as the breath issuing from his mouth, his "word" or "command." The wind, in the eyes of the Mesopotamian farmer, is not only the raging, destructive storm but also, and as significantly, the moist reviving wind of the spring that brings the rains and makes desert and fields green. At harvest time when the grain is winnowed Enlil, the wind, cleans it. The grain is Ninlil or Sud, his wife, "the Princess of the Copper [winnowing] Pan," the daughter of the goddess of the varicoloured barley. In the divine assembly Enlil is enthroned on Duku, "the Pure Mound," apparently the mythological prototype of the storage pile covered with mats and with earth to hold them down. There are indications that Enlil had to go away to the nether world, that he sleeps "the treacherous sleep," and is reawakened by Inanna. Details of this side of his nature—presumably the disappearance of the pleasant winds of spring and early summer is involved—are, however, not clear.

Enlil was son of An and presided with him in the divine assembly, which met in the court Ubshuukkinna in Ekur in Nippur. As "king of all lands," he granted with An kingship and lordship. Enlil's word, the wind, was the executive agent of the divine assembly, carrying out its decisions. When the gods had decided on the overthrow of a city it was Enlil's word that blew as a storm against it, enveloped and overwhelmed it—his word "which as stormcloud lies massively grounded on the earth, its interior inscrutable, his word which up above makes the heavens tremble, which down below makes the earth quake, his word with which the gods destroy." This divine word is the image under which the destroying, conquering enemy hordes were seen; or rather, it represented the inner truth of what was happening, the deeper reality for which the enemy horde of actuality was incidental.

Myths about Enlil include the "Myth of the Creation of the Pickax," which tells how Enlil created this basic agricultural tool and used it to break the hard crust of the earth in Uzumua in Nippur, letting the first men grow forth from the earth like plants there; the "Myth of Enlil and Ninlil," which tells how Enlil raped Ninlil when he first met her and was banished to the nether world, how Ninlil followed him, how under various disguises he united with her again and how she conceived, besides Nanna, the moon-god, the chthonian deities Meslamtaea and Ninazu and still a third god whose name is only imperfectly preserved in the text. (*See* also BEL.)

2. Ninlil, city-goddess of Tummal near Nippur, where she was known as Egitummal, and of Shuruppak, where she was known as Sud. Ninlil is "the varicoloured ear [of barley]," goddess of the grain (particularly, perhaps, of the seed corn), and counts as the daughter of Haia, god of the stores, and Ninshebargunu, "Lady varicoloured Barley," the goddess of the ripening barley, a form of the goddess Nissaba. The goddess Ezinu of the green barley issued from the seed corn seems to have been Ninlil's daughter. (*See* also BELIT.)

3. Nissaba, city-goddess of Eresh on the ancient Euphrates not far upstream from Erech, was goddess of the grasses generally, including the reeds and the cereals. As goddess of the reeds and provider of the reed stylus of the scribe she became the patroness of writing and the scribal arts, particularly of accounting.

4. Ninurta, city-god of Girsu (Telloh) in the Lagash region, where he was known by his name Ningirsu, "Lord of Girsu." Ninurta was the farmer's version of the god of the thunder and rainstorms of the spring. Since it is the early rains that melt the snow in the mountains and swell the rivers, he was also the power in the floods of spring; and since it is the rains and the general humidity in the air in spring that make the ground soft enough to be broken by the plow, he is also god of the plow and of plowing, much as his father Enlil is god of the older implement, the pickax. Ninurta's earliest name was Imdugud, which means "Rain-Cloud," and his earliest form was that of the thundercloud, envisaged as an enormous black bird floating on outstretched wings roaring its thunder cry from a lion's head. With the growing tendency toward anthropomorphism the old form and name were gradually disassociated from the god as merely his emblem; enmity toward the older inacceptable shape eventually made it evil, an ancient enemy of the god, a development culminating in the Akkadian myth about it as Anzu. The preferred names for the new human form of the god tended to be colourless epithets like Ningirsu, "Lord of Girsu," in Girsu.

Ninurta was the son of Enlil and Ninlil and was married to Bau, in Nippur called Ninnibru, "Queen of Nippur." A major festival of his, the *gudsisu* festival, marked in Nippur the beginning of the plowing season.

Myths about Ninurta are first of all the epic *Lugal-e*, which depicts the god as the type of the king as young leader of raids and wars. It tells of his battle with the rival king of the plants and the stones, the monster Asakku, in the mountains; his victory; his construction of a rocky ridge, the *hursag*, to regulate the irrigation supplies of Sumer; and of how he gave this ridge to his mother Ninlil when she paid him a visit after his victory (hence her name Ninhursaga, "Queen of the Hursag"). Lastly it recounts his judgments on the stones after his victory, judgments in which he assigned to them their various characteristics and uses. A second myth about Ninurta tells of his return to Nippur after victory in battle. An Akkadian myth deals with his victory over Anzu—his own earlier form of Imdugud, which now takes the place of Asakku as his opponent—and regains from it the tablets of destiny which it had stolen from Enlil.

5. Bau, city-goddess of Uruku in the Lagash region, and, under the name Nininsina, "the Queen of Isin," city-goddess of Isin, south of Nippur. Bau seems originally to have been goddess of the dog and her name, Bau, to have constituted an imitation of the dog's bark, as English "bowwow." As Nininsina she is till late envisaged with a dog's head, and the dog is her emblem. She became—probably because the licking of sores by dogs was supposed to have curative value—a goddess of healing. Her father was An, her husband Pabilsag, another name for Ninurta/Ningirsu. The Akkadians called her Gula (*q.v.*) or Ninkarrak as well as Bau.

6. Meslamtaea (Nergal; *q.v.*), city-god of Cuthah in Akkad. His temple in Cuthah was called Emeslam or Meslam, "Luxuriant Mesu Tree," and the god's name Meslamtaea, "He Who Issues From Meslam," indicates perhaps origin as a tree-god, which would agree with his general chthonian character. He was son of Enlil and Ninlil and appears in hymns as a warrior and so like Ninurta as to be almost indistinguishable. One difference, however, is that the weapons of Meslamtaea seem frequently to be turned against his own people and their herds, whom he kills as the divine power in the great plagues that so often swept ancient countries. Another name of Meslamtaea, Nergal, designates him as ruler of the nether world and as spouse of its queen, Ereshkigal. This may not have been original with the god, since other gods are mentioned as Ereshkigal's spouse in the older tradition, and since an Akkadian myth explicitly tells how he came to occupy that exalted position, the "Myth of Nergal and Ereshkigal."

C. Akkadian Pantheon

The gods worshiped by the Akkadians when they infiltrated Akkad are very largely unknown, but some idea of what the Akkadian pantheon was like can be gained from divine names occurring as part of Akkadian personal names of the period of the dynasty of Agade and just before. They show the presence of a not very clearly defined major god Il and of the astral triad Sin, god of the moon; Shamash, deity of the sun, seemingly a goddess; and Ashtar, later Ishtar, goddess of the morning and

evening star. The deities of this triad were identified with the Sumerian deities Nanna, Utu and Inanna respectively and merged into them.

A relatively large number of goddesses devoted to raids and battle are present: Anuna, "Skirmish," and Anunitum, "She of the Skirmish"; Inin, "Skirmishing"; Irnina, "Victory." Here belong perhaps also Shilabat, "She is a Lioness," and Shiduri, "She is My Fortress." All these figures tended in time to blend into that of Ishtar.

Lastly there was a group of deities of the thunder and rainstorms of the spring, similar to the Sumerian Ishkur and Ninurta. Most of these, it is perhaps worth noting, became city-gods: Dagan, seemingly a god of storm and rain, is the city-god of Tuttul on the Euphrates. Zababa in Kish seems to have belonged to this type also. Aba in Agade is known mainly as warrior and god of war. Tishpak, who replaced Ninazu as city-god of Eshnunna, was perhaps originally a rain-god; his name may mean "the Down-pouring One." To the gods of rain and thunder belongs also Adad.

Of frequent occurrence is Ea, probably a river-god, who was identified with Sumerian Enki. The gods Malik, "the Counsellor," the chthonian god and goddess Irra and Allatum, and the goddesses Mama and Ishhara may at least be mentioned.

Generally speaking, the early Akkadian pantheon with its prominent astral triad of moon, sun and morning and evening star, and with its gods of the rain and thundershowers that bring out grass and pasture in the spring, seems fairly close to the Sumerian herdsman's pantheon and constituted itself very probably the indigenous pantheon of pasturing nomadic tribesmen.

D. Assyro-Babylonian Pantheon

To the end of Mesopotamian civilization the long lists of gods of the Sumerians continued to be copied and hymns to ancient Sumerian gods in the Sumerian language continued to be sung in the temples; none of the old gods was deliberately discarded. Yet, as in the 2nd millennium, when the two national states of Babylonia and Assyria arose, decided changes in emphasis and attention took place. Two young autocrats, Marduk of Babylon and Ashshur (Ashur) of Assyria, came to occupy the foreground and the older gods receded, still prominent and worshiped but seen less and less as primary sources of power. The major figures besides Marduk and Ashur were in later time Marduk's son Nabu (*q.v.*) of Borsippa, god of the scribal art and secretary in the assembly of the gods, and the older gods An, Enlil, Ea (Enki), Sin (Nanna), Shamash (Utu), Adad (Ishkur), Ishtar (Inanna), Ninurta—especially in Assyria—and Nergal. Of these Marduk and Ashur may be discussed in more detail.

1. Marduk.—Marduk, the city-god of Babylon, would seem to have been in origin a Sumerian god and go back to times when Akkad and Babylon were both still Sumerian, for both Marduk's own name and the names of his temple Esangila and its ziggurat Etemenanki are Sumerian. His original character was probably —like that of Asalluhe with whom he was identified and with whom he shows intimate relation—that of a god of thunder and rainstorms, and he seems, like Asalluhe and other gods of thunder and rainstorms, to have been imagined under the outer form of a bull, the bellow of which was heard in the thunder. His weapons, with which he gained victory over the forces of primeval chaos, were the bow and arrow, probably representing the lightning shot by the god of thunder, and his symbol is an arrowhead or head of a spear. In the course of time, by a process of syncretism, Marduk came to absorb a number of other, originally independent gods such as, for example, the god of spells, Tutu; the god of irrigation, Enbilulu; the grain-gods Ezinu and Gil; and many others. As a result Marduk presents a highly complex and opaque figure. In later time the god is usually depicted in human shape and accompanied by a dragon known as the *mushhushshu*. Marduk was the son of Ea and Damkina (Enki and Damgalnunna) and was married to the goddess Sarpanitum. Around the figure of Marduk centres the Babylonian creation story, a myth that in its kernel (the battle between the god of the thunderstorm and the god of the sea) does not really fit in a Mesopotamian natural setting and seems to have been borrowed from western myths (*see* Creation, Myths of).

The most important festival for Marduk, the New Year festival in the spring, was in its essence a re-enactment and reaffirmation of his original achievement of reducing the universe to order. The first days of the month of Nisan were given over to preparations and purification of the temples for the festival. On the fourth the whole of the creation myth was recited before the god. Of the fifth, when Marduk's son Nabu arrived from Borsippa, the festival proper began with a ceremony of reinvestiture of the king. The high priest took the royal insignia away from the king, smote him on the cheek and made him kneel before Marduk to say a prayer in which he assured the god that he had done no wrong but had ruled properly. The high priest then assured him of the god's favour, restored to him the insignia of office and struck his cheek a second time. If the blow brought tears to the king's eyes it was a sign that the god was friendly; if not, that he was angry. On the eighth Marduk took his seat amidst the assembled gods in the chamber of destinies, Duku, for the deciding of destinies, probably a re-enactment of the divine assembly in which Marduk was made king. On the tenth followed a great procession and journey by boat out of town to the *akitu* temple, the king leading Marduk. This seems to reflect the march to battle with Tiamat, as related in the myth. On the 11th the assembled gods again paid homage to Marduk in the chamber of destinies, presumably a re-enactment of the celebration of Marduk's victory, his feats of organization and his election as "lord" by the gods. On the 12th day the festival ended and the gods returned to their temples. (*See* also Marduk.)

2. Ashur.—Ashur, the city-god of Ashur and national god of Assyria, is in origin and essence a most elusive figure. Possibly he was in the beginning merely a *numen loci* of the city that shares his name. In later times, from Shamshi-Adad I onward, there appear to have been strong tendencies to identify him with the Sumerian Enlil, and not only titles of Enlil but deities associated with him and cult places of his in Nippur are duplicated in Ashur in Assyria. Still later, under Sargon II, there were tendencies to identify Ashur with Anshar, the father of An in the creation myth. Under Sennacherib abundant materials testify to deliberate and thorough attempts to transfer to Ashur the primeval achievements of Marduk as told in the myth, as well as the whole ritual of the New Year festival of Babylon—attempts that clearly have their background in the political struggle with Babylonia. In view of this it may be asked whether also the earlier tendency to identify Ashur with Enlil may not have had mainly political motivation and to have implied a political program of domination over Sumer and Akkad rather than any actual affinity of nature and function between the two gods. As a consequence, the image of Ashur seems to lack all real distinctiveness and contains little that is not implied in his position as the city-god of a vigorous and warlike city that became the capital of an empire. He grants rule over Assyria, supports Assyrian arms against enemies and even receives detailed written reports from the Assyrian kings about their campaigns. He appears a mere personification of the interests of Assyria as a political entity, with little character of his own.

E. The Individual and the Powers

During the classical period Mesopotamian religion underwent a process of structuring along the lines of political organization; all of the cosmos became a great state in which the gods held the supreme offices and wielded the supreme authority. In seeking to understand the viewpoint and position of the individual worshiper it is well to keep this in mind. The individual had direct and personal relations mainly to his own personal god, the power who took a personal interest in him and his fortunes, whom he worshiped in a daily private cult, to whom he brought his immediate personal problems, and whom he occasionally badgered if he did not think he was properly taken care of. The major gods were more like high officials in the state, whom one might see on official occasions—*in casu* at the great festivals—but with whom an ordinary citizen had few personal dealings.

This does not mean, however, that the relationship to them and dependency on them was any less real and important. As the government is responsible for the smooth running of a nation's economy, for defense and for internal peace, law and order, so the gods were the responsible powers for order in nature, for peace and prosperity in social life. Direct contact with the higher gods the individual would seek mainly when he felt himself harmed, much as a citizen in such cases will turn to the government and the courts for protection. Such contacts were sought by the individual in cases of illness, attacks on him by the lawless demons of disease, when help from the higher gods was needed to restrain the demons and to pacify and reconcile the personal god who had turned from the man in anger, exposing him to attack.

Not only in illness but in every situation of anxiety and uncertainty the individual was likely to seek divine guidance through omens, that he might know the will of the gods. And such guidance was sought assiduously, even by the greatest rulers and kings, in all matters of import. The state was directly ruled in its major policies by divine instructions.

The religious framework thus affected and conditioned life in ancient Mesopotamian society intensely and on all levels. It may be assumed that, as in most societies, the majority of men in ancient Mesopotamia had normal aptitude for, and sensitivity to, religion and religious values. Occasional individuals lacking in such normal sensitivity, who could see in religion only meaningless restrictions on their personal inclinations, will of course have been found, perhaps especially among the slaves and brutalized poor. To balance them the civilization seems to have had an unusually large number of highly sensitive minds, religiously creative poets, thinkers and priests. Mesopotamian religious literature at its best is the literature of a people highly gifted in religion, capable of profound religious insights and of finding profound and moving expression for them. (T. JA.)

VI. LANGUAGE AND LITERATURE

A. LANGUAGE

The language of ancient Babylonia and Assyria—Assyro-Babylonian, or Akkadian—belongs to the Semitic language family and is customarily set apart as East Semitic from its cognates, the West Semitic languages. It is the earliest recorded Semitic language and hence of considerable importance for comparative linguistics. Records of Akkadian extend in time from *c.* 2400 B.C. into the 1st century A.D., and in space from Persepolis to Egypt. The writing system for Akkadian was borrowed from Sumerian, the world's oldest written language, and though Akkadian replaced Sumerian as a spoken language in the 3rd millennium B.C., Sumerian continued in written usage almost to the end of the life of Akkadian.

These languages are discussed in the separate articles AKKADIAN LANGUAGE and SUMERIAN LANGUAGE.

B. LITERATURE

1. Word Lists.—Among the pictographic tablets of the Protoliterate period there are a few that are not accounts but rather lists of gods. Since the sequence of the names is essentially the same as in later lists, these are the first examples of a kind of literary composition that became very important throughout Babylonian history. From the earliest stage of the Early Dynastic III period (1st dynasty of Ur) came numerous lists of gods and of common words found at Tell Fa'rah, the ancient Shuruppak. The listing of words arranged in certain categories was one branch of Babylonian scholarship. The categories were determined by graphic elements common to a group of words, either determinatives like *dingir*, "god," *gish*, "tree," "wood" (also used for implements and objects made of wood), *na*, "stone," etc.; or parts of simple and composite word signs, such as *ur*, "dog," alone and in *ur-makh*, "great dog" (*i.e.*, lion), *ur-ge*, "domestic dog," and so on. Unilingual Sumerian word lists, which were copied as late as the Old Babylonian period, show that the primary purpose of these lists was encyclopaedic: the systematic collection of all possible words and concepts. The practical purpose of providing pupils with a "spelling guide" may also have been served by these lists.

From Old Babylonian times onward Akkadian translations were added to the lists, which thus became vocabularies. The commonest type of vocabulary was arranged in three columns: the word sign or signs in the centre; the Sumerian pronunciation, expressed by simple syllables, in the left; and the Akkadian equivalent, again spelled syllabically, in the right column. As time went on, many different types of vocabularies were developed, based on different principles of listing; *e.g.*, lists of complex word signs only, of names of professions, of gods, etc. Some vocabularies were provided with a commentary (*i.e.*, with a fourth column added to the normal three) explaining the Akkadian word with a commoner synonym. Unilingual Akkadian synonym lists in two columns also were compiled. Such vocabularies of various types remained in use until the end of Babylonian scholarly activity. There is no doubt that they were used in the schools, especially for the learning of Sumerian once this language had become a dead, literary language. Grammatical paradigms of Sumerian declension and conjugation with Akkadian translation served the same purpose. Listings of legal phrases, including paradigms of the verbs occurring in them, were meant for the use of public scribes who drew up contracts for individual patrons; they begin to occur in the Isin-Larsa period, in which individual legal documents became necessary with the development of an economy based on private property and enterprise. However, the encyclopaedic character of the lists and vocabularies is manifest from their composition and should not be overlooked.

2. Historiography.—The earliest royal inscriptions are simple dedications of buildings or objects of the type "To god X has A, son of B, king of the city Y, given this vase" or "built this temple." A little later, but still in the Early Dynastic period, the occasion for such dedication was mentioned in a sentence introduced by the phrase "on the day when . . . ," and this gave an opportunity to mention a ruler's victories or other deeds. More elaborate royal inscriptions, enumerating many campaigns or various buildings with great detail, developed out of this original pattern; for a long time they retained the external form of introducing references to historical events by "when" and those to the building activities of a king by "then."

The Assyrians further developed this pattern into what is known as "annals"; *i.e.*, detailed accounts of a king's military exploits for each year. Some of the annals, instead of counting years, count "campaigns." This literary form first appeared in Middle Assyrian times and remained in use in Assyria until the downfall of the empire, but was never imitated in Babylonia.

Besides royal inscriptions, which are styled as the words of the ruler and tell of his deeds in the first person, there was also some historiography in an "objective" style—*i.e.*, in the third person. The Sumerian as well as the Assyrian king lists contain, besides the simple enumeration of kings with their regnal years, some short additions telling the most outstanding facts about some of the rulers listed. Whereas some of these entries are based on popular, sometimes even mythological stories (*e.g.*, "Etana, the shepherd, who rose to Heaven" in the Sumerian king list), others give historical information based either on reliable memory or on good sources (*e.g.*, passages on Shamshi-Adad and other kings in the Assyrian king list). The more practical aspects of the king lists are discussed above, under *History;* in connection with historiography, however, it is worth noting that the Sumerian king list by its nature reflects a certain historical concept. There was one "kingship" that came from the gods and rested with one city after another. This passing of the kingship later was explained on religious grounds: the concept of bad rulers who were punished by losing the kingship and of good rulers who were rewarded with it is the next step, reflected in certain literary texts. This concept, in turn, was developed into that of times of bliss and of distress following one another in the past and (according to late texts) also expected for the future.

Another form of nonpersonal historical account, the chronicles, is known mainly from Babylonia, though not entirely absent in Assyria. Chronicles concerning early kings are based in part on

anecdotes or popular tales, in part on good tradition. Beginning with the period of Assyrian domination over Babylonia and continuing to the conquest of Babylon by Cyrus there are chronicles based on contemporary records, listing the events of every year, often by the month and day.

3. Chronological Works.—The system of dating was different in Babylonia and Assyria, and in the former it was different as between earlier and later times. In the early periods of Babylonian history, down to and including the 1st dynasty of Babylon, each year was named after an outstanding event. From the Kassite dynasty to the Seleucid period dates were expressed by regnal years. In Assyria there was the system of naming each year after a person who held the office of *limmu* or eponym; the king himself was usually *limmu* for one year, whereas in the other years of his reign certain high officials, such as the vizier and provincial governors, held this office. It is obvious that the two systems of years named after events and of years named after eponyms were usable only if records of their sequence were kept. Such "date lists" and *limmu* lists actually have been found, though unfortunately not of all periods. The dating by regnal years necessitated the keeping of king lists, and king lists also were composed during the period of dating by events in Babylonia, as well as in Assyria at all times in addition to the *limmu* lists. It may be assumed that the parts of the king lists that deal with historical times were based on original date lists in Babylonia and on *limmu* lists in Assyria. The difficulties that confront the historian who wants to use these lists are due, on the one hand, to the accident of loss and preservation and, on the other, to the habit of listing contemporary and overlapping dynasties as though they were successive. From the viewpoint of literary and intellectual history these lists, though answering practical needs, reflect a tendency toward systematization comparable to that underlying the word lists.

4. Literary Texts.—The discovery and publication of literary texts from Nippur revealed the existence of an extensive Sumerian literature. Although the extant copies were produced for the most part in the Old Babylonian period, these Sumerian texts must have first been written earlier, when Sumerian was still a living language—a few can be dated to the 3rd dynasty of Ur—and some of them may have existed in oral tradition even earlier. Among these literary texts there are myths, epics about the deeds of early kings, lamentations (the *Lamentation Over the Destruction of Ur* must have been composed after the sack of that city at the end of the 3rd dynasty), hymns and wisdom literature (proverbs).

The Old Babylonian period, during which these Sumerian works were copied in the school of Nippur, also produced a literature in Akkadian. Although many of its works are known in later copies only, Old Babylonian fragments have been found of some (*e.g.*, of the Gilgamesh epic), while other compositions may be dated to the same period on the basis of the particular Old Babylonian dialect in which they are written. One of the latter is the *Epic of Creation,* which tells the story of how Marduk, the city-god of Babylon, slew the monster Tiamat and created the world out of her body, a deed for which the other gods rewarded him by granting him universal rule (*see* CREATION, MYTHS OF).

The stories about Gilgamesh provide a good example of literary history. Among the Sumerian works there is no "Gilgamesh epic" but rather several independent stories about the ancient king of Erech; some of them describe his wars with rival rulers, whereas others are more mythological, dealing with his slaying of the monster Huwawa or his visit to the nether world. The oldest copies of the epic proper come from the Old Babylonian period and are in Akkadian. Accordingly, the Gilgamesh epic as we know it is a creation of the Babylonians rather than the Sumerians. This epic incorporated some, but by no means all, of the individual Sumerian stories, and introduced a new motif, Gilgamesh's quest for immortality after the death of his friend, Enkidu. The classical form of the epic is known mainly from copies found in the library of Ashurbanipal at Nineveh; this version probably was written in Middle Babylonian times. An earlier version was read over a wide area and translated into foreign languages. From the 14th and 13th centuries there are fragments in Akkadian discovered at Megiddo in Palestine and in the Hittite capital, and in the latter place fragments were found of a Hurrian and a Hittite version of the epic. This spread of the most outstanding Babylonian work is important for the understanding of the history of epic literature as a whole (*see* GILGAMESH, EPIC OF). During the 14th and 13th centuries mythological epics were written by the Hittites as well as by the Semitic people of Ugarit (Ras Shamra in north Syria). Whereas the Ugaritic myths have a bearing on Old Testament studies, some of the Hittite texts are comparable in content to the *Theogony* of Hesiod; these Hittite texts, in turn, reflect the Babylonian concept of a succession of kings among the gods, which was transmitted to the Hittites by the Hurrians. Although many of the details require further study, it is clear that western literature received some influence from Babylonia through these channels.

5. The Canon.—Babylonian literature as represented in the library of Ashurbanipal consists of a collection of standard works that has been called the canon. In this collection the individual literary works had a well-established text; works that, because of their length, covered more than one clay tablet were divided into several tablets, each of fixed length, so that, for example, the 11th tablet of the Gilgamesh epic begins and ends with the same verse in all copies. Apart from the epics the canon contained the vocabularies and other lists, collections of omens of various kinds, of prayers and incantations with their ritual, etc. In those cases where Old Babylonian versions of texts are available, they differ from the canonical form. The canon, therefore, must have been established in Middle Babylonian times, between the end of the 1st Babylonian dynasty and the rule of the Assyrian Sargonids. The fact that works of Babylonian literature copied by the Hittites in the 14th and 13th centuries show a precanonical text gives some further indication that the canon did not exist before that time. Some Old Babylonian works of literature were not taken into the canon; other works were composed after it had been established and also remained outside the canon. *See* above, *Civilization: Intellectual Achievements. See* also Index references under "Babylonia and Assyria" in the Index volume.

(H. G. GK.)

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BABYLONIAN CAPTIVITY, the name generally given to the deportation of the Jews to Babylon by Nebuchadrezzar. Three separate occasions are mentioned (Jer. lii, 28–30). The first was in the time of Jehoiachin in 597 B.C. After 11 years a fresh rising of the Judaeans occurred; Jerusalem was razed to the

ground, and a further deportation ensued. Finally, five years later, Jeremiah records a third captivity. The various captivities form the material of several of the psalms. (*See* JEWS.)

The term Babylonian captivity also has been used metaphorically to describe the exile of the popes to Avignon (1309–77). *See* PAPACY: *The Papacy in Avignon.*

BABYLONIAN LANGUAGE: *see* AKKADIAN LANGUAGE.

BACĂU, a town in eastern Rumania and administrative centre of the Bacău region, lies near the confluence of the Bistrița and Siretul rivers and on the main railway from Bucharest to Chernovtsy, U.S.S.R. Pop. (1963 est.) 65,763. First mentioned in documents in 1408, Bacău is a centre of heavy industry and has factories producing oil field equipment, building materials, paper, textiles, footwear, leather and timber goods. It has a state theatre, a symphony orchestra and a regional museum.

BACĂU region, on the eastern slope and foothills of the Carpathian mountains, is drained by the Bistrița, Trotuş and Tazlău flowing southeast into the Siretul. Pop. (1963 est.) 1,103,964. Area 13,400 sq.km. (5,174 sq.mi.). The region is oil bearing, with workings at Moineşti, Lucăceşti, Solonț, Tețcani and Tazlau de Sus, and yields about 20% of the crude oil produced in Rumania. There are refineries at Dărmăneşti and Borzeşti. At Bicaz on the Bistrița, there is a hydroelectric plant. Other modern industrial developments include the production of chemicals at Borzeşti; fertilizer at Roznov; and man-made fibres at Săvineşti. Agriculture and animal husbandry are secondary, only about 27% oi the region consisting of arable land.

BACCARAT, a game of cards of French origin. In its original form, baccarat banque, it is played only in gambling casinos on the European continent, and even there it is not so popular as its variant, *chemin de fer,* which is a medium of high-stake gambling in the eastern United States and England.

Legend places the origin of baccarat in the 15th century, and it is true that similar games are described in *L'Académie de jeu* of the Abbé Bellecour (1768), but its popularity in France dates from the 1830s and in England it was known and played shortly thereafter.

Method of Play.—Baccarat is played with several 52-card packs of cards—at least three in baccarat banque, usually six in *chemin de fer*—all shuffled together. The player's object is to have, in two or three cards, a count of 9 or as nearly so as possible; court (face) cards and tens each count 0, each other card counts its face value. Only the final digit is significant; if the two cards in a hand are eight and five, the count is not 13 but 3, so that the highest possible count is 9.

In baccarat banque a banker is selected; usually an auction is held, and the banker is he who undertakes to supply the largest bank (fund with which to accept bets). The banker deals the cards, one at a time, face down, in order to his right, to his left and to himself, until he has dealt three hands of two cards each. Rules of precedence established for the game designate one player on each side to play the hand against the banker. Prior to each coup, punters (players against the bank) may bet on either the right or the left hand or on both (*à cheval*) to beat the banker's hand. The banker is not responsible for the payment of bets in excess of the announced value of his bank.

The deal completed, each active player looks at his cards. A count of 8 or 9 is a natural and wins without contest, except from another natural. A natural 9 wins at once from a natural 8. With any lower count, each player in turn either may stand (saying *non*) or may say *carte,* whereupon the banker gives him one additional card, face up. The banker may stand or take another card after seeing the additional cards, if any, he has given to his opponents.

The full hands are then compared, and the banker settles separately with each side, paying the amount bet on a side with a higher count and collecting all bets on a side with a lower count. When there is a tie, bets on that side are called off.

Elaborate rules for baccarat are established by the casinos at which the game is played and often are made available in printed form to patrons. The various codes are nearly uniform, though there are some differences. Invariably, no part of the bank plus its winnings may be withdrawn unless the banker retires. Most casinos charge 5% of the amount of each bank as a fee.

Chemin de fer may be played by any number of persons. The first banker is decided by lot or by auction; thereafter, whenever the banker loses a coup, or voluntarily relinquishes the bank, the right to be banker passes to the next player in rotation (to the left in the U.S., to the right in Europe). Each banker states the amount of his bank; it may be any amount. The house charges $2\frac{1}{2}$% of each bet as its fee, collecting from the winners of the bet. Thus a player who bets \$5 and wins must pay 25 cents, $2\frac{1}{2}$% of the \$5 he bet plus the \$5 he won.

The cards are dealt from a dealing box, called a shoe. Only two hands are dealt. The hand opposing the banker is played by the punter who made the largest bet against him.

Banco.—Always in *chemin de fer,* and often in baccarat, any punter is permitted to cry "banco," meaning that he bets the entire amount of the bank; whereupon all smaller bets must be withdrawn in deference to him. The right to banco, if two or more claim it, is in order of precedence.

Rules of Play.—A punter must stand on 6 or 7; must take a card with 4 or lower; and has the option (*à volonté*) with 5. In many clubs and casinos these restrictions do not apply to a player who goes banco.

The banker is not so restricted, though some casinos do not permit him to vary from the procedure that is best mathematically. A croupier is provided by every casino to advise the banker. In *chemin de fer,* or in baccarat as against either opponent considered separately, the banker's best play is as follows. If opponent stands: banker stands on 6 or 7, draws to 5 or under. If opponent draws an ace, face card or ten, he stands on 4; nine, he stands on 4, optional to stand or draw with 3; eight, he stands on 3; seven or six, he stands on 7; five or four, he stands on 6; three or two, he stands on 5. In each case, banker stands on any higher number and draws to any lower number.

In baccarat, however, the banker must consider his best chance of winning a net amount. Suppose, with equal bets on the two sides, the left stands and the right draws a ten. The banker will draw to 4, though it decreases his chance of winning on the right, for by standing he would surely lose to the left. But if the bets on the left total only 50 chips, and the bets on the right 200, the banker will stand on 4, relinquishing the same bets to increase his chance of winning the large bets. The croupier must commit all such combinations, of which there are hundreds, to memory.

Baccarat has a large literature, most of it in French. The mathematical theory governing skilful play is explained in *Encyclopedia of Games,* by Emanuel Lasker (1929). (A. H. MD.)

BACCELLI, GUIDO (1832–1916), Italian physician and public official whose researches on malaria gave an impetus to the reclamation of the Roman marshes, was born at Rome on Nov. 25, 1832, and attended the University of Rome, where he became assistant professor of medical jurisprudence in 1856 and later professor of clinical medicine. In 1874 he was elected deputy for a division of Rome, which he represented until his death in Rome on Dec. 10, 1916. Baccelli's career in governmental affairs also included service as minister of public instruction and as minister of agriculture.

BACCHANALIA, the Latin name for the unofficial Hellenistic mysteries of Bacchus (Dionysus). They were introduced into Rome from lower Italy by way of Etruria and were held in secret, attended by women only, on three days in the year. Subsequently, admission to the rites was extended to men, and celebrations took place five times a month. The evil reputation of these festivals, at which the grossest debaucheries took place and all kinds of crimes and political conspiracies were supposed to be planned, led in 186 B.C. to a decree of the senate—the so-called *Senatus consultum de Bacchanalibus,* inscribed on a bronze tablet discovered in Calabria in 1640 and removed to Vienna—which prohibited the Bacchanalia throughout Italy, except in certain special cases. But, in spite of the severe punishment inflicted upon those implicated in the criminal practices disclosed, Bacchanalia were not suppressed in the south of Italy for a very long time. *See* also DIONYSIA; DIONYSUS.

BACCHUS (BACCHOS), a Thracian name of the god Dionysus. *See* DIONYSUS.

BACCHYLIDES (*c.* 510 B.C.–?), one of the most famous Greek lyric poets, was born at Iulis, in the island of Ceos, about 510 B.C. His father's name was perhaps Meidylus; his mother was the sister of Simonides, also a great lyric poet. Few of his poems are datable; of those that are, the earliest must have been composed in, or soon after, 476, and the latest in, or soon after, 452. He was thus active at the same time as Pindar, and anecdotes preserved by the medieval commentators on Pindar suggest that Pindar was bitterly jealous of him. The date and place of his death are unknown; B. Snell has suggested that one of his poems (xvi) shows acquaintance with Sophocles' *Trachiniae*, but since the date of the *Trachiniae* is itself uncertain (though most scholars now would put it after the *Antigone*, produced in 442 or 441), this suggestion is of little help to the chronologer.

Quotations from and allusions to Bacchylides' work in ancient writers are very few. In the last edition of T. Bergk's *Poetae Lyrici Graeci* (Leipzig, 1882) he has 26 pages, compared with his uncle's 154. However, in 1896 the British museum acquired over 200 papyrus fragments, said to have been found by Egyptians in a tomb at Meir in the Faiyum, which proved to contain poems by Bacchylides; F. G. (later Sir Frederic) Kenyon, in his first edition of 1897, was able to restore, in whole or part, some 20 poems of which 14 were epinician odes (odes celebrating victory) closely comparable with those of Pindar, and the remainder choral poems of a type which could be classified as dithyrambs (originally songs in honour of Dionysus), paeans or hymns. Many fragments which Kenyon was unable to place, and others which have been found since, especially at Oxyrhynchus, have extended the range of information about Bacchylides; and it can now be said that his works included epinicians (at least one book, from which at least 15 poems are known in whole or part), dithyrambs (one book, from which seven poems at least are known), hymns of types other than dithyrambs (known only from quotations and allusions), encomia (after-dinner poems in praise of important people, such as Alexander I, king of Macedon and Hiero I, tyrant of Syracuse) and, as is known from the works of Athenaeus of Naucratis, erotica.

The general consensus of critical opinion about Bacchylides in antiquity is well summed up by the anonymous author of the essay *On Sublimity of Style*, writing probably about the beginning of the Christian era. He seems to divide authors into two main classes: the brilliant writers who are not afraid of facing difficulties, and who often fall heavily in consequence (such as Pindar); and the smooth, equable, rather uninspired writers who never fail because they never attempt anything beyond their capacity (in this second category he puts Bacchylides). So far as the epinicians are concerned, it is possible to test the justice of this comparison between Bacchylides and Pindar, since the third, fourth and fifth of Bacchylides' poems were composed in honour of victories for which Pindar also wrote odes: ode iii is for Hiero I's victory with the four-horse chariot at Olympia in 468, to which, if Sir Maurice Bowra's persuasively argued suggestion is accepted, Pindar's *Pythian ii* also refers; ode iv is for the same victory as *Pythian i* (470); and ode v for the same victory as *Olympian i* (476). By comparison with those of Pindar, Bacchylides' metrical schemes are almost startling in their simplicity and his language usually shows much of the same quality; his treatment of his subjects, and especially his attitude to moral questions, is less austere than Pindar's and it is easy to understand from this why Hiero I seems to have liked Bacchylides more than he did Pindar, and also why the medieval commentators construe Pindar's attack upon his competitors' lack of verbal restraint (*panglôssia*) as a reference to Simonides and Bacchylides. Mostly, Bacchylides' style by its polish and perspicuity merits the praise bestowed on it in antiquity; but it cannot be said that he never fails—at times he shows himself an unscrupulous plagiarist from Pindar, and there are cases which reveal how ill-qualified he really was to challenge Pindar (the scholiasts' suggestion that Pindar's "ape" in *Pythian ii* is an allusion to Bacchylides is seen to be completely justified). For the history of literature, Bacchylides' dithyrambs are more important than his epinicians, since they represent a type of poetry of which we have not as yet any other complete example; among the dithyrambs the most interesting is xviii ("Theseus"), a dialogue in alternate stanzas between a chorus and a single speaker (the relationship of this form to the history of the drama, if any, has not yet been satisfactorily determined).

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BACCIO D'AGNOLO: *see* AGNOLO, BACCIO D'.

BACCIO DELLA PORTA: *see* BARTOLOMMEO, FRA.

BACH, the surname of the most consistently successful family in musical history, nearly 40 of its members having established reputations from the late 16th to the early 19th centuries. J. S. Bach is the subject of a separate article; five of his sons are mentioned here. Though falling short of their father's genius, they made varying contributions to the new music of their day.

WILHELM FRIEDEMANN BACH (1710–1784), eldest son of J. S. and Maria Barbara Bach, was born at Weimar, Nov. 22, 1710. His main musical instruction was from his father (who wrote for him, when he was 10, the charming *Klavierbüchlein vor Wilhelm Friedemann Bach* of keyboard pieces). He also studied the violin with J. G. Graun. He matriculated at Leipzig university in 1729. In 1733 he was appointed organist to the Sophienkirche in Dresden. He was already composing successfully and extensively. In 1746 he moved to the Liebfrauenkirche at Halle. At about this time or a little later (perhaps after his father's death in 1750) he evidently began to experience personality difficulties, no doubt latent hitherto. He had been, perhaps, too dependent on his father's help and advice. He has been charged with excessive drinking and other lapses, and, though modern scholars tend to dismiss these charges, they were brought by contemporaries at least one of whom, F. W. Marpurg, might be expected to be reliable. He made a late marriage in 1751. He became restless; applied unsuccessfully for a change of post in 1753 and 1758 and successfully (to the Darmstadt court) in 1762, but did not take up his new appointment; resigned his old post in 1764; and for 20 years sought in vain for regular employment. He must have become almost unemployable through paranoiac touchiness and unreliability; his talents were never doubted, though he imagined that they were. In 1774 he moved to Berlin, where he lived by giving recitals and teaching until his death, July 1, 1784.

His personality problems are discernible in his compositions. The influence of his father's style remained too strong to cast off and too much at variance with the new spirit of the times, and with his own true personality, to use spontaneously and convincingly. He wrote old-fashioned works of little relevance to his day and new-fashioned works too consciously contemporary to be altogether satisfactory, but never found a style that was at the same time true to himself and his age. It is not surprising that his compositions are very few for his many years. Yet their feeling is unmistakable and often impassioned and he had it in him to become a greater composer than his actual achievement makes him.

CARL PHILIPP EMANUEL BACH (1714–1788), second surviving son of J. S. and Maria Barbara Bach, was born at Weimar, March 8, 1714. A precocious musician who remained successful, C. P. E. Bach was his father's true successor and a very important figure in his own generation. In his autobiography he tells us: "For composition and keyboard-playing, I have never had any teacher other than my father." He studied law, taking his degree at Frankfurt in 1735, and, though he probably never had any intention of a career other than music, the legal training gave him an accuracy of mind that helped him become the most outstanding teacher of music of his day. In 1740 he was appointed harpsichordist to Frederick II of Prussia. Frederick was a good flautist and so fond of music that he had his court orchestra accompany him in concertos every night except Mondays and Fridays, which were opera nights. The subservience that he required from his distinguished harpsichordist grew irksome, but it was not until 1767 that C. P. E. Bach was able to resign and to take up an ap-

pointment as *Kapellmeister* at Hamburg. Meanwhile he had married (1744); published (part I, 1753; part II, 1762) his *Versuch über die wahre Art das Klavier zu spielen* (ed. by W. Niemann, 1906; Eng. trans., *Essay on the True Art of Playing Keyboard Instruments* [1949]); and acquired an enviable reputation both as a composer and as a performer on and teacher of the harpsichord and clavichord. He died at Hamburg, Dec. 15, 1788.

Unlike Friedemann, C. P. E. Bach was successful in assimilating the powerful influence of their father and in making the transition into the new style. This represented a break with the past such as very few periods of musical development have equaled. The monumental character of baroque music gave way to a mercurial romanticism for which the favourite contemporary description was "sensibility" (*Empfindsamkeit*). C. P. E. Bach became a leader of this movement but retained the advantage of a solid craftsmanship and assurance for which he always gave full credit to his father's teaching and example.

C. P. E. Bach's compositions are very numerous. Those of his Berlin period are comparatively old-fashioned in the main, because of the conventional preferences of his royal employer. After his move to Hamburg, he developed a more adventurous vein, and his work there did as much as any to open up the future. His influence on Haydn, Mozart and even Beethoven was freely acknowledged, and it is interesting that having influenced Haydn, C. P. E. Bach later allowed himself to be influenced in his turn, just as Haydn allowed himself to be influenced by Mozart.

As a performer, he was famous for the precision of his playing, for the beauty of his touch and for the intensity of his emotion. "He grew so animated and possessed," wrote Charles Burney (*Present State of Music in Germany . . .*, 1773), "that he looked like one inspired. His eyes were fixed, his underlip fell, and drops of effervescence distilled from his countenance."

The influence of C. P. E. Bach's *Essay* was unsurpassed for two generations. Haydn called it "the school of schools." Mozart said, "He is the father, we are the children." Beethoven, when undertaking to teach young Czerny, wrote "be sure of procuring Emanuel Bach's treatise." It is, indeed, one of the essential source books for understanding the style and interpretation of 18th-century music. It had also a particular bearing on the fingering of keyboard instruments, though it was less novel in this respect than has been claimed. It is comprehensive on thorough bass and on ornaments and is an authentic guide to many other refinements of 18th-century performance.

Johann Gottfried Bernhard Bach (1715–1739), third surviving son of J. S. and Maria Barbara Bach, was born at Weimar, May 11, 1715. His father got him the organist's position in the Marienkirche at Mühlhausen in 1735, and in the Jacobikirche at Sangerhausen in 1737. But he was in financial difficulties and in 1738 fled from his creditors; other complaints were also made known against him. His father paid his debts and sought his reinstatement but could not find him. He had hidden in Jena, where he soon died of a fever (May 27, 1739).

Johann Christoph Friedrich Bach (1732–1795), eldest surviving son of J. S. and Anna Magdalena Bach, was born at Leipzig, June 21, 1732. His musical instruction is thought to have been partly in the hands of his father's cousin, Johann Elias Bach. He was made a chamber musician to Count Wilhelm at Bückeburg in 1750, becoming *Konzertmeister* in *c.* 1758. He married Lucia Elizabeth Münchausen, a singer, in 1755. His career was steady and his output of compositions extensive. These are successful rather than important. He had an easier transition into the new style than his older brothers, but perhaps because of this, and because his temperament was easy-going, his work lacked the depth of theirs. It kept well abreast of his times, but without ever leading them. He is at his best in his later symphonies, which reveal the style though not the inspiration of Haydn. He died at Bückeburg, Jan. 26, 1795.

Johann Christian Bach (1735–1782), youngest son of J. S. and Anna Magdalena Bach, called the "English Bach," was born at Leipzig, Sept. 5, 1735. He too is likely to have received his early training from Johann Elias Bach; but after his father's death (1750) he enjoyed the advantage of working with his half-brother, C. P. E. Bach, in Berlin. At the age of 20 he made his way to Italy and in 1756 became a pupil of the famous Padre Martini in Bologna. Having a grace and tactfulness of manner notably lacking in older generations of Bachs, he found a generous patron, while his compositions, though immature, were already well received. They are in a serious style. Having become a Catholic convert, he was appointed organist of Milan cathedral in 1760. His conversion was thought cynical and reprehensible by his strongly Lutheran family, from whom he became somewhat estranged. His taste next turned to opera, and he was thought to have neglected his official duties.

In 1762 he became composer to the King's theatre in London and wrote for it a number of successful Italian operas, besides producing much orchestral, chamber and keyboard music, and a few cantatas. In 1764, he started his fashionable series of concerts with Karl Friedrich Abel (*q.v.*). He received a lucrative appointment as music master to Queen Charlotte and her children and became a social as well as a musical success. In 1772, he was honoured by an invitation to write an opera for the elector at Mannheim. In 1773, he married the Italian singer Cecilia Grassi.

J. C. Bach had no difficult transition to make into the post-baroque style of music; he was born into it. Well-grounded by C. P. E. Bach, thoroughly trained by Martini, naturally receptive to the latest Italian music in Milan, Naples and elsewhere, he early became a fashionable composer. Among those who learned from and greatly respected him was the young Mozart. Nevertheless, his early success apparently relieved him of any urgent pressure to continue developing, and though always a sensitive and imaginative composer, he never grew to be a profound one. Running into financial and other difficulties, he seemed unable to respond to the challenge, and died, in London, Jan. 1, 1782.

See Karl and I. S. Geiringer, *The Bach Family* (1954), for an excellent bibliography concerning the Bach family and their compositions.
(R. Do.)

BACH, (JULIUS) CARL VON (1847–1931), German specialist in mechanics of materials, was born in Stollberg, Saxony, March 8, 1847, the son of a saddler and wainwright. He first learned the machinist's trade. In 1866 he entered the Polytechnikum at Dresden. After service in the artillery in the Franco-Prussian War, he entered the technical school at Karlsruhe, from which he graduated in 1873. After industrial experience in Vienna and Bautzen, he was appointed in 1878 professor of mechanical engineering at the technical school at Stuttgart, where he remained until retirement in 1922. His work in the testing of materials led to the establishment of a great engineering laboratory at Stuttgart in 1900.

Bach was a pioneer in the determination of suitable stresses to be used in the design of machine elements. His *Elastizität und Festigkeit* went through nine editions between 1881 and 1924 and exerted far-reaching influence. His work also gave direction to the design procedures for concrete and reinforced concrete structures.

He died in Stuttgart on Oct. 10, 1931. (S. C. Hr.)

BACH, JOHANN SEBASTIAN (1685–1750), German composer, the most important member of a remarkable family of musicians and the chief representative of the German late baroque period. His contemporaries admired him as an outstanding harpsichordist, organist and expert on organ-building, but found many of his compositions old-fashioned. Posterity has done him more justice, and he is generally regarded as one of the greatest composers of all time.

The Bachs (*q.v.*) were proud of their achievements, and about 1735 Sebastian drafted a genealogy, *Ursprung der musicalisch-Bachischen Familie*. He traced his ancestry back to his great-great-grandfather Veit Bach, a Lutheran baker (or miller), who was driven from Hungary to Wechmar in Thuringia by religious persecution late in the 16th century and died in 1619. There were Bachs in the area before this, and it may be that when Veit moved to Wechmar he was returning to his birthplace. He used to take his cittern to the mill and play it while grinding was going

on. Sebastian remarked, "A pretty noise they must have made together! However, he learnt to keep time, and this apparently was the beginning of music in our family."

Until the birth of Sebastian, his was the least distinguished branch of the family; its members had been competent practical musicians, but not composers such as Johann Christoph (1642–1703), Johann Michael (1648–94) and Johann Ludwig (1677–1743). In later days the most important musicians in the family were Sebastian's sons, Wilhelm Friedemann (1710–84), Carl Philipp Emanuel (1714–88), and Johann Christian (the "English Bach," 1735–82) (*see* BACH). Emanuel's compositions influenced Haydn and Mozart; his book on keyboard-instrument playing, *Versuch über die wahre Art das Klavier zu spielen* (1753–62), remained in use until Beethoven's time and is more valuable than ever today. But the family talent was not exclusively musical; some of the 18th-century Bachs were competent painters.

LIFE

Early Years.—J. S. Bach was born at Eisenach, Thuringia, on March 21, 1685, the youngest child of Johann Ambrosius Bach (1645–95) and Elisabeth Lämmerhirt (1644–94). Ambrosius was a string player, employed by the town council and perhaps by the ducal court of Eisenach. In spite of his complaints of poverty he must have been reasonably well off, to judge by the social status of his two wives.

Sebastian started school in 1692 or 1693 and did well in spite of frequent absences. Of his musical education at this time nothing definite is known; but he may have picked up the rudiments of string playing from his father, and no doubt he attended St. George's church, where Johann Christoph Bach was organist until 1703.

By 1695 both his parents were dead, and he was taken in by his eldest brother, also named Johann Christoph (1671–1721), organist at Ohrdruf. This Christoph had been a pupil of Johann Pachelbel; he apparently gave Sebastian his first formal keyboard lessons. The latter again did well at school, until in 1700 his voice secured him a place in a select choir of poor boys at the school of St. Michael's church, Lüneburg.

His voice must have broken soon after this; but he remained at Lüneburg for a time, making himself generally useful. No doubt he studied in the school library, which had a large and up-to-date collection of church music; no doubt also he heard Georg Böhm, organist of St. George's church; and certainly he visited Hamburg to hear J. A. Reinken at St. Catherine's and contrived to hear the French orchestra maintained by the duke of Celle.

He seems to have returned to Thuringia in the late summer of 1702, for at some time between July and November he applied for the post of organist at Sangerhausen. But for ducal interference he would have obtained it; and when every allowance is made for the low technical standards of that area, this means that he must already have been a reasonably proficient organist. His experience at Lüneburg, if not at Ohrdruf, had turned him away from the secular string playing tradition of his immediate ancestors; thenceforth he was, chiefly though not exclusively, a composer and performer of keyboard and sacred music.

The next few months are wrapped in mystery; but by March 4, 1703, he was a member of the orchestra employed by Duke Johann Ernst of Weimar (brother of Duke Wilhelm Ernst, whose service Bach entered in 1708). This post was a mere stopgap; he probably already had his eye on the organ then being built at St. Boniface, Arnstadt. When it was finished he helped to test it, and in Aug. 1703 he was appointed organist—all this at the age of 18. Arnstadt documents imply that he had been court organist at Weimar; this is incredible, though it is likely enough that he had occasionally played there.

Arnstadt.—At Arnstadt Bach devoted himself to keyboard music, the organ in particular. While at Lüneburg he had apparently had no opportunity of becoming directly acquainted with the playing and compositions of Dietrich Buxtehude (*q.v.*); in Oct. 1705 he repaired this gap in his knowledge by obtaining a month's leave and walking to Lübeck (over 200 mi.). His visit must have been profitable, for he did not return until about the middle of Jan. 1706. In February his employers complained about his absence and other things as well: he had harmonized the chorales so freely that the congregation could not sing to his accompaniment, and, above all, he had not produced any cantatas. Strictly speaking, he was not bound to do so, for he was employed purely as an organist; but no doubt the real reasons for his neglect were that he was temporarily obsessed with the organ and was on bad terms with the local singers and instrumentalists, who were not under his control and did not come up to his standards. In the summer of 1705 he had made some offensive remark about a bassoon player, which led to an unseemly scuffle in the street.

His replies to these complaints were neither satisfactory nor even accommodating; and the fact that he was not dismissed out-of-hand shows that his employers were as well aware of his exceptional ability as he was himself and were reluctant to lose him.

Mühlhausen.—In 1707 he obtained a better post at St. Blasius, Mühlhausen. He moved there in September and married his cousin Maria Barbara Bach (1684–1720) at Dornheim on Oct. 17. At Mühlhausen things seem, for a time, to have gone more smoothly. He produced two or three cantatas, including no. 71 (Feb. 4, 1708), which was printed at the expense of the city council; copied music, to enlarge the choir library; tried to encourage music in the surrounding villages; and was in sufficient favour to be able to interest his employers in a scheme for rebuilding the organ (Feb. 1708). His real reason for resigning on June 25, 1708, is not known. He himself said that his plans for "regular [concerted] church music" had been opposed by members of his own congregation and that his salary was inadequate. It is generally supposed that he had become involved in a theological controversy between his own Pastor Frohne and Archdeacon Eilmar of St. Mary's. Certainly he was friendly with Eilmar, who provided him with librettos and became godfather to Bach's first child; and it is likely enough that he was not in sympathy with Frohne, who, as a Pietist, would have frowned on elaborate church music. At all events, his resignation was accepted, and he moved to Weimar shortly afterward; but he continued to be on good terms with Mühlhausen personalities, for he supervised the rebuilding of the organ, is supposed to have reopened it on Oct. 31, 1709, and composed a cantata for Feb. 4, 1709, which was printed, but has completely disappeared.

Weimar.—It has now been established that Bach from the outset was court organist at Weimar as well as a member of the orchestra. Encouraged by Duke Wilhelm Ernst, he once more concentrated on the organ. Late in 1713 Bach had the opportunity of succeeding F. W. Zachau at St. Mary's church, Halle; but the duke raised his salary, and he stayed on at Weimar, becoming *Konzertmeister* on March 2, 1714, with the duty of composing a cantata every month. He became friendly with his relation Johann Gottfried Walther, the lexicographer (1684–1748), who was organist of the town church, and, like Walther, he took part in the musical activities at the Gelbes Schloss, then occupied by Duke Wilhelm's two nephews, Ernst August and Johann Ernst. He taught them both. The latter was a talented composer, who wrote concertos in the Vivaldi manner, some of which Bach arranged for keyboard instruments; the boy died in 1715, in his 19th year. During these years Bach occasionally visited Weissenfels, in March 1714 to serve as a godfather, in Feb. 1716 to take part in a court celebration that included a performance of his first secular cantata, no. 208.

J. S. Drese, the Weimar *Kapellmeister*, died on Dec. 1, 1716, and was succeeded by his nonentity of a son. Bach presumably resented being thus passed over; and in due course he accepted an appointment as *Kapellmeister* to Prince Leopold of Köthen, which was confirmed on Aug. 5, 1717. Duke Wilhelm, however, refused to accept his resignation—partly, perhaps, because of Bach's friendship with the duke's nephews, with whom the duke was on the worst of terms. About September, a contest between Bach and the famous French organist Louis Marchand was arranged at Dresden. The exact circumstances are not known;

but Marchand avoided the contest by leaving Dresden a few hours before it should have taken place. By implication, Bach won. Perhaps this emboldened him to renew his request for permission to leave Weimar; at all events he did so, but in such terms that the duke imprisoned him for a month. Released on Dec. 2, he moved to Köthen a few days later.

Köthen.—There, as *Kapellmeister*, he was concerned chiefly with chamber and orchestral music. Even though some of the works may have been composed earlier and revised later, it was at Köthen that the sonatas for violin and clavier, viola da gamba and clavier, and the works for unaccompanied violin and cello were put into something like their present form. The *Brandenburg Concertos* were finished by March 24, 1721; in no. 6—so it has been suggested—Bach bore in mind the technical limitations of the prince, who played the gamba. Bach played the viola for choice; he liked to be "in the middle of the harmony." He wrote a few cantatas, for the prince's birthday and other such occasions; most of these seem to have survived only in later versions, adapted to more generally useful words. He also found time to compile educational keyboard works: the *Clavierbüchlein* for W. F. Bach (begun Jan. 22, 1720); some of the French suites; the first book (1722) of *Das wohltemperierte Klavier* (*The Well-Tempered Clavier*, consisting of two books, each of 24 preludes and fugues in all keys and known as the "Forty-eight"); and the Inventions (1723). In the last two collections he made use, to some extent, of material that had already appeared in the *Clavierbüchlein*, and some of the "Forty-eight" probably go back a good deal further.

Maria Barbara Bach died unexpectedly and was buried on July 4, 1720. About November, Bach visited Hamburg; his wife's death may have unsettled him and led him to inquire after a vacant post at St. James's church. Nothing came of this; but he played at St. Catherine's in the presence of J. A. Reinken (1623–1722). After hearing Bach improvise variations on a chorale, the old man said, "I thought this art was dead; but I see it still lives in you."

On Dec. 3, 1721, Bach married Anna Magdalena Wilcken (1701–60), daughter of a trumpeter at Weissenfels. The courts of Weissenfels and Köthen were on friendly terms, and Anna, who was a soprano, had visited Köthen on various occasions and apparently had been employed there since the autumn of 1720.

Apart from his first wife's death, these four years at Köthen were probably the happiest of Bach's life. He was on the best of terms with the prince, who was genuinely musical; and in 1730 Bach said that he had expected to end his days there. But the prince married on Dec. 11, 1721, and conditions deteriorated. The princess—described by Bach as "an *amusa*" (*i.e.*, opposed to the muses)—required so much of her husband's attention that Bach began to feel neglected. He also had to think of the education of his elder sons, born in 1710 and 1714; and he probably began to think of moving to Leipzig as soon as the cantorate fell vacant with the death of Johann Kuhnau on June 5, 1722, even though, as he said, he did not like the idea of becoming "a mere cantor" after having been a *Kapellmeister*. His friend G. P. Telemann (*q.v.*) applied and was appointed but withdrew in November. Bach applied in December, but the post was offered to Christoph Graupner, *Kapellmeister* at Darmstadt. As the latter was not sure that he would be able to accept, Bach gave a trial performance (Cantata 22) on Feb. 7, 1723; and when Graupner withdrew (April 9), Bach was so deeply committed to Leipzig that, although the princess had died on April 4, he applied for permission to leave Köthen. This he obtained on April 13, and on May 13 he was sworn in at Leipzig.

He was appointed honorary *Kapellmeister* to Köthen, and both he and Anna were employed there from time to time until the prince died, on Nov. 19, 1728. Memorial services were held in March 1729; on March 24 Bach conducted a funeral ode, consisting partly of adaptations from the *Passion According to St. Matthew*. Anna and Friedemann Bach were among the performers.

Leipzig.—As cantor of St. Thomas' school, Bach had to supply performers for four churches. At St. Peter's, the choir merely led the hymns. At the New church, St. Nicholas' and St. Thomas', part-singing was required; but Bach himself conducted only at the last two. He also had various nonmusical duties connected with the school.

Since Bach regarded the cantorate as a step downward in the social scale and had a fully justified sense of his own importance as the greatest organist in Germany, whereas his employers regarded him as a rather poor substitute for Telemann and Graupner, friction was inevitable. Bach frequently absented himself without leave, playing or examining organs, taking Friedemann to hear the "pretty tunes" at the Dresden opera and fulfilling the duties of the honorary court posts that he contrived to hold all his life. To some extent, no doubt, he accepted engagements because he needed money; he complained in 1730 that his income was less than he had been led to expect (there were not enough funerals); but obviously his routine work must have suffered. On the other hand, the authorities insisted on admitting unmusical boys to the school, thus making it difficult for Bach to keep his churches supplied with singers; furthermore, they refused to spend enough money to keep a decent orchestra together. The resulting ill feeling had become serious by 1730. It was temporarily dispelled by the tact of a new rector, J. M. Gesner, who admired Bach and had known him at Weimar; but Gesner stayed only until 1734 and was succeeded by J. A. Ernesti, a young man with up-to-date ideas on education, one of which was that music was not one of the humanities but a time-wasting side line. Trouble did not actually begin until July 1736; it then took the form of a dispute over Bach's right to appoint prefects and became a public scandal. Fortunately for Bach, he became court composer to the elector of Saxony in Nov. 1736. As such, after some delay, he was able to induce his friends at court to hold an official inquiry, and his dispute with Ernesti was settled in 1738. The exact terms of the settlement are not known; but thereafter Bach did as he liked.

From what has been said, it will be understood that after his first two or three years at Leipzig—during which he produced a large number of new cantatas, sometimes at the rate of one a week—Bach lost interest in composing church music. In 1726 he began to publish the clavier *Partitas* singly, with a collected edition in 1731; according to J. N. Forkel (*see* below), their difficulty attracted attention. The second part of the *Clavierübung* followed in 1735, the third in 1739; both were reprinted. From *c.* 1729–36 Bach was honorary *Kapellmeister* to Weissenfels; and from 1729 to 1737, and again from 1739 for a year or two, he directed the Leipzig *Collegium Musicum*, for whose concerts some of his concertos are supposed to have been adapted. About 1733 he began to produce cantatas in honour of the elector of Saxony and his family, evidently with a view to the court appointment that he secured in 1736; many of these secular movements were adapted to sacred words and reused in the *Christmas Oratorio* (performed 1734–35). The Kyrie and Gloria of the B minor Mass, written in 1733, were also dedicated to the elector; the rest of the Mass was put together during Bach's last years. On his visits to Dresden he had won the regard of Count Hermann Karl von Keyserlingk, the Russian envoy, who commissioned the so-called *Goldberg Variations*; these were published about 1742, and Book II of the "Forty-eight" seems to have been completed about the same time. For the rest, he wrote a few cantatas, revised some of his Weimar organ works and published the so-called *Schübler Chorale Preludes* about 1746. In May 1747 he visited his son Emanuel at Potsdam and played before Frederick II (the Great) of Prussia; in July his improvisations, on a theme proposed by the king, took shape as *Das musikalische Opfer* (*The Musical Offering*). In June 1747 he joined a Society for the Promotion of Musical Science that had been founded in 1738 by his former pupil L. C. Mizler; he presented the canonic variations on *Vom Himmel hoch da komm' ich her* to the society, in manuscript, and afterward published them.

It is generally supposed that Bach was a devout orthodox Lutheran. He may have had some leanings toward Pietistic emotionalism; but, as a professional musician, he cannot have been fully in sympathy with that revivalistic movement, which dis-

approved of elaborate music. He appears to have been a good husband and father. There is amusing evidence of a certain thriftiness, a necessary virtue, for he was never more than moderately well off, and he delighted in hospitality. Living as he did at a time when music was beginning to be regarded as no occupation for a gentleman, he occasionally had to stand up for his rights both as a man and as a musician; he was then obstinate in the extreme. But no sympathetic employer had any trouble with Bach, and with his professional brethren he was modest and friendly. He was also a good teacher and from his Mühlhausen days onward was never without pupils.

Of Bach's last illness little is known, except that it lasted several months and prevented him from finishing *Die Kunst der Fuge* (*The Art of Fugue*). His constitution was undermined by two unsuccessful eye operations performed by the chevalier John Taylor, the itinerant English quack who numbered Handel among his other failures; and he died on July 28, 1750. His employers proceeded with relief to appoint a successor; Burgomaster Stieglitz remarked, "The School needs a cantor, not a *Kapellmeister*—though certainly he ought to understand music." Anna Magdalena was left badly off. For some reason her stepsons did nothing to help her, and her own sons were too young to do so. She died on Feb. 27, 1760, and was given a pauper's funeral.

Unfinished as it was, *The Art of Fugue* was published in 1751. It attracted little attention and was reissued in 1752 with a laudatory preface by F. W. Marpurg, the well-known Berlin theorist, who later became director of the royal lottery. In spite of Marpurg, and of some appreciative remarks by Johann Mattheson, the Hamburg critic, only about 30 copies had been sold by 1756, when Emanuel Bach offered the plates for sale. As far as is known they were sold for scrap.

Emanuel Bach and J. F. Agricola (a pupil of Sebastian's) wrote an obituary; Mizler added a few closing words and published the result in the journal of his society (1754). This was reprinted in *Bach-Jahrbuch*, 1920, and there is an English translation in *The Bach Reader* (*see* below). Though incomplete and inaccurate, the obituary is of very great importance as a firsthand source of information.

MUSIC

The Revival.—For about 50 years after Bach's death, his music was neglected. This was only natural. The same fate befalls many authors and composers, even in this historically minded age; and the musical world of 1750 was not historically minded. Besides a fashionable desire for novelties, there was a sincere though mistaken belief that music was getting better and better every year; in the days of Haydn and Mozart, no one could be expected to take much interest in a composer who had been considered old-fashioned even in his lifetime—especially as his music was not readily available, and half of it (the church cantatas) was fast becoming useless, as a result of changes in religious thought.

At the same time, musicians of the late 18th century were neither so ignorant of Bach's music nor so insensitive to its influence as some modern authors have suggested. Manuscripts of that date are much more numerous than one would suppose from the inadequate lists given in 19th-century publications; and such important works as the clavier *Partitas*, the *Concerto in the Italian Style in F major* (*Italian Concerto*) and the *Goldberg Variations* circulated in editions of perhaps 100 or 200 copies. Furthermore, historians have a natural tendency to concentrate on the men from whom a great composer learned, rather than on the men who learned from him. Thus, much more is known about the Buxtehudian elements in Sebastian Bach than about the Sebastianic elements in Emanuel Bach, and probably both Emanuel's debt to his father and the latter's indirect influence on the Viennese classics are underrated. In any case, if Bach influenced only a few people directly, he did at least influence the three who mattered: Haydn, Mozart and Beethoven.

A. F. C. Kollmann, a Hanoverian settled in England, was one of the first to see that Bach's music was worth reviving. He planned to publish the "Forty-eight Preludes and Fugues," but failed to obtain the necessary support and was anticipated by Nägeli and Simrock in 1801. J. N. Forkel published a *Life and Works* in 1802, and acted as adviser to Hoffmeister and Kühnel, whose collected edition, begun in 1801, was cut short by the activities of Napoleon. With these events the revival began in earnest. Four volumes of chorale preludes were issued by Breitkopf and Härtel in 1803–06: the Six "Great" Preludes and Fugues (for organ) by Riedl of Vienna, about 1812; and the latter must have been in demand, for Riedl's successors kept them in print until 1838 at least. In England, Kollmann published the *Chromatic Fantasy and Fugue in D minor* in 1806, and a translation of Forkel in 1820; Samuel Wesley and C. F. Horn began to publish the organ sonatas in 1809, and the "Forty-eight" in 1810.

By 1829 a representative selection of the keyboard music was available; but very few of the vocal works were published, most of them being considered unsuitable for performance in church. In that year Eduard Devrient and Mendelssohn took the next step with their centenary performance of the *St. Matthew Passion*. It and the *Passion According to St. John* were both published in 1830; the B minor Mass followed, half in Nov. 1832, the rest in 1845. Peters began a collected edition of "piano" and instrumental works in 1837; the organ works followed in 1844–52; and Mendelssohn edited an important collection of chorale preludes for Coventry and Hollier in 1845.

Encouraged by Schumann, the Bachgesellschaft (BG) was founded in the centenary year 1850. By 1900 all the known works had been published, and the BG was succeeded by the Neue Bachgesellschaft (NBG). It organizes festivals and publishes popular editions, but is chiefly important for its research journal, the *Bach-Jahrbuch* (from 1904).

By 1950 the deficiencies of the BG edition had become painfully obvious, and the Bach-Institut was founded, with headquarters at Göttingen and Leipzig, to produce a new standard edition (the *Neue Bach-Ausgabe* or NBA), expected to comprise 84 volumes.

Besides these musical publications, biographical and critical works appeared. The most important was P. Spitta's monumental study, *Johann Sebastian Bach*, 2 vol. (1873, 1880), covering not only Bach's life and works but also a good deal of the historical background. Although wrong in many details, the book is indispensable to the Bach student. Valuable work, though more limited in scope, was done by C. H. Bitter, André Pirro, Albert Schweitzer, C. H. H. Parry, Harvey Grace and C. S. Terry, among others.

There had been a certain amount of antiquarian activity before 1800, at any rate in England; but the Bach revival was the first conspicuous example of the deliberate exhumation of old music, accompanied by biographical and critical studies; and it served as an inspiration and a model for subsequent work of that kind. The fact that library shelves groan under the weight of collected editions is largely the result of the enthusiasm of A. F. C. Kollmann, J. N. Forkel and Samuel Wesley, and the critical insight of P. Spitta. The revival is thus an interesting subject in its own right, and F. Blume's account of it, *Two Centuries of Bach* (1950), is well worth reading.

The Music in General.—Bach's working life, from about 1700 to 1750, covered a period of transition in musical history. The antique idea that the arts make their effect by "imitating nature" and appealing to the expert intellect fell out of favour, as being an incomplete explanation, and was largely replaced by the notion (perhaps equally unsatisfactory) that art ought to appeal to the emotions of the layman—the emotion felt by the composer being relived by the performer and so communicated to the listener—and that music could be explained in terms of rhetoric. These ideas—to the effect that the function of art is not to teach but to arouse feeling—were nothing new. In religious art they can be traced back to the Council of Trent (1545–63); and with them went an increasing emphasis on the personality of the creative artist, which can be traced back to about the same date. Ever since G. Vasari's *Vite* (1550) there had been an uneasy feeling that a painter's sketch might in some ways be better than his finished picture, because expressed with less restraint and more closely related to his original inspiration. These aesthetic principles led to a temporary rejection of counterpoint (*q.v.*) in

favour of homophonic tunefulness and clear-cut sectional forms, and in due course produced the classical sonata; they also affected the musical practice of symbolism.

Texture.—Soon after 1700 Telemann, like other bright young devotees of the Leipzig opera, was preaching the virtues of what he called "the new school of melodic composition" as against "the unmelodious artifices of the ancients." He meant that intricate counterpoint and esoteric symbolism are no substitutes for a good tune. Between 1700 and 1708 Bach lived either in the far north or in the backwoods of Thuringia, and the ideas of the new school had little effect on him till he moved to Weimar, became friendly with Telemann and saw how those ideas had already been put into practice by Italian concerto-composers such as Vivaldi. Between 1708 and 1714 his style underwent a profound change; and thereafter, although he never went all the way with the innovators, he was never an old fogy who deliberately turned his back on the new music of his day. Albert Schweitzer's fatally memorable dictum ("Bach is thus a terminal point. Nothing comes from him; everything merely leads up to him") is a dangerously misleading half-truth. It has done incalculable harm, by leading students to suppose that Bach's aesthetic principles were those of 1600 rather than of 1710, and that in such practical matters as interpreting ornaments the testimony of Bach's own son is less valuable than that of any foreigner or German nonentity who was born a few years before 1685.

Of Bach's major works, the first that became readily accessible was the "Forty-eight Preludes and Fugues." As a desiccated form of fugue makes a convenient subject for examinations, the emphasis has always been on the fugues, with the result that Bach's name has become almost synonymous with fugue and with elaborate counterpoint in general. In fact, he wrote much less counterpoint than he is usually given credit for; if circumstances had permitted the cantatas and the clavier *Partitas* to become household words, a very different conception of Bach would have come into being. *Secco* recitatives are not contrapuntal; arias accompanied by *continuo* alone are not necessarily any more contrapuntal than 19th-century songs accompanied by arpeggios or repeated chords; arias for *continuo* and one *obbligato* instrument are comparable with songs whose accompaniment has some independent interest: and such movements bulk large in Bach's output. From this point of view the dance pieces also are worth examining; many of them can only be described as accompanied melodies.

Bach's attitude was shrewdly summed up by an anonymous author (probably Mizler) in 1738: "if Herr Bach often writes more elaborate inner parts than other composers do, he has modelled his music on that of 20 or 25 years ago. He can write otherwise, however, when he wants to." The author goes on to say that a recent secular cantata, whose music has been lost, was "entirely according to the latest taste, and approved by everyone." These remarks were provoked by J. A. Scheibe's attack on Bach's "turgidity," in 1737. At the time, Scheibe's criticism was not unreasonable, as can be seen from Mizler's admission about Bach's unfashionably elaborate inner parts. But it is a mistake to ignore Mizler's words: "He can write otherwise, however, when he wants to," or to forget that Scheibe himself had realized this by 1739, when he praised the *Italian Concerto* to the skies.

Again, much has been made of the story that Bach used to take Friedemann to Dresden "to hear the pretty tunes." It is generally assumed that "pretty tunes" was an expression of contempt. The fact remains that Bach frequently visited Dresden, and that in his last years (according to Emanuel) he admired, among others, Telemann, J. A. Hasse and both the Grauns (J. G. and C. H.). Emanuel wrote this in 1775. Hasse had retired, Telemann and the Grauns were dead; and there seems no reason why he should have misrepresented his father's taste.

So far, the safest conclusion seems to be that Bach was not a bigoted reactionary but a moderate progressive; and there is other evidence pointing in the same direction.

Forms.—In discussing Bach's forms, one must distinguish between those that are intrinsically logical and those that are not, a reasonable key-scheme always being assumed. Intrinsically logical forms—fugues, ground basses, ritornello and *da capo* movements—are all based, like the classical sonata, on repetition of recognizable themes. Illogical forms may be exemplified by such things as the *Chromatic Fantasia*—rhapsodical outpourings, beyond the reach of structural analysis, but effective when based on a rhetorical scheme of contrast or intensification—and also by chorale preludes of the motet type. Here each line of the chorale is fugued separately; and since, as a rule, most of the lines are different, such a prelude is simply a string of short fugues on unrelated subjects. It requires educated listeners who know the chorale by heart; and such coherence as it may have is in fact supplied by the listeners, who note each line of the chorale as it occurs and consciously look forward to the next one.

As one would expect, 18th-century developments in matters of form can be interpreted as rational consequences of the increasing emphasis on emotion, rather than intellectual activity, as the source of artistic enjoyment. Rhapsodical writing could be regarded as written-out improvisation—a close approximation to direct emotional contact between composer and listener, having virtues similar to those of a painter's sketch. It became less common but did not disappear. Motet form, because of its intrinsic incoherence, and the ground bass, because of its very narrow limitations, became less popular. Fugue, as such, suffered for its supposed turgidity; but it staged a comeback, even in advanced circles in Berlin, about 1750, and some elements of fugue technique remained in favour throughout the period. They were too useful to be discarded; a fugal exposition, which could be written to rule in a few minutes, was a good way of getting a movement started and called for little real thought. But the typical forms of the period were the intrinsically logical ones that depended on repetition but were not necessarily contrapuntal—the ritornello and *da capo* forms, leading ultimately to the classical sonata.

Here again Bach appears as a moderate progressive. At Weimar, between 1708 and 1714, he studied the concertos of such composers as Vivaldi, and thereafter his taste in form was that of his age. He almost ceased to write rhapsodically. He did not reject motet form—the prelude on *Vor deinen Thron*, supposed to have been dictated on his deathbed, is not only in motet form but, what is much more significant, was deliberately rewritten in that form—but he used it less frequently. He continued to use fugal devices and to write whole fugues, but until his last years (when counterpoint was again just beginning to be considered respectable) he showed no special liking for the form. His favourite forms were the intrinsically logical but noncontrapuntal ones. The *da capo* and ritornello principles governed a host of arias and concerto movements, influenced many of his larger fugues (especially the mature ones for organ) and profoundly affected his treatment of chorales. A mature setting of a chorale melody, whether in an organ prelude or a cantata chorus, is usually a ritornello movement, constructed on concerto principles. The chorale lines are interludes, comparable with the solo sections of a concerto; what holds the movement together is the repetition of ritornello material—material that often has nothing to do with the chorale.

Occasionally Bach looked further into the future. As is well known, some of the preludes of the "Forty-eight" come very close to sonata form; and there are other examples in the clavier *Partitas*. The *sarabande* of *Partita IV* has a "first subject," a "second subject" in the dominant, a long modulating "development" and a "recapitulation" of first and second subjects, both in the tonic. The *corrente* of *Partita VI* has a similar but much larger scheme, and these are merely two examples out of several in these neglected works, written about 1725–30. In other ways also, the *Partitas* show the supposedly reactionary Bach demolishing conventions. The saraband had become stereotyped as a sober little piece in triple time, almost always beginning on the first beat of the bar. In the last four *Partitas*, three sarabands begin emphatically on an offbeat, and all four are not only totally unlike the stereotype but also totally unlike each other. The term saraband is here nothing more than a conventional title for a fancy piece in triple time. When Emanuel Bach wrote a fancy saraband and called it *La Stahl* (about 1762), he was doing little more than his father had done in 1725.

It must also be remembered that Bach was one of the first composers to write harpsichord concertos, and to use the harpsichordist's right hand as an *obbligato* part in trio sonatas. As for his organ solos in the trio-sonata style, they may perhaps be a synthesis of ideas derived from certain chorale-prelude types, from chamber music and from the Italianate concertos that he and Johann Gottfried Walther arranged for organ; but the synthesis was an entirely original one. Bach seems at first to have written these trios singly; he then used them in two ways. While at Weimar he experimented two or three times with a sonatalike (or rather, concertolike) organ form obtained by inserting a trio between a prelude and a fugue. At least one of these experiments (with the short Prelude and Fugue in C [*Bach-Werke-Verzeichnis,* BWV 545]) was successful; and the only reason why it is not familiar today is that Bach himself withdrew the central trio and used it in a complete organ sonata. The date at which Bach began to think in terms of complete sonatas is not known, perhaps at Weimar, certainly before 1731, and the complete sonatas were even more unprecedented than the single trios. The idea was taken up by his pupils, and in 1788 Emanuel Bach described the sonatas as "so galant that they still sound very well." In all these ways, therefore, Bach showed an inventiveness that was entirely in accordance with the spirit of the age.

Symbolism.—The question of Bach's attitude to symbolism is bound up with that of his "modernity." The symbolism that has been read into his music is, roughly speaking, of two kinds: abstract and pictorial. Schweitzer and his followers thought that Bach used a system of motives, not unlike Wagner's, with certain rhythmic and melodic figures standing for such abstractions as joy or confident faith. It is easy to show that Bach did not use these motives consistently, and that they are nothing more than stock figures. Again, various theorists of Bach's day made lists of keys that they considered suitable for joyful or sorrowful music. The lists do not agree, and during Bach's lifetime the whole idea became discredited; it had been challenged by Johann Kuhnau, in the preface to his *Bible Sonatas,* as early as 1700. Today there can be few who believe that Bach made any serious use of abstract symbolism.

Pictorial symbolism occurs when a composer writes a rising scale to match words that speak of rising from the dead; or a descending chromatic scale (depicting a howl of pain), to sorrowful words; or a fugue with ten entries of the subject, to words that refer to the Ten Commandments. It occurs only in connection with words—in vocal music, and in chorale preludes, where the words of the chorale are in the listener's mind. There is no point in looking for resurrection motives in the "Forty-eight." But, even so, pictorialism is common in Bach. The question is: Why did he use it? Did he expect his audiences to listen for it and understand it, and did he think that it intensified the expressive power of his music? As he is not known to have said a word about this or any other form of symbolism, the answer to this question is a matter of opinion.

Pictorialism seems to be a fundamental musical instinct; it has been used by almost every composer of importance from the madrigalists to the present day. In 1597 Thomas Morley taught it as a matter of course, a way of "imitating Nature," and it was common throughout the 17th century; but about 1700 it began to be regarded with suspicion, as men came to realize that a composer's business is to grasp the emotional drift of his libretto as a whole and that pictorial emphasis on individual words often injures the general effect. Furthermore, the forms then coming into use required the same notes to be repeated to different words, and this made pictorialism difficult, if not impossible. The result was that after 1750 composers and commentators either said nothing about pictorialism or apologized for it (as Beethoven did in the *Pastoral Symphony*)—until Schweitzer thought he could trace another quasi-Wagnerian system of "motives" in Bach's pictorialism.

Believing, as he did, that Bach drew his inspiration exclusively from the past, Schweitzer inevitably supposed that he took pictorialism seriously as a means of expression. Now that Bach is beginning to be regarded as a moderate progressive, one has to ask whether he really agreed with Morley and "the ancients," rather than with the skeptical Kuhnau (1700) and such members of the new school as J. D. Heinichen (1683–1729).

By 1711, Heinichen regarded pictorialism less as a means of expression than as an aid to invention. In those days composers earned their living by composing and often had to set dull words in a hurry. Heinichen pointed out that if a poem, as a whole, suggested nothing to a composer, he should look for individual words that could be treated pictorially. A dull poem about love might nevertheless suggest "the fires of love" and thus a flickering "fire motive." Alternatively, the composer might visualize a pompous man making advances to his lady and write a "comic" bass theme depicting his strutting gait and frequent bows. It is worth noting that Heinichen's "comic" theme incorporates a descending chromatic scale. This shows that orthodox commentators are wrong in imagining that such scales were universally understood as "grief motives."

There are three strong objections to the post-Schweitzerian view that Bach regarded pictorialism as a means of expression. Firstly, his pictorialism is sometimes inappropriate; as in the last aria of Cantata 166, where a solemn warning against earthly joys—"When Fortune laughs upon you, beware!"—is set to a laughter motive. Secondly, in revising a movement he sometimes destroyed its pictorial features; as in the *Deposuit* aria of the *Magnificat,* at the end of the ritornello. The first version puts the mighty down from their seat; the second version, musically superior, puts them most emphatically up. Thirdly, he adapted pictorial movements to other words, as in many of the pieces that were borrowed for use in the *Christmas Oratorio.* The allusion to writhing serpents in the secular Cantata 213 (no. 9, middle section) reappears in no. 4 of the *Oratorio* "Bereite dich, Zion" as a harmless arpeggio accompaniment.

On the whole, it is reasonable to conclude that with Bach, as with Heinichen in 1711 and Mattheson in 1739, pictorialism was often nothing more than an aid to invention. Schweitzer himself remarked on the excessive symbolism of the chorale cantatas; significantly, it is now known that these works were written under pressure—52 of them in one ecclesiastical year. Furthermore, Bach's best works are often not conspicuously pictorial. When a commentator spills much ink over a "masterpiece of symbolism," one often finds dull or unsuitable music, set to dull words.

Number symbolism is sometimes pictorial; in the *St. Matthew Passion* it is reasonable that the question "Lord, is it I?" should be asked 11 times, once by each of the faithful disciples. But almost any number may be called "symbolic" (3, 6, 7, 10, 11, 12, 14 and 41 are only a few examples); any multiple of such a number is itself symbolic; and the number of sharps in a key signature, notes in a fugue subject, entries of the subject, bars, notes in a whole movement, a chosen section of a movement or a single part may all be considered significant. As a result, it is easy to find symbolic numbers anywhere and ridiculous to suppose that such discoveries have any meaning.

To sum up: It is permissible to suppose that Bach was as up-to-date as Heinichen. If so, he used pictorialism partly by instinct, like any other composer; partly by habit, because he was used to seeing sorrowful words set to chromatic scales; and partly as an aid to invention. The reason why the subject has had to be discussed at some length is that it is greatly overemphasized in many otherwise excellent writings on Bach. It is in fact unimportant. It helps one to understand how he came to write such pointless movements as the last aria of Cantata 166; otherwise, it needs attention only when it is obvious; and in such cases Bach's pictorialism can be taken for granted, like Byrd's, Purcell's, Beethoven's or Wagner's. It is not necessary to read books about it.

Stylistic Development.—Any discussion of this subject must be tentative. Many of what seem to be Bach's earliest works are undated and probably undatable. Moreover, Spitta's chronology, which remained almost unchallenged until after 1950, was seriously upset in 1958 by the discoveries of Alfred Dürr and Georg von Dadelsen; and the consequences of the new chronology can be only slowly digested. Further, when Bach had the chance he would revise his works, perhaps two or three times; the date of the

final version (even if known) is therefore no clue to the date at which the broad outline of the work first came into his mind.

Bach inherited the mixed and rather old-fashioned musical culture of the Thuringian area, perhaps (through his brother, Johann Christoph) with a bias toward the orderly styles of the south. When circumstances took him to Lüneburg, he nevertheless learned eagerly from the northern rhapsodists, Buxtehude above all. By 1708 he had probably learned all that his German predecessors could teach him and arrived at a personal synthesis of northern and southern styles. He had also studied some French organ and instrumental music; but apart from a few alleged thematic borrowings there is little trace of French influence in Bach's music at any time of his life.

Among the few works that can be ascribed to these early years with anything more than a show of plausibility are the *Capriccio sopra la lontananza del suo fratello dilettissimo* (*Capriccio on the Departure of a Beloved Brother* [1704]); the chorale prelude on *Wie schön leuchtet* (*c.* 1705); the fragmentary early version (still unpublished) of the organ Prelude and Fugue in G minor (before 1707); Cantatas 131, 106 (?), 71, 196, 4 (?); and perhaps the organ Toccata and Fugue in D minor and Prelude and Fugue in D major.

As far as keyboard technique is concerned, Bach had already equaled the showiest of his predecessors (except possibly in organ double pedaling); but his keyboard writing was sometimes ungrateful. In rhapsodical writing (*see* above, the organ toccata) he was less violent than the average northerner and correspondingly more effective; he had already started on the path of increasing self-control that led through the *Chromatic Fantasia* and the organ *Fantasia* in G minor to the toccata of *Partita VI* (1725). Melodically there are traces of a desire for shapely expressive line, in the manner of the new school; but he had not yet broken away from the tricks of his predecessors, whose writing, even in fugue subjects, was riddled with repeated notes and changing-note formulas such as *e f e f, d e d e*. Repeated notes are also common in the declamatory vocal writing of the earliest cantatas (least noticeable in no. 4, where the voice parts are largely derived from a chorale). Rudiments of ritornello form can be detected here and there, but in movements of any size Bach generally obtained coherence (or a semblance of it) by fugue, motet form, or quasi-*ostinato* treatment. The organ Fugue in G minor, even in its early version, shows the concertolike division into sections with and without pedal, which is characteristic of the mature organ fugues; but preludial writing developed more slowly—the associated prelude is shapeless and ineffective.

The organ *Passacaglia*—a close imitation of Buxtehude, which cannot be much later than 1708—is worth mentioning as an early and amusing example of Bach's instinct for large-scale organization. To write a *passacaglia* of 168 bars on the traditional four-bar basses, a composer had to devise 41 variations (after stating the theme). The strain on the inventive faculty was very considerable, and was often lessened by such illogical devices as writing pairs of almost identical variations, metamorphosing the bass almost beyond recognition or even inserting what seem to be free interludes. Apparently it took Bach to see that with an eight-bar bass only 20 variations were necessary. His *Passacaglia* shows traces of the paired-variation device but otherwise is strictly logical, with neither free interludes nor unreasonable metamorphoses.

Most unfortunately, Bach's development cannot be traced in detail during the vital years 1708–14; there are too few datable works. From the series of cantatas written in 1714–16, however, it is obvious that he had been decisively influenced by the new school and the Italian concerto-composers, with results that have been mentioned already and can be seen in such cantatas as no. 182, 199, 61 (1714); 31, 161 (1715); and 208, 70, 147 (1716).

Among other works pretty certainly composed at Weimar are most of the *Orgelbüchlein;* all but the last of the so-called 18 Chorale Preludes; the earliest organ trios; and most of the organ preludes and fugues. The "Great" Prelude and Fugue in G major for organ (BWV 541) was finally revised about 1715, and the Toccata in F major may have been played at Weissenfels in 1714 or 1716. It has not yet been proved that any of the organ preludes and fugues were actually composed at Leipzig, though fair copies of the Preludes and Fugues in B minor and E minor ("The Wedge") were made about 1730.

The chief works of the Köthen period are listed above (see *Life*). Stylistically there does not seem to be any very notable change, partly, perhaps, because some of these works were composed at Weimar and only revised at Köthen.

As a result of the upheaval caused by the new chronology, it would be rash to attempt a detailed account of stylistic developments during Bach's earlier years at Leipzig; but the following hints may be useful. The lists of cantatas are far from complete, but they include works that are likely to be recorded.

In the early months of 1723 Bach produced Cantata 22, just possibly the *St. John Passion* (there is no real evidence for a performance before 1724) and perhaps one or two other works.

His first official performance was on May 30, 1723, the first Sunday after Trinity Sunday, with Cantata 75. New works produced during this year include Cantatas 76, 46, 77, 25, 95, 40; the motet *Jesu, meine Freude;* and the *Magnificat.* In these last two Bach toyed with the idea of unifying a work by making the last movement repeat or refer to the first. The idea does not seem to have appealed to him, though he returned to it in the motet *Fürchte dich nicht* (1726?), Parts II and III of the *Christmas Oratorio* (1734) and the *Goldberg Variations* (*c.* 1742). The first half of 1724 saw the production of Cantatas 65, 104, 166 and the *St. John Passion;* the latter was subsequently revised. The total number of cantatas produced during this ecclesiastical year was about 62, of which about 39 were new works.

On June 11, 1724, the first Sunday after Trinity, Bach began a fresh annual cycle of cantatas, and within the year he wrote 52 of the so-called chorale cantatas, formerly supposed to date from 1735–45. The chorale cantatas of 1724 include no. 20, 135, 10, 93, 8, 180, 38, 116 and 91. The Sanctus of the *B minor Mass* was produced at Christmas. Chorale cantatas of the first half of 1725 include no. 125, 127, 6, 87, 68, 175 and 176.

For the later months of 1725, only about nine cantatas have been preserved; these include no. 110 and 151. In 1726 Bach lightened the burden of composition by producing 18 cantatas by Johann Ludwig Bach, but also performed such works as Cantatas 13, 43, 45, 17, 27, 169 and 49. After this he lost interest in church cantatas, for reasons suggested above (see *Life* above); no. 140 (1731) and 14 (1735) are among the comparatively few that can be definitely dated after 1730. He did, however, produce the *St. Matthew Passion* in 1729 (like the *St. John,* it was subsequently revised) and a *St. Mark Passion,* which has disappeared, in 1731. It must also be remembered that the *Christmas Oratorio* is in fact a sequence of six cantatas.

Of the other Leipzig works, the most important have been mentioned under *Life,* above. Very tentatively, one may suggest that the works of this period show the following tendencies: (1) the themes and melodic lines become less broadly singable; they seem to be conceived more in terms of orchestral (not, as a rule, keyboard) instruments; (2) the harmony becomes smoother and more academic; various asperities in the E flat *Magnificat* of 1723 were removed in the D major revision of *c.* 1730; (3) about 1740, following (or perhaps anticipating) current taste, Bach began to exhibit an interest in elaborate counterpoint. He continued to "write otherwise when he wanted to," as in the third movement of the sonata in *The Musical Offering,* perhaps his most remarkable piece of *galanterie* (1747); but the characteristic compositions of these last years are the canons of the *Goldberg Variations,* of the variations on *Vom Himmel hoch* and of *The Musical Offering,* with the canonic and fugal complexities of *The Art of Fugue.* To judge by the numerous corrections made in *Vom Himmel hoch,* the supreme contrapuntist did not find strict canon particularly easy.

Spurious Works.—The following works (among many others, for which *see* Wolfgang Schmieder's *Bach-Werke-Verzeichnis*) are more or less certainly spurious: the *St. Luke Passion;* the *Magnificat* for soprano solo; the motets *Ich lasse dich nicht* (*I Wrestle and Pray*) and *Lob, Ehr' und Weisheit* (*Blessing and Glory*); Cantatas 15, 141, 142, 160, 189, 218, 219; the organ Concerto

in E flat; the Eight Short Preludes and Fugues; and the two chorale preludes in C on *Ach Gott und Herr.* Although Bach knew that the letters of his own name represented notes and were musically significant, it is doubtful whether any of the fugues on those notes are authentic, except the unfinished movement in *The Art of Fugue.*

Editions.—C. S. Terry once remarked: "Bach's business mind was as orderly as his counterpoint." The truth probably is that it was a great deal more orderly. It is unlikely that Bach ever spent a penny without knowing where it went; but in dealing with his own music he was slovenly. The second part of the *Clavierübung* was published twice during his lifetime; neither edition is correct, and in places the second is worse than the first.

For a summary account of editorial problems in general, *see* Walter Emery, *Editions and Musicians,* 2nd ed. (1958). First editions and facsimiles of autograph manuscripts are not infallible guides to Bach's intentions. In fact, they are often dangerously misleading, and practical musicians should take expert advice before consulting them. Editions published between 1752 and *c.* 1840 are little more than curiosities, chiefly interesting for the light they throw on the progress of the revival.

No comprehensive edition is trustworthy throughout; neither Peters, nor the BG, nor even the NBA (*see* above, *The Revival*). Nevertheless, students of Bach will do well to begin by finding out whether the music they want has been published by the NBA.

The word *Urtext* (original text) may lead the uninitiated to suppose that they are being offered an exact reproduction of what Bach wrote. It must be understood that the autographs of many important works no longer exist and that the extant autographs are often wrong. As a rule, Bach's intentions have to be pieced together from anything up to 20 sources, all different, and all more or less wrong. The result may come very close to what Bach meant, but does not necessarily represent what he wrote; in a certain sense, and to a strictly limited extent, it has been composed by the editor. This is inevitable, because of the mistakes made by 18th-century copyists and engravers, and, above all, because of Bach's own carelessness.

Until and unless they are superseded by the NBA, the following editions can be recommended. The "Forty-eight," ed. by H. Bischoff; the *Inventions, English Suites, Partitas, Italian Concerto* and *French Overture, Goldberg Variations* and *Gamba Sonatas,* in the Peters *Urtext* edition; the *St. John Passion,* ed. by A. Mendel; *The St. Matthew Passion* (in German), ed. by Max Schneider; the *Organ Sonatas* and *Orgelbüchlein,* ed. by John Dykes Bower and Walter Emery; *The Cantatas,* recent Breitkopf editions. *See* also Index references under "Bach, Johann Sebastian" in the Index volume.

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Karl and I. S. Geiringer, *The Bach Family* (1954), is a good general summary, with a long section on J. S. Bach, and a useful bibliography. The following works are worth noting: A. E. F. Dickinson, *The Art of J. S. Bach,* 2nd rev. ed. (1951); J. N. Forkel, *J. S. Bach: His Life, Art and Work,* trans. by C. S. Terry (1920); also in *The Bach Reader;* Harvey Grace, *The Organ Works of Bach* (1923); Hermann Keller, *Die Orgelwerke Bachs* (1948), *Die Klavierwerke Bachs* (1950); G. Kinsky, *Die Originalausgaben der Werke J. S. Bachs* (1937); W. Neumann, *Handbuch der Kantaten J. S. Bachs,* 2nd rev. ed. (1953); A. Schweitzer, *J. S. Bach,* trans. by E. Newman, 2 vol. (1911); P. Spitta, *Johann Sebastian Bach, His Work and Influence on the Music of Germany, 1685–1750,* trans. by C. Bell and J. A. Fuller-Maitland, 3 vol. (1883–85); C. S. Terry, *Bach,* 2nd. rev. ed. (1933); *Bach's Chorals,* 3 vol. (1915–21); *J. S. Bach: Cantata Texts, Sacred and Secular* (1926); D. F. Tovey, *A Companion to "The Art of Fugue"* (1931).

For the motets *see* W. G. Whittaker, *Fugitive Notes on Certain Cantatas and the Motets of J. S. Bach* (1924). For Bach's "modernity," *see* H. Besseler's contribution to *J. S. Bach in Thüringen* (1950), and Winfried Schrammek's article in *Bach-Jahrbuch* (1954). For symbolism, *see* W. Emery, "A Rationale of Bach's Symbolism" in *The Musical Times* (Oct. and Nov. 1954); H. Schwarzschild, "New Light on the Forty-eight" in *The Musical Times* (April 1956); and R. F. T. Bullivant, "Word-painting and Chromaticism in the Music of J. S. Bach" in *The Music Review* (Aug.–Nov. 1959).

For problems of performance *see* C. P. E. Bach, *Essay on the True Art of Playing Keyboard Instruments,* trans. and ed. by W. J. Mitchell 2nd ed. (1951); Walter Emery, *Bach's Ornaments* (1953); the preface to A. Mendel's edition of the *St. John Passion* (1951); and W. G. Whittaker (*see* above). There is no adequate discussion of the important but highly controversial question of how far the rhythmic conventions of the period (double-dotting, etc.) apply to Bach; but the chief possibilities are mentioned in Arnold Dolmetsch, *The Interpretation of the Music of the 17th and 18th Centuries* (1915) and in the article *Inégales* by Robert Donington in G. Grove, *Dictionary of Music and Musicians,* 5th ed. (1954). *See* also Sol Babitz, "A Problem of Rhythm in Baroque Music" in the *Musical Quarterly* (Oct. 1952). For continuo-playing *see* A. Mendel's preface (above), and F. T. Arnold, *The Art of Accompaniment From a Thorough-Bass as Practised in the XVIIth and XVIIIth Centuries* (1931). The following books make stimulating reading but need to be used with the greatest caution: W. G. Whittaker, *The Cantatas of Johann Sebastian Bach, Sacred and Secular,* 2 vol. (1959), and Erwin Bodky, *The Interpretation of Bach's Keyboard Works* (1960). (W. E.)

BACHAUMONT, the name of two French writers.

François Le Coigneux de Bachaumont (or Bois-Chaumont: 1624–1702) began a career in the *parlement* of Paris but resigned early for a life of ease. He is remembered as the originator of the name Fronde for the malcontents of 1648 and as co-author, with Chapelle (Claude Emmanuel Luillier), of the *Voyage de Chapelle et de Bachaumont,* a book of light verse and prose describing a journey through the south of France with much wit and occasional satire. First printed in 1663, the *Voyage* went through many editions, under varying titles, in the ensuing 200 years (modern ed. by D. Jouaust, 1874).

Louis Petit de Bachaumont (1690–1771), born in Paris on June 2, 1690, attached himself about 1730 to a widow, Mme Doublet (née Legendre), over whose *salon* he presided until his death (April 29, 1771). He recorded news and gossip of all sorts and circulated manuscript bulletins to subscribers. These bulletins were forbidden, but he still kept two registers, one for facts and one for rumours, incorporating anything that he thought to be of literary, theatrical, worldly or scandalous interest. The *Mémoires secrets pour servir à l'histoire de la république des lettres en France,* 36 vol. (1777–89), began with the posthumous publication of his material for the years 1762–71 (6 vol.); the following years, to 1787, were covered by continuators.

Bachaumont is most enjoyably read in selections. His tone is that of the contemporary Philosophes, skeptical and urbanely subversive. (J. G. R.-S.)

BACHELLER, IRVING ADDISON (1859–1950), U.S. novelist, the setting of whose books is generally upper New York state, was born in Pierpont, N.Y., on Sept. 26, 1859. He graduated from St. Lawrence university, Canton, N.Y., in 1882 and entered journalism. In 1883 in Brooklyn, N.Y., he founded the first modern newspaper syndicate and through its services distributed fiction by such writers as Joseph Conrad, Rudyard Kipling and Stephen Crane, as well as non-fictional material. From 1898 to 1900 he was editor of the *New York World.* Bacheller became extremely popular as a writer of fiction, being known especially for *Eben Holden: a Tale of the North Country* (1900), which sold over 1,000,000 copies. This novel about a hired man gives an authentic picture of 19th-century farm life and character in upper New York state. *D'ri and I* (1901), a novel about the battle of Lake Erie in the War of 1812, was also popular. His 31 published works are generally humorous and full of penetrating character delineations, especially of rural types. His own favourites were *The Light in the Clearing* (1917) and *A Man for the Ages* (1919), a story of Lincoln. *Opinions of a Cheerful Yankee* (1926), *Coming up the Road: Memories of a North Country Boyhood* (1928) and *From Stores of Memory* (1938) were autobiographical. He died at White Plains, N.Y., Feb. 24, 1950.

BACHELOR, a word derived from the medieval Lat. *baccalaris,* which seems originally to have designated a vassal of very low rank in the feudal hierarchy but soon to have been extended to men of subordinate position in other systems. Similarly, bachelor has been applied to various categories of persons as follows: (1) ecclesiastics of an inferior grade, for instance young monks or even recently appointed canons; (2) those belonging

to the lowest stage of knighthood (*see* KNIGHTHOOD, CHIVALRY AND ORDERS); (3) those holding the preliminary degree of a university, enabling them to proceed to that of master which alone entitled them to teach (in modern universities the degree of bachelor, which moreover may also be held by women, varies in its significance as a step toward other degrees, but in no case is the bachelor a full member of the university); (4) the younger or inferior members of a trade guild or city company, otherwise known as yeomen (now obsolete); (5) unmarried men, since these presumably have their fortunes yet to make.

Bachelors, in the sense of unmarried men, have in many countries been subjected to penal laws. In ancient Greece, at Sparta, citizens who remained unmarried after a certain age suffered various penalties, and at Athens, though there was no definite legislation on this matter, certain minor laws were evidently dictated by a spirit akin to the Spartan doctrine. At Rome, the *lex Julia et Papia Poppaea,* while restricting marriages between the several classes of the people, laid heavy penalties on unmarried persons, gave certain privileges to citizens with several children and imposed lighter penalties on married persons who were childless. Isolated instances of such penalties occur in western Europe during the middle ages. In Great Britain there has been no direct legislation bearing on bachelors, but occasionally taxes have been made to bear more heavily on them than on others; *e.g.*, two acts of 1695, which taxed bachelors to pay for the war with France, and the income tax of 1799, which also differentiated against bachelors. Since 1908, moreover, the British income tax law, by giving special abatements to men of family, has in effect taxed bachelors. The U.S. income tax law has a like effect. In Italy this principle was carried further by the Fascist governments under Mussolini, which imposed taxation directly on unmarried men.

BACHMAN, JOHN (1790–1874), U.S. naturalist and minister, most famous for his work with John James Audubon (*q.v.*), was born Feb. 4, 1790, in Rhinebeck, N.Y. He became a Lutheran minister in 1813 and founded both the Lutheran Synod of South Carolina, of which he was first president, and the state's Lutheran Theological seminary. Bachman wrote most of the Audubon-illustrated *Viviparous Quadrupeds of North America* and assisted Audubon in the preparation of his book on American birds. He was also the author of numerous other works on both nature and religion. He died in Columbia, S.C., Feb. 24, 1874.

See J. B. Haskell and C. Bachman, *John Bachman . . . Letters and Memories of his Life* (1888).

BACHOFEN, JOHANN JAKOB (1815–1887), Swiss anthropologist and jurist, was born in Basel, Dec. 22, 1815. He is remembered almost solely for *Das Mutterrecht* (1861), in which he challenged, for the first time, the prevailing patriarchal theory of social evolution. (*See* MATRILINY.) Having found evidence of matrilineal descent in ancient Greece and among primitive peoples of Africa and America, he formulated the following theory of social evolution: In the beginning a condition of promiscuity prevailed. This was followed by matriarchy. Then men gained the ascendancy and patriarchy was permanently established. Bachofen conceived of these sequences as universal stages of social evolution. He was correct in arguing for matrilineal descent, but matriliny is not matriarchy, and no society in which women were predominant has ever been found. The theory of primordial promiscuity has been shown to be invalid. Finally, Bachofen's sequences cannot be regarded as universal stages of evolution. However, by demonstrating the existence and prevalence of matrilineal descent, Bachofen exerted a salutary influence upon ethnological theory and research.

Bachofen was educated in Basel, Berlin, Cambridge and Paris. From 1841–45 he was professor of Roman law at the University of Basel, and from 1842 a judge in the criminal court of that city.

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(LE. A. W.)

BACICCIO (GIOVANNI BATTISTA GAULLI) (1639–1709), Italian painter, whose frescoes exemplify the most ambitious decorative style of the Roman baroque, was born on May 8, 1639, in Genoa where, a pupil of Luciano Borzone, he was also influenced by Van Dyck and Bernardo Strozzi. He moved to Rome about 1660. A visit to Parma in 1669, to study the frescoes of Correggio, left some mark on his style, but the chief formative influence upon him was that of Bernini, who befriended the young painter and introduced him to his circle of Roman patrons.

Baciccio's principal works are his fresco decorations in the Roman churches Sta. Agnese in the Piazza Navona (1668–71), the Gesù (finished 1683) and SS. Apostoli (1707). In these, and particularly in the Gesù, where Antonio Raggi's stuccoes are said to have been based on Baciccio's designs, he combined an ecstatic religious figure-style, derived from Bernini, and a melting, sensual treatment of the heads, derived from Correggio, with his own masterly organization of masses of light and shade and an attractive bravura of execution. He also painted altarpieces for various Roman churches and was well known as a portraitist of the papal circle. He died in Rome on April 2, 1709.

See R. Wittkower, *Art and Architecture in Italy 1600–1750* (1958).

(D. KG.)

BACILLARIOPHYCEAE: *see* DIATOMS.

BACILLUS, a genus of rod-shaped, spore-forming, aerobic bacteria of the family Bacillaceae, order Eubacteriales. Of the 25 or more species differentiated, relatively few are disease producing. *Bacillus anthracis* is the causative agent of anthrax (*q.v.*). *Bacillus larvae* and *B. alvei,* the causative agents of American and European foul brood of bees, respectively, do not cause disease in man (*see* BEEKEEPING); a few other species that cause disease in certain insect pests are used as biological control (*see* ENTOMOLOGY: *Principles of Insect Control*). Most of the other species of *Bacillus* are harmless saprophytes occurring in air, soil and dust; but one, *Bacillus subtilis,* is a rare cause of conjunctivitis in man.

The term bacillus is sometimes applied to any rod-shaped bacteria.

See BACTERIA. (W. BU.; X.)

BACK, SIR GEORGE (1796–1878), British explorer and sailor, who helped trace the North American arctic coast line, was born in Nov. 1796 at Stockport in Cheshire. Back entered the navy as a midshipman in 1808 and fought against the French in Spain and in North America. He was a member of Capt. D. Buchan's expedition of 1818 to Spitsbergen, sailing in the "Trent" under Lieut. J. Franklin; afterward he joined Franklin in exploring the Coppermine river in North America (1819–22) and the Mackenzie river (1825–27). Back offered, in 1833, to search for Capt. J. Ross, of whose arctic expedition nothing had been heard since 1829. He wintered at Ft. Reliance, near the Great Slave lake, where in April 1834 he heard that Ross had returned to England. Back, however, proceeded to explore the Great Fish river (later renamed the Back river), tracing it to its mouth on the Arctic ocean. On his return in Oct. 1835, he received the medal of the Royal Geographical society. He sailed in the "Terror" in 1836 to explore the North American coast line, from Repulse bay to the mouth of the Back river; but the ship was icebound for four months, and he returned in Sept. 1837 with his task unaccomplished. Back was prevented by ill-health from further activity. He was knighted in 1839 and was made an admiral in 1857. He died in London, on June 23, 1878.

He wrote *Narrative of the Arctic Land Expedition to the Mouth of the Great Fish River* (1836), and *Narrative of an Expedition in H.M.S. Terror* (1838).

BACK BOND (BACK LETTER), in Scots law, a deed qualifying the terms of another deed or declaratory of the purposes for which another deed has been granted. In Scotland, building societies usually take security in the form of an apparently absolute conveyance qualified by a back bond which expresses the limitation on their right and states the redemption terms. The transaction resembles the English deed of trust, and similar qualifying instruments are known in other countries. (M. C. ME.)

BACKBONE: *see* SKELETON, VERTEBRATE; SPINE, DISEASES

AND DISABILITIES OF; VERTEBRATE.

BACKGAMMON, a game of moving counters on a board or table, the object of the game being a race to a goal, and the movement of the counters being controlled by the throw of two dice. The elements of chance and skill are nicely balanced in backgammon so that each is usually essential to victory.

Precursors of backgammon are among the most ancient of all games. A playing board suitable for backgammon, found at Ur of the Chaldees, may date from as early as 3000 B.C. The ancient Greeks and Romans played a game, *ludus duodecim scriptorum* ("twelve-lined game"), which was identical or nearly so with modern backgammon. The game is still most generally played in the eastern Mediterranean countries. Oriental equivalents of backgammon are generally thought to be importations from the west, despite legends to the contrary. Those who place the invention of backgammon in the 10th century probably refer to the change from a board resembling the one used in pachisi (Indian precursor of parcheesi) to the present type. In early English writing, backgammon was "a game played within the tables," or more simply "tables"; Chaucer alludes to such a game. The many past variants of backgammon include Irish, ticktack (from *trictrac,* the French name for backgammon, imitative of the rattle of the dice), and many European, African and oriental games. In England Edmond Hoyle codified the rules and strategy of backgammon in 1743 and there has been little significant change, except for the introduction of "doubling," which produced a renascence of interest in backgammon about 1925.

AFTER THE LOUTERELL PSALTER

A GAME OF BACKGAMMON OR "TABLES" IN MEDIEVAL ENGLAND

Method of Play.—Backgammon is played by two persons, but three or more may participate in the stakes by chouette, that is, by one player agreeing to take all bets. The board (*see* diagram) comprises four sections, or tables, each marked with six narrow wedges, or points, in two alternating colours. The division between the inner and outer tables is the bar. The pieces, often called stones, are 15 white and 15 black draftsmen. The initial position is shown in the diagram. There is no standard notation, but the general practice is to consider the points on each side of the board as numbered from 1 to 12, from inner to outer table beginning with the ace point. The two stones initially posted on the adversary's 1-point, and also any stones subsequently placed in the adversary's inner table, are often called runners.

Each player has two dice and a dicebox. To commence a game, each casts one or two dice, as agreed, and the higher throw marks the first player. The latter either adopts the numbers thrown or, according to local custom, casts again, using both his own dice. Thereafter the players alternately cast both dice and move the stones accordingly. The movement is in opposite directions, from adversary's inner table to adversary's outer, thence to own outer, finally to own inner table and "off." The stones are moved from point to point, the exact number of points shown on the dice. The two numbers may be applied separately to two different stones or, in turn, to one. Doublets (identical numbers on the two dice) are taken twice over; *e.g.,* two sixes count as four sixes, making a total of 24 points traversed.

A point occupied by two or more stones of one colour is made by that player and cannot be occupied by the opponent. Any other point is open. The advance of a stone is legal only if it lands on a point not made by the opponent. When both numbers are applied to one stone, each is played separately and both landing places in its advance must be open. There is no limit to the number of stones that a player may pile on a point made by himself. A player must use both of his numbers if able and either number may be played first; but if he can use only one number he must use the higher if able. If he cannot use either, the turn passes.

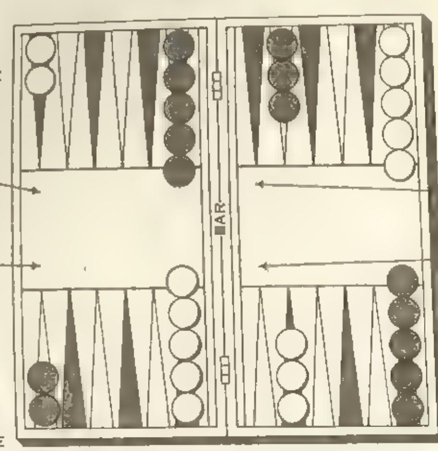
A single stone on a point is a blot, liable to be hit (or taken up) by an adverse stone landing on that point. If hit, a blot is picked up and placed literally on the bar, and the owner may make no other move until it is re-entered. Re-entry must be made in the adverse inner table, upon an open point of the same number as is cast with either die. A stone may re-enter and move in the same turn; *e.g.,* on the cast of 6–5, it may be entered on the adverse 5-point (if open) and then moved to the adverse 11-point. When a player makes all six points in his inner table he has a shutout; if he then hits an adverse blot, he alone continues to roll his dice until such time as he opens a point in the shutout and so affords his opponent possible entry. Making six adjacent points elsewhere than in one's own home table is called a side prime or prime; obviously, since each number cast is played separately and must land on an open point, it prevents the escape of adverse runners trapped behind it.

On getting all 15 of his stones into his own home table, a player may begin bearing off. This process is equivalent to continuing their movement in the same direction, upon imaginary points beyond the edge of the board. Once borne off, a stone stays off the board, but if a blot is hit (by an adverse stone in one's home table) it must be placed on the bar, re-entered and brought around to the home table again before bearing can be resumed. The player who first bears off all 15 stones wins the game. If the loser has borne off at least one stone, the game is a single; if he has borne none, it is a gammon and counts double, and if in addition he has any stone left in the winner's inner table, it is a backgammon and counts triple.

Doubling.—Backgammon is played for an agreed base stake, and modern practice is to allow voluntary doubling of stakes during the play. Either may offer the first double; thereafter the right to double alternates. A player may resign and pay the current stake, when a double is proposed by his opponent, in preference to playing on at the doubled stake. Gammon or backgammon further doubles or triples the stake. In addition, some allow automatic doubles. When the roll for first turn is a doublet, the stake is doubled; such automatic doubles are usually limited by agreement to one or two.

The Rules of Play.—According to Hoyle, a piece touched by the caster must be moved if possible, and a move is irrevocable after the piece is quitted. Modern club practice is to allow the caster to change his moves until he has picked up his dice. An incorrect move must be rectified on demand, but stands if the next roll has been made. If a die is cocked, both must be cast again (a die is cocked if it does not rest squarely on one face).

The Chief Principles of Play.—(1) To make points where they will have the best chance of obstructing the opponent. At the outset, the most valuable points to make are considered to be one's own 5-point, own 7-point (called the bar point) and adverse 5-point. (2) To minimize the hazard in leaving blots. The degree of risk that can be accepted in blotting is proportionate to the



A MODERN BACKGAMMON BOARD WITH PIECES IN POSITION AT THE BEGINNING OF PLAY

In addition to this special board, two dice are required to play the game

number of points open in the adverse inner table, and the opponent's prospects of making a prime, etc. If a blot must be left, it is evidently safer seven or more points away from its attacker than six or less. Exact odds on various plays can usually be calculated quickly as there are only 36 possible permutations of the two dice. (*See* Dice: *Probabilities*.)

For example, of the 36 possible rolls, 11 contain an ace, for an ace on either of two dice may be combined with any of five numbers on the other, making 10 different rolls, and the 11th roll is the doublet 1–1. The odds are thus 25 to 11 that a player will not roll an ace. In the same manner one learns that the odds of 25 to 11 apply when it is necessary to enter the opponent's inner table with only one of its points open.

Centuries of analysis have established certain moves as best to make on opening throws. In the following summary of these

First Throw	White's Move
6-5	B1-B12
6-4	B1-B11
6-3	B1-B10
6-2	B1-B9 or B12-W5
6-1	{ B12-W7, W8-W7 }
5-4	B1-B10 or { B1-B5, B12-W8 } or { B12-W8, B12-W9 }
5-3	{ W6-W3, W8-W3 } or { B12-W8, B12-W10 }
5-2	{ B12-W8, B12-W11 }
5-1	{ B12-W8, B1-B2 }
4-3	{ B12-W9, B12-W10 } or { B12-W9, B1-B4 }
4-2	{ W8-W4, W6-W4 }
4-1	{ B12-W9, B1-B2 }
3-2	{ B12-W10, B12-W11 } or { B12-W10, B1-B3 }
3-1	{ W8-W5, W6-W5 }
2-1	{ B12-W11, B1-B2 } or B12-W10

moves, it is White's first play. The notation B12-W7, would indicate that White moves one man from Black's 12-point to White's 7-point, and so forth, (see *Method of Play,* above). The classic move is given first; in some cases it is followed by an alternative move which is preferred by modern expert players.

When a player casts doublets on his first throw, his best play (if his opponent's previous move has not made it impossible) is considered to be as follows. In each case, two pieces are moved at a time:

Doublet	Move
1-1	{ W6-W5, W8-W7 }
6-6	{ B1-B7, B12-W7 }
5-5	B12-W3
4-4	B12-W5 or (a) { B12-W9, B1-B5 } or (a) B1-B9
3-3	B12-W7 or (a) { W8-W5, B1-B4 } or (b) { W8-W5, W6-W3 }
2-2	(a) B1-B5 or (c) { B1-B3, W6-W4 } or { B12-W11, W6-W4 }

(a) If Black has made his bar-point.
(b) Favoured by modern experts.
(c) If Black has made his 5-point.

Russian Backgammon.—This varies from the above game in that all stones are originally off the board, are entered in the same table and travel concurrently around to the same home table. Variants differ as to other rules. The first stone entered may be moved thereafter, or two men must be entered before moving.

Blots may be hit at any time; a blot must be re-entered before making any other move. Doublets are used twice over, together with the doublets on the opposite faces (opposite faces of a die total seven); sometimes the opposite doublets may be used first, and sometimes the caster may roll a second time after throwing doublets. This privilege is lost if he cannot use all of his first roll, and sometimes his opponent is allowed to use what he cannot. Complementary doublets and the second roll are usually barred on the first turn.

Acey Deucey.—This is a variant in which the roll of 2–1 gives special privileges, as choice of any doublet and a second turn. The rules differ widely in various localities. It is usual to begin with all men off the board, as in Russian backgammon.

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BACKHAUS, WILHELM (1884–), German pianist, best known for his interpretation of the works of Beethoven. Born March 26, 1884, at Leipzig, he studied there with A. Reckendorf and later with Eugen d'Albert in Frankfurt am Main. His first concert appearance was at the age of 8, and at 16 he made his first appearance abroad, in London. In 1905 he won the Rubinstein prize in Paris, and from 1912 to 1914 he toured the United States. He has held several teaching appointments: in 1905 he taught at the Royal Manchester College of Music, and played often with the Hallé orchestra under Hans Richter, who turned his attention to the music of Brahms. He also taught at Sondershausen (1907) and at the Curtis institute, Philadelphia (1925). After World War II he settled in Lugano in Switzerland but continued to spend his time touring and also recording. His style is marked by the devotion with which he subordinates his brilliant technique to the expression of the composer's intention, and by a clarity of tone that never lacks warmth. His remarkable memory has become legendary.

BACKHUYSEN (Bakhuysen, Backhuizen), **LUDOLF** (1631–1708), Dutch painter, celebrated for his sea pieces, was born on Dec. 18, 1631, at Emden, Hanover. He studied under Allart van Everdingen and Hendrik Dubbels. His numerous compositions are nearly all variations of one subject, and in a style peculiarly his own, marked by intense realism. In his later years Backhuysen employed his time in etching and calligraphy. He died in Amsterdam on Nov. 17, 1708.

BACK RIVER, formerly Great Fish river, in Mackenzie and Keewatin districts, Northwest Territories, Can., rises in a small lake about 120 mi. northeast of eastern Great Slave lake, at a height of about 1,280 ft. above sea level.

Named for Capt. (later Sir George) Back who descended the river to Chantrey inlet on the Arctic ocean in 1834, it is the longest river (605 mi.) in the Barren Grounds, but is not a usable waterway because of numerous rapids and falls. There is a tortuous upper course to Beechey lake. Downstream the flow slackens and the river leads through large sand areas containing Pelly, Garry and Macdougall lakes. From there it descends 450 ft. in 220 mi. through hill country.

Back river receives most of its tributaries from the south. Its largest tributary, Hayes river, enters south of Chantrey inlet from the east. There is a Roman Catholic mission for the inland Eskimos at Garry lake. (An. Kr.)

BACKUS, ISAAC (1724–1806), U.S. religious leader and historian, was born in Norwich, Conn., Jan. 9, 1724. Although he did not attend a college or religious seminary, he was awarded an honorary degree by Rhode Island college (now Brown university) in 1797. He was a controversial figure in religious disputes and for many years as an itinerant preacher in Massachusetts and Connecticut carried on his fight for religious freedom. He became the leading spokesman for the Baptist church. As historian, his leading contribution was *A History of New England, With Particular Reference to the Denomination of Christians Called Baptists*, published in three volumes (1777–96). A revision, edited by David Weston, was published in 1871. (E. E. R.)

BACOLOD, CITY OF, a chartered city and capital of Negros Occidental province, Philippines, lies on the western side of Negros Island, opposite the small island of Guimaras. Pop. (1960) 119,169. A paved coastal highway extends both north and south from the city.

A regional trade centre 330 mi. S.E. of Manila and the largest urban unit on the island, Bacolod has expanded rapidly. Since 1918 its population has progressively grown and in 1960 the increase was 17% above the 1948 census figure. This growth is explained, in part, by the fact that it is the capital of the wealthiest province and centrally located within the nation's most im-

portant sugar-producing area.

Bacolod lies on a flat coastal plain amid rice paddies and cane fields. It has a rectangular street pattern, unusual in Philippine coastal communities. In the northern part of the city are the large concrete capitol building, set amid spacious landscaped grounds; a 100-bed provincial hospital; and the provincial high school. The stone church and convent are on the plaza in the central business district.

The airport is at the southern limits of the city. The nearest sugar central (mill) is $1\frac{1}{2}$ mi. from the coast. There are many modern residences, owned by wealthy planters. The vernacular is a dialect of Visaya (Bisaya). (AN. C.)

BACON, FRANCIS, BARON VERULAM, VISCOUNT ST. ALBANS (1561–1626), lord chancellor of England, philosopher and man of letters. He long failed to attain in politics a position consonant with his birth and ability, ultimately owing his tenure of office to his support of the doctrine of royal prerogative and to the patronage of George, duke of Buckingham, the king's favourite. His position as a herald of the "new philosophy" (modern science) at the transition between medieval and modern thought, his breadth of vision and his pungency of style have made him more influential in the history of ideas than many greater philosophers. His *Essays* stand apart from his other writings and by their vivid aphoristic style would themselves ensure him a place in English literature.

LIFE

Francis Bacon was born on Jan. 22, 1561, in London; he was the younger son of Sir Nicholas Bacon, lord keeper, by his second wife Ann, daughter of Sir Anthony Cooke and sister-in-law of Sir William Cecil, Lord Burghley. In April 1573 he entered Trinity college, Cambridge. On June 27, 1576, he and his elder brother Anthony were admitted to Gray's Inn, but a few months later he went abroad with Sir Amias Paulet, the English ambassador to France. In 1579, after his father's death, he returned to England and took up residence at Gray's Inn, where he was admitted an outer barrister in 1582. Two years earlier he had applied unsuccessfully through his uncle, lord treasurer Burghley, for preferment in the royal service. In 1584 he was chosen member of parliament for Melcombe Regis in Dorset, and during the winter of 1584–85 he wrote a "Letter of Advice to Queen Elizabeth" which reveals a political judgment mature beyond his years and a coolness of temper considerably in advance of the times. In it he advocated not only a milder treatment of the Puritans but also, for Catholics, replacement of the oath of supremacy by an oath acknowledging that any Englishman would be a traitor if he refused to bear arms against any foreign enemy, the pope included.

In the 1586 parliament Bacon sat for Taunton and in that of 1589 for Liverpool, serving on a number of committees. Still lacking official preferment, he next attached himself, probably in 1591, to the queen's favourite, the young earl of Essex. He became one of Essex's confidential advisers and early in 1593 he drew his brother, Anthony, into the earl's service. However, in the parliament of 1593, when he sat for Middlesex, he seriously marred his prospects by his determined but untimely opposition to the government's demand for a triple subsidy to help to meet the expenses of the Spanish war. This conduct turned the queen against him and when the office of attorney general fell vacant she would not listen to Essex's enthusiastic advocacy of his claims. Instead, she appointed (1594) Sir Edward Coke, whom Burghley had supported. Even when, in the next year, Burghley joined Essex in recommending Bacon for the post of solicitor general, the queen still refused to appoint him, although she did make him one of her learned counsel.

Essex sought to make up for these disappointments by pressing upon him the gift of a piece of land at Twickenham. He also recommended him again—and again without success—for the post of master of the rolls. It seems, indeed, that this all-too-insistent advocacy was more of a hindrance than a help. Moreover, Bacon had begun to feel doubts about his patron's courses. Essex had always been attracted to an active career and enamoured of military renown. Also he was impetuous and easily provoked to rash actions when his counsels were resisted or rejected. In 1596, after the Cádiz expedition, he had become the idol of the military men and of the populace and Bacon saw clearly that for such a man to court such a reputation must assuredly alienate the queen's affections and arouse her fears. Accordingly he wrote (Oct. 1596) to Essex, urging him to seek the favour of the queen alone and to shun any appearance of popularity or of a "military dependency." His advice had little effect, for Essex was by then absorbed in the preparations against invasion and afterward, in 1597, with the Islands voyage. Bacon, who early in 1597 increased his reputation by the publication of a volume containing his first *Essays*, together with the *Colours of Good and Evil* and the *Meditationes sacrae*, remained on friendly terms with the earl and in 1598 was writing advice to him about Irish problems. After Essex's disgrace (1599), in consequence of his failure in Ireland and his unauthorized return to court, Bacon seems to have made some effort to mitigate the queen's wrath, but he also took a minor part, as one of her learned counsel, in accusing his patron at his informal trial before a body of privy councillors in June 1600. Essex bore him no ill will and shortly after his release was again on friendly terms with him. In Essex's desperate project of seizing the queen's person, forcing her to dismiss his rivals and rousing the city of London in his support, Bacon had neither share nor knowledge and after the abortive rebellion of Feb. 8, 1601, he played a prominent part, as queen's counsel, in the trial of the rebels, and helped considerably to secure Essex's conviction for treason. By thus biting the hand that had fed him, Bacon incurred much ill feeling, so much that in 1604 he published an *Apology* for his action. He had also been responsible for drafting in 1601 the official *Declaration of the Practices and Treasons Attempted and Committed by Robert, Late Earl of Essex*, though his draft was extensively altered and corrected by the queen and council. It is, of course, impossible to admire his conduct toward Essex; but it is only fair to remember that he often had warned the earl that "I love some things much better than I love your lordship, as the queen's service, her quiet and contentment, her honour, her favour, the good of my country and the like." Even so, his part in these actions and his efforts in the great monopolies debate of 1601 to guide the house of commons into courses not offensive to the queen did not win him any further advancement from Elizabeth. Nor did the accession of James I in 1603 bring immediate realization of his hopes. Through his cousin Robert Cecil he procured knighthood (July 1603). In 1604 he was confirmed as learned counsel and sat in the first parliament of the new reign as member for Ipswich, taking an active but not very successful part in the debates of its first session. He was also active as one of the commissioners for discussing a union with Scotland. In the autumn of 1605 he published his *Advancement of Learning*, dedicated to the king, and in the following summer he married Alice Barnham, the daughter of a London alderman. Preferment in the royal service, however, still eluded him, and it was not until June 1607 that his petitions and his vigorous though vain efforts to persuade the commons to accept the king's proposals for union with Scotland were at length rewarded with the post of solicitor general. Even then his political influence remained negligible, a fact which he came to attribute to the power and jealousy of Cecil, now earl of Salisbury and the king's chief minister. He had, however, not forgotten his project of reorganizing the study of natural science. He had surveyed the ground in the *Advancement of Learning;* and some short pieces not published at the time were probably written during the following two or three years. Toward the end of 1607 he sent to his friends a small tract entitled *Cogitata et Visa*, probably the first draft of the work now known under that title. In 1608 he wrote the panegyric *In felicem memoriam Elizabethae* and the learned and ingenious *De sapientia veterum*. He also completed what seems to have been the *Redargutio philosophiarum*, a treatise on the idols of the theatre.

After Salisbury's death (May 1612), Bacon renewed his efforts to gain influence with the king, writing a number of remarkable papers of advice upon affairs of state and, in particular, upon the relations between crown and parliament. The king did adopt his proposal for removing Coke from the common pleas to the king's

bench, transferring Sir Henry Hobart to the common pleas and putting Bacon in Hobart's place as attorney general (Oct. 1613). But, this apart, little heed was paid to his political advice, for James had fallen under the spell of Robert Carr (later earl of Somerset) and the Howards, while the "addled" parliament of 1614, in which Bacon sat for Cambridge university, showed an equal reluctance to listen to his counsels.

During the next few years, however, Bacon's views upon the royal prerogative brought him, as attorney general, increasingly into conflict with Coke, the champion of the common law and of the independence of the judges. It was Bacon who examined Coke when the king ordered the judges to be consulted individually and separately in the case of Edmond Peacham, a clergyman charged with treason as the author of an unpublished treatise justifying rebellion against oppression. It was he who instructed Coke and the other judges not to proceed in the case of commendams (holding of livings in the absence of the regular incumbent) until they had spoken with the king (*see* COKE, SIR EDWARD). Coke's dismissal (Nov. 1616) for defying this order was quickly followed by Bacon's appointment as lord keeper on March 7, 1617. It was largely to James's new favourite, George Villiers, later duke of Buckingham, that Bacon owed this advancement and also his promotion to be lord chancellor in Jan. 1618 and Baron Verulam in July. Yet Buckingham's favour still did not bring Bacon any real political influence and most of his time was still spent upon the judicial duties of his office. He displayed great energy as chancellor and also took a prominent part in the prosecutions of Sir Walter Raleigh (1618) and the earl of Suffolk (1619). Meanwhile he found time to enhance his fame by the publication in 1620 of his most celebrated work, the *Novum organum;* and on Jan. 27, 1621, he was created viscount St. Albans. Three days later parliament met for the first time since 1614 and soon the commons began to air their accumulated grievances, in particular against the king's grants of monopolies by patent. Bacon had earnestly pressed the king to recall the more obnoxious patents before parliament met but his advice had been ignored, and the commons then proposed to proceed against him as one of the referees who had certified that there was no legal objection to the grants. The proposal, however, was allowed to drop, probably because a more dangerous weapon was placed in the hands of his enemies. This was the accusation of bribery and corrupt dealings in chancery suits, an accusation apparently quite unexpected by Bacon but nevertheless the direct cause of his downfall. The charges against him rapidly accumulated and, giving up all idea of defense, he sent in a general confession of guilt. On May 3 the house of lords after considerable discussion decided upon the sentence, which was that he should undergo a fine of £40,000; that he should be imprisoned in the Tower during the king's pleasure; that he should forever be incapable of any office in the state; and that he should never sit in parliament, or come within the verge of the court. This sentence was executed only partially. The fine was in effect remitted by the king; imprisonment in the Tower lasted for about four days; a general pardon was made out and was passed in Oct. 1621. Bacon also received permission to come within the verge of the court, but he never sat again in parliament.

On the whole it appears that Bacon's own account of this painful episode is correct. He confesses (*Letters and Life*, vii, pp. 235–236) that he had received gifts from suitors involved in pending litigation. Yet he affirms that his intention was never swayed by a bribe; and in several cases his judgment appears to have been given against the party bestowing the bribe. Bacon was well aware that the practice was in itself indefensible. So far, then, as the mere taking of bribes was concerned, he would permit no defense, and his own judgment on his action contains as severe a condemnation as has ever been passed upon him. Yet he does not hesitate to call himself "the justest chancellor that hath been in the five changes since Sir Nicholas Bacon's time" (*Letters and Life*, vii, p. 560), on the plea that his intentions had always been pure and had never been affected by the presents received.

The remaining five years of his life were spent in work far more valuable to the world than anything he had accomplished in his high office. In March 1622 he presented to Prince Charles his *History of Henry VII.* In Nov. 1622 appeared the *Historia ventorum;* in Jan. 1623 the *Historia vitae et mortis;* and in Oct. the *De augmentis scientiarum,* a Latin translation, with many additions, of the *Advancement.* Finally, in 1625 he published his *Apophthegms* and *The Translation of Certain Psalms into English Verse,* dedicated to George Herbert; also, in 1625, a third and enlarged edition of the *Essays.*

His life then drew rapidly to a close. In March 1626, driving one day near Highgate and deciding on impulse to discover whether snow would delay the process of putrefaction, he stopped his carriage, purchased a fowl and assisted to stuff it with snow. He was seized with a sudden chill, considered to have brought on bronchitis, and died on April 9, 1626. (R. B. WM.)

BACON AS PHILOSOPHER AND STYLIST

Putting aside the letters and occasional writings, Bacon's works may be conveniently classified as professional, philosophical and literary, although it is impossible to consider him as a writer without considering his work as a whole, for he did not cease to be a stylist when he wrote philosophy nor abandon his philosophy, which indeed embodies his whole outlook on life, when writing even the most purely literary of his works, the *Essays.* The professional works include *The Learned Reading of Sir Francis Bacon Upon the Statute of Uses* (1642) and *The Elements of the Common Laws of England* (1630), part i of which consists of a collection of rules and maxims; part ii, on the use of the law, is probably not by Bacon. Bacon's legal writings exhibited a comprehensive intelligence of the abstract principles of jurisprudence, with a richness and ethical fullness that more than compensate for their lack of dry legal detail. Bacon seems to have been a lawyer of the first order, with a keen scientific insight into the bearings of isolated facts and a power of generalization which admirably fitted him for the self-imposed task, unfortunately never completed, of digesting or codifying the chaotic mass of the English law.

Philosophical Works.—The great mass of Bacon's philosophical writings consists of treatises or fragments, which either formed integral parts of his grand comprehensive scheme or were closely connected with it. More exactly they may be classified under three heads: writings originally intended to form parts of the *Instauratio* but which were afterward superseded or thrown aside; works connected with the *Instauratio* but not directly included in its plan; and writings which actually formed part of the *Instauratio magna.*

In the first group are some important tracts which certainly contain little, if anything, that was not afterward taken up and expanded in the more elaborate works but deserve attention because of the difference in the point of view and method of treatment. The most valuable are: (1) The *Advancement of Learning,* of which no detailed account need be given, as it is completely worked up into the *De augmentis* and takes its place as the first part of the *Instauratio.* Unlike most of Bacon's philosophical works, the *Advancement* was written in English. (2) *Valerius terminus,* a remarkable piece composed probably about 1603, though perhaps retouched at a later period. It contains a brief and somewhat obscure outline of the first two parts in the *Instauratio* and is of importance as affording some insight into the gradual development of the system in Bacon's own mind. (3) *Temporis partus masculus,* another curious fragment, remarkable not only for its contents but for its style, which is arrogant and offensive and in this respect unlike any other writing of Bacon's. (4) *Redargutio philosophiarum,* a highly finished piece in the form of an oration, composed probably about 1608 or 1609 and containing in considerable detail much of what afterward appeared in connection with the *Idola theatri* in book i of the *Novum organum.* (5) *Cogitata et visa,* perhaps the most important of the minor philosophical writings, dating from 1607 (though possibly the tract in its modern form may have been to some extent altered) and containing in weighty and sonorous Latin the substance of the first book of the *Organum.* (6) The *Descriptio globi intellectualis et thema coeli,* which is to some extent intermediate between the *Advancement* and the *De augmentis,* goes over in detail the general

classification of the sciences and enters particularly on some points of minor interest. (7) The brief tract *De interpretatione naturae sententiae duodecim* is evidently a first sketch of part of the *Novum organum*, and in phraseology is almost identical with it. (8) A few smaller pieces, such as the *Inquisitio de motu*, the *Calor et frigus*, the *Historia soni et auditus* and the *Phaenomena universi*, concerned respectively with motion, heat and cold, sound and natural phenomena, are early specimens of his *Natural History* and exhibit the first tentative applications of the new method.

The second group consists of treatises on subjects connected with the *Instauratio* but not forming part of it. The most interesting is the philosophic romance, the *New Atlantis*, a description of an ideal state in which the principles of the new philosophy are carried out by political machinery and under state guidance. The work was to have been completed by the addition of a second part, treating of the laws of a model commonwealth, which was never written. Another important tract is the *De principiis atque originibus secundum fabulas cupidinis et coeli*, where, under the disguise of two old mythological stories, Bacon (in the manner of *De sapientia veterum*) finds the deepest truths concealed. The tract is unusually interesting, for in it he discusses at some length the limits of science, the origin of things and the nature of primitive matter, giving at the same time full notices of Democritus among the ancient philosophers and of Telesio among the later ones. Deserving of attention also are the *Cogitationes de natura rerum*, probably written early, perhaps in 1605, and the treatise on the theory of the tides, *De fluxu et refluxu maris*, written probably about 1616.

Plan of the Instauratio.—In the third group the philosophical works which form part of the *Instauratio* must of course be classed according to the positions which they respectively hold in that scheme of the sciences. The great work, the reorganization of the sciences and the restoration of man to that command over nature which he was conceived to have lost by the fall of Adam, consisted in its final form of six divisions:

(1) *Partitiones scientiarum*, a survey of the sciences, either such as then existed or such as required to be constructed afresh—in fact, an inventory of all the possessions of the human mind. The famous classification on which this survey proceeds is based upon an analysis of the faculties and objects of human knowledge. (The division of the sciences adopted in the great French *Encyclopédie* was founded upon this classification of Bacon's; *see* ENCYCLOPAEDIA: *The French Encyclopaedists*.) This division is represented in the *Instauratio* by the *De augmentis scientiarum*.

(2) *Interpretatio Naturae.*—The new method, by which the mind of man is to be trained and directed in its progress toward the renovation of science. This division is represented, though only imperfectly, by the *Novum organum*, particularly book ii.

(3) *Historia Naturalis et Experimentalis.*—The new method is valueless, because inapplicable, unless it be supplied with materials duly collected and presented—in fact, unless there be formed a competent natural history of the *Phaenomena universi*. A short introductory sketch of the requisites of such a natural history, which according to Bacon is the *basis totius negotii*—the primary requirement—is given in the tract *Parasceve*, appended to the *Novum organum*. The principal works intended to form portions of the history, and either published by himself or left in manuscript, are *Historia ventorum, Historia vitae et mortis, Historia densi et rari* and the collection of facts and observations, *Sylva sylvarum*.

(4) *Scala Intellectus.*—It might have been supposed that the new philosophy could now be inaugurated. Materials had been supplied, along with a new method by which they were to be treated, and naturally the next step would be the finished result. But for practical purposes Bacon interposed two divisions between the preliminaries and the philosophy itself. The first was intended to consist of types or examples of investigations conducted by the new method, serviceable for keeping the whole process vividly before the mind or, as the title indicates, such that the mind could run rapidly up and down the several steps or grades in the process. Of this division there seems to be only one small fragment, the *Filum labyrinthi*.

(5) *Prodromi*, forerunners of the new philosophy. This part, strictly speaking, is quite extraneous to the general design. According to the *Distributio operis*, it was to contain certain speculations of Bacon's own, not formed by the new method but by the unassisted use of his understanding. These, therefore, form temporary or uncertain anticipations of the new philosophy. There is extant a short preface to this division of the work, and some of the miscellaneous treatises, such as *De principiis, De fluxu et refluxu maris, Cogitationes de natura rerum*, may have been intended to be included under this head. This supposition receives some support from the manner in which the fifth part is spoken of in the *Novum organum*, i, 116.

(6) The new philosophy, which is the work for future ages, and the result of the new method.

Bacon's Purpose.—Bacon's grand motive in his attempt to found the sciences anew was the intense conviction that the knowledge man possessed was of little service to him. "The knowledge whereof the world is now possessed, especially that of nature, extendeth not to magnitude and certainty of works." Man's sovereignty over nature, which can be founded on knowledge alone, had been lost, and instead of the free relation between things and the human mind there was nothing but vain notions and blind experiments. To restore the original commerce between man and nature and to re-establish the dominion of man (*imperium hominis*) is the grand object of all science. The want of success which had hitherto attended efforts in the same direction had been due to many causes but chiefly to the want of appreciation of the nature of philosophy and its real aim. The true philosophy is not the science of things divine and human; it is not the search after truth. "I find that even those that have sought knowledge for itself, and not for benefit or ostentation, or any practical enablement in the course of their life, have nevertheless propounded to themselves a wrong mark, namely satisfaction (which men call Truth) and not operation." "Is there any such happiness as for a man's mind to be raised above the confusion of things, where he may have the prospect of the order of nature and error of man? But is this a view of delight only and not of discovery? of contentment and not of benefit? Shall he not as well discern the riches of nature's warehouse as the beauty of her shop? Is truth ever barren? Shall he not be able thereby to produce worthy effects, and to endow the life of man with infinite commodities?" Philosophy is altogether practical; it is of little matter to the fortunes of humanity what abstract notions one may entertain concerning the ultimate nature and the principles of things. This truth, however, has never yet been recognized; it has not yet been seen that the true aim of all science is "to endow the condition and life of man with new powers or works," or "to extend more widely the limits of the power and greatness of man." Nevertheless, it is not to be imagined that by this being proposed as the great object of search there is thereby excluded all that has hitherto been looked upon as the higher aims of human life, such as the contemplation of truth. Not so, but by following the new aim we shall also arrive at a true knowledge of the universe in which we are, for without knowledge there is no power; truth and utility are in ultimate aspect the same; "works themselves are of greater value as pledges of truth than as contributing to the comforts of life."

Such was the conception of philosophy with which Bacon started and in which he felt himself to be thoroughly original. As his object was new and hitherto unproposed, so the method he intended to employ was different, he felt, from all modes of investigation hitherto attempted. "It would be," as he says, "an unsound fancy and self-contradictory to expect that things which have never yet been done can be done except by means which have never yet been tried." There were many obstacles in his way, and he seems always to have felt that the first part of the new scheme must be a *pars destruens*, a destructive criticism of all other methods. Opposition was to be expected, not only from previous philosophies but especially from the human mind itself. In the first place, natural antagonism must be looked for from the two opposed sects, the one of whom, in despair of knowledge, maintained that all science was impossible; while the other, resting on authority and on the learning that had been handed down from

the Greeks, declared that science was already completely known and consequently devoted their energies to methodizing and elaborating it. Secondly, within the domain of science itself, properly so-called, there were two "kind of rovers" who must be dismissed. The first were the speculative or logical philosophers, who construe the universe *ex analogia hominis* and not *ex analogia mundi*—or, in terms of their knowledge of man rather than of nature—who fashion nature according to preconceived ideas and who employ in their investigations syllogism and abstract reasoning. The second class, equally offensive, consisted of those who practised blind experience, which is mere groping in the dark (*vaga experientia mera palpatio est*), who occasionally hit upon good works or inventions, which, like Atalanta's apples, distracted them from further steady and gradual progress toward universal truth. In place of these straggling efforts of the unassisted human mind, a graduated system of helps was to be supplied by the use of which the mind, when placed on the right road, would proceed with unerring and mechanical certainty to the invention of new arts and sciences. Such were the peculiar functions of the new method, though it had not definitely appeared what that method was, or to what objects it could be applied.

The Idols.—Before proceeding to unfold his method Bacon found it necessary to enter in considerable detail upon the general subject of the obstacles to progress and devoted nearly the whole of the first book of the *Organum* to the examination of them. This discussion, though strictly speaking extraneous to the scheme, has always been looked upon as a most important part of his philosophy, and his name is perhaps as much associated with the doctrine of idols (*idola*) as with the theory of induction or the classification of the sciences. The doctrine of the kinds of fallacies or general classes of errors into which the human mind is prone to fall appears in many of the works written before the *Novum organum*, and the treatment of them varies in some respects. But the classification in the *Organum* has the author's sanction, and comparison of earlier notices, though a point of literary interest, has no important philosophic bearing. The *idola* (*Novum organum*, i, 39), false notions of things or erroneous ways of looking at nature, are of four kinds: the first two innate, pertaining to the very nature of the mind and not to be eradicated; the third creeping insensibly into men's minds and hence in a sense innate and inseparable; the fourth imposed from without.

The first kind is the *idola tribus*, idols of the tribe, fallacies incident to humanity or the race in general. Of these, the most prominent are the proneness to suppose in nature greater order and regularity than there actually is; the tendency to support a preconceived opinion by affirmative instances, neglecting all negative or opposed cases; and the tendency to generalize from few observations or to give reality to mere abstractions, figments of the mind. Manifold errors also result from the weakness of the senses, which affords scope for mere conjecture; from the influence exercised over the understanding by the will and passions; from the restless desire of the mind to penetrate to the ultimate principles of things; and from the belief that "man is the measure of the universe," whereas, in truth, the world is received by us in a distorted and erroneous manner. The second kind is the *idola specus*, idols of the cave, or errors incident to the peculiar mental or bodily constitution of each individual, for according to the state of the individual's mind is his view of things. Errors of this class are innumerable because there are numberless varieties of disposition; but some very prominent specimens can be indicated. These include the tendency to make all things subservient to or take the colour of some favourite subject; the extreme fondness and reverence for either what is ancient or what is modern; and excess in noting either differences or resemblances among things. A practical rule for avoiding these is also given: "In general let every student of nature take this as a rule, that whatever his mind seizes and dwells upon with particular satisfaction is to be held in suspicion." The third class consists of the *idola fori*, idols of the market place, errors arising from the influence exercised over the mind by mere words. This, according to Bacon, is the most troublesome kind of error and has been especially fatal in philosophy. For words introduce a fallacious mode of looking at things in two ways: first, there are some words that are really merely names for nonexistent things, which are yet supposed to exist simply because they have received a name; secondly, there are names hastily and unskilfully abstracted from a few objects and applied recklessly to all that have the faintest analogy with these objects, thus causing the grossest confusion. The fourth and last class is the *idola theatri*, idols of the theatre; *i.e.*, fallacious modes of thinking resulting from received systems of philosophy and from erroneous methods of demonstration. The criticism of the demonstrations is introduced later in close connection with Bacon's new method; they are the rival modes of procedure to which his own is definitely opposed. The philosophies which are "redargued" are divided into three classes, the sophistical, of which the best example is Aristotle, who, according to Bacon, forces nature into his abstract schemata and thinks to explain by definitions; the empirical, which from few and limited experiments leaps at once to general conclusions; and the superstitious, which corrupts philosophy by the introduction of poetical and theological notions. (In criticism of this famous analysis it may be mentioned that Bacon himself failed to discern a fifth set of idols, which may be termed the *idola academiae*, the idols of the schools, the fallacy of supposing that a blind though learned rule can take the place of judgment. It was this fifth idol that prevented Bacon from entering into the promised land of scientific discovery.)

The Importance of Natural Philosophy.—Such are the general causes of the errors that infest the human mind; by their exposure the way is cleared for the introduction of the new method. The nature of this method cannot be understood until it is seen exactly to what it is to be applied. What idea had Bacon of science, and how is his method connected with it? Now, the science which was specially and invariably contemplated by him was natural philosophy, the great mother of all the sciences; it was to him the type of scientific knowledge, and its method was the method of all true science. To discover exactly Bacon's view of the characteristics and the object of natural philosophy it is necessary to examine the place it holds in the general scheme furnished in the *Advancement* or *De augmentis*. All human knowledge, it is there laid down, may be referred to man's memory or imagination or reason. In the first, the bare facts presented to sense are collected and stored up; the exposition of them is history, which is either natural or civil. In the second, the materials of sense are separated or divided in ways not corresponding to nature but after the mind's own pleasure, and the result is poesy or feigned history. In the third, the materials are worked up after the model or pattern of nature, though we are prone to err in the progress from sense to reason; the result is philosophy, which is concerned either with God, with nature or with man. Natural philosophy is again divided into theoretical and practical, according as the end is contemplation or works. Theoretical natural philosophy has to deal with natural substances and qualities and is subdivided into physics and metaphysics. Physics inquires into the efficient and material causes of things; metaphysics into the formal and final causes. The principal objects of physics are concrete substances or abstract though physical qualities. The research into abstract qualities, the fundamental problem of physics, comes near to the metaphysical study of forms, which indeed differs from the first only in being more general and in having as its results a form strictly so-called; *i.e.*, a nature or quality which is a limitation or specific manifestation of some higher and better-known genus. Natural philosophy is, therefore, in ultimate resort the study of forms, and, consequently, the fundamental problem of philosophy in general is the discovery of these forms.

> On a given body to generate or superinduce a new nature or natures, is the work and aim of human power. . . . Of a given nature to discover the form or true specific difference, or nature engendering nature (*natura naturans*) or source of emanation (for these are the terms which are nearest to a description of the thing), is the work and aim of human knowledge.

Bacon's Concept of Forms.—The questions, then, whose answers give the key to the whole Baconian philosophy, may be put briefly thus—What are forms and how is it that knowledge of

them solves both the theoretical and the practical problem of science? Bacon himself, as may be seen from the passage quoted above, finds great difficulty in giving an adequate and exact definition of what he means by a form. As a general description, the following passage from the *Novum organum*, ii, 4, may be cited:

> The form of a nature is such that given the form the nature infallibly follows. . . . Again, the form is such that if it be taken away the nature infallibly vanishes. . . . Lastly, the true form is such that it deduces the given nature from some source of being which is inherent in more natures, and which is better known in the natural order of things than the form itself.

From this it would appear that since by a nature is meant some sensible quality, superinduced upon or possessed by a body, so by a form we are to understand the cause of that nature, which cause is itself a determinate case or manifestation of some general or abstract quality inherent in a greater number of objects. But all these are mostly marks by which a form may be recognized and do not explain what the form really is. A further definition is accordingly attempted in *Aphorism* 13:

> The form of a thing is the very thing itself, and the thing differs from the form no otherwise than as the apparent differs from the real, or the external from the internal, or the thing in reference to the man from the thing in reference to the universe.

This throws a new light on the question and from it the inference at once follows that the forms are the permanent causes or substances underlying all visible phenomena, which are merely manifestations of their activity. Are the forms, then, forces? At times it seems as if Bacon had approximated to this view of the nature of things, for in several passages he identifies forms with laws of activity. Thus, he says:

> When I speak of forms I mean nothing more than those laws and determinations of absolute actuality which govern and constitute any simple nature, as heat, light, weight, in every kind of matter and subject that is susceptible of them. Thus the form of heat or the form of light is the same thing as the law of heat or the law of light. . . . Matter rather than forms should be the object of our attention, its configurations and changes of configuration, and simple action, and law of action or motion; for forms are figments of the human mind, unless you call those laws of action forms. . . . Forms or true differences of things, which are in fact laws of pure act. . . . For though in nature nothing really exists besides individual bodies, performing pure individual acts according to a fixed law, yet in philosophy this very law, and the investigation, discovery and explanation of it, is the foundation as well of knowledge as of operation. And it is this law, with its clauses, that I mean when I speak of forms.

A study of the various passages in the *Novum organum* in which the definition of forms is attempted seems to show that Bacon's forms are no ideas or abstractions but highly general physical properties. Further, it is hinted that these general qualities may be looked upon as the modes of action of simple bodies. Thus, by a knowledge of forms, Bacon believed that man's practical control of nature would be enormously increased. For example, so long as we possess only certain practical recipes for the production of heat, these can be applied only when the requisite conditions are available. But, armed with the knowledge of what heat consists of (*i.e.,* the form of heat is violent, irregular, motion of particles), we can produce heat by any method which will induce such motion. This fruitful conception, however, Bacon does not work out; and though he uses the word cause and identifies form with formal cause, yet it is perfectly apparent that the modern notions of cause as dynamical and of nature as in a process of flow or development are foreign to him and that in his view nature was regarded in a purely statical aspect.

That the sciences are organically connected is a thought common to him and to his distinguished 13th-century predecessor, Roger Bacon. "I that hold it for a great impediment towards the advancement and further invention of knowledge, that particular arts and sciences have been disincorporated from general knowledge, do not understand one and the same thing which Cicero's discourse and the note and conceit of the Grecians in their word *circle learning* do intend. For I mean not that use which one science hath of another for ornament or help in practice; but I mean it directly of that use by way of supply of light and information, which the particulars and instances of one science do yield and present for the framing or correcting of the axioms of another science in their very truth and notion." In accordance with this, at the basis of all Bacon placed a body of general truth, common to all the sciences, which he called the *prima philosophia.* Following this summary philosophy come the sciences proper, rising like a pyramid in successive stages, the lowest stage being occupied by natural history or experience; the second by physics; the third, which is next the peak of unity, by metaphysics. The knowledge of the peak or of the one law which binds nature together is perhaps denied to man.

The Baconian Method.—Nature presented itself to Bacon's mind as a huge congeries of phenomena, the manifestations of some simple and primitive qualities, which were hidden from us by the complexity of things themselves. The world was a vast labyrinth, the clue to which, the *filum labyrinthi,* is the new method of induction. But the new method could not be applied until facts had been observed and collected. Concealed among the facts presented to sense are the causes or forms, and the problem therefore is so to analyze experience that we shall with certainty and mechanical ease arrive at a true conclusion. For this purpose Bacon proposed to draw up three "tables of comparative instances." We must have before us instances in which any given nature is present; instances in which it is absent; and instances in which the nature is present in different degrees. To make clear the nature of these tables let us take for example the case of heat. We wish to discover the form of heat; *i.e.,* the condition which is present or absent when heat is present or absent and which increases or decreases as heat increases or decreases. To do this we begin with a process of elimination of all those inessential conditions which are not found always and only in conjunction with the phenomenon of heat. Bacon, for instance, excludes the property of rarity, since metals such as gold are of very great density, even though heated. Thus, by a process of elimination, we should arrive at the true form of heat. But as it is exceedingly difficult to make our exclusive table at all exhaustive, Bacon proposes that we pause when a certain stage is reached and a tentative survey be made of the state of the inquiry. This survey, which he calls the "first vintage," is probably Bacon's nearest approximation to the modern conception of the formation of a scientific hypothesis, the department in which Bacon's chief weakness lay. It is evident that if the tables were complete and our notions of the respective phenomena clear the process of exclusion would lead infallibly to the detection of the cause or form. But it is just as evident that these conditions can never be fulfilled adequately. Such was the method devised by Bacon and to which he ascribed the qualities of absolute certainty and mechanical simplicity. But even supposing that this method were accurate and completely unfolded, it is evident that it could be made applicable and produce fruit only when the phenomena of the universe have been very completely tabulated and arranged.

Criticism of Bacon's Philosophy.—It has been pointed out, and with perfect justice, that science in its progress has not followed the Baconian method. The reason of this is not far to seek. The process of scientific discovery is essentially an act of judgment. Facts, phenomena, are infinite in number. We cannot choose them all, as Bacon would have had us do, and then pass them through a mill of logic and elicit a result. Still less dare we choose at random. The process of choosing facts is an act of judgment on the part of the man of science. His choice is doubtless limited by his knowledge of his art. He exercises his judgment to choose things which bear a certain relation to each other. But no knowledge of the nature of reasoning, however profound, nor even knowledge of his science, however complete, will make a man a scientific discoverer. The scientific man has, in fact, to practise two distinct mental processes, the making of the discovery and the demonstration of its truth. Essentially the two processes are distinct and the one might be largely developed while the other was in a state of relative arrest.

This distinction between the act and demonstration of discovery was consistently missed during the middle ages. Medieval thought is further distinguished from our own by the persistent conviction in those ages that a wide measure of truth could be

elicited from a very small series of observations by the extensive use of ratiocination. The latter error Bacon clearly discerned, and his discernment entitles him to rank as the herald of modern science. His claim that a direct appeal to nature was the only way to truth at once raised the functions of the observer while it tended to depress the vast medieval claims for ratiocination.

On the other point in which our thought is separated from that of the middle ages, however, Bacon remained in darkness. He succeeded indeed in emphasizing the importance of the operation of collection of facts, but he failed to perceive how deeply the act of judgment must be involved in the effective collection of facts.

Bacon's Influence.—It is significant that Bacon has made himself more felt in the department of the moral and metaphysical sciences than in the physical. While many who have written about science have done him homage—notably Voltaire and Jean le Rond d'Alembert and the other contributors to the *Encyclopédie* by whom he was regarded as "the greatest, the most universal and the most eloquent of the philosophers"—while men of science such as Gottfried Leibniz, Christiaan Huygens and, above all, Robert Boyle have had him in good regard, yet there is not the least evidence that these or any other eminent scientific men have ever followed his method. Despite Bacon's failure in the field of the practical application of his method, however, the world certainly owes to him some developments of high importance, which may be summarized as follows:

1. He did in fact set forth clearly the widening intellectual breach which separated the men of his day from the middle ages. He perceived the defects of the scholastic method, and in the clearness of his vision and explanation he stands above his contemporaries, men such as Tommaso Campanella (*q.v.*) (1568–1639) and Giordano Bruno (*q.v.*) (*c.* 1548–1600), who like him were striving toward a new form of intellectual activity.

2. English writers of the later 17th century concur in ascribing to the impetus of Bacon's writings the foundation of the Royal society (*q.v.*). It is one of the ironies of history, however, that Bacon himself was not associated with two of his English contemporaries who were notable exponents of the experimental method—William Gilbert and William Harvey (*qq.v.*).

3. It is perhaps in the department of psychological speculation that the influence of Bacon has been most marked. The basic principle of John Locke's work, *An Essay Concerning Humane Understanding* (1690), that all ideas are the product of sensation and of reflection is implicit in the first aphorism of Bacon's *Novum organum*, "Man, who is the servant and interpreter of nature, can act and understand no further than he has observed, either in operation or in contemplation, of the method and order of nature." The whole atmosphere of Locke's work is taken from or at least is characteristic of the *Novum organum*. Through the practical tendency of his philosophy and through Locke, Bacon was the father alike of English psychological speculation and of the empirical method in the department of ethics. Whatever his positive achievements may have been we may thus accord to him his own claim that he "rang the bell which called the wits together."

(C. St.; R. A.; J. M. M.; X.)

Literary Importance.—The most notable of Bacon's literary works are the *History of Henry VII*, the *Essays* and the *New Atlantis:* these stand out from among a number of eulogies, apothegms, paradoxes, speeches for masques, sacred meditations, collects, versified psalms and a few ascribed lyrics, by virtue of the interesting matter and equally for their dense and pungent style.

Bacon had large plans for a history of Britain but he had much else on hand and completed only the brilliant study of Henry VII. The diplomatic Tudors were congenial; in this history Bacon's wit is sharp in narrative and characterization. In the Utopian fiction there is a more leisurely eloquence. The *Essays*, which he associates with Seneca's *Epistles*, were ostensibly the most informal of his compositions but they have stood time's testing even better than the lucid, dignified *Advancement of Learning* which is finer in construction. The *Essays* are good value at any time but come best as an index to the volume of his total reflections. Edward Arber's *Harmony of the Essays* (1871) collects the three editions (10 essays in 1597; 38 in 1612; and 58 in 1625) and reveals Bacon at work. Similar exercises in addition and revising may be observed in his philosophical works. His secretary claims to have seen about 12 versions of *De augmentis* and comments "he did rather drive at a masculine and clear expression than at any fineness or affectation of phrases . . . if his style were polite, it was because he would do no otherwise."

Bacon made rhetorical collections in the *Promus of formularies and elegances* and the *Colours of Good and Evil* but it is misleading to confine attention to works deemed literary in any narrow sense. In *De augmentis VIII* he remarks that he was born "for letters," a claim as true as it is unusual. In the last analysis it is by force of style that he transmutes literature "of knowledge" into literature "of power." He admitted to lighting his torch at other men's candles; he left much unfinished; he lies open to the criticism of specialists on all sides, but among those who have used language reliably, forcibly and subtly he is unassailable. Yet it is not wise to approach him as a pure stylist; his is an applied art. He is always busy about some observation, reflection or argument and it is to this that his readers must first attend. The reward is to find delight stealing in by the stimulus of his images, the finely fashioned epigrams, the poised phrases, the elaborate build of his paragraphs and the accomplished varying of tone. He was distrustful of the imagination and would keep it to subserve the reason; the result is a display of rhetorical power such as his own theory of that art would have recognized and approved. He was alive to the dangers of language and yet fascinated by it. It is legitimate to infer that what his practice at the bar, in parliament and at court had taught him of the "points and stings" of words is reflected in the nicety and savour of those remarks in the *Essays* which have been quoted until they rank as proverbs. Bacon was interested in problems of communication and although he deplored the contemporary excesses in the cult of "choiceness of the phrase, and the round and clean composition of the sentence, and the sweet falling of clauses and the varying . . . with tropes and figures" it was his achievement to recover the balance of sense and sound without loss of these very graces. Jonson praised his oratory: "No man ever spoke more neatly, more pressly, more weightily . . . the fear of every man that heard him was, lest he should make an end."

This judgment is based on Bacon's use of English but he was bilingual and many characteristics could be illustrated as well from what he close to publish in Latin, as for instance, in the *De sapientia veterum*, a work worth more respect than it commonly receives. C. W. Lemmi has done it a service by relating it to the tradition of myth interpretation to which it belongs (*The Classic Deities in Bacon*, 1933).

Bacon was reserved by temperament, by necessity of high office and by genius and he is notoriously hard to know. He is never intimate except in an occasional letter, but he is not in an absolute sense inaccessible. It is his style that betrays his tastes, his biblical education, his sensuous alertness and above all reveals a mind continually "musing, searching, revolving new notions and ideas." To read him is "to be moved with a desire to know" and it is palpable from the preface to his *Pseudodoxia epidemica* that Sir Thomas Browne was stirred to follow him in investigating vulgar errors, for all that the follower's method and result differ so widely from his master's. Sir Henry Wotton, as provost of Eton, recommended Bacon to be read "in my domestic college as an ancient author." How he has fared in the modern world is usefully indicated by A. E. Taylor (1926) and by Rudolf Metz in "Bacon's part in the Intellectual Movement of his time," in *Seventeenth-Century Studies Presented to Sir Herbert Grierson* (1938). Perhaps all that Bacon himself would ask is still to be "weighed and considered."

(K. M. L.)

For the Bacon-Shakespeare controversy *see* the article SHAKESPEARE, WILLIAM.

See also Index references under "Bacon, Francis" in the Index volume.

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BACON, HENRY (1866–1924), U.S. architect whose work represents the classical revival styles of the late 19th and early 20th centuries, was born at Watseka, Ill., Nov. 28, 1866. He studied architecture at the University of Illinois and then joined the firm of McKim, Mead and White in New York city. Later he was a member of the firm of Brite and Bacon and after that worked independently. He successfully executed numerous commissions ranging from banks to bridges but came to specialize in public monuments and memorials. In 1911 he received his most important commission, the Lincoln memorial in Washington, D.C., now a major landmark of the capital city. He died Feb. 16, 1924, in New York.

See C. A. Platt's tribute to Bacon in R. U. Johnson *et al.* (eds.), *Commemorative Tributes to Page, Wilson, Bacon* (1925). (C. J. W.)

BACON, JOHN (1740–1799), British sculptor, was born in Southwark on Nov. 24, 1740, and apprenticed at 14 in a porcelain works at Lambeth. There he was at first employed in painting small ornamental pieces of china, but soon became modeler to the works. During his apprenticeship he improved the method of working statues in artificial stone, an art which he afterward carried to perfection. Bacon first attempted working in marble about 1763, and improved the method of transferring the form of the model to the marble (technically "getting out the points") by the invention of a more perfect instrument for the purpose. This instrument was more exact, took a correct measurement in every direction, was contained in a small compass and could be used upon either the model or the marble. In 1769 he won the first gold medal for sculpture given by the Royal Academy, his work being a bas-relief representing the escape of Aeneas from Troy. In 1770 he exhibited a figure of Mars, which gained him the gold medal of the Society of Arts and his election as associate of the Royal Academy. He was then engaged to execute a bust of George III, intended for Christ Church, Oxford. He died on Aug. 4, 1799. Perhaps his best works are to be found among the monuments in Westminster abbey.

BACON, LEONARD (1802–1881), U.S. Congregational preacher, church historian and writer, sometimes referred to as the "Congregational pope" of New England, was born at Detroit, Mich., on Feb. 19, 1802, the son of David Bacon (1771–1817), missionary among the Indians in Michigan. The son graduated at Yale in 1820 and at the Andover Theological seminary in 1823, and from 1825 until his death was minister in the First church (Congregational) in New Haven, Conn., although he gave up the active pastorate in 1866. He was, from 1826 to 1838, an editor of the *Christian Spectator;* was one of the founders of the *New Englander* (later the *Yale Review*), and, with R. S. Storrs, H. C. Bowen and others, of the *Independent* (1848). He served as acting professor of didactic theology at Yale university from 1866 to 1871 and as lecturer on church polity and U.S. church history from 1871 until his death.

An advocate of liberal orthodoxy himself, in all the heated theological controversies of the day Bacon used his influence to bring about harmony, and in the councils of the Congregational churches he manifested great ability both as a debater and as a parliamentarian. He also was identified with the temperance and antislavery movements, in which, as in most other controversies, he took a moderate course. His *Slavery Discussed in Occasional Essays From 1833 to 1846* (1846) exercised considerable influence upon Abraham Lincoln. The most important of his historical works is his *Genesis of the New England Churches* (1874). Bacon died on Dec. 24, 1881.

See the commemorative volume issued by his congregation (1882) and Williston Walker's *Ten New England Leaders* (1901).

(W. W.; X.)

BACON, NATHANIEL (1647–1676), Virginia planter and leader of "Bacon's rebellion" in 1676, was born in Suffolk, Eng., a kinsman of the famous Francis Bacon (*q.v.*). He graduated from Cambridge, toured the continent and studied law at Gray's Inn. Until shortly before his arrival in Virginia in 1674, Bacon was destined to the life of a country squire. His marriage to Elizabeth, daughter of Sir Edward Duke of Suffolk, was violently opposed by her father. Her disinheritance and the involvement of Bacon in a rather unsavory deal to defraud a neighbour of his inheritance contributed to Bacon's decision to migrate to America.

Adequately financed by his father, Bacon acquired two estates along the James river—a main plantation 40 mi. above Jamestown and an outer plantation at the present site of Richmond. By virtue of his social position and financial means, his kinship by marriage to Gov. William Berkeley, and the wealth and influence of his cousin, Nathaniel Bacon, Sr., he was appointed to the governor's council in less than one year after his arrival in Virginia.

The cordiality between Governor Berkeley and Bacon was short-lived. In part the differences seem to have been a result of personality conflicts between two ambitious and strong-minded men —an irascible, opinionated, aging, cautious and avaricious governor and his youthful, ambitious, impetuous and demagogic cousin. The initial dispute arose over the Indian policy espoused by Berkeley. Bacon endorsed a policy of removing all Indians in the interests of unlimited territorial expansion and as a revenge for Indian attacks on the frontier settlements. Berkeley, influenced by fear of a general Indian war, a sense of justice, a concern for the Indian trade and a desire to avoid the costs of a major conflict, advocated a policy of caution.

In defiance of Berkeley, Bacon organized an expedition against the Indians. At the start the governor branded Bacon a rebel but was soon forced by public pressure to give Bacon a commission. Later he again denounced Bacon's activities as rebellious and the latter turned his forces on Berkeley and for a time controlled practically all of Virginia.

At the height of his power Bacon died and the rebellion collapsed. Because he exploited the colonial grievances which stemmed in part from the arbitrary, self-perpetuating and privilege-seeking nature of Berkeley's government, Bacon often has been pictured as a democratic reformer and forerunner of the American Revolution, but many historians reject this interpretation.

See T. J. Wertenbaker, *Torchbearer of the Revolution* (1940) and W. E. Washburn, *The Governor and the Rebel* (1957). (Ra. Mu.)

BACON, SIR NICHOLAS (1509–1579), lord keeper of the great seal of England during the reign of Elizabeth I, was born at Chislehurst, Kent, the second son of Robert Bacon of Drinkstone, Suffolk. He was educated at Corpus Christi college, Cambridge. After spending some years in Paris, Bacon returned to England, entered Gray's Inn, and was called to the bar in 1533. He became a bencher of Gray's Inn in 1550 and treasurer two years later. He was appointed solicitor of the court of augmentations in 1537 and was made attorney of the court of wards and liveries in 1546. Despite his known Protestant sympathies he retained this office throughout the reign of Mary I, but he was forbidden to leave England.

The accession of Elizabeth I in Nov. 1558 brought Bacon immediately to prominence. He became a privy councilor, was knighted, and as lord keeper took custody of the great seal on Dec. 22. In April 1559 he was authorized to exercise the full jurisdiction of lord chancellor. Bacon was dismissed from court in 1564 when John Hales, of whom he was patron, displeased the queen by writing a pamphlet suggesting Lady Catherine Grey as Elizabeth's heir. But Bacon soon proved his innocence and regained his influence, later himself writing a reply to Sir Anthony Browne, another supporter of the house of Suffolk to which Lady Catherine belonged.

Bacon was a close friend of Sir William Cecil, afterward Lord Burghley, and of Matthew Parker, archbishop of Canterbury, and with them he did much to establish and maintain the Elizabethan church settlement. The conference between the Protestant and Catholic parties over which he presided in March 1559 weakened the power of the Catholics. He urged on the queen an alliance in 1561 with Navarre and the French Protestants; in the same year, he and Cecil persuaded her to refuse the pope's invitation to send representatives to the third assembly of the Council of Trent. He thoroughly distrusted Mary Stuart and he warned Elizabeth against the proposal made in 1569 to marry her to the duke of Norfolk and against plans for her restoration in 1570.

Bacon died in London on Feb. 20, 1579. He had been twice married and by his first wife Jane had three sons and three daughters. His eldest son, Nicholas, was in 1611 created premier baronet of England by James I. His sons by his second wife, Ann, were Anthony, a diplomatist, and the illustrious Francis Bacon.

BACON, ROGER (*c.* 1220–*c.* 1292), English philosopher, scientist and educational reformer, belonged to a wealthy family which fought on the king's side in the Barons' War. The place of his birth is uncertain; one tradition assigns it to Ilchester in Somerset, another to the parish of Bisley in Gloucester. The approximate date of his birth is deduced from his having stated in 1267 that it was 40 years since he first learned the alphabet. He was well versed in the classics and enjoyed the advantages of an early training in the various disciplines of the quadrivium (geometry, arithmetic, music and astronomy); and he boasts that he had frequently "heard" and "read" the works of Aristotle. As he lectured in the faculty of arts at Paris, it seems probable that his degree of master of arts was conferred there (presumably not before 1241). He relates that he saw Alexander of Hales with his own eyes and that he heard William of Auvergne dispute twice in the presence of the whole university; Alexander died in 1245 and William in 1249.

About 1247 a considerable change took place in Bacon's intellectual development. The work to which he devoted time, energy and money from that date forward marked a definite departure from the usual routine of the faculty of arts. He expended huge sums of money in experimental research, in acquiring "secret" books, in the construction of instruments and of tables, in the training of assistants, in seeking the friendship of savants. No traces of such preoccupations appear in the earlier part of his career when he lectured on Aristotelian and pseudo-Aristotelian treatises at the University of Paris. The change was caused by his return to Oxford and the influence of the great Robert Grosseteste, of Adam de Marisco and of Thomas the Welshman. From 1247 to 1257 Bacon devoted himself wholeheartedly to the cultivation of those new branches of learning to which he was introduced at Oxford—languages, mathematics, optics, alchemy and astronomy. He complacently remarks that the prodigious energy and zeal that he displayed in the pursuit of experimental science was talked about everywhere.

In 1257 another marked change took place. Bacon speaks of himself as forgotten by all and, as it were, buried. The reasons for this were ill-health and his entry into the Order of Friars Minor. His university career and his literary career seemed to be at an end. There can be no doubt that his feverish activity, his amazing credulity, his superstition and his contempt for those not sharing his interests—a contempt which he voiced at every opportunity—incurred the displeasure of his superiors and brought him under some severe form of discipline. He decided to appeal to Pope Clement IV, whom he had known when the latter was in the service of the Capetians. In a letter written from Viterbo and dated June 22, 1266, the pope referred to letters received from Bacon who had come forward with certain proposals of great importance for the welfare of the church and of the universities. The pope desired to be more fully informed of these projects and commanded Bacon to send him the work that he had already tried to obtain before his elevation to the papacy. But Bacon had had in mind a vast encyclopaedia of all the known sciences, which required many collaborators and could be undertaken only if the pope were to set up some institute where savants might dispose of the means and funds necessary. The work, then, was merely projected when the pope thought that it already existed. But in obedience to the pope's command Bacon set to work and in a remarkably short time had dispatched the *Opus majus*, the *Opus minus* and the *Opus tertium*—in that order. He had to do this secretly and notwithstanding any command of his superiors to the contrary; and even when the irregularity of his conduct attracted their attention and the terrible weapons of spiritual coercion were brought to bear on him he was deterred from explaining his position by the command of secrecy enjoined on him by the pope. In the circumstances his achievement was truly astounding. He did not fail to remind the pope that he could have covered quires of vellum with the "puerilities" and vain speculations which filled the commentaries and *summae* of the leaders of the schools. He aspired to penetrate realms undreamed of in the schools at Paris and to lay bare the secrets of nature by positive study. His cherished sciences were languages, mathematics, optics, alchemy and astronomy, and his originality lies not so much in any positive contribution to the sum of knowledge as in his insistence on fruitful lines of research and methods of experimental study. The *Opus majus* was a *persuasio*, an effort to persuade the pope of the urgent necessity and manifold utility of the reforms he proposed. The death of Clement IV in Nov. 1268 brought to an end Bacon's dreams of gaining for the sciences their rightful place in the curriculum of university studies.

Bacon projected yet another encyclopaedia of which only fragments were ever published, viz., the *Communia naturalium* and the *Communia mathematica*, written about 1268. In 1272 there appeared the *Compendium philosophiae*. In philosophy—and even Bacon's so-called scientific works contain lengthy philosophical digressions—he is the disciple of Aristotle and not of St. Augustine or of Avicenna. Even though he does incorporate Neoplatonist elements into his system of philosophy, this remains, nevertheless, Aristotelian in its main lines.

Some time between 1277 and 1279 Bacon was condemned to prison by his fellow Franciscans because of certain suspected novelties in his teaching. The condemnation was probably because of his bitter attacks on the theologians and scholars of his day and his excessive credulity in matters of alchemy and astrology. How long he was imprisoned it is not possible to determine. His last work, incomplete as so many others, was written in 1292 and shows him as aggressive as ever. The tradition that he died in 1292 and was buried in the Franciscan church at Oxford is related by John Rous. Exaggerated accounts of his wonderful experiments won him a place in popular literature and doubtless played some part in determining the title *doctor admirabilis* under which he became known to posterity. *See* also Index references under "Bacon, Roger" in the Index volume.

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BACON is the cured side of a pork carcass, but varying in type in the United States and Europe. It has been one of mankind's favourite meats throughout recorded history because of its comparative ease in smoke-curing and its keeping qualities. As "the poor man's meat" of medieval Europe it was the subject of famous folk sayings. Rabelais, writing in Paris in the 1540s, used the phrase, "Let us flee and save our bacon." The saying, "Bring home the bacon," still a simile for material success, reputedly originated at the monastery of Dunmow in Norman England where the monks gave a flitch of bacon to any man who knelt before the church door and swore that "for twelve months and a day, I have never had a household brawl nor wished myself unmarried."

Migrating to the new world with the first Spanish, French and English settlers, bacon continued its ancient role. It was such a necessity in colonial New England that Puritan authorities disregarded its prevalence in the homes of widows and orphans seeking public charity. Consequently, it became a standard ingredient of the most famous New England dishes.

The dietary importance of the breakfast meal emphasized by medical researchers in the 20th century again validated broiled or fried bacon strips as a mainstay of the American's breakfast menu. Bacon chunks persisted, too, as popular "flavouring" for green beans, squash, turnip greens and other fresh vegetable cookery in the southern United States. Bacon fats and chunks remained ingredients of most fish, dried bean, fried potato and corn meal dishes throughout the United States.

In the second half of the 20th century the leading bacon producing and exporting countries were the United States, Denmark, Canada, the Netherlands, Ireland, Poland and Sweden. The United Kingdom, Germany, France and Austria were large importers.

Types.—Bacon in the United States generally refers to the fatty side between the fourth or fifth rib and the hipbone. The bacon represents about 12% of the live weight of a pig. After the spareribs are removed, the cut is trimmed to a rectangular shape. With the choice grades of bacon, all "seeds" or mammary tissue and rib cartilages or "buttons" are removed. From the front of the bacon, a strip from 1½ to 2 in. wide is removed. This may be cured and smoked as a seasoning piece and is designated a bacon brisket. The jowl is occasionally trimmed square, cured and smoked, after which it is known as a bacon square.

Canadian bacon is the cured and smoked fleshy part of a heavy pork loin (weighing more than 14 lb.). The tenderloin and all the bones are removed. The lean strip is cured and smoked.

In Europe, and particularly in Great Britain, the term bacon generally designates a Wiltshire side—one-half of a properly finished bacon-type pig that weighed from 150 to 210 lb. alive. For the British market, supplied by home and continental European producers, carcasses are centre split and the neck and shanks trimmed closely. Their length is graded according to the varying requirements of the ministry of agriculture, the topmost grade, AA+, having in 1960 a minimum length of 800 mm. from the indentation of the first rib to the anterior edge of the aitchbone. The tenderloin, backbone, pelvic bone and breastbone are removed and the entire side mildly cured and lightly smoked. Wiltshire sides weighing 50 to 65 lb. are preferred. Wiltshire sides are generally graded according to the following maximum measurements, (in millimetres) of thickness of back fat for each of grades 1, 2 and 3:

Grades	Shoulder	Mid-back	Loin
1	50 mm.	30 mm.	30 mm.
2	55 mm.	35 mm.	35 mm.
3	60 mm.	40 mm.	40 mm.

Quality.—Although there is a distinct preference on the part of consumers for the leaner grades of bacon, quality bacon must contain some fat. Too much fat results in a wasty bacon and too little in a flabby bacon lacking in tenderness. Choice bacon should have a good lean streak, and the side should be uniform in thickness. A choice breakfast bacon usually is trimmed so that the length is approximately two and one-half times the width. The fat should be firm, white and flaky. A rubbery condition of the fat generally indicates a lack of tenderness. A thin rind, free from wrinkles, is considered to be an indication of quality.

Curing.—Bacon is cured by the application of salt, sugar and sodium or potassium nitrate or sodium or potassium nitrite. Salt serves as a preservative and flavouring agent; sugar reduces the harshness of the salt and under favourable conditions may promote the growth of useful bacteria. Cane sugar is commonly used because dextrose (corn sugar) will cause excessive browning upon frying. Sodium or potassium nitrate, reduced to nitrite by bacterial action, reacts with the meat pigment myoglobin to form the cured meat colour. Potassium and sodium nitrite also act as bacteriostatic agents.

Two basic types of curing are employed. Bacon cured on the farm or in small plants serving a local trade is more strongly cured than most commercial products. In the farm curing operation either a dry cure or a brine cure is used. For dry curing, 6–6.5 lb. of a mixture of 8 lb. of salt, 2 lb. of sugar and 2 oz. of sodium nitrate are applied to each 100 lb. of meat. This is spread over the fresh pork as it is packed, usually in wooden boxes. Dry cured bacon is cured for approximately two days per pound depending upon the thickness (10-lb. cuts will be cured 20 days) at 38° F. One or more times during the cure, the position of the bellies is changed to achieve a more uniform cure, an action called overhauling. Curing also may be done in a water solution of the dry cure ingredients. The bellies are packed in tierces or barrels and pickle poured over them. After the curing, the bellies are rinsed with water to remove the excess cure from the surface and are placed on hangers for smoking.

A rather heavy smoke is applied to country cured bacon. Hardwood sawdust generally is preferred. The smoking process results in some loss of moisture, tends to seal the surface and deposits a layer of smoke constituents that have a mild bacteriostatic effect. This type of bacon frequently is sold in complete sides or slabs but may be sliced at the point of purchase.

Most commercially cured bacon is much milder than that referred to above. In the second half of the 20th century emphasis has been placed upon curing procedures. It is not uncommon for bacon to be sold in the retail store six or seven days after the slaughter of the hog. Accelerated curing procedures rely on rapid and thorough penetration of the cure by pumping. One piece of equipment for this purpose has 144 hollow needles, which penetrate the entire belly at close intervals. The cure for such bacon is made from a 60° to 70° brine to which is added 25 to 100 lb. of sugar and up to 1½ lb. of sodium or potassium nitrite or their equivalent of nitrate per 100 gal. of brine. The bellies are pumped to approximately 110% of their "green" weight. Most of this increase in weight is lost during subsequent processing. The pumped bellies are frequently piled on skids or pallets and cured a few days. The trend in the second half of the 20th century was toward smoking immediately after pumping. Heat processing and smoking is completed in 12 to 15 hours with an internal temperature of 120° to 125° F.

The addition of ascorbic acid to the curing brine accelerates the curing process, tends to retain colour by retarding oxidation and permits heat processing to take place immediately after pumping. Alkaline phosphates have been used to decrease the amount of shrinkage in smoked products but their use has not proved to be so helpful in bacon as in other cured products. Artificial sweeteners, such as sodium cyclamate, also are used as a replacement for sugar. The use of these eliminates the undue darkening of bacon cured with dextrose sugars. Attempts have been made to accelerate the deposition of smoke by an electrostatic process in which bacon can be smoked in 30 minutes and the smoke particles are attracted to the bacon.

While bacon keeps better than fresh pork, the mildly cured products are perishable and must be refrigerated. Sliced bacon is more perishable than slab bacon, and extreme care is needed in slicing and packaging to keep it fresh.

Food Value.—Bacon's chief food value is in its high caloric content: a pound of bacon contains about 3,000 cal. Crisp bacon has a lower energy value than bacon less well cooked. The fat is completely digested. The protein in bacon is of high quality and readily digested. The leaner grades especially of Canadian bacon have a materially higher protein value. *See* also PORK; HAM.

(W. J. L.; G. D. W.; R. W. HD.)

BACONIAN METHOD is the method of interpreting nature (or studying natural phenomena) formulated by Francis Bacon (*q.v.*). It was intended to replace the method of citing the views of authorities or of having recourse to fanciful guesses. It insisted on the dismissal of prejudices and preconceptions of all kinds and on the close and methodical observation of the facts concerned. It was essentially an empirical method and consisted of three main steps: first comes a description of the facts; next, a tabulation or classification of them into three classes showing (1) instances of the presence of the characteristic or quality, etc., under investigation, (2) instances of its absence and (3) instances of its presence in varying degrees; thirdly, the rejection or elimination of whatever appears, in the light of these tables, not to be connected with the phenomenon under investigation and the determination of what is connected with it. Bacon may be credited with recognizing, in their essence, the methods of agreement, the joint method and the method of concomitant variations. But he exaggerated the mechanical element in scientific investigation when he assumed that by following his method anybody might make sound scientific discoveries, much in the same way as anybody might, with the help of a pair of compasses, construct an almost perfect circle. *See* also INDUCTION; SCIENTIFIC METHOD.

BACONTHORPE, JOHN (JOHANNES BACONTHORP or BACON) (d. 1348?), English theologian and philosopher, known by the honorific of *Doctor resolutus*, was born at Baconthorpe in Norfolk and brought up in the Carmelite monastery of Blakeney. He studied in Paris, taught at Cambridge and perhaps at Oxford and was provincial of the English Carmelites from 1327 to 1333. A learned and sharp critic of such theologians as Thomas Aquinas, John Duns Scotus and Henry of Ghent, he failed to counter them with constructive work. His deep knowledge of Averroës (*q.v.*) and his benevolent interpretation of some of his views, although he dissented on fundamentals, availed him the title of *princeps Averroistarum*. He wrote a commentary on Peter Lombard's *Sentences* (first published in Paris, 1484); *Quodlibeta* (first published in Venice, 1527); commentaries on St. Matthew, St. Paul's Epistles and on some works of St. Augustine and of St. Anselm.

(L. M.-Po.)

BACTERIA, microscopic organisms whose influence in the biosphere is incalculable. They include far more beneficial types than spoilers and pathogens. *See* BACTERIOLOGY; BACTERIAL AND INFECTIOUS DISEASES.

BACTERIAL AND INFECTIOUS DISEASES. An infectious disease can be defined in the broadest sense as a disease that may be transmitted from one living thing to another; but it is probably better to use an etiological definition and to say that it is one that is caused by invasion of the host by a microorganism capable of multiplying in the tissues, of giving rise to pathological lesions and of being passed on to other hosts of the same or a different species. The host may be a man, an animal, a plant, an insect or perhaps even a microorganism itself, such as the infection of bacteria with the viruslike particles known as bacteriophages. The microorganism must be able to reproduce itself in the tissues of the host and to give rise to cellular damage. Mere implantation of the microorganism on the surface membranes—skin, conjunctiva, mucosae—accompanied by its reproduction is not sufficient to constitute disease, since many bacteria find their normal habitat in these situations and flourish without harming the host. This is an example of parasitism, but not of infection in the strict sense of the word. The term infectious implies that the disease can be passed from one host to another. A disease caused by a microorganism that is unable to set up a similar disease in other suitable hosts to which it is transmitted is better described as an infective disease. The distinction between the two is not always easy to draw but is worth maintaining. Lastly, it may be pointed out that the use of the word infection in this article is restricted to invasion with unicellular microorganisms. Invasion by multicellular organisms, such as worms or insects, is considered under PARASITOLOGY. This article, dealing with infection in a broad sense, including both infectious and infective diseases contains the following sections:

I. GENERAL BACKGROUND

1. Origination of Infectious Disease.—There is no exact knowledge of when or how infectious disease originated. Microbiology is a science of such recent development that any explanation of the way in which bacteria and other infective microorganisms arose during the process of evolution and became adapted to growth in the tissues of more highly organized living beings must be a matter for mere speculation. It is fairly safe to surmise that bacteria developed first of all as saprophytes, obtaining their food material from nonliving matter. From time to time some of these organisms, which were probably widespread in soil and decaying vegetable material, must have gained access through wounds to the tissues of animals. Most of these organisms probably died off, either because they were not equipped with the necessary range of enzymes to obtain nourishment from the tissue fluids, or because they were killed by cellular or humoral activity on the part of the host. A few, however, may have succeeded in establishing themselves within the body. Since bacteria readily undergo variation, there must have been in these circumstances a natural selection of the variant that was most fitted to survive under the new conditions. To do this it must have been capable of inflicting serious damage on the host, usually by the production of some toxic substance, with the result that the host must often have succumbed to the attack. From a biological point of view, such an event is an unfortunate result for the microorganism; unless it can gain access to the body of another host, it will die out, and the particular variant, therefore, that has become adapted to a parasitic mode of life will perish. This probably happened over and over again, and many strains of potentially pathogenic organisms must have been evolved, have thrived for a brief period and passed into oblivion without leaving progeny to continue their race. Until a means could be found for fairly rapid transmission of the microorganism from one host to another, little progress would be possible in the development of pathogenic (disease-producing) organisms. F. M. Burnet is probably right in supposing that infectious disease must have developed among gregarious animals, and that it was therefore not till a fairly advanced stage in the evolution of life upon this globe that bacterial infection can have played any considerable part in the causation of disease.

Numerous species of microorganisms are known to exist, each of which is able to give rise to a specific disease. Since, however, the number of ways in which the body can react to microbial attack is limited, it follows that the final diagnosis of any disease is dependent upon laboratory investigation. For this reason many diseases that now are known to be distinct were confused with each other in the prebacteriological era. Influenza (*q.v.*), for example, is still imperfectly differentiated; it is difficult to say how many of the numerous epidemics that were described in the past by this name were in fact caused by the influenza group of viruses. Leprosy (*q.v.*) is another example. Readers of the Bible are well aware of the frequency with which this disease is men-

tioned. It is probable that the word leprosy was used to cover not only the disease caused by the bacillus *Mycobacterium leprae*, but also numerous other diseases giving rise to changes in the skin and subcutaneous tissues. The "leprosy," for instance, from which Naaman the Syrian suffered (II Kings v) and which was cured by bathing in the waters of the Jordan may well have been a form of psoriasis or other skin disease curable by sulfur. Plague (*q.v.*) is a name that was used in relation to several major outbreaks of disease. There is a fairly clear reference to it in the Old Testament (I Sam. v, vi); and there is little doubt that the plague of Justinian's reign in the 6th century, the Black Death of the 14th century and the Great Plague of London in 1665 were all caused by the true plague bacillus, *Pasteurella pestis*. The nature, however, of other plagues, described in Greece and the Roman empire, is more doubtful. Among diseases, apart from those just mentioned, that existed in the pre-Christian era are nonpulmonary tuberculosis, which has been recognized in Egyptian mummies; smallpox, which also probably occurred in ancient Egypt; and diphtheria, pneumonia and cholera, all of which appear to have been prevalent in Greek or earlier civilizations.

2. Historical Summary.—It would not be profitable in this article to describe in detail the various explanations that have been put forward during the centuries of the nature and causation of infectious disease. None of them, so far as can be judged, had any serious influence in guiding later investigators to the real truth, and their appeal is mainly to the historian. However closely the views of Hieronymus Fracastorius, Marcus Antonius von Plenciz and others approached the correct explanation, they were incapable of proof, at the time they were put forward, through lack of the necessary equipment and methods of study. Not until the development of the microscope by Anthony van Leeuwenhoek in the 17th century did it become possible to demonstrate the existence of living unicellular organisms by actual observation. Even then no immediate progress was made, because other techniques that were necessary to this end had not yet been developed.

Louis Pasteur (1822–95) was the real founder of microbiology. Becoming interested, as a chemist, in the problems of fermentation, he observed that there was a close association between the breakdown of certain organic compounds and the presence of living microorganisms, demonstrable by microscopic means. He made the further observation that apparently different microorganisms were associated with different types of fermentation, each type of organism being in this respect specific. These findings led him to challenge the widely held views of the German chemist Justus von Liebig (1803–73) and to face the still more fundamental problem of spontaneous generation. By a series of ingeniously devised experiments, Pasteur was able to bring convincing evidence to show that the multiple animalcules of Leeuwenhoek arose not from nonliving matter but from the reproduction of similar pre-existing animalcules. By growth in fluid media generation after generation of specific microorganisms could be cultivated, provided the necessary conditions, which he defined, were present. Media in which all living matter had been destroyed by heat remained permanently sterile, so long as the entrance of living cells was adequately guarded against. As soon, however, as fresh cells were inoculated into the media, growth took place with the resulting fermentative or other changes characteristic of their specific activity. Following his studies on the fermentation of organic substances by living microorganisms, Pasteur turned his attention to the nature of disease, first of all in silkworms and bees, and later in animals and man. During the ensuing years he proved beyond doubt that many diseases were associated with the growth in the tissues of a specific microorganism, and in spite of intense opposition from the medical profession he revolutionized the whole conception of transmissible disease.

The German bacteriologist Robert Koch (1843–1910) introduced technical methods for obtaining different microorganisms in pure culture and described the bacterial agents responsible for tuberculosis and cholera. Pupils of Pasteur and Koch discovered the causative microorganisms of a whole range of different diseases. Joseph Lister (1827–1912) at Glasgow, Scot., applied Pasteur's teaching to the prevention of sepsis in wounds, with results so striking that a new era in surgery was begun. Agricultural studies revealed that soil fertility was essentially dependent on microbial action, and plant pathology was illuminated by the discovery of pathogenic bacteria and viruses. Infectious diseases in the animal and vegetable world are known to be caused by the action of specific microorganisms, and methods of diagnosis and treatment are but a natural sequence of the fundamental researches of Pasteur.

II. CAUSES OF DISEASE

1. Etiology.—The ways in which the specific role of a microorganism in the causation of a given disease is established are summarized in what are referred to as Koch's postulates: (1) the microorganism should be present in all cases of the disease, its distribution within the body being in general conformity with the nature and site of the pathological lesions; (2) the microorganism should be isolated from the diseased tissues and grown in pure culture outside the body for a number of generations; (3) administration of the microorganism in pure culture to a susceptible animal should give rise to the disease in question, and the microorganism should be recovered from the tissues of the diseased animal. In most bacterial infections these postulates can be fulfilled; exceptions do occur, such as in leprosy, where the last two have not yet been satisfied. The presence of the leprosy bacillus in the tissues, however, is so uniformly associated with the disease that, in spite of the continued failure of bacteriologists to cultivate it in artificial media and so reproduce the disease with pure cultures, no one has any serious doubt of its etiological significance.

In rickettsial and virus infections these postulates are not easy to satisfy, mainly because of our inability to cultivate the microorganisms of these diseases in lifeless media. The second postulate was therefore modified to include the use of tissue cultures and the chick embryo for purposes of growth, even though the purity of the culture under these conditions cannot be guaranteed.

With the smaller viruses there is difficulty in fulfilling even the first postulate, since they are below the limit of resolution of the microscope and cannot be distinguished with certainty from inanimate particles. In virus work the microscope is largely replaced by the use of graded ultrafilters and the high-speed centrifuge, both of which help to determine the size and, to some extent, shape of the virus particles, though the electron microscope is helping to overcome the limitations of ordinary microscopical equipment.

Since Koch's time other methods have been introduced that help to prove the etiological role of any given organism. These comprise particularly the appearance in the blood stream of immune bodies following an attack of the disease, and their specific action in agglutinating or lysing the suspected organism, or in neutralizing its infectivity or toxicity.

2. Agents Producing Infectious Disease.—Microorganisms commonly producing disease may be classified as follows:

Bacteria.—The chief diseases caused by these organisms are enumerated in the table. Pathogenic bacteria vary greatly in their infectivity and invasiveness. Most species multiply in the internal tissues and produce their effect by the formation of so-called endotoxins. A few, like the diphtheria and the tetanus bacillus, multiply locally and produce their effect by the formation of a powerful exotoxin, which is carried by the blood stream to other parts of the body. *Clostridium botulinum* is not a parasite at all. It forms a potent exotoxin by growth in food kept under favourable conditions, and the resulting disease is therefore a toxemia rather than an infection.

Rickettsiae.—These are small organisms whose natural habitat is the intestinal canal of arthropods. A few species have become adapted to man and give rise to such diseases as typhus fever, Rocky mountain spotted fever, tsutsugamushi (scrub typhus), Q fever and trench fever. Infection is carried to man by lice, fleas, ticks and mites.

Viruses.—These organisms are even smaller than the rickettsiae, are mostly below the limit of ordinary microscopical resolu-

Main Groups of Pathogenic Bacteria and the Diseases Caused by Them

Bacterial genus	Chief pathogenic species and types	Natural diseases produced	Special treatment	Remarks
Actinobacillus	*Actinobacillus lignieresi*	Wooden tongue in cattle	—	Probably noninfective for man
Actinomyces	1. *Actino. bovis* (microaerophilic)	Actinomycosis in man and cattle (lumpy jaw)	Penicillin, terramycin, chloramphenicol and aureomycin	Not highly infectious; mode of transmission doubtful
	2. Numerous aerobic species	Madura foot in man, farcy of cattle and other granulomatous lesions	—	—
	3. *Actino. muris* (*Streptobacillus moniliformis*)	One form of rat-bite fever in man and infective arthritis of mice	—	Normal parasite of the rat's nose
Bacillus	1. *B. anthracis*	Anthrax in animals; malignant pustule and woolsorters' disease in man	Aureomycin, penicillin and specific antiserum	—
Bartonella	1. *Bart. bacilliformis*	Oroya fever and verruga peruana in man	Possibly chloramphenicol	Infection carried by sand flies
	2. *Bart. muris*	Infectious anemia of rats	Arsenic and antimony	Infection carried by rat lice
	3. *Bart. canis*	Infectious anemia of dogs	—	Infection carried by dog fleas
Brucella	1. *Br. melitensis*	Septicemic infection of sheep and goats; brucellosis in man	Terramycin and aureomycin	Occurs chiefly along Mediterranean littoral
	2. *Br. abortus*	Contagious abortion of cattle; brucellosis in man	Terramycin and aureomycin	Universal distribution
	3. *Br. suis*	Local or general infection of pigs; brucellosis in man	Terramycin and aureomycin	Occurs mainly in middle west of U.S.
	4. *Br. tularensis* (classified by some as *Past. tularensis*)	Plaguelike disease in rodents and occasionally in man	Chloramphenicol	Occurs in Rocky mountains, U.S.S.R., Norway, etc.
Clostridium	1. *Cl. tetani* (anaerobic)	Tetanus in horses and man (lockjaw)	Toxoid for prevention; antitoxin for treatment	—
	2. *Cl. botulinum* (anaerobic)	Botulism in man, limberneck in chickens and ducks, forage poisoning in horses, lamziekte in cattle	Antitoxin	Conveyed to man and animals by toxic food
	3. Several species, such as *welchii, septicum, oedematiens, bifermentans, histolyticum* (anaerobic)	Gas gangrene in man *Cl. welchii* may give rise to one form of food poisoning	Antitoxin	Disease follows wound infections
Corynebacterium	1. *C. diphtheriae*	Diphtheria in man	Toxoid for prevention; antitoxin for treatment	Specific human parasite
	2. Several species	Pseudotuberculosis in sheep and mice, suppurative lesions in cattle, pyemia in horses, etc.	—	Not transmissible to man
Erysipelothrix	1. *Ery. rhusiopathiae*	Swine erysipelas, erysipeloid in man, septicemia in mice	Vaccines and antisera in pigs and antiserum in man	—
	2. *Ery. monocytogenes*	Infective mononucleosis of rabbits, meningoencephalitis of various animals and other lesions	—	Occasionally infective for man
Escherichia	*Esch. coli*	Gastroenteritis in infants; white scours in calves	Possibly sulfadiazine and chloramphenicol	Only certain types of this organism are pathogenic
Fusiformis	Multiple species (anaerobic or microaerophilic)	Suppurative lesions in numerous animals and occasionally in man	—	Found mainly in necrotic lesions
Haemophilus	1. *H. influenzae*	Secondary invader in respiratory infections; occasionally meningitis	Meningitis susceptible to streptomycin and antiserum	Multiple serological types
	2. *H. pertussis*	Whooping cough in man	Vaccines in prophylaxis	Specific human parasite
	3. *H. ducreyi*	Soft chancre (venereal disease in man)	Sulfonamides or antibiotics	Specific human parasite
	4. Some other species	Infections in dogs, pigs and other animals	—	—
Leptospira	1. *Lepto. icterohaemorrhagiae*	Weil's disease in man	Possibly penicillin	Normal parasite of rats
	2. Numerous other species	Autumn fever of Japan, coastal fever of Queensland, swamp fever, etc., in man	—	Primarily parasites of rodents. Several different animals affected
Mycobacterium	1. *Myco. tuberculosis*—human type	Tuberculosis in man, pigs, monkeys, dogs, parrots	Favourably influenced by streptomycin, isoniazid and P.A.S.	Primarily a human parasite
	2. *Myco. tuberculosis*—bovine type	Tuberculosis in man, cattle, pigs, monkeys, dogs, cats, sheep, goats	Favourably influenced by streptomycin, isoniazid and P.A.S.	Primarily a bovine parasite. Causes some nonpulmonary tuberculosis in man
	3. *Myco. tuberculosis*—murine type	Tuberculosis in voles	—	Noninfective for man
	4. *Myco. tuberculosis*—avian type	Tuberculosis in fowls and other domestic birds and sometimes in wild birds; also pigs	—	Practically never infects man
	5. *Myco. tuberculosis*—cold-blooded type	Tuberculosis in cold-blooded animals and fish	—	Noninfective for man
	6. *Myco. leprae*	Leprosy in man	—	Another type gives rise to rat leprosy
	7. *Myco. johnei*	Johne's disease in cattle and sheep	—	Progressive type of pseudotuberculous enteritis

Main Groups of Pathogenic Bacteria and the Diseases Caused by Them—(Continued)

Bacterial genus	Chief pathogenic species and types	Natural diseases produced	Special treatment	Remarks
Neisseria	1. *N. meningitidis*	Cerebrospinal fever in man	Sulfonamides and penicillin	Specific human parasite
	2. *N. gonorrhoeae*	Gonorrhea in man	Sulfonamides and penicillin	Specific human parasite
Pasteurella	1. *Past. pestis*	Plague in numerous species of rodents and in man	Sulfadiazine, streptomycin and chloramphenicol	Infection transmitted by fleas
	2. *Past. septica*	Hemorrhagic septicemia in numerous animals	—	Occasionally pathogenic for man, as after a cat bite
	3. *Past. pseudotuberculosis*	Pseudotuberculosis in rodents	—	Rarely infective for man
Pfeifferella	1. *Pf. mallei*	Glanders and farcy in horses, glanders in man	—	Has been eliminated from Great Britain
	2. *Pf. whitmori*	Primarily affects rodents; melioidosis in man	—	Usually fatal in man
Salmonella	1. *Salm. typhi*	Typhoid fever in man	Vaccine for prophylaxis. Antiserum and chloramphenicol for treatment	Specific human parasite. Numerous Vi-phage types recognized
	2. *Salm. paratyphi* (*A, B and C*)	Paratyphoid fever in man	Vaccine for prophylaxis	Probably specific human parasites
	3. Over 300 species of the so-called food-poisoning group differing in antigenic structure	Food poisoning or typhoid-like fevers in man; enteritis in rodents and domestic animals	Furazolidone in animals	Primarily parasites of rodents, fowls, pigs, cattle, etc.
Shigella	Numerous species, such as *shigae, schmitzi, flexneri, boydi, sonnei*	Bacterial dysentery in man	Sulfonamides	Numerous types of *flexneri* and *boydi* species. Specific human parasites
Spirillum	*Spirillum minus*	One form of rat-bite fever in man	Arsenic and possibly penicillin	Normal parasite of rats and mice
Staphylococcus	*Staph. aureus*	Localized suppurative lesions in man and animals, particularly boils, wound infections and mastitis, and one form of food poisoning	Sulfonamides, penicillin, terramycin and aureomycin	*Albus* species much less pathogenic
Streptococcus	1. *Str. pyogenes* (Group A; β-hemolytic)	Scarlet fever, tonsillitis, erysipelas, puerperal fever and possibly rheumatic fever in man; occasionally mastitis in cattle	Sulfonamides and penicillin	About 30 serological types
	2. *Str. agalactiae* (Group B)	Mastitis in cattle	Sulfonamides	Low degree of infectivity for man
	3. Groups C to N	—	—	Groups D and G occasionally infective for man
	4. *Str. pneumoniae* (α-hemolytic)	Pneumonia in man and some animals	Sulfonamides and penicillin	77 serological types recognized
	5. Numerous other species of the α-hemolytic or viridans type	Occasionally infective endocarditis and other lesions in man	Penicillin	—
Treponema	1. *Trep. pallidum*	Syphilis in man	Arsenic and penicillin	Specific human parasite
	2. *Trep. pertenue*	Yaws in man	Arsenic and penicillin	Tropical disease, nonvenereal, spread by contact and insects
	3. *Trep. recurrentis*	Relapsing fever in man	Arsenic and antimony	Transmitted by blood sucking insects
Vibrio	*V. cholerae*	Asiatic cholera	Possibly sulfonamides	Specific human parasite

tion, usually pass through bacterial filters, cannot be cultivated in the absence of living tissue and vary greatly in the range of species they attack. Some viruses are specific parasites of man, others of animals, and some infect both man and animals. Infection is often air-borne, but it may occur by insect bites or occasionally by food. These organisms are responsible for a wide range of diseases.

Yeasts and Fungi.—Several yeasts or yeastlike fungi are pathogenic for man, such as the causative organisms of thrush (*Candida albicans*) and several infections of the lung (*see* RESPIRATORY SYSTEM, DISEASES OF; THRUSH). Several typical fungi, of which the commonest is ringworm, are of importance in human pathology.

Protozoa.—The main diseases of man caused by these unicellular organisms are malaria, trypanosomiasis, leishmaniasis and amoebic dysentery. Apart from the last, they are carried by bloodsucking insects.

III. SPREAD OF DISEASE

1. Epidemiology.—Numerous factors determine the prevalence of a given disease in a community, such as the mode of transmission of the disease, the virulence of the infecting organism, the age, sex, occupation, nutritional state and degree of immunity of the exposed population, climatic conditions and so on. As each of these may vary independently, it is usually impossible to predict without more knowledge than is generally available what course a particular infection is likely to run when introduced into a community. Broadly speaking, bacteria may gain access to the body by the respiratory tract, by the alimentary tract, by wounds or abrasions in the skin or by direct inoculation, as through insect bites.

Infections via the Respiratory Tract.—Several pathogenic bacteria are able to attack the mucosae lining the upper respiratory tract (*i.e.*, the nose, mouth and nasopharynx) and give rise to disease; notable among these are the diphtheria bacillus, the streptococcus responsible for scarlet fever and tonsillitis, and the whooping-cough bacillus. Patients suffering from these diseases are infectious to others, because they may expel the causative organism into their surroundings, particularly by sneezing and coughing. The same applies to infections of the lower respiratory tract, including the lung, with organisms such as the human tubercle bacillus and the pneumococcus. Multiple droplets of saliva and mucus, varying in size, are expelled with explosive violence forming a cloud of so-called cough spray. Many of these contain the infecting organism and are therefore dangerous to other people if inhaled. C. Flügge at the end of the 19th century was the first to draw attention to this method of droplet infection, especially in respect to pulmonary tuberculosis, and the subject thereafter received considerable study from British and U.S. workers.

W. F. Wells in the United States showed that the fate of the droplets depends mainly on their size. The rate at which they fall is proportional to the square of their diameter. The larger droplets, of one millimetre or more in diameter, fall in a curved trajectory to the ground, where they settle and may dry up to form dust. Those with a diameter of less than one-tenth millimetre evaporate so rapidly in unsaturated air that they never reach the ground but remain suspended as droplet nuclei. These behave much like a gas and can be carried by air movements over considerable distances. Droplets with a diameter between one-tenth millimetre and one millimetre may reach the ground before they evaporate or may become transformed into droplet nuclei, depending on the height from which they are liberated, the degree of saturation of the atmosphere and other factors.

It will be seen, therefore, that infective particles may reach the respiratory tract either in the form of dust, of droplets or of droplet nuclei. Droplet infection is restricted to persons in the immediate vicinity of the sneeze or cough, since the droplets fall to the ground within five or six feet after being expelled by a standing person of normal height. On the other hand, they may be heavily infected with bacteria, and their direct passage within a second ensures that the organisms are unaltered by exposure to inimical agencies in the outside world. The droplet nuclei are carried much farther, but on the other hand are less often infected than the larger droplets and may be exposed to influences such as sunlight that are harmful to the contained microorganisms. Dust may result from the drying of large droplets that have fallen to the ground, or of gross particles of sputum that have been expectorated. Though G. Cornet in the 19th century believed that dried sputum constituted the chief source of infection in pulmonary tuberculosis, the teaching of Flügge led to a considerable modification in this view; later the pendulum swung back, and many experimentalists by the mid-20th century regarded dust as an important vehicle of infection. It must be remembered, however, that the atmospheric conditions in cold damp climates are often unfavourable to complete desiccation of sputum, and that out-of-doors the sterilizing effect of sunlight may lead to a gross loss in its infectivity. Moreover, desiccation by itself often has a destructive effect on bacteria so that the infectivity of dust and of droplet nuclei may well be less than that of directly inhaled droplets. It is probable that all three forms of infective material—dust, droplets and droplet nuclei—play a part in causing respiratory infection, the exact part in any particular instance depending on a number of variable factors.

Infections via the Alimentary Tract.—Most infections that are conveyed by this route give rise to some form of inflammation of the alimentary tract so that the infective material itself is usually derived from the excreta. There are, however, exceptions to this rule. The upper part of the alimentary tract (namely, the throat) is shared by the respiratory tract; and some diseases, such as scarlet fever and diphtheria, that are normally acquired by respiratory infection may be caused by the consumption of food contaminated with the cough spray of patients, or by milk derived from cows whose udders or teats are infected with the causative organisms of these diseases. Another exception is the bovine tubercle bacillus, which is ingested in milk, passes through the lymphatic tissue in the throat or intestine and gives rise to disease in the bones, joints, glands, meninges or other organs but not usually in the alimentary tract itself.

Apart from these, and some other milk-borne diseases such as brucellosis, infection via the mouth occurs directly or indirectly from the feces by ways that may be summarized in three words: fingers, food and flies. Fingers of patients and carriers suffering from intestinal infections are almost invariably contaminated after a visit to the lavatory and, unless they are washed immediately, are liable to contaminate every object with which they come into contact. Other persons handling the same objects pick up the infecting organisms and may transfer them with their fingers to the mouth, nose or conjunctiva, whence they reach the throat and are swallowed. The danger of contaminated fingers is greatest in cooks and other persons concerned in the preparation and handling of food, because many food substances act as excellent media for the growth of intestinal bacteria. If the food is kept at a suitable temperature, prodigious bacterial multiplication may occur, and persons consuming the food are exposed to grave risk of disease. The most favourable foods for bacterial multiplication of this sort are milk, custard, gravy, soup and made-up meat dishes, such as stews, pies, sausages, pressed beef and brawn. Food may be contaminated from other sources than fingers, particularly dust and flies. In countries or places where the water carriage system of sewage disposal is not practised, fecal material deposited on the ground may dry up and be blown about in the form of dust, or particles may be transferred to food by flies. Shellfish that are laid down in sewage-polluted estuaries are regularly contaminated with intestinal bacteria, and if pathogenic forms, such as typhoid bacilli, happen to be among them, they may render the shellfish dangerous for human consumption.

Infections via Wounds and Skin Abrasions.—The skin forms an excellent defense mechanism for the body, protecting the underlying tissues from infection. With a few doubtful exceptions, no pathogenic organisms are able to penetrate the intact skin. The presence, however, of small abrasions, and still more of actual wounds, enables pathogenic organisms in contact with them to pass to the subcutaneous tissue or muscle and either set up disease locally or be transferred by the lymph and blood streams to other parts of the body where they may proliferate. Venereal disease is spread by direct contact of the skin (or mucous membranes) with an infected surface; boils result from the ingress of staphylococci, often at a site subject to irritation or pressure.

Infections Borne by Insects.—Bloodsucking insects play an important part in the transmission of certain diseases. Sometimes, as in malaria, the organisms in the capillary blood are ingested by a mosquito, undergo proliferation in the insect's body and after a few days reach the salivary glands, whence they may be injected into the skin of persons bitten by the mosquito. Sometimes, as in typhus fever, the organisms multiply in the lining of the intestinal tract of the body louse and are deposited in feces on the skin of an infested person and then get rubbed into the skin at the site of the insect's bite as the result of scratching. In most insect-borne diseases the main reservoir of infection is an animal, and man becomes infected more or less incidentally; in a few, like malaria and possibly louse-borne typhus, man constitutes the sole mammalian host.

2. Virulence and Immunity.—By virulence is generally meant the power of the organism to invade the body of the host, to multiply in the tissues and to produce disease. These factors, however, are affected by the degree of immunity of the host. An organism that is highly virulent for a person with a low degree of immunity may be comparatively avirulent for another person with a high degree of immunity.

Both virulence as applied to the microorganism and immunity as applied to the host are relative terms. It is true that an organism may be described as completely avirulent or a host as completely insusceptible, but these conditions usually apply only to nonpathogenic bacteria to which a given host possesses absolute immunity. Normally, virulence and immunity have to be defined relatively. One strain of organism may be shown to be more virulent than another, or one host more immune than another; but it is impossible to say that an organism has a given degree of virulence independent of the degree of immunity of the host. (*See* IMMUNITY AND IMMUNIZATION.)

Bearing this in mind, it may be said that different species of organisms vary greatly in virulence, and that the same organism may exhibit differences in virulence from time to time. An organism like the foot-and-mouth virus is practically avirulent for man, seldom giving rise to disease. An organism such as the human tubercle bacillus has a relatively high degree of infectivity, but in only a small proportion of infected persons does the organism multiply sufficiently in the tissues to give rise to evident tuberculosis. An organism such as the measles virus, on the other hand, has not only a high degree of infectivity but is able to produce the characteristic disease in practically every nonimmune person with whom it comes into contact.

The result of infection, therefore, in any given host is deter-

mined by the balance of virulence and immunity. In a highly immune person the infection may be completely resisted and the organisms destroyed before any damage is done. In one rather less immune, the organism may be able to establish itself in the tissues, but be unable to produce any serious lesion; such a person becomes a so-called healthy carrier. In one still less immune, the organism multiplies to a certain extent, produces mild systemic disturbance (subclinical attack) and is then overcome by the resisting forces of the body. In a normally susceptible person the organism establishes itself in the tissues, multiplies freely, produces its toxic substances and gives rise to a typical attack of the disease. In an abnormally susceptible person in whom the natural defense mechanism of the body is defective, rapid proliferation of the invading organism occurs with the production of a fulminant attack of the disease. Whether the illness proves fatal or not depends on the natural virulence of the organism and the degree of immunity of the host. Some diseases have a much higher case fatality than others.

Of special interest to the epidemiologist is the apparent increase in virulence that may occur in a given organism from time to time. It is always tempting to explain a major epidemic prevalence of a particular disease as the result of an increase in the virulence of the infecting organism, but it is difficult to prove beyond all measure of doubt that such an increase does in fact occur under natural conditions. Usually the fluctuations in epidemic prevalence of an endemic disease are determined mainly by the level of herd immunity. Measles, for example, in most civilized communities attacks young children. As the virulence of the organism is high, practically every exposed child develops the disease, and those who recover are left permanently immune. The disease, therefore, dies down, not because of any loss in virulence of the organism, but because the supply of susceptible hosts tends to become exhausted. For the next year or so the prevalence of the disease remains low, until a large enough population of young susceptible children has grown up to enable a fresh outbreak to occur.

It is difficult, however, to explain all epidemic manifestations in this way. Influenza, for example, is a disease that attacks the population of any given country every few years, producing a fairly large number of cases but comparatively few deaths. Every now and again, however, it assumes a much more serious character. This is illustrated by the pandemic of 1918–19, when the disease swept over the entire world, killing more persons in its train than World War I itself.

There is nothing to suggest that the general level of immunity to influenza was any lower in 1918–19 than it was in the 20 years before or after the outbreak, and we are therefore driven to assume that a particularly virulent strain of virus had developed that was able to overcome the resistance of a high proportion of the persons who were exposed to attack. What mechanism is responsible for the development of these hypervirulent strains it is impossible to say. Variation is constantly occurring in microorganisms, and it can only be supposed that occasionally a particularly virulent variant arises under conditions that favour its rapid transmission from host to host and so enable it to assume temporary predominance over other variants with the resulting production of widespread disease.

3. Other Factors Affecting the Prevalence of Diseases.—Age, sex and occupation all have a bearing on the incidence of infectious diseases. Many infections are confined mainly to childhood and leave behind them an immunity that serves to protect the host when re-exposed during adult life. Infancy and early childhood are generally the periods of greatest susceptibility, though by no means always. Typhoid fever, for instance, is much commoner, at any rate in its typical form, in adults than in children. Old age is a period when the resistance of the body begins to weaken, and death frequently results from so-called terminal infections that would be relatively harmless in the prime of life.

The difference in susceptibility between the sexes is usually small, though a striking exception is afforded by the much higher incidence of pulmonary tuberculosis in young adult females than males. Certain occupations predispose to infection, either because the work is carried on under conditions that favour exposure to, or transmission of, infection (as in the relatively high incidence of anthrax among hide porters), or because the person's resistance to some organism with which he is already infected but with which he has established an equilibrium is disturbed by factors dependent on his occupation (such as the effect of inhaled silica in predisposing to pulmonary tuberculosis in hard-coal workers and knife grinders).

Though defective nutrition is popularly believed to predispose to infection, there is comparatively little evidence to show that, so far as the acute infectious diseases are concerned, it has more than a minor effect. Measles, for example, appears to be just as common in the well-fed as in the poorly fed child, and the same holds true of many other infectious diseases. Only when there is a gross deficiency of certain constituents of the diet, particularly vitamin A, does the resistance appear to be seriously affected. On the other hand, there is a good deal of evidence to suggest that inadequate nutrition does enable the tubercle bacillus, with which a high proportion of European adults are latently infected, to give rise to overt disease, which would normally be held in check in persons who were better nourished. The widely held assumption that infectious disease would not occur in a properly fed people is entirely without foundation.

The effect of climate on infectious disease is difficult to separate from other factors. Enteric diseases are commoner in warm, and respiratory diseases in cold, countries; but the former can be explained largely by the greater opportunities for infection from improperly disposed excreta and the lower level of personal hygiene in those preparing food, and the latter by the greater ease with which respiratory infection spreads under overcrowded indoor conditions. On the whole, the available evidence does not suggest that climate by itself has any great influence on the prevalence of infectious disease.

4. Endemic and Epidemic Diseases.—In civilizations that have been long in contact with a particular microorganism, a state of equilibrium has usually become established whereby the organism is widely spread in the community without giving rise to extensive fatal disease. An endemic prevalence of this sort is often possible only by the elimination of the more genetically susceptible members of the community in the earlier generations, followed by breeding from those having a higher genetic resistance. Examples of two widespread diseases in which this appears to have occurred in Great Britain are tuberculosis and syphilis.

Epidemic prevalence of an endemic disease is determined by many factors that are only imperfectly understood. A sufficiently high proportion of the population must be susceptible, and the means for sufficiently rapid transmission of the infecting agent must be available. In a disease like influenza an epidemic is preceded by an increasing number of sporadic cases. The proportion of cases rises rapidly to a maximum, then falls progressively till the usual endemic level is regained. The rise and fall usually occur at about the same rate so that the cases, if plotted on a graph, form a symmetrical curve. In typhoid fever, on the other hand, an outbreak of the disease is generally confined to a particular section of the population which has been exposed to an unusual source of infection such as the consumption of contaminated water, milk, ice cream or shellfish. Outbreaks of this sort tend to be explosive; the upward limb of the curve is steep, but the downward limb, because of the occurrence of secondary cases, tends to be flatter and is often prolonged for several weeks.

Other forms of epidemic prevalence are seen in other diseases depending on factors that are too numerous or complex to be specified here.

5. General Features of Infectious Diseases.—The incubation period elapsing between the access of the infecting organism to the body and the appearance of manifest symptoms of disease varies greatly. At one end of the scale is acute streptococcal septicemia following, for instance, a wound received while carrying out a post-mortem examination, which may be fatal within 24 hours. At the other end is a disease such as leprosy in which infection may not be followed by clinical evidence of disease for several

years. In most of the acute eruptive fevers (such as measles) the incubation period ranges from two or three days to two or three weeks. Longer incubation periods of six weeks or so are seen in diseases such as rabies and brucellosis, and in tuberculosis a year or two often passes between infection and manifest disease.

In the acute fevers the incubation period is probably indicative of the time taken for the organism to multiply sufficiently in the tissues to bring about serious disturbance in the economy of the host. In tuberculosis, on the other hand, though disease may follow within a few weeks of infection, it is commoner for the organism to give rise to a latent infection, detectable only by special tests, which after a variable period may progress to the stage of manifest disease or may gradually undergo retrogression and healing. A delicate equilibrium is set up between the parasite and the host, which is liable to be disturbed by any factor leading to a temporary reduction in the natural defense mechanism of the body.

Infection with any parasite gives rise to a series of reactions on the part of the tissues. The commonest of these is the phenomenon of inflammation (*q.v.*), which is characterized by vascular and cellular changes tending to localize the site of infection and to destroy the invading organism. Inflammation is a general reaction seen in some form or other in practically all living matter and results not only from attack by microorganisms but from the introduction into the tissues of any irritant substance. Infection by microorganisms gives rise to an additional series of reactions that are specific to each individual type of organism. Special substances, known as antibodies, are produced in certain cells of the body, collectively known as the reticulo-endothelial system, which act on the particular type of microorganism that is responsible for infection. The union between the antibody and the corresponding substance in the microorganism, referred to as the antigen, is highly specific, resembling a lock-and-key mechanism; and when antibodies are present in sufficient quantity, they act on the microorganism in various ways, bringing about a change which renders it vulnerable to attack by the normal phagocytic cells of the blood and tissues. Specific immunity acquired in this way may be lifelong or comparatively transient. If the former, then a second attack of the particular disease is improbable; if the latter, second, third and fourth attacks may occur at quite short intervals.

Little knowledge is yet available concerning the factors that determine the degree and duration of acquired immunity in different diseases. Generally speaking, the disseminated virus infections give rise to a strong and permanent immunity, the bacterial respiratory infections to a relatively weak and transient immunity.

IV. CONTROL

1. Prevention.—Prevention of infectious disease may be attempted in three ways: diminution in the amount of infective material, control of the means of transmission and increasing the resistance of the host.

Attempts to diminish the amount of infective material comprise a wide variety of measures depending on the nature and source of the infective material. Spitting and sneezing or coughing except into a handkerchief should be avoided. Patients suffering from infectious disease should be isolated, and carriers may need to be segregated or restricted in their occupations. In practice, this is often difficult. Little or no objection, for example, is raised to the isolation of patients suffering from diphtheria or smallpox, but the isolation or even the segregation of tuberculous persons is much more difficult to effect. Quarantine may have to be imposed on ships carrying plague, cholera, smallpox and yellow fever. Here again, social and economic difficulties usually prevent the use of this method except in a limited form. Experience has shown that attempts to impose strict quarantine almost invariably fail. The compelling urgency of personal business results in a breaking of the sanitary cordon.

Much better results are obtained by a policy of partial supervision. Healthy passengers are allowed to leave the ship and proceed to their destinations. The medical officer of health of the district to which they are going is notified, and the passengers themselves are asked to report to a doctor at once if they become ill. In this way a correct diagnosis can be rapidly made in contacts developing the disease, and the patients themselves removed to a hospital.

Destruction of the infective agent by heat or chemical disinfectants is useful in particular circumstances but is seldom practicable on a large scale. In air-borne infection adequate ventilation of buildings constitutes one of the most important methods of protection, since it reduces the total number of microorganisms in the atmosphere and so lowers the risk of any occupant's receiving a dose larger than his tissues are able to cope with at any one time. Cleanliness and avoidance of dust are likewise of value. Sunlight has a sterilizing effect on bacteria so that the traditional methods of soap and water, open windows and removal of blinds and curtains to let in the maximum amount of light are all well supported by scientific evidence.

Where climatic conditions are unfavourable, destruction of microorganisms in the air of the room may be attempted by ultraviolet light irradiation and by the use of finely divided disinfectant sprays, known as aerosols. These methods, however, are still in the experimental stage and are at best poor substitutes for sunlight and fresh air.

Control of the means of transmission of the infecting agent had its most striking success in the intestinal group of diseases. Provision of a pure water supply in Great Britain has led to the eradication of cholera and to a great reduction in the incidence of enteric fever. In the larger cities of the United States compulsory pasteurization of milk resulted in the practical elimination of milk-borne disease.

Much greater care, however, is still needed in the hygienic handling of food. Veterinary inspection of animals before slaughter, the provision of properly equipped and controlled abattoirs, the examination by qualified inspectors of meat after slaughter, the institution of sound hygienic practices in food-processing plants, the education in hygiene of all persons handling food, a revision of the system of communal feeding (which presents problems differing from those met with in the domestic kitchen and requiring special technique for their solution), improved methods of storage and distribution of food, destruction of rats and mice and the control of flies and other insects are some of the measures required if food-borne diseases are to be avoided.

The strict enforcement of muzzling in countries where rabies (hydrophobia) is spread by dogs can lead, in conjunction with a rigid system of control of imported animals, to the complete disappearance of the disease.

In the prevention of diseases caused by bloodsucking insects, considerable success has attended the destruction of breeding places and the killing of the larvae by chemical agents.

The resistance of the exposed population may be increased to some extent by the usual hygienic measures such as good food, regular meals, personal cleanliness, fresh air, sufficient exercise, adequate sleep and avoidance of all forms of excess; though it must be pointed out that these measures by themselves are unable to ensure freedom from infectious disease. Indeed persons in excellent physical condition coming from rural areas often prove far more susceptible than poorly developed persons brought up in the towns, who have been exposed to various infections in early life and have acquired some degree of immunity against them.

To forestall this natural method of immunization, which, of course, is always accompanied by a considerable amount of disease and death, attempts have been made to raise the resistance of the exposed population by prophylactic vaccination. In theory, this would appear to be the most promising method of controlling infectious disease, but in practice its use is limited. There are only a few diseases against which prophylactic vaccination can be relied on to give a high degree of protection. Against the others either no vaccine is available or the degree of immunity it confers is insufficient to protect against heavy or repeated infection. Moreover, for this method to be successful, all per-

sons who are likely to be exposed to risk of infection must not only be vaccinated against each disease, but must be revaccinated at suitable intervals. This may be practicable in the armed services, but it is more difficult to ensure in civil life. Generally speaking, the protective power of a given vaccine is proportional to the degree of immunity resulting from an attack of the natural disease. That is to say, vaccination is of most value in diseases that leave behind them a lifelong immunity and in which second attacks are rare. The most conspicuous examples are some of the virus diseases, such as smallpox and yellow fever, and distemper in animals.

The next most potent vaccines are those against diseases caused by bacteria that produce a powerful exotoxin. Diphtheria and tetanus are the most striking examples. The success of diphtheria immunization has been outstanding. If it is to be used to eliminate the disease from the community and not merely to protect the individual child, a sufficiently high proportion of the population must be immunized, and this must include the most susceptible age groups. Unless the proportion immunized reaches 75% and is maintained at or about this level, and unless children are revaccinated every five years or so during school life, the disease may continue to spread. Against other bacterial diseases vaccination is less effective. It is used most frequently to protect against enteric fever, whooping cough and typhus, but the degree of immunity it produces, though valuable, is not very high.

With the exception of diphtheria (*see* above) and perhaps of whooping cough, attempts to control respiratory diseases by vaccination have so far been unpromising. (*See* also VACCINATION; VACCINE THERAPY.)

Prophylactic administration of antisera is sometimes of value when only a transient immunity is required; but this particular method is limited to diphtheria, tetanus and gas gangrene. Chemoprophylaxis, or the daily administration of a drug, may be practised when other methods of control are unsatisfactory. Mepacrine (Atabrine), for example, proved of outstanding value in the suppression of malaria during World War II, and good results were claimed by U.S. workers for sulfonamides in protecting against respiratory infections. The danger of the development of sulfonamide-resistant strains is so great, however, that these drugs should not be used prophylactically except under special conditions.

2. Treatment.—Apart from measures to relieve the patient's symptoms, treatment of infectious diseases is directed to the removal or destruction of the invading microorganisms. Where there is a focus of disease, like an infected tooth or an abscess, surgical intervention may be required; but where infection is more general, reliance has to be placed on other methods. In one disease, diphtheria, the toxin secreted by the organisms may be neutralized by the injection of adequate doses of antitoxin. Serum treatment, however, of diseases caused by organisms that do not produce a powerful exotoxin is usually of but little value. Arsenic, antimony or mercury have long been used with success in the treatment of some of the spirochetal and trypanosome diseases; but until the introduction of the sulfonamide group of drugs and of the antibiotics, no chemical agents of sufficiently low toxicity were available for the treatment of systemic bacterial infections. These two groups of compounds, however, completely changed the picture.

Since the introduction of sulfonamidocrysoidin (Prontosil) by Gerhard Domagk in 1935, large numbers of compounds belonging to the sulfonamide group have been prepared. Their greatest success has been in the treatment of pneumococcal, streptococcal, meningococcal and gonococcal infections.

How the sulfonamides act is still open to doubt, but there is general agreement that they interfere with the metabolism of the bacteria and prevent them from making use of certain substances essential for their reproduction. The antibiotic agents are products formed during the growth of certain organisms, particularly fungi. Penicillin, streptomycin, chloramphenicol, chlortetracycline (aureomycin) and oxytetracycline (terramycin) are among the most useful for the treatment of bacterial diseases. Not all bacteria are susceptible, and none of the virus infections can be influenced by these substances, but the success of chloramphenicol in tsutsugamushi (scrub typhus), one of the rickettsial diseases, holds out hope of ultimately influencing infections caused by some of the larger viruses.

Unfortunately, some bacteria may become resistant both to the sulfonamides and to the antibiotics if treatment is kept up for long, and there is a not altogether groundless fear that the resistant variants may gradually replace the normally susceptible strains of bacteria and largely nullify the value of these new drugs.

See EPIDEMIOLOGY; IMMUNITY AND IMMUNIZATION; INFLAMMATION; PARASITOLOGY; PHAGOCYTOSIS; *see* also references under "Bacterial and Infectious Diseases" in the Index.

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(G. S. W.)

BACTERIOLOGY is the science that deals with bacteria. Bacteriology is important because all living things, including man, owe their existence to the activities of bacteria. Without bacteria, the soil would not be fertile, and all plants and animals ultimately are dependent upon soil fertility for life-sustaining materials. Although some bacteria cause disease, scores of others are not only harmless but actually are beneficial.

One of the main objects of this article will be to show the value of bacteria. Information on bacteria that produce disease is contained in the articles BACTERIAL AND INFECTIOUS DISEASES; PARASITOLOGY; IMMUNITY AND IMMUNIZATION; and PATHOLOGY.

This survey is divided into the following sections:

I. HISTORY

1. Beginnings of Bacteriology.—It is quite clear that in such an article as this any attempt at a comprehensive survey of the

history of the subject would be out of place. It is well, however, to select a few dates so that the reader may realize that, in comparison with other sciences, bacteriology is quite young. In the middle of the 19th century bacteria were known only to a few experts and in a few forms as curiosities of the microscope, chiefly interesting for their minuteness and motility. The beginnings of bacteriology ran parallel with the development of the microscope. The first compound microscope was introduced by Z. Janssen in 1590. This instrument gave only small magnification and it is doubtful whether A. Kircher, who wrote in 1659 of "minute living worms in putrid meat, milk, vinegar, etc.," had seen anything smaller than protozoa or possibly the larvae of insects. The first to see microorganisms was probably the Dutch naturalist A. van Leeuwenhoek, who in 1683 sent a paper to the Royal society in London in which he described some animalculae, as they were then called, in water, saliva and dental tartar. These had been seen with a simple lens magnifying about 100–150 diameters. The organisms seem to correspond with some of the very large forms of bacteria as now recognized. In 1762 M. A. Plenciz propounded a theory of infectious disease, namely, that a special organism is associated with each disease and that the organisms are capable of reproduction outside the body and can be carried from place to place by the air. In this enlightened view, Plenciz was well in advance of his time, for little was known of these minute creatures before 1860. Great assistance came with the introduction of the oil-immersion lens by G. Dollond in 1844; although the use of this instrument made magnifications of 1,000 diameters possible, the definition at this magnification was very imperfect until the light was focused on the object by means of the substage condenser. E. Abbe introduced his condenser in 1870 and C. Zeiss completed the present-day microscopic equipment with his apochromatic lenses in 1880. It is clear that bacteria were recognized before they were distinctly seen. O. F. Müller knew several important forms in 1773, while F. Ehrenberg in 1830 had advanced to the commencement of a scientific separation and grouping of them, and in 1838 had proposed at least 16 species, distributing them into four groups or genera. Our modern, more accurate knowledge of the forms of bacteria, however, dates from F. J. Cohn's brilliant researches, the chief results of which were published at various periods between 1853 and 1872. Cohn's classification of bacteria, published in 1872 and extended in 1875, in fact dominated the study of these organisms thereafter. He based his classification on what may be considered the constancy of forms that he called species and genera. The fact that some bacteria produce spores appears to have been discovered by Cohn in 1857.

While various observers added to the knowledge of the morphology of bacteria, others laid the foundation of what is known about the relations of the organisms to fermentation and disease. When L. Pasteur in 1857 showed that lactic fermentation depends on the presence of an organism, it was already known from the researches of T. Schwann (1837) and H. L. F. von Helmholtz (1843) that fermentation and putrefaction are intimately connected with the presence of organisms derived from the air, and that the preservation of putrescible substances depends on this principle. In 1862 Pasteur placed it beyond reasonable doubt that production of ammonia by the fermentation of urea is caused by the action of a minute bacterium. In 1864 this was confirmed by P. van Tieghem, and in 1874 by Cohn, who named the organism *Micrococcus ureae*. Pasteur and Cohn also pointed out that putrefaction is but a special case of fermentation, and before 1872 the doctrines of Pasteur were established with respect to bacteria.

Meanwhile two branches of inquiry had arisen from the above. In the first place, the disputed question of spontaneous generation received fresh impetus from the difficulty of keeping such minute organisms as bacteria from reaching and developing in organic infusions; and, secondly, the long-suspected analogies between the phenomena of fermentation and those of certain diseases again made themselves felt as both became better understood. J. T. Needham in 1749 had declared that heated infusions of organic matter were not deprived of living beings; L. Spallanzani (1765) had replied that more careful heating and other precautions prevent the appearance of organisms in the fluid. Various experiments by Schwann, Helmholtz, M. Schultze, K. Schroeder, T. von Dusch and others led to the refutation, step by step, of the belief that the more minute organisms, and particularly bacteria, arose *de novo* in the special cases quoted. Nevertheless, instances were adduced where the most careful heating of yolk of egg, milk, hay infusions, etc., had failed—the boiled infusions, etc., turning putrid and swarming with bacteria after a few hours.

In 1862 Pasteur repeated and extended such experiments, and paved the way for a complete explanation of the anomalies; Cohn in 1872 published confirmatory results; and it became clear that no putrefaction can take place without bacteria or some other living organism.

In the hands of O. Brefeld, H. A. de Bary, J. Tyndall, J. Lister and others, the various links in the chain of evidence grew stronger and stronger, and every case adduced as one of spontaneous generation fell to the ground when examined. No case of so-called spontaneous generation withstood rigid investigation; but the discussion contributed to more exact ideas as to the ubiquity, minuteness and high powers of resistance to physical agents of the spores of bacteria, and led to more exact ideas of antiseptic treatment. Methods were also improved, and the application of some of them to surgery by Lister, Robert Koch and others yielded results of the highest value.

2. Later Developments.—The modern methods of bacteriological technique had their beginnings in 1870–85 with the introduction of the use of stains by C. Weigert in 1871 and the discovery by Koch in 1881 of the method of separating mixtures of organisms on plates of nutrient media solidified with gelatin and agar. Following closely on the introduction of this technique came the separation of pure cultures of many bacteria. In 1882 F. Löffler and F. Schulze discovered that a bacillus is the cause of glanders; in 1883 Koch isolated the organism of Asiatic cholera and the same year E. Klebs found that of diphtheria.

In 1885 A. Nicolaier observed the tetanus bacillus in pus produced by inoculating mice and rabbits with soil. It was left, however, to the famous Japanese S. Kitasato to discover the way in which these organisms could be cultivated. In 1889 he showed that previous failures in this connection had resulted from a lack of appreciation of a necessary condition, namely, absence of oxygen. W. D. Miller, a U.S. dentist, in the 1880s studied the microorganisms of the human mouth and their possible relationship to the decay of teeth.

Important discoveries came in 1880 and 1881 when Pasteur succeeded in immunizing animals against two diseases caused by bacteria. He found that old laboratory cultures of the bacterium that causes chicken cholera became attenuated, *i.e.*, lost their virulence, and produced only a mild, temporary illness when injected into healthy fowls. More remarkable, subsequent inoculation of the same birds with freshly isolated, fully virulent cultures demonstrated that the birds had acquired a marked resistance to the fowl cholera organism.

Pasteur, together with his associates C. Chamberland and P. Roux, also found that the anthrax bacillus when cultivated in broth at a temperature of 42°–43° C. (a little above its optimum temperature of 37° C.) lost a considerable measure of virulence after a few culture generations. It then proved to be relatively innocuous when injected into animals. Sheep and cattle that had been inoculated with such attenuated bacilli proved to be curiously resistant to the deadly effects of subsequent inoculation with virulent anthrax bacilli.

In other words, animals vaccinated with the cultivated bacillus showed immunity to disease when reinoculated with the deadly wild form. These findings were destined to lead to a study of the principles of immunity that underlie the prevention and treatment of disease by vaccines and immune serums. The questions as to causes and nature of the changes in the bacillus and in the host, the extent of immunity enjoyed by the latter, etc., are of the greatest interest and importance.

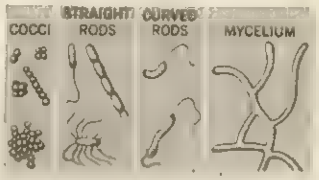
While the investigations on infectious disease and immunity were under way it became apparent that other activities of bacteria are also of importance to mankind. In 1878, only two years after Koch announced the discovery of the anthrax bacillus, W.

J. Burrill discovered the bacterial cause of fire blight in pears; it became apparent that certain bacteria are associated with diseases of plants. This field of investigation was later developed especially by Erwin F. Smith. The importance of some bacteria in soil and their contribution to soil fertility came to be recognized in the 1880s and 1890s. The significance of bacterial activities in many aspects of the dairy industry was recognized at about the same time.

Aside from the earlier studies on alcoholic and lactic fermentations, the further application of bacterial activities to industrial processes came a little later. Thus in a few decades the study of bacteria progressed enormously, and by the opening years of the 20th century it was recognized that the activities of bacteria bore an intimate relation to many aspects of human activity. Originally, the chief interest centred upon what bacteria do. Later, this interest became broader and came to include the study of the bacteria themselves, what they are, their relationships to each other and to various living forms.

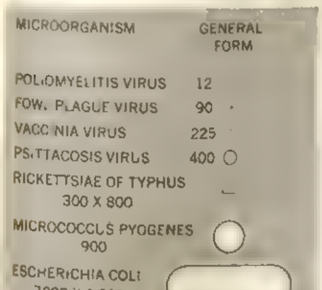
II. NATURE OF BACTERIA

1. Appearance, Size, Cell Structure.—Bacteria are unicellular and are among the smallest living creatures known. One of the periods on this page would cover about 250,000 average-sized bacteria. Because of their minute size they are often termed microorganisms. When they are viewed through the microscope a magnification of about 1,000 × is usually used. The shape of bacteria is simple, being modeled on four main cell types, the spherical or coccus form, the rod or bacillus type, the spirally twisted spirillum, and a long filamentous type (fig. 1). Each type maintains a certain constancy of appearance under standard conditions of laboratory cultivation, but different environments may cause some modification in appearance. The dimensions of bacterial cells are usually stated in microns. A micron (μ) is $\frac{1}{1,000}$ of a millimetre or approximately $\frac{1}{25,000}$ of an inch. Many of the spherical bacteria are about 1 μ in diameter. An average-sized rod or short spiral cell is 3 μ to 5 μ long and about 1 μ across. There is considerable variation in size among different kinds of bacteria; some are smaller, others larger than the foregoing dimensions (fig. 2). Some of the longer spiral cells and the filamentous cells attain lengths of 10 μ to 20 μ or more. They are usually quite slender, however, and seldom exceed 1 μ to 2 μ in width.



FROM R. Y. STANIER, M. DOUDOROFF AND E. A. ADELBERG, "THE MICROBIAL WORLD"; REPRODUCED BY PERMISSION OF PRENTICE-HALL, INC.

FIG. 1.—SHAPE AND ARRANGEMENT OF BACTERIA



FROM M. FROBISHER, "FUNDAMENTALS OF MICROBIOLOGY"; REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO., PHILADELPHIA (1957)

FIG. 2.—APPROXIMATE SIZES AND FORMS OF CERTAIN MICROORGANISMS COMPARED WITH HUMAN RED BLOOD CELL

Each bacterial cell consists of a mass of protoplasm surrounded by a thin cell membrane that in turn is held within and presses against a rigid cell wall (fig. 3). Granules and droplets of fatty material can at times be seen in the cell. Some variability in the make-up of their protoplasm exists between one kind and another. This is indicated by their capacity to produce markedly different chemical changes that help distinguish one species from another.

The bacteria, with few exceptions, are not equipped with chlorophyll, the green colouring matter of plants.

Evidence has accumulated to show that bacteria possess a definite nucleus that can be distinguished, at least in a number of them, by the use of special methods. The nucleus commonly appears as a dumbbell-shaped or spherical body, often in pairs and at times in a group of four. The nucleus has been shown to contain a compound called deoxyribonucleic acid that is characteristic of the nuclei of the cells of other living organisms. Further, mitotic figures associated with division of the cell have been distinguished in a few cases. Thus, it appears that the components and general make-up of bacteria are basically quite similar to those of the cells of higher forms.

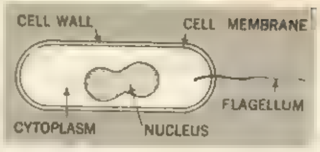


FIG. 3.—SCHEMATIC DRAWING OF STRUCTURE OF A BACTERIAL CELL

In the case of some bacteria the cell body is encased in a gelatinouslike material that is known as a capsule. Chemically this material is composed largely or entirely of polysaccharide. Often each cell is surrounded by a distinct capsule, but in some cases a mass of cells may be embedded in such material; this is termed a zoogloea. Some bacteria are provided also with thin whiplike appendages projecting from the cell body. These are termed flagellums.

There may be only one flagellum, several of them or a large number. The arrangement of the flagellums varies with different species of bacteria. Sometimes only one projects from the end of a rod-shaped or spiral cell; or they may be arranged in a tuft at one end or at both ends of the cell, and in some cases they are distributed over the whole cell surface. With the aid of flagellums some bacteria are capable of rather rapid movement.

2. Spore Formation.—Some bacteria are able to form spores. The spores present a quite different microscopic appearance from that of the original cell before spore formation. The spore is formed within the cell and for this reason is sometimes referred to as an endospore. Spores are formed usually when conditions become unsatisfactory for active metabolism and for cell reproduction.

The first visible sign of spore formation is the appearance of a light spot in the cell when viewed unstained under the microscope. This differentiated portion increases in size and after several hours appears as a distinct rounded or oval body enclosed by a wall. Having formed the spore the rest of the cell gradually disappears.

Spores are much more resistant to heat, drying, light, disinfectants and other harmful agents than the original cell. They serve to tide the organism over a period when the environment is unfavourable. Spores may remain alive for more than ten years and probably much longer, withstanding conditions of drought that would speedily kill the nonspore-forming cell. When more suitable conditions return the spore germinates and from it there develops again a cell similar to the one that originally formed the spore. This new cell, under favourable conditions of moisture, temperature and food supply, then starts active metabolism and reproduction. This continues for a time until conditions change and spores are again formed.

It is to be emphasized that some kinds of bacteria are not able to form spores. Spores are usually formed only by the rod-shaped cells, and not by all of them. Usually only one spore is formed in one bacterial cell. Upon subsequent germination of the spore, usually only one vegetative cell emerges from the spore. Thus spore formation is not ordinarily a method of multiplication. Few of the disease-producing bacteria are able to form spores. This is fortunate because much more rigorous treatments than now used

FROM A. L. HOUWINK & W. VAN ITERSON, IN "BIOCHIMICA ET BIOPHYSICA ACTA" 5 (1950) 10. PREPARATION, C. F. ROBINOW

FIG. 4.—ELECTRON MICROGRAPH OF A COMMON BACTERIUM (PROTEUS VULGARIS) HAVING MANY FLAGELLA. (GREATLY MAGNIFIED)

would be necessary to kill them. The chlorination of water supplies to destroy diphtheria bacilli and tubercle bacilli, for example, would be enormously complicated if these bacteria were able to form spores.

3. Physiological Characteristics.—Aside from differences in microscopic appearance bacteria exhibit great diversity in their physiological activities. The energy necessary for carrying on cell activity and the building materials needed for formation of new cells during multiplication are secured in a variety of ways. The acquisition of energy and materials, in turn, is related in large measure to the different enzymes possessed by various bacteria. Many of the common bacteria of air, soil and water are capable of digesting dead organic materials, proteins and carbohydrates, breaking them down to simpler molecules and in turn utilizing these substances. Some bacteria are unable to degrade the larger molecules but make use of simpler organic substances that diffuse through the cell membrane; examples of such substances are various sugars, organic acids, amino acids and alcohols. There are many differences as to substances utilized and end products formed.

In contrast with the foregoing are other bacteria, also found in soil and water, that are independent of preformed organic materials and are capable of obtaining energy by the oxidation of inorganic compounds. A few are equipped with a chlorophyll-like pigment, make use of the energy of sunlight and in the presence of light carry on a process akin to that of photosynthesis of green plants.

It is obvious that bacteria are extraordinarily varied in their physiological activities, much more so than in their cell shape and form. (See *Food Requirements*, below.) The marked ability of bacteria as a group to produce such a great diversity of chemical changes and end products constitutes one of the outstanding facts of the natural economy. Through the agency of the bacteria and certain other microorganisms the elements necessary for life are kept in circulation. In connection with this microbic activity certain processes or end products have been found useful to man. (See *Some Activities of Bacteria* and *Bacteriology in Industry*, below.)

III. RELATIONSHIPS AND CLASSIFICATION OF BACTERIA

1. Algal and Fungal Relationships.—In many respects the bacteria resemble some of the simpler plants, particularly the blue-green algae and some of the molds, and it is largely on the basis of this resemblance that bacteria are considered to be simple plants rather than animals. Bacteria as a group often have been referred to as Schizomycetes, that is, fission fungi. In some classifications of primitive plants, bacteria are assigned the status of a phylum, Schizomycophyta, distinct from other phyla of fungi and algae. In other outlines the Schizomycetes are given a class status.

Bacteria are distantly related to the protozoa, a large group of unicellular animals that includes the amoeba, paramecium and the causative agent of malaria.

The classification of bacteria into subgroups and smaller divisions presents some difficulties since the number of morphological characteristics is limited in these very small forms of life. However, the bacteria show a considerable diversity of physiological characteristics relative to the fermentation of different sugars and other carbohydrates, different end products formed, the ability to digest proteins, different nutritive requirements and different immune responses on the part of animals. These characteristics are used along with morphological characteristics in separating bacteria into successively narrower subgroups and finally into species. The details of classification and the technical terms applied to the subgroups can be found in bacteriology textbooks.

Certain rather simple filamentous branching forms, the actinomycetes including *Streptomyces* and others, are included with the bacteria rather than the molds. Also the long spiral forms, the spirochetes, are placed in one of the subgroups of bacteria. The proper classification of bacteria is complicated to some extent by the variability of bacteria in different environments.

2. Other Related Groups: Rickettsiae and Viruses.—There are several groups of microorganisms that, although included in the subject of bacteriology, are usually placed in a group by themselves. These are the rickettsiae and the viruses.

The rickettsiae are named after H. T. Ricketts, one of the early investigators of this group. They are small bacteria or bacterialike organisms that are primarily parasites of insects and other arthropods. Some of them also cause disease in man. Typhus and Rocky mountain spotted fever are two examples. These microorganisms fail to grow in the usual culture solutions used for the bacteria, but in cases of human disease they actually invade and multiply within certain tissue cells. In many respects they appear to be more highly parasitic than the bacteria and are often thought of as intermediate between the bacteria and the larger viruses.

The term virus is applied to a group of extremely small infectious agents that produce disease in man, animals or plants. Viruses once were called filterable viruses because of their ability to pass through a very fine filter that retains the ordinary bacteria. Other characteristics also set them apart from the bacteria. For the most part they are too small to be seen with the ordinary light microscopes; they fail to propagate in test-tube nutrient solutions used for bacteria and, in contrast, usually require the presence of living and metabolizing tissue cells. *See* VIRUSES.

IV. MULTIPLICATION OF BACTERIA

1. Mode of Reproduction.—When a bacterial cell is about to divide, the material of the cell is gradually increased until its volume is practically doubled. Spherical forms become oval and rod forms stretch to nearly double their length; the cell then either becomes constricted at the middle or a cross wall forms until finally the contents are held in two compartments.

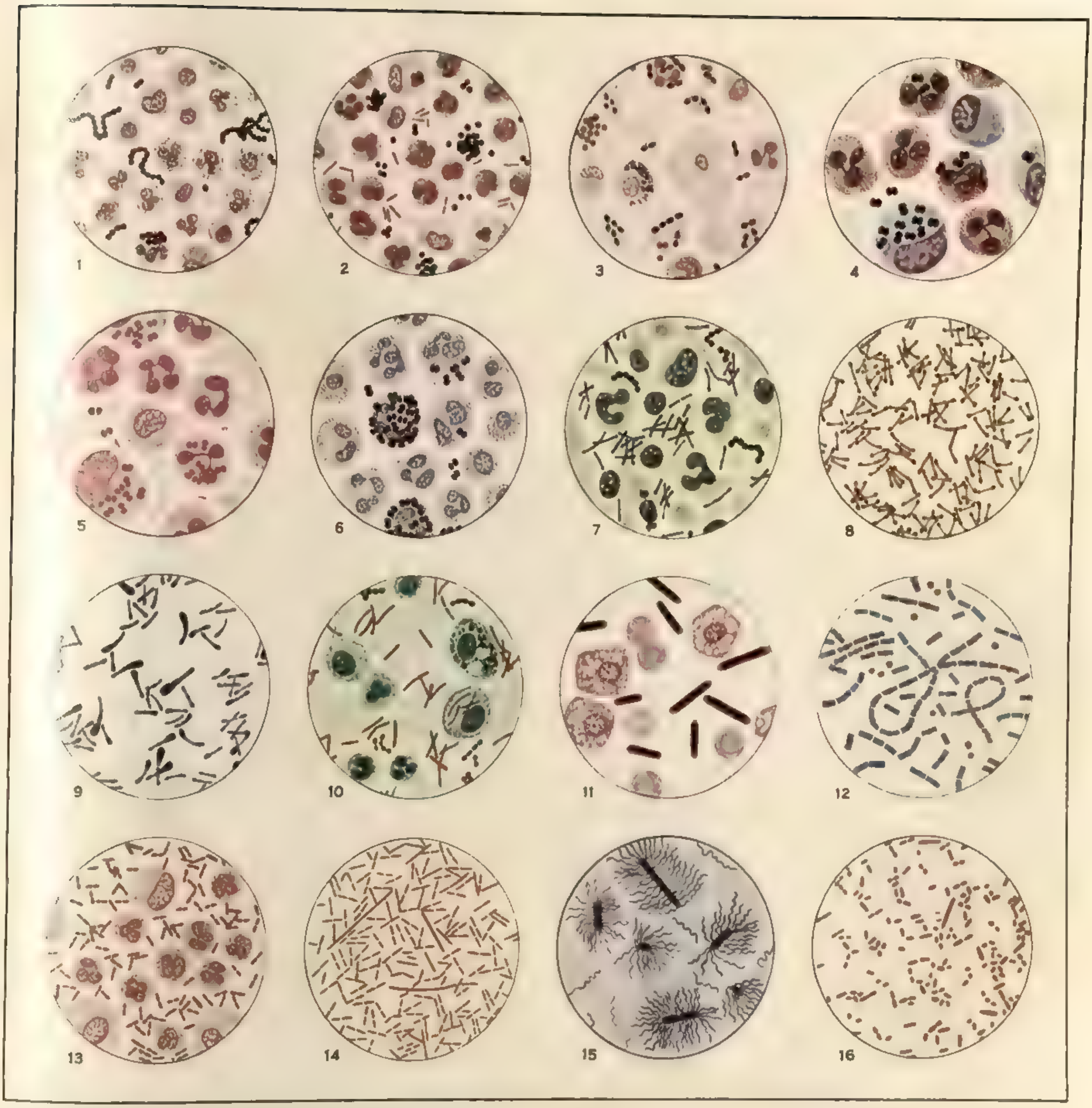
The two new cells may adhere for some time but in many cases they separate and form two new individuals or daughter cells that ordinarily are the exact counterpart of the mother cell and of each other. Because of this method of growth some authorities regard bacteria as fission fungi.

Fission represents the chief form of reproduction for many bacterial species. Other methods of reproduction, however, have been described. Reproduction by formation of a bud that develops into a mature cell has been observed. Formation of special reproductive smaller cells (conidia) occurs in some of the higher bacteria that are related to the molds, and some investigators have claimed that conidia can be formed by most or by all bacteria. There is also evidence, based upon genetic experiments with a few species of bacteria, that a procedure analogous to a sexual process occurs at times. However, reproduction is primarily asexual.

2. Bacterial Genetics; Mutation.—From the early 1940s information has accumulated to show that the hereditary apparatus of bacteria is basically the same as that of other living organisms. At that time convincing evidence of the presence of nuclei in bacteria appeared. It was demonstrated that the nuclear bodies contained deoxyribonucleic acid. Evidence has accumulated to show that, like higher organisms, heredity in bacteria is controlled by genes. It is inferred that bacterial genes are organized into chromosomal threads within the nucleus, though direct cytological evidence of this is lacking.

Three processes are known by which genetic material may be transferred from one bacterial cell to another: (1) The transfer by diffusion of soluble deoxyribonucleic acid from one type of cell. This is termed transformation. (2) Transfer of genetic material from one cell to another with a particle of bacteriophage, termed transduction. (See *Bacteriophages*, below.) (3) Gene recombination which involves direct cell contact with temporary cell fusion. These processes have been demonstrated with only a few of the many different kinds of bacteria. How widespread their occurrence may be is not known.

Heritable variations in bacteria are in most cases the result of gene mutation and are not the result of "directed variation" caused by the environment, as commonly believed at one time. In a large population of bacteria, such as a billion cells in a test-tube culture or in a colony, a mutant may appear, either spontaneously or after application of a mutagenic agent. If the mutant possesses,

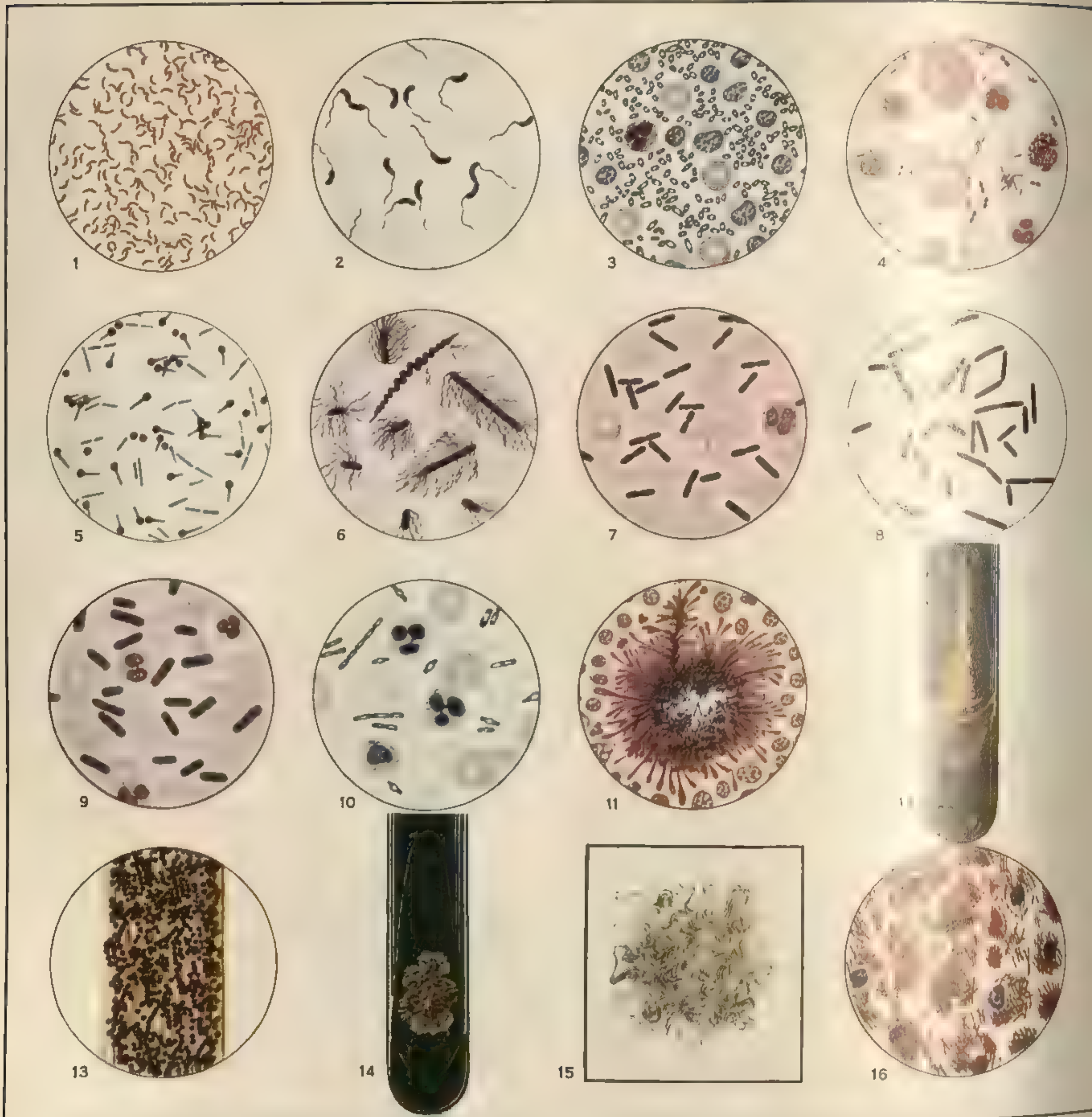


FROM MUIR, "BACTERIOLOGICAL ATLAS" (LIVINGSTONE)

DISEASE-PRODUCING BACTERIA VIEWED THROUGH THE MICROSCOPE

1. Streptococcus pyogenes in pus. X (magnified) 1,500. Stain: Gram, neutral red. This is a common species of streptococcus and is often associated in "mixed infections" or "secondary infections." (*See* also fig. 10)
2. Staphylococcus aureus (dark spheres) and Pseudomonas aeruginosa (pink rods) in pus. X 1,500. Stain: Gram, neutral red. Micrococci are commonly found in boils, abscesses, carbuncles and other suppurative processes in man. S. aureus is characterized by the golden-yellow pigment formed in pus. Pseudomonas aeruginosa is found in man associated with streptococci and micrococci, also found in pure culture in some cases of pneumonia
3. Pneumococcus (encapsuled dark ellipses) and Neisseria catarrhalis (red spheres in clumps) in sputum. X 1,500. Stain: Gram, neutral red. The majority of pneumonia cases are caused by pneumococci
4. Meningococcus (encapsuled diplococci) from cerebrospinal fluid in epidemic cerebrospinal meningitis. X 1,500. Stain: Leishman
5. Same stained: Gram, neutral red. The diplococci are mainly intracellular
6. Gonococcus from pus in gonorrhoea. X 1,500. Stain: Methylene blue, eosin. The diplococci are mainly intracellular
7. Corynebacterium diphtheriae (rods) and a few chains of streptococci from a smear of the throat lesion in diphtheria. X 1,500. Stain: Thionin blue
8. Corynebacterium diphtheriae from 12 hours' culture on Löffler's serum medium. X 1,500. Stain: Neisser's method with methylene blue and Bismarck brown. Note the bipolar staining of the metachromatic granules
9. Corynebacterium diphtheriae: involution forms. From a 5-day agar culture. X 1,500. Often found in throat lesion. Stain: Thionin blue
10. Mycobacterium tuberculosis (human type). From sputum in a case of pulmonary tuberculosis. X 1,500. Stain: Ziehl-Neelsen's method, methylene blue. A few streptococci (blue) are seen
11. Bacillus anthracis from liver of diseased guinea pig (experimental anthrax). X 1,500. Stain: Muir's method to show Gram-positive reaction and capsule staining. (*See* also fig. 15, Plate II)
12. Bacillus anthracis from 3 days' agar culture to show spores (red) within the bacilli. X 1,500. Stain: Ziehl-Neelsen's method with 0.5 per cent sulphuric acid, methylene blue
13. Escherichia coli from case of cystitis. X 1,500. Stain: Gram, neutral red. It occurs abundantly in the intestinal tract of man and derives its name "coli" from the fact that it is found most abundantly in the colon. Though these organisms may be present in large quantities without causing specific disease, they sometimes invade the gall-bladder and bile-ducts, causing cholangitis and cholecystitis, and produce lesions of the urinary tracts, causing cystitis
14. Typhoid bacillus from young agar culture. X 1,500. Stain: Gram, neutral red. This intestinal tract organism causes typhoid fever
15. Same to show flagella: 12 hours' agar culture. X 1,500. Stain: Muir's method
16. Shigella dysenteriae (Shiga): young agar culture. X 1,500. Stain: Gram, neutral red. This is one of a group of four or more organisms of the intestinal tract causing dysentery in man

BACTERIOLOGY



(1-11) FROM MUIR, "BACTERIOLOGICAL ATLAS" (LIVINGSTONE), (12, 14, 15) FROM LEHMAN NEUMANN, "BACTERIOLOGISCHE DIAGNOSTIK" (LEHMAN)

DISEASE-PRODUCING BACTERIA VIEWED THROUGH THE MICROSCOPE

1. Vibrio comma: 24 hours' agar culture. X (magnified) 1,500. Stain: Carbol fuchsin. Formerly known as "Comma bacillus," causing cholera
2. Same as fig. 1, to show flagella: 12 hours' agar culture. X 1,500. Stain: Muir's method
3. Pasteurella pestis from bubo in case of Oriental plague. X 1,500. Stain: Methylene blue, eosin
4. Haemophilus influenzae (Pfeiffer) from sputum in case of influenzal pneumonia. X 1,500. Stain: Gram, neutral red. Note presence of a few pneumococci in pairs (dark). (*See* also fig. 3, Plate I)
5. Clostridium tetani showing bacilli and terminal spores ("drumsticks") from 3 days' glucose agar stab culture. X 1,200. Stain: Ziehl-Neelsen, decolourized with 5% sulfuric acid, washed (water) mordanted with saturated watery potash alum, washed (water) methylene blue. This is the blood poisoning (lockjaw) organism which grows best with a very low oxygen supply. For this reason the bacilli develop in deep, dirty wounds, though these may be relatively as small as pin pricks
6. Same as fig. 5, to show flagella: 12 hours' anaerobic agar culture. Stain: Muir's method. X 1,200. The wavy mass at top is a cluster of shed flagella
7. Clostridium perfringens from a case of gas gangrene. X 1,500. Stain: Gram, neutral red
8. Same as fig. 7, from young agar culture grown anaerobically. X 1,500. Stain: Gram
9. Same as fig. 7. X 1,500. Stain: Muir's method to show capsule
10. Clostridium septicum from subcutaneous tissue in case of malignant edema with gas gangrene. X 1,200. Stain: Methylene blue. Note numerous spore-bearing bacilli singly or in chains
11. Actinomyces bovis ("ray fungus") from lesion in tongue of cow. X 800. Stain: Gram, eosin. Note that the mycelial filaments are Gram-positive, the clubs are Gram-negative. Around the colony mononuclear cells predominate
12. Naked-eye culture of Staphylococcus aureus on gelatine slope: at the bottom the gelatine is liquefied. (*See* fig. 2, Plate I)
13. Microsporum audouini. Hair from scalp in case of ringworm. X 800. Stain: Adamson's modification of Gram's method. The violet spheres are spores of the fungus on the surface of the hair
14. Naked-eye culture of Mycobacterium tuberculosis. (*See* fig. 10, Plate I)
15. Impression of minute colony of Bacillus anthracis. X about 20. Unstained. Note the "Medusa locks" arrangement of the filament of bacilli. The demonstration by Robert Koch in 1876 of the causal relation between anthrax (splenic fever) and a specific bacillus marks the beginning of modern bacteriology. (*See* fig. 11, Plate I)
16. Mycobacterium leprae in tissue. From subcutaneous nodule in case of leprosy. X 1,500. Stain: Carbol fuchsin, methylene blue

for example, a greater resistance to an antibiotic than the other cells, it has the advantage and will outgrow them if the antibiotic happens to be present in the environment. Soon the culture is composed of antibiotic-resistant individuals. The same effect is true of other properties; the environment tends to give certain mutants an advantage. If it does not, the mutant is often lost in the vast majority of other cells and is not recognized.

From 1942 much use has been made of radiations, such as ultraviolet light or X-rays, and of certain chemicals to induce mutations experimentally in bacteria. A gene mutation usually alters a biochemical reaction of the cell, and the mutant differs in one primary way from the nonmutant parent strain. It is not possible to specifically change any gene that one may wish, but the cells are exposed to the radiation or other mutagenic agent and then the treated population is "screened" by one method or another to detect the desired altered type. In this way bacterial populations have been obtained experimentally that are more resistant to chemical agents (penicillin, a sulfonamide, dyes, etc.), or to ultraviolet radiation, or to bacteriophage or other detrimental agents; the mutants may have different nutritive requirements; they may carry on certain aspects of cell metabolism through different channels than the nonmutant cells or exhibit a difference in any one of many other properties.

3. Rate of Multiplication.—Given suitable conditions for growth, the rate of asexual multiplication of bacteria is very rapid; it has been found that a cell divides every 20 or 30 minutes.

Assuming that conditions are conducive to a rate of one division every 30 minutes, a single individual cell will have produced 4 cells at the end of the first hour, 16 at the end of two hours and about 1,000,000 at the end of 15 hours. It can be calculated that these would occupy a space of one cubic millimetre. Such a mass of bacteria, easily visible to the naked eye, is called a colony, and it is no unusual thing in bacteriological practice to obtain colonies of this size as the result of one night's growth. Conditions for bacterial growth, fortunately for man's position in the world, never remain favourable for such unrestricted growth very long.

In order to produce any quantity of bacteria there must be an equivalent weight of suitable food material. There are other factors that influence the growth of bacteria. For instance, the by-products of bacterial activity, unless removed, militate against bacterial growth. It is very noticeable when cultivating bacteria in the laboratory upon plates of nutrient media; growth, which in the initial stages of incubation is so rapid that a colony may appear in 10 to 15 hours, gradually becomes less rapid and usually comes to a complete standstill after 30 to 36 hours. Many of the by-products of bacterial growth are acidic, and acids generally are unfavourable to bacterial multiplication.

V. CONDITIONS AFFECTING GROWTH OF BACTERIA

1. Food Requirements.—Bacteria must obtain from their environment all nutrient materials necessary for their metabolic processes and cell reproduction. The food must be in solution and must pass into the cell. In general, large molecules such as proteins and starches do not penetrate, but there is evidence of selectivity on the part of the cell wall or membranes with respect to penetration of smaller molecules. The food materials contain the elements carbon, hydrogen, oxygen, nitrogen, sulfur and phosphorus in varying degrees of complexity. Other important elements also are supplied: potassium, sodium, calcium, magnesium, manganese, iron, copper, cobalt and others. If the supply of even one essential substance is inadequate, metabolic activities and growth are limited. As with those of other living organisms, the foods essential for bacteria can be placed in four main groups: (1) sources of energy; (2) building materials for the cell; (3) accessory growth factors or vitamins; (4) inorganic salts. Water is also necessary.

Bacteria exhibit great diversity with respect to the particular chemical forms in which the elements can be utilized as nutrients. Certain bacteria, termed autotrophs, are able to make use of inorganic compounds, including carbon dioxide. Others, termed heterotrophs, require organic compounds (those derived from living organisms). The distinction between autotrophs and heterotrophs, though not as clear-cut as formerly believed, is nevertheless useful. Most bacteria, including the disease-producing species, are heterotrophs.

Autotrophs.—Among the autotrophs are a few bacteria that contain chlorophyll or a chlorophyll-like substance. These bacteria, like the algae and higher green plants, secure energy from sunlight. They obtain carbon from carbon dioxide, nitrogen commonly in the form of an ammonium salt, and other elements from inorganic compounds. From such simple substances their own cell protoplasm is formed.

Other autotrophic bacteria lack chlorophyll and are unable to cause photosynthesis. They secure carbon from carbon dioxide or carbonates and the other elements from inorganic compounds, like the previous group. They are remarkable in being able to derive energy from the oxidation of elements or very simple compounds. One group obtains energy from the oxidation of sulfur, another from the oxidation of ammonia to nitrites and a third from the oxidation of nitrites to nitrates.

The many differences in the metabolic activities of different bacteria are apparent when it is seen that a few bacteria that possess chlorophyll are not autotrophs but, on the contrary, use organic compounds as the source of hydrogen for reduction of carbon dioxide in photosynthesis.

Heterotrophs.—Heterotrophic bacteria derive energy from the oxidation of relatively complex organic food materials, such as sugars, other carbohydrates and fats. These substances also supply carbon for the building of new cell material. There are great differences among the various heterotrophic bacteria regarding the diversity of compounds each can utilize. Some, for example, are able to break down a wide variety of different sugars. Others can utilize only glucose or a few closely related sugars. A few are unable to utilize glucose and must rely on other organic compounds for carbon moieties and energy. The differences are due to different enzymic actions of the cells.

Nitrogen.—The same diversity is seen with respect to the requirement for and the utilization of nitrogenous compounds. The nitrogen needed for formation of new cells is supplied primarily by amino acids (the "building blocks" of protein) or other relatively simple compounds of nitrogen combined with carbon, hydrogen, and often oxygen. Some bacteria are able to synthesize (manufacture) all of the 20 or so amino acids needed for their cell protein, using inorganic nitrogen, such as in an ammonium salt, as the source of the nitrogen of the amino acids. A limited few are able to capture and fix nitrogen itself (see *Some Activities of Bacteria: In Soil: Nitrogen Fixation*, below). These bacteria are still classed as heterotrophs because other organic compounds are needed. In contrast, other heterotrophic bacteria lack the ability to synthesize one or more amino acids and must secure them preformed from the environment. The amino acids thus required vary from 1 to 12 or more, and often differ somewhat from the 8 to 10 required for human or rat nutrition.

Vitamins.—Vitamins that play an important part in bacterial metabolism are mostly the B vitamins: thiamine (vitamin B_1), riboflavin (vitamin B_2), niacin, biotin, pantothenic acid, vitamin B_6, pteroylglutamic acid (folic acid), and vitamin B_{12}. The roles played by these different vitamins in microbic metabolism are similar to their roles in higher forms of life and are necessary for the proper functioning of the cell. Great diversity also exists among different kinds of bacteria with respect to their ability to synthesize vitamins from simpler substances. Some bacteria—unlike man and animals—can synthesize all known vitamins used in their metabolic processes. In such cases the vitamins do not need to be supplied along with the food materials. Indeed, such bacteria are one of the important sources of vitamins in nature. Other bacteria are deficient in synthesizing ability and may be unable to synthesize one, two or half a dozen vitamins. Since these vitamins are required for the usual cell functions, they must be obtained from the environment. Under natural conditions this often occurs.

Laboratory Cultivation.—For cultivation of the usual heterotrophic bacteria in the laboratory, digests of protein (called pep-

tone) and an extract of meat are commonly used. Sometimes a sugar is added. These substances are dissolved in water to give 0.5% to 1.0% solutions. They supply a wide variety of both carbon- and nitrogen-containing organic foodstuffs, some vitamins and inorganic salts, including some metal ions needed only in trace amounts. For certain microorganisms, however, such a culture medium may be supplemented with certain vitamins or other compounds. Of the natural fluids available, milk supplies the nutrients needed by most bacteria and is an excellent culture medium. It must be realized that a deficiency of any one required substance, whether it is an amino acid, vitamin or metallic ion, is sufficient to limit or prevent cell metabolism and growth, even though all other requirements for growth have been met.

2. Temperature.—For every bacterium there are certain cardinal points of temperature. There is first the minimum point, below which growth is impossible. This varies with individuals, but for the majority it lies between 5° and 10° C.; some marine bacteria and certain soil types are active near 0° C., but they are exceptions. The optimum, depending largely on the usual habitat of the organism, is around 30° C. for soil organisms and about 37° C. for animal parasites. The maximum, above which no growth is possible, for many organisms lies between 38° C. and 48° C. Death of the organism as a rule occurs at a point about 10° or 15° higher than the maximum temperature for growth. The actual death temperature can only be considered in relation to time; a low temperature acting for a long time will produce the same effect as a high temperature applied for a short time. A thermal death point standard has been chosen arbitrarily by bacteriologists and represents the lowest temperature that, when applied for exactly ten minutes, will destroy every individual in a fluid suspension of the organism. Temperatures below the minimum prevent bacterial growth but there appears to be no equivalent thermal death point at low temperatures. It is known that typhoid and other disease germs survive quite a long inclusion in ice, and instances are known in which typhoid epidemics have been spread by ice cream. J. MacFadyen and S. Rowland found that organisms frozen in liquid air and even in liquid hydrogen at −252° C. were still capable of development when restored to normal incubation temperature.

Thermophilic Bacteria.—A few bacteria are unusual in that they are able to carry on active cell metabolism and multiply at 50° to 60° C. or even somewhat higher temperatures that would deactivate or kill other bacteria. The term thermophilic has been applied to these forms. Some thermophiles are active only at higher temperatures; others are active also at more ordinary temperatures, as 30° or 37°.

Thermophilic bacteria are sometimes responsible for the heating that occurs in haystacks or manure heaps. They occur also in hot springs. They do not belong to any one morphological group of bacteria; some are rod-shaped, others round or spiral. Some are not able to form spores. What peculiar property or attribute of the cell substance permits them to remain alive and active at high temperatures is not known.

3. Sterilization.—Methods of sterilization have to be chosen in full appreciation of the high resistance to heat of the bacterial spore cell. The ordinary cells are destroyed at temperatures of 50° to 60° C., hence a single boiling of a fluid or even pasteurization (application of heat of 63° C.) is sufficient to destroy them or most of them. The spores, however, must be subjected to very prolonged heating at these temperatures before they are destroyed; in order to produce sterility in a liquid in a reasonably short time, temperatures above 120° C., obtained by steam under pressure, are employed. Dry spores withstand even higher temperatures, but 160° C., maintained for 60 minutes, will usually destroy them.

4. Moisture.—Experiments have shown that bacteria will not grow in soil when the water content is 2% to 3%, but bacteria become active at 5% to 10% and reach their optimum, depending on the character of the soil, at 25% to 40%.

The importance of moisture for bacterial growth will be seen clearly if it is realized that bacteria have no mouth parts and that all their food must be imbibed in a soluble form by the process of diffusion through the cell wall; without sufficient moisture, therefore, the inflow of food and the outflow of excreta becomes impossible. Microorganisms vary considerably in their resistance to drying, and some die much more quickly than others. Practical use is made of drying, or desiccation, in many ways: in dehydration of foods, for example, and in other industries where the product is subject to microbic spoilage. By extracting sufficient water from the product, microbic cell metabolism is stopped and spoilage prevented. The cells are not always killed, however, and if the moisture content is allowed to rise sufficiently spoilage may soon occur. The point at which this happens varies with the product and many other conditions.

In general, molds are able to develop under conditions of somewhat lower moisture content than are the bacteria; consequently molds are often the most serious offenders in spoilage of flour, grain, textiles and other products.

5. Oxygen.—Bacteria of various kinds exhibit wide differences in their relation to oxygen of the air. Some need oxygen for respiration and cannot grow unless it is provided. These are known as aerobes. Others grow only in the absence of free oxygen and are unable to use it in their respiration; they are called anaerobes. Still others can grow under either condition and are termed facultative. Anaerobes, in spite of their peculiar requirement, are common in nature and are encountered in decomposing organic matter, in soil and in the mud of pond bottoms. Often they are able to grow in association with aerobes. It has been shown that the relative proportion of oxidizing and reducing conditions, as expressed by what is termed the oxidation-reduction potential, is important in the growth of anaerobes. If sufficient amounts of reducing substances, such as ascorbic acid (vitamin C), cysteine, or other such agents are present, even strict anaerobes may be grown in open tubes in the laboratory exposed to air. Spore-forming anaerobes have been especially troublesome in the canning of food. If the product is heated insufficiently, a few spores may survive the processing. Later they germinate and the cells multiply in the food product since the amount of oxygen is lowered inside the heated container; spoilage results. These bacteria are often harmless, but occasionally *Clostridium botulinum* is encountered. This anaerobe, the cause of botulism, forms a toxin that is extremely poisonous to man and many animals when taken by mouth.

6. Light.—Bacteria die rapidly if thin layers of them are exposed to direct sunlight, as for instance on the surface of an agar plate. Some organisms survive under these conditions for only 10 or 15 minutes. Sunlight is regarded as one of the most powerful destroyers of pathogenic germs. The part of sunlight that possesses the lethal effect is that at the ultraviolet end of the spectrum. Ultraviolet rays with a wave length of around 2,600 Å are especially effective. Some artificial sources of ultraviolet light provide a greater concentration of rays within this range than does sunlight. Most nonspore-forming bacteria, or those that have not gone into the spore stage, are killed by a few minutes of exposure if the source of the light is relatively close, within a foot or two. Spores are most resistant. While ultraviolet light is effective and useful if properly controlled it has certain limitations of application although many extravagant statements of its effectiveness have been made.

7. Reaction of the Culture Medium.—The reaction of the culture medium, that is, the amount of free acid or free alkali present in it, is of the greatest importance for bacterial development. A culture medium that is neither acid nor alkaline is said to be neutral and is best adapted to the growth of many kinds of bacteria. There are numerous organisms that are favoured in their growth by a faintly acid medium and others that prefer the medium to be slightly alkaline. The reaction is commonly expressed in terms of the reciprocal of the hydrogen ion concentration, using the symbol pH. A value of pH 7.0 represents the neutral point; lower figures, such as 6.0, 5.5, etc., represent increasing acidity; higher figures, such as 7.6, 8.0 and so on, represent increasing alkalinity. Most species of microorganisms are able to grow within a range of pH 6.0 to 8.0. Some bacteria and many yeasts and molds are able to grow in environments as

acid as pH 3.5 to 4.5, a few at a pH of 2.0 to 3.0.

8. Antiseptics and Disinfectants.—Many substances inhibit metabolic activity and multiplication of microorganisms. Some produce this effect without killing, others kill within short periods of time. A distinction between these effects is not always clear; a high dilution of a substance may merely inhibit while a more concentrated strength kills in a short time. Mercuric chloride, the alcohols, carbolic acid and many phenolic compounds are well known as disinfectants. Several other groups of substances have found increasing usefulness: the surface active agents, sulfonamide drugs and antibiotics. The antibiotics are substances produced by microorganisms that inhibit the growth of other microorganisms (see *Bacteriology in Industry*, below). The chemical constitution of some of the antibiotics is not known.

There are great differences in the effectiveness of antiseptics and disinfectants; consequently, they are used for many purposes: as preservatives in a variety of products, or as killing agents when applied to open wounds or internally. A number of factors either speed or retard the process of disinfection. The more important of them are the concentration of the disinfecting substance, the length of action time, the number and kinds of bacteria present, temperature, surface tension and other characteristics of the surrounding environment.

The spores of bacteria are usually much more resistant to disinfection than are the cells without spores. But even among nonspore-forming bacteria there are differences in resistance to different disinfectants; thus a staphylococcus from boils or abscesses may survive a treatment with a disinfectant that would kill the typhoid bacillus. However, toward another substance the typhoid bacillus might be somewhat more resistant than the staphylococcus. Stated another way, the differences in resistance seen in different bacteria with respect to one disinfectant cannot always be carried over and applied to another disinfectant, particularly one of a different chemical group and with a different mode of action. The compounds that are most useful in treating infections are not necessarily those that produce the speediest killing. In some cases the potency is relatively low but the substance is of value because it restrains the activities of bacteria and at the same time is not especially toxic to man and animals in the amounts usually needed.

VI. BACTERIA IN AIR AND WATER

Bacteria have existed from very early periods, as is shown by their presence in fossils; the researches of B. Renault and P. van Tieghem have shown that large numbers of bacteria existed in Carboniferous and Devonian times. In modern times they are universally present in still ponds and ditches, in running streams and rivers, in the sea, especially in drains, rubbish and manure heaps, in the soil and wherever organic matter is allowed to stand for a short time. Any liquid (blood, urine, milk, beer, etc.) containing organic matter or any solid foodstuff (meat, bread, potatoes, etc.) allowed to stand exposed to the air soon swarms with bacteria if sufficient moisture is present and the temperature is not abnormally cold. Though they occur in the air all the world over their distribution is by no means equal in all parts. As might be conjectured, they are most numerous in the air of cities, but even there the number of living bacteria is not so great as one would expect considering the enormous number of dust particles. Every mote in the air doubtless carries its quantum of bacteria, but the conditions of rapid drying and the exposure to ultraviolet light are responsible for the death of some of the organisms that are raised by the wind from the earth's surface. The air of the country is relatively free from bacteria as compared with that of the towns. The atmosphere over the ocean becomes more and more free from microscopic organisms as the distance from land increases.

The possible transmission of disease-producing bacteria through the air has attracted attention from the earliest days of bacteriology, particularly in the case of the bacteria causing respiratory infections that are found in the mouth and nose. It is known that in coughing or sneezing many small droplets of moisture are ejected out of the mouth or nose in the form of a fine spray. Bacteria on the mucous membrane are also expelled and may float in the air for a time before settling.

While many of these bacteria are killed by drying within a relatively short time (since most disease-producing bacteria are not able to form spores), it is quite possible for some of them to reach other persons in instances where a short route and a short space of time are involved. Thus, it appears that air-borne infection is mostly limited to the immediate environment of the sick person or the carrier.

The bacterial flora of water is quite varied. Each stream and pond receives a generous contribution of microscopic life from nearby soil. Many of the microorganisms thus carried into water supplies are unable to multiply and often gradually die. At times, however, sufficient organic matter and other food materials are present to permit some limited multiplication of bacteria in natural waters. In the mud and decomposing vegetative material of pond bottoms large numbers of bacteria from the intestinal tracts of man and animals may find their way into water supplies in populated areas. Many from this last source are harmless types, but occasionally disease-producing bacteria from the intestine also gain access to a water supply. Typhoid bacilli, dysentery bacilli and the cholera vibrio may be transmitted from one person to another by such means.

VII. SOME ACTIVITIES OF BACTERIA

1. In Milk and Dairy Products.—Without bacteria or other microorganisms milk undergoes little detectable change and may be kept in its original state almost indefinitely. Different kinds of bacteria and related microscopic forms produce different effects when they gain access to milk and multiply in it. Some attack principally the milk protein and break it down with the accompaniment of decomposition odours; others attack principally the milk sugar and produce acid from it, often curdling the milk; still others may curdle the milk through the agency of an enzyme secreted by the cells. In unheated milk, acid-forming bacteria (such as *Streptococcus lactis* or various species of *Lactobacillus*) frequently gain the upper hand and the milk sours without decomposing. For some purposes such an effect is desirable, and lactic-acid-producing bacteria may be added purposely to induce a controlled fermentation.

Many disease-producing bacteria are able to multiply readily in milk if the temperature is sufficiently high. Since the metabolic activities and multiplication of bacteria are slowed or stopped at lower temperatures, refrigeration of milk is important. Occasionally disease-producing bacteria may invade milk from the cow, the milk handler or by other means, in spite of all precautions. To protect against this mischance the milk is pasteurized by heating at a temperature of 143° to 145° F. for 30 minutes or else at a higher temperature such as 160° F. for a shorter time. These methods destroy disease-producing microorganisms that might be present and at the same time kill a large percentage of harmless microorganisms.

Bacteria play a part in the preparation of many milk products. In buttermaking, milk cultures of certain bacteria are mixed with the cream or are worked into the butter to add flavour. In the making of cheese, coagulation of the milk protein at times is brought about by acid produced by acid-forming bacteria. Since the numbers and kinds of bacteria present are of prime importance, cultures of a desired kind, called "starters," often are added to control the flavour and appearance of the product as well as to form acid.

Many different kinds of cheeses may be made by varying the conditions of manufacture and assuring a certain sequence of events in proper order under controlled conditions. Activity of some microorganisms is encouraged while that of others is suppressed. Lactic-acid-forming bacteria, propionic-acid-forming bacteria, types that digest fats or proteins and molds all play a part in the various steps in the process.

2. In Soil.—Many different kinds of bacteria, molds and other microorganisms are numerous in fertile soils and play an outstanding role in determining the composition of the soil and its

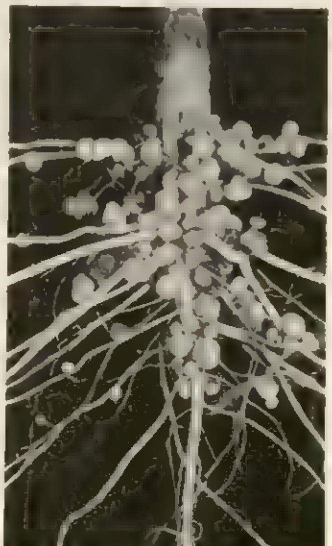
productivity for plant life. Most of this microbic population is found in the top few inches of soil. The usual range in numbers is from about 1,000,000 to 50,000,000 bacteria per gram (about $\frac{1}{30}$ oz.) of soil with lesser numbers of molds and other forms. However, much smaller as well as larger numbers may be encountered. These soil microorganisms are quite diverse as to kinds and metabolic activities. There is a complicated interplay of effects of one upon another. Some exert a restraining effect upon others while some assist the growth of others. In addition, their activities are governed by a wide variety of conditions, some of which are more favourable to certain types; *i.e.*, the amount of organic matter, inorganic salts, moisture, temperature, acidity or alkalinity and the supply of oxygen. The changes that go on in the presence of a mixed flora of this sort are exceedingly complicated; nevertheless it has been possible to assign definite roles to some of the microorganisms by means of pure culture studies carried on in the laboratory. Some of these activities are of the utmost importance to the existence of higher plants, animals and man.

Nitrogen Fixation.—One of the most striking processes is that of nitrogen fixation. This is the process by which the element nitrogen, a gas that composes roughly 80% of the air, is combined with other substances and made available to various forms of life in the form of nitrogenous compounds. Very few types of living cells are able to accomplish this combination because nitrogen is relatively unreactive chemically. Artificially, that is, by strictly chemical methods in contrast with the biological method, high temperatures and high pressures are necessary to cause nitrogen to combine with either hydrogen or oxygen.

In contrast, certain bacteria are able by means of little-understood catalysts in the cells to bring about the combination of nitrogen and hydrogen at ordinary temperatures and pressures. The first recognizable product of this process is ammonia (NH_3) or an ammonium compound. Once this stage is reached many reactions can occur. The simple nitrogen compound resulting from the first stage in fixation is combined with carbon compounds by bacteria or plants to make various organic nitrogenous compounds. In one way or another, sometimes only after a number of changes, the nitrogen compound becomes available as plant food. Thus the soil is enriched in nitrogenous compounds through the nitrogen fixation. Since many field crops deplete the supply of nitrogenous compounds in soil, it is evident that nitrogen fixation counteracts this loss by "capturing" nitrogen from the air.

The bacteria making this unique contribution to the natural economy are some species belonging to each of the following groups: *Rhizobium, Azotobacter, Clostridium* and another that is unusual in containing a pigment akin to the chlorophyll of green plants. In addition, one or more of the blue-green algae are known to be able to fix nitrogen.

Rhizobium exhibits an unusual relationship with leguminous plants (alfalfa, clover, pea, soybean, lupine and others). The bacteria form small nodules on the roots of these plants and it is there that the process of nitrogen fixation occurs. Different species of *Rhizobium* show a considerable degree of specificity for one or another of the leguminous plants. For this reason the farmer who seeks to enrich soil through the addition to it of these bacteria must take into account the kind of legume to be grown and add the appropriate kind of *Rhizobium*. Efficient fixation of nitrogen by *Rhizobium* under field conditions occurs only if this requirement is fulfilled.



BY COURTESY OF THE NITRAGIN COMPANY

FIG. 5.—SOYBEAN ROOTS SHOWING BACTERIA-CONTAINING NODULES IN WHICH NITROGEN FIXATION OCCURS

The remaining nitrogen-fixing microorganisms are free-living forms and fix nitrogen independently of a plant relationship. Several species of *Azotobacter* are important nitrogen fixers. The practical importance of the other nitrogen-fixing bacteria is not well established. In the laboratory under appropriate conditions they fix nitrogen effectively, but their practical importance in soil is not entirely clear.

Decomposition of Organic Matter.—Another important bacterial action in the soil is the decomposition of organic matter. Many large molecules containing carbon and nitrogen are added to the soil through the death of plants and animals; these large molecules occur as cellulose, starches, lignins, fats, proteins and others. A number of soil microorganisms possess enzymes that are capable of breaking down these molecules to much simpler substances. These changes are complex, and there is a complicated interplay of many factors in determining the final result, but it is known that many of the large numbers of microorganisms in soil play a part. One of the products resulting from the decomposition of protein and other nitrogenous organic compounds is ammonia. The process by which it is formed is known as ammonification. Thus the nitrogen at one time locked in large protein molecules is once again converted to a simple form, ammonia or an ammonium salt, that is quite reactive chemically and readily undergoes further changes.

The oxidation of ammonia to nitrite and of nitrite to nitrate is termed nitrification. Relatively few kinds of bacteria bring about this change, but those that do are widely distributed in large numbers in most soils. *Nitrosomonas* and *Nitrosococcus* accomplish the first stage of the oxidation process by forming nitrite; *Nitrobacter* oxidizes nitrite to nitrate.

It is apparent that microorganisms play important parts in many of the changes undergone by nitrogenous compounds in soil. Equally important changes are brought about in nonnitrogenous compounds. Large molecules composed of carbon, hydrogen and oxygen, such as cellulose and starches, are broken down by some of the soil microorganisms to simpler fragments. These simpler compounds, in turn, are more readily assimilated by various forms of life and used as sources of energy and as building material for cellular substance.

Other changes are brought about with respect to sulfur, phosphorus, iron and inorganic compounds. Sulfur occurs to some extent in the protein of the cells of dead plants, animals, and microorganisms, and in protein decomposition products. It is found also in nature in the form of sulfates, hydrogen sulfide and the element sulfur itself. A good number of the soil microorganisms take an active part in one or another of the transformations of sulfur. Some produce hydrogen sulfide from the sulfur of organic compounds. Others oxidize the hydrogen sulfide to sulfur and then to sulfates, an important source of sulfur for green plants. One rather striking group of sulfur-oxidizing bacteria, *Thiobacillus*, oxidizes sulfur to sulfuric acid, which under most conditions is soon converted to sulfate. Many of the changes in phosphorus, iron and other inorganic compounds are also brought about by the varied microbic population of the soil.

3. Sewage Disposal.—Microorganisms play an important part in the treatment of sewage. As a rule large numbers of bacteria are present in sewage; some of them are of intestinal origin, others are from soil, air and, in some cases, from industrial wastes. Many of these bacteria are able to decompose the organic matter present in sewage. A main objective in any method of sewage treatment is to remove or decompose the organic material to a final product that is stable chemically and not subject to further decomposition. The changes by which this is accomplished are essentially similar to those occurring in natural decay, but they are carried out under controlled conditions. Another prime objective is the destruction of any disease-producing bacteria that may be present. The processes that go on and the final products formed depend in large measure upon the conditions under which digestion occurs and the degree of aeration.

In preliminary settling tanks a considerable proportion of the solid matter settles out as sludge. In deep tanks anaerobic bacteria play the predominant part. Proteins, cellulose and other

large molecules are broken down to simpler end products. Here the breakdown is rapid but only partial. Part of the suspended organic material is liquefied and gases are formed, but some of the products are objectionable and are subject to further changes. If the product is aerated, as in a trickling filter or in the activated sludge process, aerobic species of bacteria predominate, organic matter is decomposed and more rapid and complete oxidation occurs. The products of ammonification are oxidized to nitrites and nitrates, the sulfides to sulfates, and in general more stable and less objectionable end products are formed. The over-all process here has been a pronounced breakdown and digestion of the organic matter originally present with the formation of soluble and on the whole quite simple and stable end products that can be emptied into a nearby body of water or otherwise disposed of without undergoing further decomposition. The final product may be chlorinated before discharge into a neighbouring body of water to destroy any disease-producing bacteria that may have survived the treatment process.

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VIII. BACTERIOLOGY IN INDUSTRY

This subject may be divided into two parts, one dealing with the application of microbic activities that yield desirable products, the other concerned with the destruction caused by bacteria and related microorganisms in industrial undertakings. The division, of course, is not always clear-cut and some problems of economic importance do not fit exactly in either category. Most of the following discussion deals with the use of bacteria to produce desirable products.

Careful attention to minute details of practice in these industrial processes is imperative. Such details include concentration of the nutrient media (particularly of sugar and salt), degree of acidity, amount of aeration and temperature control.

1. Baking and Production of Baker's Yeast.—The fermentation that takes place during the raising of dough is usually induced by the addition of suitable types of yeast—baker's yeast. This shortens the time of dough raising and prevents other miscellaneous microscopic forms in the flour from taking part in the process. The large-scale production of yeast for use in baking calls for scrupulous attention to many details to insure the maximum production of a satisfactory yeast crop. Selected strains of *Saccharomyces cerevisiae* are employed.

Nutrient materials consist of appropriate substances to supply nitrogenous and carbon compounds, salts and vitamins; mashed grains, molasses and ammonium lactate are commonly used. Since the objective is a large yeast crop the material is aerated, and little alcohol remains in the final product.

2. Bacterial Decomposition of Pectin.—The bacterial activities that cause decomposition of the pectinous middle lamellae of plant tissues have long been exploited for the retting of fibre plants. The best-known example is that of flax retting. Many attempts have been made to substitute the use of vats, controlled conditions and known cultures of bacteria for the old custom of relying upon chance contamination with appropriate microorganisms in a pond or slow-flowing stream where the bundles of plant material are immersed. The old procedures are still used, however, in many parts of the world.

Enzymes capable of softening the pectin layer of the plant are possessed by relatively few bacteria and related microorganisms. *Clostridium felsineum* (*Bacillus felsineus*) and several bacteria related to *Clostridium butyricum* are important pectin-dissolving bacteria. Enzymes capable of breaking down pectin have also found considerable use for the pretreatment of fruit juices as a means of clarification. Such commercial pectolytic enzymes are usually obtained from molds, especially various species and strains of *Penicillium* and *Aspergillus*.

3. Decomposition of Starch and Sugars.—In addition to brewing and wine making, there are many other processes in which starch- and sugar-decomposing enzymes of bacteria, yeasts and molds can be used in producing industrially important products. (Most of the products listed below also can be produced commercially by synthetic processes.)

Ethanol.—Ethanol (ethyl alcohol) is produced for many industrial purposes and by several different processes. Most ethanol produced for human consumption is a product of sugar fermentation by yeast, of which the most commonly used is *Saccharomyces cerevisiae*. The starting material varies; it may be molasses or starchy materials such as corn, wheat or potato mashes. Since starch is not attacked directly by the yeast it is necessary first to convert the starch to sugar by cooking under pressure, followed by the use of enzymes. Yeast is added, fermentation takes place and the alcohol is recovered by distillation.

The details of treatment, types of containers and other items vary. Another source of commercial ethyl alcohol is sulfite liquor, a waste product in papermaking that contains some sugar. After removal or neutralization of certain detrimental substances resulting from earlier treatments, yeast is added and the fermentation ensues.

Glycerol.—The production of glycerol (glycerin) by yeast through the breakdown of sugars is based on the fact that sodium sulfite and certain other alkaline salts, when added to a fermenting sugar solution, interfere with the normal alcoholic fermentation and cause glycerol to accumulate at the expense of alcohol and carbon dioxide. Yields of 25% of glycerin, on the basis of the sugar fermented, may be obtained.

Acetone-Butanol Fermentation.—A number of bacteria produce closely associated fermentations that yield acetone, ethanol and butanol (butyl alcohol) as the chief end products. *Clostridium acetobutylicum* (formerly termed *Bacillus granulobacter pectinovorum*) is usually employed. Molasses or starchy material such as ground corn meal is most commonly used in the United States as a starting material. From this there is produced about 60% butanol, 30% acetone and 5% ethanol. Here again, attention to many details and careful control of the process are important.

During World War I the fermentation was used chiefly for acetone production. Later, a demand arose for butanol in the manufacture of paints and lacquers and this became the principal product of industrial importance. Many other fermentation processes involving the breakdown of starchy materials, cellulose and related substances have been described. Various end products may be obtained depending upon the microorganism used and the conditions employed in the process.

Acetic-Acid (Vinegar) Fermentation.—In the production of vinegar from sugary solutions, such as apple juice or other fruit juices, two main fermentations are involved. One is brought about by yeast that converts the sugar to ethyl alcohol and carbon dioxide; a second fermentation oxidizes the alcohol to acetic acid. The latter is caused by *Acetobacter aceti*, *Acetobacter xylinum* and related species, all commonly referred to as acetic-acid bacteria. The organisms grow on the top of the mixture in a thick jellylike layer called mother of vinegar. Various methods of making vinegar differ with respect to the type and size of the vats, methods of aeration, etc. In some instances alcohol rather than sugar is used as the starting material to facilitate the process.

Citric Acid.—The conversion of sugars to citric acid can be performed by certain fungi, notably by species of *Aspergillus*. High sugar concentration—about 15%—and adjustment to a fairly high acidity facilitate citric-acid production with concurrent production of only small amounts of oxalic acid.

Gluconic Acid.—Gluconic acid, an oxidation product of glucose, is produced by a number of the molds and by some bacteria. Certain strains of *Penicillium chrysogenum* and *Aspergillus niger* have found favour as producers of high yields of the product. Good yields of gluconic acid may be obtained by submerged growths and aeration. Gluconic acid is converted to the calcium, sodium or other salts for various medicinal or industrial uses.

Lactic Acid.—By employing certain bacteria known as lactic-acid bacteria, sugar solutions can be made to undergo another

type of fermentation that results in the accumulation of lactic acid. This fermentation was exploited industrially from the middle of the 19th century, but the introduction of modern bacteriological methods and the use of pure cultures improved the yield and reduced the occurrence of undesirable secondary fermentations. Yields of 85% to 90% on the basis of the sugar fermented may be obtained. *Lactobacillus delbrueckii*, *L. casei*, *L. plantarum* and several related species, as well as *Streptococcus lactis*, are the bacteria chiefly used.

During the fermentation a calcium salt is added to neutralize the acidity that would otherwise limit metabolic activity of the bacteria and lead to incomplete fermentation. Lactic acid is recovered as calcium lactate.

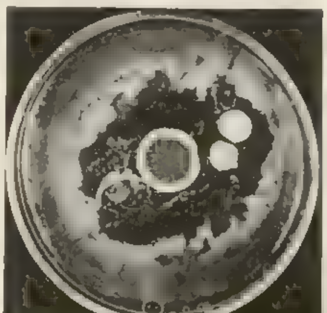
4. Enzyme Preparations.—Aside from the end products of fermentation, the catalytic agents, or enzymes, in the cells of microorganisms are themselves desirable for some industrial uses. Most microorganisms produce a variety of enzymes, and some species have been found to be convenient sources of them. Enzymes that break down proteins and starches (proteases and amylases) have been prepared from some of the fungi, such as *Aspergillus oryzae*, and from bacteria.

The microorganism is grown in a suitable culture environment with nutritive materials, some of which serve as substrate for the enzyme desired. When maximum enzyme activity has developed the material is harvested by extracting the enzyme with water or an appropriate solvent. This crude concentrate may be purified to some extent depending upon its intended use.

5. Vitamin Production.—Most microorganisms are capable of synthesizing a number of the B-complex vitamins that are needed by man and animals. It is probable that microorganisms constitute an important source of the vitamins in nature. In some instances microorganisms have been used as sources of vitamins, particularly in some of the industrial fermentations where large masses of microorganisms and liquor remain after a fermentation product has been recovered. The vitamin thus represents an additional product of value that may be secured. Many yeasts contain considerable quantities of vitamin B_1 (thiamine). Several processes for vitamin B_2 (riboflavin) production have been patented, based on the use of one or another of the yeasts such as *Eremothecium* or *Candida*. *Clostrium acetobutylicum* synthesizes riboflavin, and material from the acetone-butanol fermentation contains considerable amounts of this vitamin. *Streptomyces griseus*, which is used for production of the antibiotic, streptomycin, gives a good yield of vitamin B_{12}. Yeasts contain ergosterol, a substance yielding vitamin D when irradiated. There can be little doubt that many other microorganisms might be utilized for the production of one or another of the vitamins.

6. Antibiotics.—The antibiotics are chemical substances produced by living microorganisms and are capable of inhibiting the growth of other microorganisms. Many microorganisms produce antibiotic substances, but the most important sources have been some of the filamentous fungi, particularly certain penicillia and aspergilli, the actinomycetes—filamentous branching forms classed with the bacteria—and the bacteria proper.

The phenomenon of antibiosis, the inhibitive effect of one organism upon another, is an old one and was observed in the early days of microbiology. It attracted only transient interest for years because many of the earlier antibiotic preparations were quite toxic to higher forms of life and therefore impractical to use. In 1929 Alexander Fleming in England called attention to penicillin—so named because it is derived from a mold of the *Penicillium* group.



BY COURTESY OF MERCK & CO., INC.

FIG. 6.—THREE LARGE COLONIES OF PENICILLIUM NOTATUM. DARK ZONE AROUND THE COLONIES REPRESENTS BACTERIAL INHIBITION, THE PHENOMENON THAT LED TO THE DISCOVERY OF PENICILLIN

This substance was effective against certain bacteria and at the same time much less toxic than earlier antibiotic preparations. Many investigators tested literally thousands of molds, actinomycetes and bacteria for their ability to produce substances effective against one or another of the disease-producing bacteria or filterable viruses. By the early 1960s about 500 antibiotic substances had been given names. Some of them were possibly duplications; others might prove to have no practical value; but a few had shown considerable promise and had taken a place among the most potent of weapons for combating bacterial infection, largely replacing the sulfa drugs.

The antibiotics are prepared by growing the organism on a large scale, often in large tanks or vats but sometimes in shallow layers of nutrient solution. The details of cultivation vary considerably, depending upon the organism and the substance sought, but in each case exact attention to detail is highly important in obtaining maximum yield. Then the material is subjected to different processes to separate the antibiotic from other products of microbic growth; these processes are at times quite involved and expensive.

Many of the antibiotics have been subjected to chemical analysis and in some instances the exact chemical structure is known, penicillin, for example. Most of them have turned out to be molecules too big or too complicated to be prepared commercially by purely synthetic chemical processes, so that microorganisms are still relied upon for the most part for their production. The question of just how antibiotics bring about their beneficial effects in combating microbic invasion of man and animals had been only partially answered by the early 1960s. (*See* ANTIBIOTICS.)

7. Destruction by Bacteria in Industrial Processes.—In contrast with the many benefits obtained from the controlled utilization of bacteria and related microorganisms in industrial processes is the large amount of damage that may result from their uncontrolled activity. It is important and sometimes very necessary to arrest or prevent their activity. In the textile industries, for instance, much damage is caused through the destruction and mildewing of fibres and fabrics. In the meat industry one of the prime problems has been reduction of the number of bacteria and other microorganisms together with prevention of their growth in meat products. In the sugar industry the cane or beet juice is often changed (inverted) by bacteria to a less desirable type of sugar in which crystallization is rendered difficult.

Another problem in this industry is the formation from sugar by bacteria of gummy materials that interfere with the manufacturing processes.

In the wood industries serious losses occur through the action of some of the fungi. In dairying, in dairy manufacturing and in many other industries serious economic loss is caused by the activities of bacteria.

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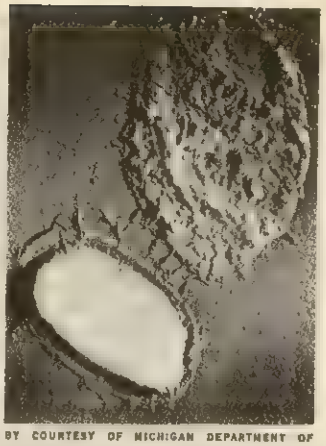
IX. VIRUSES ATTACKING BACTERIA (BACTERIOPHAGES)

A bacteriophage is an agent that causes transmissible lysis (disintegration and dissolution) of bacteria. This phenomenon was noted by F. W. Twort in 1915 and by F. H. d'Hérelle in 1917. The latter coined the term bacteriophage (sometimes abbreviated to phage) to indicate an agent that destroys bacteria. Bacteriophages are believed to be viruses. (*See* VIRUSES: *Bacterial Viruses* [*Bacteriophages*].)

1. Infection Process.—The effect of bacteriophage on a test-tube culture of susceptible bacteria is quite striking, and the result may be seen without the aid of a microscope. Ordinarily, as bacteria multiply in a test tube in a solution of nutrient materials the liquid becomes very turbid because of the newly formed mass of bacterial cells. If a drop of bacteriophage is added to the culture at an early stage in development, the turbidity disappears and the liquid becomes quite clear. On microscopic examination few, if any, bacteria can be seen. Within a few hours many mil-

lion bacteria have been destroyed. If a cleared or lysed culture is passed through a very fine filter, the bacteriophage goes through but the whole or intact bacterial cells do not. If a very small amount of filtered material containing bacteriophage is added to another young culture of the same bacterium, lysis of the cells again occurs.

This process can be repeated indefinitely. Since the lysis can be transmitted in series with undiminished vigour it is evident that the lytic agent, bacteriophage, is reproduced during the process. When a mixture of bacteria and bacteriophage is viewed through the microscope during the process of lysis, the cells of the bacteria are usually seen first to swell and then suddenly to disappear, with perhaps only a shadow or vague suggestion of the cell remaining for a short time. With each destruction of a cell many phage particles are released and are then free to make contact with other cells, where the process is repeated in a short time. The phage multiplies in numbers at the expense of the bacteria. Thus, as bacterial cells are lysed the bacteriophage population increases, eventually reaching a high figure such as 100,000,000 to 1,000,000,000 or more phage particles in a millilitre (about $\frac{3}{100}$ oz., or $\frac{1}{5}$ tsp.).



BY COURTESY OF MICHIGAN DEPARTMENT OF HEALTH

FIG. 7.—ELECTRON MICROGRAPH OF BACTERIA BEING ATTACKED BY BACTERIAL VIRUS (BACTERIOPHAGE): (BOTTOM) BACTERIUM APPARENTLY STILL HEALTHY; (TOP) BACTERIUM IN LAST STAGES OF DESTRUCTION. BACTERIOPHAGE PARTICLES ARE THE MINUTE, PADDLE-SHAPED OBJECTS SEEN AT THE CELL SURFACE OF THE BACTERIA

The same phenomenon occurs when bacteria are grown on the surface of a nutrient jelly instead of in a liquid. If a drop of bacteriophage is applied to a film of susceptible bacteria growing on such a surface, lysis of the bacterial cells occurs and a clear area results. The area may be large or small depending upon the extent of the original application of phage. If a high dilution with only a few phage particles rather widely distributed is brought in contact with a similar surface film of growing bacteria, small areas in the film of bacteria are cleared of cells and show up as moth-eaten spots, termed plaques.

2. Nature of Bacteriophages.—For many years a lively discussion centred upon the nature of bacteriophages. It became generally agreed, however, that bacteriophages are viruses and that their fundamental characteristics are similar to those of other viruses that cause diseases of man, animals or plants. Thus it appears that bacteria, including many that produce disease in higher forms of life, are themselves subject to disease caused by still smaller microorganisms, the viruses.

Phages are not ordinarily visible with the usual light microscopes. With the development of the electron microscope it became possible to obtain an accurate idea of their appearance, which can be seen clearly at magnifications of 15,000 × to 30,000 ×. Many phages are spherical or oval; others tend to be somewhat cubical in shape; and some have a hexagonal-shaped "head" portion with a slender "tail" attached, giving a tadpolelike appearance. In size the different bacteriophages range from about $\frac{4}{10,000,000}$ in. to $\frac{8}{1,000,000}$ in. in diameter. Where a tail is present it may be as much as $\frac{5}{1,000,000}$ in. long in the case of some of the larger phages.

The conditions under which phages develop are limited. Like most of the viruses, which multiply either exclusively or for the most part within the cells of the host, there is an intimate relation between the bacteriophage and the host cell. The phage does not propagate by itself in any of the nutrient solutions used for test-tube cultivation of bacteria.

For reproduction the phage ordinarily requires the presence of young, living and actively metabolizing bacterial cells. Phage does not propagate in the absence of susceptible bacteria, nor does it multiply on dead cells; however, it may be adsorbed on the surface of the latter.

Bacteriophages exhibit a considerable degree of specificity with respect to the kind of bacteria attacked, and different kinds or races of phage have been recognized on this basis. In some cases a single species of bacterium is affected; at times the relationship is even more specific in that only a single strain, or a few strains, of a species are lysed. In other instances the range of activity is broader and several species may be affected by the same phage. Where this occurs it often happens that the species belong to a closely related group.

Phage activity with cell lysis seems to be limited to the cells of bacteria and a few related microorganisms. There appear to be no recorded instances of comparable injury to the cells of higher forms—man, animals or plants. Sometimes bacteriophage may be carried by resistant bacteria, termed lysogenic strains. Thus a culture of the colon bacillus, a common inhabitant of the intestinal tract of man, may carry a bacteriophage capable of lysing the dysentery bacillus. The colon bacillus is not affected by the phage for the dysentery bacillus, but when contact with the appropriate dysentery bacillus is made under favourable conditions, propagation of the dysentery phage takes place and lysis of dysentery bacilli occurs.

If events are followed closely after a bacteriophage is brought into contact with susceptible bacterial cells, it is evident that subsequent developments occur in several stages. First, phage particles are adsorbed on the surface of the bacterial cell. Environmental conditions also play a part, and the contact may not occur in the absence of certain important organic compounds and inorganic salts.

Next, the phage or a part of it penetrates the bacterial cell. This is followed usually by multiplication of the phage within the cell and then by a process in which phage units change to some extent or become "mature." The phage, or the deoxyribonucleic acid of the phage, takes over genetic control of the host cell and new phage units are produced.

The last stage is that of lysis of the bacterial cell. The cell breaks down and phage particles are liberated, usually about 100 to 200 or more of them from one cell. This often occurs within 20 to 40 minutes after the phage was adsorbed on the bacterial cell; the process of new phage formation evidently is a speedy one. The liberated particles are adsorbed to other cells and the process previously described is repeated until practically all of the bacteria have been destroyed. At times, one or more cells resist the lytic action of the phage. Later these resistant cells may multiply in the presence of the lysed material, thus producing a variant or mutant culture of the bacterium that is resistant to the phage.

3. Metabolism, Resistance, Occurrence.—The metabolic activity of bacteriophages is evidently quite limited. They appear incapable of carrying out many of the energy-yielding processes and other metabolic reactions that independent single living cells must perform in order to exist. Presumably they benefit from the processes carried on in the bacterial cell, supposedly appropriating for their own use some of the energy and materials from the cellular processes at the time of multiplication. It is difficult to separate the metabolic processes of such intracellular parasites from those of the host cells, but there is evidence that the bacterial cell is not simply divided into many smaller units, each of which becomes a bacteriophage particle. Characteristic phage substance is synthesized within the bacterial cell and this process involves for the most part the combination of relatively small molecules, a large portion of which are drawn from the environment. When a bacteriophage, purified to free it from extraneous materials as far as possible, is subjected to chemical analysis it is found to consist largely of protein and deoxyribonucleic acid. The latter substance is a characteristic constituent of the nuclei of the cells of many forms of life. It is present in unusually high proportion in bacteriophage. This is in agreement with the often-expressed idea that phages contain a bare minimum of substances found in most cells—some nuclear materials and not much else. Polysaccharide is absent, or present

in only small amounts, in the several phages that have been subjected to analysis.

Bacteriophages are antigenic; *i.e.*, when introduced into the animal body they stimulate the production by the animal of immune substances (antibodies) specific for the bacteriophage. This is analogous in a general way to the response on the part of the body to typhoid or smallpox vaccination when immune substances specific for the disease organisms are formed. The antibodies formed in animal tissues in response to bacteriophage have the property of neutralizing activity of the phage when mixed with phage and susceptible bacteria. They are specific for particular types of phage; *i.e.*, antibodies for one type of phage do not affect those of another type. Bacteriophages are subject to variation or to mutationlike changes that remain constant through subsequent intracellular periods of propagation.

These changes may involve characteristics such as the size and type of plaques formed, resistance to heat, resistance to a dye or changes in the specificity of phage for different bacteria.

Resistance of bacteriophages to disinfectants and to physical agents, such as light and high temperatures, is not notably different from that of the respective nonspore-forming bacterial cells with which they are associated. Bacteriophages are inactivated by exposure to X-rays and ultraviolet light. Bacteriophages may retain their ability to lyse susceptible bacteria for a year or more when held at refrigerator temperatures. They may be encountered in nature; sewage, feces, contaminated water and pus from wounds are some of the other sources in which they are found. They are usually obtained by first passing the material through a fine filter to remove bacteria and then adding some of the filtered material to a young actively growing culture of the species of bacterium against which a phage is desired. Its presence is made evident by lysis of the bacteria.

A number of attempts have been made to exploit for practical purposes the unique properties of bacteriophages. Obviously any agent that multiplies at the expense of bacteria and destroys them while at the same time perpetuating itself might, theoretically at least, be of great value. The possibility of using appropriate races of bacteriophages as agents for treatment of human and animal diseases caused by bacteria was one of the first items to receive attention. This was strongly championed by d'Hérelle in the decade or so following the discovery of bacteriophage activity and was tried by many others in various parts of the world. Races of bacteriophages specific for one or another of the bacteria causing human or animal disease were applied in various ways: taken by mouth in the case of intestinal infection (such as typhoid or cholera), injected into boils or abscesses, introduced into the urinary bladder and even injected into the blood stream in cases of invasion of the blood by bacteria such as the streptococcus. However, results on the whole were definitely disappointing and there is little evidence that bacteriophages assist or play a part in recovery from infectious disease. Apparently the phages do not make contact with the bacterial cells, or the environment is such as to delay or prevent adsorption of phage onto the cells. Obviously such conditions are quite different from those of the laboratory in which lysis occurs so readily. The high hopes at one time entertained for such a practical use of bacteriophages were not fulfilled.

Phages have also been studied from certain other aspects, particularly for elucidation of some fundamental characteristics of viruses. The ease with which they may be handled in the laboratory, propagated in bacterial cultures, obtained in concentrated and relatively pure form all combine to make them the instrument of choice for attempts to unravel some of the mysteries of viruses as a group. This is particularly true of studies on the source of food materials.

With the use of radioactive isotopes of carbon, nitrogen and phosphorus it has been possible to ascertain with a considerable degree of accuracy what food substances come from smaller molecules in solution in the environment of the host cell and to learn what may be derived by the virus from the substance of the host cell that is parasitized.

Correlated with this aspect of virus nutrition is the problem of how the virus forms new units like itself when conditions for multiplication are appropriate. The method by which the virus penetrates a host cell and the sequence of events immediately following this event are also fundamental questions that may be answered by the use of bacteriophages and bacteria as experimental tools. Some idea of these processes, it is hoped, may assist in clearing up some of the uncertainties regarding virus infections in general. Thus, bacteriophages are of outstanding scientific interest.

See also references under "Bacteriology" in the Index.

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(S. A. Kr.)

BACTRIA (BACTRIANA) is the ancient name of the country lying between the Hindu Kush (Paropamisus) mountains and the Amu Darya (Oxus) river, with its capital Bactra, also called Bactra-Zariaspa (probably Balkh [Wazirabad], ancient Vahlika). In Islamic times the area was known as Tukharistan, after the Tukharians who settled there in the 1st century B.C., and was usually differentiated from the northern plain of the Amu Darya, but anciently it may well have included both plains. The main features of Bactria are its extreme flatness and severe climate. The greater part of the region is a waste of barren clay flats or sand. In places the soil would be rich agriculturally if irrigation were available; elsewhere it is heavily impregnated with salts. (For other physical features and climate *see* AFGHANISTAN.) The modern population includes Tajiks, Uzbeks and Turkmens and an element of recently settled Afghans (Pathans).

Archaeologically Bactria has great potentialities. There is a profusion of mounds and abandoned water channels that testify to its ancient prosperity. Leaving aside the finds of Stone Age remains in the alluvial gravels at Balkh and in cave deposits at Haibak, the recent settlement begins with Iron Age deposits at Balkh and Khulm. These correspond to the earliest settlements at Samarkand, Merv and Kobadian in Soviet territory and may date from the second quarter of the 1st millennium B.C. They appear to be the relics of an Eastern-Iranian-speaking people who settled there at that time, and should belong to the society in which Zoroaster taught. If so then the references in the Avesta to "Baxdis beautiful with banners" must refer to this first settlement at Balkh. (*See* ZOROASTRIANISM.)

Bactria enters history with the Achaemenids. It appears along with Sogdiana, Parthia and Aria in the Achaemenid satrapal lists, and Herodotus further describes the Bactrian soldiers who fought in the army of Darius and mentions the tribute paid by the 12th satrapy. Probably Bactria was first subdued by Cyrus and remained an Achaemenid province for two centuries. When Alexander the Great had defeated Darius III, the Bactrian satrap Bessus tried to organize resistance in the east, but Bactria was soon overcome. Along with the other Asian satrapies Bactria passed under the rule of Seleucus Nicator upon the death of Alexander.

Both Alexander and his successors established Greek colonies or cities in their territories, and the great fortifications at Alexandria-Bactra (?Balkh) and Alexandria of the Oxus (?Termez) should date from this time. In the second half of the 3rd century B.C. either Diodotus (*q.v.*), the Seleucid satrap of Bactria, or his son of the same name threw off the imperial yoke and founded an independent kingdom. Antiochus III the Great defeated their successor, the usurper Euthydemus (*q.v.*), but nevertheless continued to recognize his independence, providing as he did a buffer against the unruly nomads of the north. Euthydemus' son Demetrius I (*see* DEMETRIUS) extended Greek rule in several directions, and in the next decades Antimachus and Demetrius II advanced into the Hindu Kush and thence into northwestern India where they established the Indo-Greek branch of the kingdom. The extent of the Greek domains was somewhat curtailed by the vigorous campaigns of the Parthian Mithradates I, who *c.* 160 B.C., during the reign of Eucratides (*q.v.*), even invaded Bactria itself. Some time before 125 B.C. Greek rule

north of the Hindu Kush was suddenly challenged by the advance of the Yüeh-chih hordes into Sogdiana and the lands beyond the Amu Darya. By 125 B.C. the Greeks were their tributaries, and soon afterward the Yüeh-chih occupied Bactria. Greek rule may have continued for a decade in the valleys of Badakhshan.

It was formerly thought that the influence of the Bactrian Greek kingdom was far reaching and that whole new fields of art (*e.g.*, the Gandhara style of northwestern India) owed their existence to it. This view must be modified. Except for their remarkable coinage (*see* NUMISMATICS: *Asiatic Coins: India*) the material remains of the Bactrian Greeks differ little from those of their non-Greek neighbours, and there is no evidence that they imported works of art from their homeland in any quantity. From the start the cities were as much Asian as Greek, and the same is probably true of their ruling groups. On the other hand the Greek script continued to be used in Bactria and central Asia for many centuries after the end of Greek rule, and Greek influence may also be detected in the Sanskrit drama. The influence so strongly present in the Gandhara art style relates to Roman-Parthian contacts at the beginning of the Christian era.

The Yüeh-chih tribes were possibly an Iranian people. They certainly included the Tukharians, who later gave their name to Bactria. During the 1st century B.C. they settled in the area and appear to have rapidly absorbed elements of Parthian-Hellenistic culture. Thence in the 1st century A.D. they extended their rule into northwestern India. This movement is associated with a group known as the Kushans, who reached the zenith of their power under the emperor Kanishka (*q.v.*). In the latter half of the 4th century there appear to have been fresh invasions, bringing the Little Kushans under Kidara and soon after the Hunas (Chionites) including the Hephthalites (*q.v.*). These two latter are thought to have been non-Iranian, possibly Mongol. The Hephthalites settled in Bactria and thence for two centuries warred with the Sassanians. In 565 the western Turks overthrew them and ruled in Bactria until the mid-7th century when Arab armies carried Islam into Tukharistan. For later history of the area *see* AFGHANISTAN.

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(F. R. A.)

BADAGA, the most numerous of the peoples of the Nilgiri hills of Madras state in the south of India. They have increased very rapidly, from less than 20,000 in 1871 to about 85,000 by the early 1960s. Their language is a Dravidian dialect closely akin to Kannada (Kanarese, *q.v.*) as spoken in Mysore state to the north of the Nilgiris. The name Badaga means "northerner" and it is clear that they came into the Nilgiris from the north, perhaps impelled by economic or political pressures. The time of their migration was after the founding of the Lingayat sect in the 12th century, because some of them apparently came as Lingayats. It was before the first recorded observation of them, by a Catholic missionary in 1602, when they were well established and maintaining symbiotic relations with the other Nilgiri peoples.

The Badagas are divided into six endogamous groups which were ranked in ritual order. The two highest were vegetarians; the lowest provided servants for the other five. Their traditional religion and economy depended on goods and services supplied by the Nilgiri peoples—Kota, Toda (*qq.v.*), and Kurumba.

Badagas generally have taken to education and have vigorously advanced their community. In addition to grain, they now grow large crops of potatoes and vegetables. Concomitantly, most have altered their traditional religious and social practices. Improved agriculture, local and national policies, high-caste Hindu tradition—these matters now engross a good many Badagas. In all, the Badagas are one of those indigenous groups who have turned their circumstances in the 20th century to success for their community.

See T. Burrow and M. B. Emeneau, *A Dravidian Etymological Dictionary* (1961); *Census of India*, vol. 1, part II-C(ii), p. 45 (1961).

(D. G. M.)

BADAJOZ, the largest province in Spain, which with Cáceres, forms the region of Extremadura (*q.v.*). Area 8,362 sq.mi. (21,658 sq.km.), representing 4.3% of the total area of the country. Pop. (1960) 834,370. The climate is characterized by the extreme length of its summers, which are dry and hot, when the temperature often exceeds 40° C. (104° F.), sometimes the highest in Spain. The province is almost entirely flat, but rises in the south and southwest near the Sierra Morena, and in the north joins the foothills of the mountains of Toledo. It is crossed from east to west by the Guadiana (*q.v.*) river, of which the most important tributary is the Zujar. One of the most typical areas of the central plain is the Tierra de Barros, the largest cereal, wine and oil-producing region of Extremadura. Its main centre is Almendralejo. Another region is the Vegas Altas y Bajas del Guadiana which extends on both sides of the river and contains the historic town of Mérida (*q.v.*). Serena is a wool-producing area and a centre for the merino breed of sheep. Another area is that known as Siberia Extremena from its arid and extreme climate.

In 1952 the Spanish government promoted a scheme known as the Plan Badajoz which considerably raised the standard of living, productivity and agriculture and intensified development and industrialization in the province. Irrigation was undertaken using the waters of the Guadiana and the Zujar. Six dams were constructed (Cijara, Puerto Peña, Orellana, Zujar, Alange and Montijo) with a total capacity of 3,245,000,000 cu.m. (*c.* 114,600,000,000 cu.ft.) which permits about 1,000 cu.m. (about 35,314 cu.ft.) of water to be used each year for irrigation. The Instituto Nacional de Colonización created new towns and established thousands of settlers to whom grants of land were made. Industrially the Plan Badajoz provided for the establishment of new industries based on agriculture: flour, vegetable preserving, oil and cotton. Electrification was also increased, and communications improved. The province is crossed by the Madrid-Badajoz, Cáceres-Seville, and Zafra-Jerez de los Caballeros railway lines.

BADAJOZ, the provincial capital, overlooks the Guadiana from a slight eminence, crowned by the ruins of a Moorish castle. A bastioned wall with moat and outworks and forts on the surrounding heights gives an appearance of great strength. The river, which flows between the castle hill and the fort of San Cristóbal, is crossed by a granite bridge, built in 1596 and rebuilt 1833. The aspect of Badajoz recalls its stormy history; even the cathedral (1234–84) resembles a fortress with massive embattled walls. Badajoz was the birthplace of Manuel Godoy, duke of Alcudia (1767–1851), and of the painter Luis Morales "the divine" (1509–86). Two pictures by Morales, unfortunately retouched in modern times, are in the cathedral. The city enjoys a considerable transit trade with Portugal; its principal industries are the manufacture of foodstuffs of various kinds, alcoholic and other drinks, basket work, blankets and wax. Pop. (1960 est.) 110,580.

History.—The most outstanding episodes in the history of Badajoz occurred during the Peninsular War. French troops under Marshal Nicolas Jean de Dieu Soult, duke of Dalmatia, attacked and took the town in March 1811. In May the English under Viscount Beresford tried to recover it but had to retire in the face of strong resistance by the French garrison. The duke of Wellington, with the Spanish generals Joaquín Blake, Francisco Javier de Castaños and Francisco López Ballesteros, won the battle of Albuera nearby and decided to put Badajoz to the siege again, but Wellington's attacks were ineffective and the siege was raised. The following year, 1812, Wellington, already master of Ciudad Rodrigo, returned to Badajoz, where the siege recommenced on March 16. The French troops under General Philippon resisted strongly, but eventually the English were able to take the fortress of San Vicente and enter the town. The French fled and then surrendered. The English troops put the captured town to the sack for three days. (*See* PENINSULAR WAR.) In the Spanish Civil War the nationalists of General Franco captured Badajoz on Aug. 14, 1936.

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BADAKHSHAN, including the Wakhan panhandle, is a province on the northeast frontier of Afghanistan. Area 16,000 sq.mi. Pop. (1962 est.) 316,574. It is bounded on the north by the southern bank of the Amu Darya (Oxus) or its headstream the Panj (Ab-i-Pandj). On the west it is bounded by a line which crosses the Turkistan plains southward from Chah-i-Ab near the Amu Darya until it touches the eastern water divide of the Kunduz river and then runs south along the Khwaja Muhammad range until it strikes the Hindu Kush. The southern boundary is carried along the crest of the Hindu Kush as far as the Dorah pass (14,941 ft.). The Dorah connects Zebak and Ishkashim, at the bend of the Amu Darya, with the Lutku valley leading to Chitral. From the Dorah eastward the crest of the Hindu Kush again becomes the boundary until it effects a junction with the Muztagh and Sarikol ranges, which shut off China from the Soviet Union and Kashmir. Skirting the head of the Tafdumbash Pamir, it merges into the Pamir boundary, and turns westward later following the course of the Pamir river and the Panj to near Chah-i-Ab. Before 1873 the small states of Rushan and Shugnan extended to the left bank of the Amu Darya and the province of Darwaz extended to the right bank. Now, however, the two extensions are exchanged and the river throughout is the boundary between Soviet and Afghan territory; the political boundaries of those provinces and of Wakhan are no longer coincident with their geographical limits.

The Kokcha river traverses Badakhshan from southeast to northwest and, with the Kunduz, drains all the northern slopes of the Hindu Kush west of the Dorah pass. Some of its sources are near Zebak, close to the great bend of the Amu Darya northward, so that it cuts off all the mountainous area included within that bend from the rest of Badakhshan. Its chief affluent, the Minjan, is a considerable stream where it approaches the Hindu Kush close under the Dorah. Like the Kunduz, it probably drains the northern slopes of the Hindu Kush by deep lateral valleys, more or less parallel to the crest, reaching westward toward the Khawak pass (11,650 ft.). From the Amu Darya (1,000 ft.) to Faizabad (6,083 ft.) and Zebak (8,500 ft.) the course of the Kokcha offers a highroad across Badakhshan; between Zebak and Ishkashim, at the Amu Darya bend, there is a comparatively low pass of 9,500 ft.; and from Ishkashim by the Panj, through the Pamirs, is the continuation of what was once probably a much-traversed trade route connecting Afghan Turkistan with Kashgar and China. North of the Kokcha, within the Amu Darya bend, is the mountainous district of Darwaz, of which the physiography belongs to the Pamir type rather than to that of the Hindu Kush.

A very remarkable meridional range extends for 100 mi. northward from the Hindu Kush (across this range lies the route from Zebak to Ishkashim), which determines the bend of the Amu Darya northward from Ishkashim, and narrows the valley of that river into a trough as far as the next bend westward at Kala Wamar. The western slopes of this range drain to the Amu Darya northwestward, by the Kokcha and the Ragh, or else they twist their streams into the Shiwa, which runs due north across Darwaz. There again the main routes which traverse the country follow the rivers closely.

The more important wild animals of Badakhshan include a large wild sheep (*Ovis poli*), foxes, wolves, jackals, bears, boars, deer and leopards; among birds, there are partridges, pheasants, ravens, jays, sparrows, larks and a famous breed of hawks.

Badakhshan proper is inhabited primarily by Tajiks or Tadzhiks (*q.v.*) and some who speak the Persian and Turkic languages and profess the orthodox doctrines of the Islamic law adopted by the Sunnite sect, while the mountainous districts to the east are inhabited by Tajiks, professing the Shi'ite creed and speaking distinct dialects in different districts.

The chief urban centres are Faizabad (*q.v.*), the capital, Rustak, Zebak, Kishm and Jurm.

Under cultivation are about 320 sq.mi. of which about half are irrigated. The main crops are wheat, barley, maize, rice, pulses, alfalfa and cotton. Vines and fruit trees are common in gardens. The principal domestic animal is the yak. There are also large flocks of sheep, cows, goats, ponies, dogs and Bactrian camels. Forestry and mining are not important industries; however, the lapis lazuli (*q.v.*) mines on the upper Jurm river are still in production. (J. P. C. N. H.)

History.—The name Badakhshan first appears in the Chinese writers of the 7th and 8th centuries A.D., Hsüan Tsang and T'ang-shu. In the 5th century A.D. it had formed part of Tukharistan ruled by the Haytal or Hephthalites (*q.v.*). They were displaced in the 6th century by the Turks and in the 7th century by the Arabs. Of the details of Muslim penetration, nothing is known. After falling first under the Ghorids of Bamian, in the second half of the 12th century, and then under the Khwarizmshah, at the beginning of the 13th, Badakhshan escaped the full consequences of Genghis Khan's destruction of the Khwarazmian empire in the 1220s. For two centuries it remained under a local dynasty claiming descent from Alexander the Great. In 1466–67, however, it came under the rule of the Timurids. Sulaiman, nephew of the Mogul Babur (*q.v.*), ruled the country from *c.* 1530 to 1575. In 1584 the Uzbek Abd-Allah Khan conquered it, and although there were Timurid attempts to regain it, Badakhshan became part of the loosely confederated Uzbek empire in 1669. It remained under the local Uzbek dynasty of the Mirs until 1822 when it was overrun by Murad Beg, the Kataghan Uzbek of Kunduz. After intermittent dynastic struggles under his descendants, in 1873 the area south of the Oxus (Amu Darya) river and west of the Panj was annexed by Afghanistan. By 1891–92 the Russians had penetrated the whole of eastern Pamir. In 1895, an agreement between Britain and Russia allotted Badakhshan proper to Afghanistan, and the territories of western Pamir, north and east of the Panj to the principality of Bukhara (*q.v.*), under Russian protection. After the Revolution of 1918, this Pamir region became the Gorno-Badakhshan Autonomous *oblast* (*q.v.*), part of the Tadzhik Soviet Socialist Republic, U.S.S.R.

See article "Badakhshan," *Encyclopaedia of Islam*, vol. i, 2nd ed. (1958). (P. H.)

BADALONA, a town of northeastern Spain, in the province of Barcelona and Catalonia is situated on the outskirts of Barcelona city along the shores of the Mediterranean, at the mouth of the Besós river. Its geographical position gives it a temperate climate both in summer and winter. Its beach, extending for about 3½ mi., is much frequented. Pop. (1960) 92,257. Although an industrial suburb of Barcelona, Badalona has a character of its own derived from a history of more than 2,000 years. During the Roman occupation it was the important Baetulo that was founded before Barcelona. Numerous relics from these times are preserved in the town museum. The ancient buildings include the Gothic monastery of San Jerónimo de la Murtra; the *cartuja* (Carthusian monastery) of Montalegre; the plateresque palace of Pinós; and the Pallaresa tower where the emperor Charles V stayed before leaving for the conquest of Tunis. Badalona has a variety of industries including the manufacture of chemicals, metals, glass, spirits, perfume and textiles. (S. A. VA.)

BADDELEY, ROBERT (*c.* 1732–1794), English actor, chiefly remembered for his will, is said to have been a cook to the actor Samuel Foote. Later, as a valet he acquired a familiarity with foreign languages and manners that made him especially successful in "broken English" parts. In 1761, described as "of Drury Lane theatre," he was seen at the theatre in Smock alley, Dublin, as Gomez in Dryden's *Spanish Friar*. Two years later he was a regular member of the Drury Lane company in London. He remained at this theatre and the Haymarket until his death on Nov. 20, 1794. He wore scarlet and gold livery as a King's Servant, being the last actor to do so.

Baddeley was the original Moses in *The School for Scandal*. In his will he bequeathed property to found a home for infirm actors and also money to provide wine and cake in the green room of Drury Lane theatre on Twelfth-night. The ceremony of the Baddeley cake remained a regular institution.

His wife, SOPHIA BADDELEY (1745–1786), was born in London,

the daughter of a sergeant-trumpeter named Valentine Snow. At the age of 18 she ran away with Baddeley, then acting at Drury Lane, and appeared there on April 27, 1765, as Ophelia.

Her extravagance and profligacy led him to leave her, and after a career as actress, singer and courtesan, she died in Edinburgh in July 1786.

See Elizabeth Steele, *Memoirs of Mistress Sophia Baddeley*, 6 vol. (1781).

BADEN, the southwesternmost part of Germany, forming the western part of the *Land* Baden-Württemberg (*q.v.* for geographical detail) in the German Federal Republic. Baden is bounded on the west by the Rhine, separating it from France and from the Palatinate, on the north by Hesse and by part of Bavaria, on the east by Württemberg and on the south by Switzerland.

HISTORY

The plains of Baden show traces of human settlement from the Stone Age onward. Inhabited by a Celtic population from the 4th to the 2nd century B.C., with centres at Breisach, at Zarten (near Freiburg) and at Ladenburg (on the Neckar) and occupied subsequently by Germans, the country was conquered in the 1st century A.D. by the Romans (*see* AGRI DECUMATES), who developed its economy, strengthened its defenses and early united it with their province of Germania Superior west of the Rhine. The spas (Ger. *Bäder*) of Baden-Baden and Badenweiler prospered under the Romans, as archaeological evidence shows. The Romans, however, were displaced by the Alamanni (*q.v.*), who invaded the area in the middle of the 3rd century and divided it between petty kings until in the 5th century a tribal or "stem" duchy began to emerge. The victory of Clovis over the Alamanni in 496 won the northern part of the country (up to the Oos and Murg rivers) for the Franks, but the south, at first under the protection of the Gothic king Theodoric, maintained a degree of independence until 748, when the Franks acquired it also.

The Franks, with the help of Irish missionaries, established Christianity in the place of Alamannic paganism. The monastic foundations of Säckingen, Schuttern and Ettenheimmünster date from the 7th century, those of Reichenau, Schwarzach, Gengenbach and St. Trudpert from the 8th. The Franks also set up countships instead of the old *Gaue* and tribal divisions, but on the decline of the Carolingian dynasty this system was weakened by the rise of a landowning class of ecclesiastical and secular magnates who acquired grants of crown lands and immunities from the authority of the counts. Some of the counts moreover sought to make themselves independent of royal control by uniting other countships to their own and by assuming new rights. The house of Zähringen was the major dynasty to rise by this process in southern Germany.

The Dukes and the First Margraves.—First recorded as counts of Breisgau in the 10th century, the Zähringer in the 11th and 12th centuries built up a ducal state which extended from the Black forest over much of Switzerland and Upper Burgundy and might have changed the course of history in southern Germany had not the line of dukes of Zähringen become extinct on the death of Berthold V in 1218. In 1061, however, Hermann I (d. 1074), the elder son of the duke Berthold I, had been invested with the mark or margraviate of Verona in Italy, and subsequently the margravial title had been transferred from Verona to the family seat at Baden. Less ambitious than the dukes, the Zähringer margraves were to form a more lasting power.

The rise of the margraves began with their acquiring rights as counts in Breisgau in the south and in Ufgau, near Baden-Baden, in the north. Their northern holding was strengthened by the addition of Pforzheim, Ettlingen and Durlach in the 13th century and consolidated as a territorial state by Bernhard I (1364–1431), but its further development was to some extent restricted by that of the Palatinate on its frontier. Jacob I, however, margrave from 1431 to 1453, established himself at Hunsrück on the western side of the Rhine in 1437 and acquired a condominium over the lordships of Lahr and Mahlberg in middle Baden in 1442, thus effecting a junction with the family's southern possessions. Separated from the northern margraviate since the 12th century, these southern possessions comprised the countships of Breisgau (part of which was alienated in 1218) and the lordships of Hachberg and Sausenberg, with Rötteln added in 1310 and Badenweiler in 1444. The extinction of the southern branch of the Zähringer in 1503 enabled Christopher I (d. 1527), margrave from 1475 to 1515, to unite the family possessions.

Christopher, who by acquiring Rodemachern as a fief from Luxembourg in 1492 had further strengthened his position west of the Rhine, now controlled a territory extending along the east bank of the Rhine from the gates of Basel to Graben south of Philippsburg (apart from some minor ecclesiastical and secular lordships). He organized it efficiently under a central administration, and Baden might thus have won a dominating position in the basin of the upper Rhine if the state had not subsequently been partitioned among the Zähringer. After a threefold distribution in 1515, the lands were finally divided in 1535 between two margraviates, Baden-Baden and Baden-Durlach.

Baden-Baden and Baden-Durlach.—The margraviate of Baden-Baden comprised, together with the districts west of the Rhine, the original family possessions in the Rhine basin from Bühl to Ettlingen with the condominium of Lahr and Mahlberg; everything else went to Baden-Durlach. For a short time both margraviates were Protestant, but Baden-Baden was brought back to Catholicism in the 1570s. As the two lines moreover became rivals dynastically, Baden was soon overshadowed as a power by neighbouring German states and was left helpless in the face of French expansion across the Rhine in the 17th century. The country was terribly devastated in the wars of this period; in 1689 the towns and citadels of Pforzheim, Durlach and Baden were completely destroyed. Louis William (called "Türkenlouis"), margrave of Baden-Baden from 1677 to 1707, distinguished himself as a commander in the imperial army, first against the Turks in the battle of Slankamen (1691), then against the French. It was he who built the palace of Rastatt as his residence. Charles William, margrave of Baden-Durlach from 1709 to 1738, likewise moved his residence—from Durlach to his newly founded Karlsruhe (*q.v.*).

Charles Frederick.—Under Charles William's grandson and successor Charles Frederick (*q.v.*), margrave of Baden-Durlach from 1738 to 1811 and of Baden-Baden also from 1771 (when the other line of margraves became extinct), the country enjoyed a long period of happiness and prosperity. Then the outbreak of the French Revolutionary Wars made the margrave's position difficult. His country was too open to attack by the French for him to remain long in the alliance against them. Having lost his possessions west of the Rhine, he was obliged to sign the treaty of Paris in 1796, which made him a satellite of France but also proposed compensations for his losses. Subsequent treaties in fact gave him such compensation that the margraviate was enlarged to four or five times its former size. Baden received, in 1803, not only parts of the bishoprics of Constance, Basel, Strasbourg and Speyer as well as Lahr, Lichtenau, Willstätt and several abbatial lands and imperial cities, but also the greater part of the Palatinate east of the Rhine, with Mannheim and Heidelberg; in 1805, part of Breisgau, Ortenau, Mainau and Constance itself; and, in 1806, Heitersheim, Fürstenberg, Leiningen, Wertheim, Klettgau, Bonndorf and the cantons of the knights of the empire. In 1803, accordingly, Baden was made an electorate of the Holy Roman empire and in 1806 it became a grand duchy.

The Grand Duchy.—Consolidated by a central administration, the grand duchy of Baden was recognized by the congress of Vienna in 1815 as a sovereign member of the German confederation. The granting of a constitution in 1818 made Baden one of the first German states to introduce the parliamentary system, and the deliberations of the *Landtag* were echoed throughout Germany even when reaction against the system was strongest. Under Leopold, grand duke from 1830 to 1852, the administration introduced more reforms, but these did not check the progress of radicalism, and the revolutionary movement of 1848 was particularly violent in Baden when Friedrich Hecker and Gustav von Struve raised volunteer troops to set up a republic. This rising was suppressed, but in 1849, when the army mutinied and a revolutionary government was set up, Prussian forces had to restore the grand ducal

administration. Frederick I, grand duke from 1852 to 1907, was the son-in-law of the future German emperor William I and favoured the "Little German" solution of the German question in the form of a close union with Prussia. Though circumstances made him take the Austrian side in the Seven Weeks' War (1866), after it he allied Baden with Prussia and took a leading part in the founding of the German empire. His internal policy, like Charles Frederick's, was characterized by legislative activity, concern for his people's welfare and encouragement of the arts and sciences. The last grand duke was Frederick II, who ruled from 1907 to his abdication at the close of World War I, in 1918.

Later History.—Baden was governed from 1919 to 1933 as a state of the German Reich, with its own state president, and then, under the Nazi regime from 1933, by a *Gauleiter* and *Reichsstatthalter*. During the occupation by the Allies after World War II, it was divided into French and U.S. zones, their boundary drawn between Karlsruhe and Rastatt. Subsequently these two northern and southern zones became administrative districts of the *Land* Baden-Württemberg.

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BADEN (Baden bei Wien), a spa in Lower Austria, 17 mi. S. of Vienna, lies at the east edge of the Wiener Wald and at the gateway to the Helenental, a woodland dale watered by the Schwechat. Pop. (1961) 22,484. It is famous for its 15 warm (73° to 96° F.), radioactive sulfur-chlorine springs, used in the treatment of rheumatic pains, gout, neuralgia and neuritis, which rise chiefly at the foot of the Kalvarienberg (1,250 ft.), a mass of dolomitic limestone. There is a notable Roman spring with supply pipes dating from the year A.D. 1, and two swimming pools filled with water from the Marienquelle (95° F.). In the old town, besides most of the baths, are the town hall and the Gothic parish church of St. Stephen, which resembles St. Stephen's cathedral in Vienna. Beethoven, Mozart, Schubert, Johann Strauss and other composers, and poets have lived at Baden, and memorials to them are to be seen in the town.

Baden shows evidence of continuous settlement since early times and appears to have maintained its present function through the ages. West of the old town lie several parks and the Rollet museum which is rich in local prehistoric and Roman remains.

BADEN, a town in the Swiss canton of Aargau, lies on the left bank of the Limmat, 1,272 ft. above sea level, 14 mi. (23 km.) N.W. by rail of Zürich. Pop. (1960) 13,949. The hot sulfur springs mentioned by Tacitus were fashionable in the 15th, 16th and 19th centuries and still attract great numbers of persons of all nationalities who suffer from rheumatic complaints. The spa quarter is approached from the old town by a boulevard. The old town is very picturesque with its steep and narrow streets, and its one surviving gateway; it is dominated on the west by the ruined castle of Stein, formerly a stronghold of the Habsburgs, and contains also the town hall with an old assembly chamber and the municipal library. To the northwest of the baths is a new industrial quarter with large electrical engineering works. One mile south of Baden, on the Limmat, is the famous Cistercian monastery of Wettingen (1227–1841) which has old painted glass in the cloisters and early 17th-century carved stalls in the choir of the church; the monks are now at Mehrerau near Bregenz. Six miles west of Baden is Brugg, on the Aar, and nearby are the remains of the Roman colony of Vindonissa (Windisch), and the monastery (founded 1310) of Königsfelden, formerly the burial place of the early Habsburgs.

In 1415 Baden (with the Aargau) was conquered by the Eight Swiss confederates whose bailiff inhabited the castle on the right bank of the Limmat which defended the ancient bridge. The delegates of the confederates met at Baden from 1427 to about 1712. The diet sat in the old town hall. Baden was the capital of the canton of Baden from 1798 to 1803, when the canton of Aargau was created.

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BADEN-BADEN, a town and spa in the Black forest of Germany which after partition of the nation following World War II was located in the *Land* of Baden-Württemberg, German Federal Republic, lies on the bank of a narrow stream, the Oos. Pop. (1961) 40,029. It owes its importance to its thermal springs, which have been known from Roman times. The baths, built in the reign of Caracalla (A.D. 211–217) for the garrison of Strasbourg, are still visible. After the departure of the legions the town fell to ruins and reappeared only in the middle ages; its first margrave (1112) was Hermann II of Zähringen. The town was almost entirely destroyed in 1689 and did not revive for nearly a century. It was an asylum for numerous refugees from the French Revolution. The popularity of Baden-Baden as a watering place dates from 1808 but it reached its zenith under Napoleon III, when it was the resort of French society. There is a casino which attracts many players. Among the buildings are the Greek chapel; the Trinkhalle or Pump room; the Friedrichsbad (1869–77), a bathhouse for men only; the Kurhaus social rooms; the Stiftskirche, now the parish church, founded in the 7th century on the site of a heathen temple, destroyed in 1689, rebuilt in 1753 and restored under the grand duke Leopold in 1837; and the Neues Schloss, which was built under the margrave Christopher (1475–1527). It too was partly destroyed in 1689, but was restored and enlarged very soon afterward. It was the residence of the grand dukes of Baden and has subterranean chambers which date back to Roman times.

The famous waters, saline and radioactive, are used for both bathing and drinking, and are said to be efficacious in the relief of certain rheumatic and paralytic conditions. The establishments are open all year. The station, on the railway line joining Karlsruhe and Freiburg, is Baden-Oos (3 mi. away), and there is an airport, Karlsruhe-Baden-Baden, about the same distance to the northeast.

BADENI, KASIMIR FELIX, Graf (1846–1909), Austrian statesman who worked for a reconciliation of the conflicting national interests of the western half of the empire, was born in Surochów in Galicia on Oct. 14, 1846. After studying law at the University of Cracow, Badeni, one of the richest Galician landowners, entered the Galicia department of the ministry of the interior in 1866 and was appointed district commissioner first for the district of Zolkiew (1871), then for Rzeszow and eventually *Statthalter* in Cracow (1879). Retiring to his estates in 1886, he returned to the civil service in 1888 as *Statthalter* of Galicia. On Oct. 2, 1895, Badeni, on the recommendation of the military, was appointed first minister and minister of the interior for the western half of Austria-Hungary. His appointment occurred at a critical time. Tax reform, settlement of the German-Czech language problem and reform of the suffrage laws could no longer be postponed, and the Compromise (*Ausgleich*) with Hungary of 1867 was soon to come under its decennial review. Badeni's first measure was to end the state of emergency in Prague, which had been declared in 1893. He opposed all extreme nationalism such as that of the anti-Semite Karl Lueger (*q.v.*). On Badeni's advice the emperor Francis Joseph three times refused to confirm the election of Lueger as chief burgomaster of Vienna.

In May 1896 Badeni brought about a suffrage reform which added a fifth category of electors consisting of all men over 24 years old who paid at least five gulden in tax. His tax reforms passed no less easily, and it was only with the elections of March 1897 that the situation became threatening. The Young Czechs, the Croats and the Social Democrats benefited most from the new voting structure, and to conciliate the Young Czech party Badeni elevated Czech to the status of an administrative language in Bohemia and Moravia. This provoked intense opposition from the German minority parties, especially from Georg Schönerer's faction (to which Lueger belonged), and in June 1897 Badeni prorogued the *Reichsrat*. The *Reichsrat* had to be reconvened in September to review the Hungarian Compromise; but on Nov. 26 and 27, authorized by new standing orders (the Falkenhayn laws), Badeni had some of the brawling deputies expelled by the police. Demonstrations followed in the streets of Vienna. Lueger, whose

fourth election to the burgomastership had been confirmed by the emperor, demanded Badeni's resignation, with the warning that unless constitutional procedures were restored there might be revolution in the city. Badeni had in fact offered to resign immediately before the November session of the *Reichsrat*, and on Nov. 28 the emperor accepted his offer. Because of this change of mind the measures that had been designed to allay discord between the nationalities had the effect of exacerbating it, as rioting broke out in Prague in protest against Badeni's resignation and a state of emergency had to be proclaimed there.

Badeni resolutely attacked the problem of the nationalities and, although his reputation has suffered from partisan misappraisals, his fall marked a serious loss for Austria-Hungary. He died near Krasne in Galicia on July 9, 1909.

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BADEN-POWELL, ROBERT STEPHENSON SMYTH BADEN-POWELL, 1ST BARON (1857–1941), founder of the Boy Scouts' movement, was born in London, the seventh son of Baden Powell, Savilian professor of geometry at Oxford, on Feb. 22, 1857. He joined the 13th Hussars in India in 1876 and began to develop scouting as a branch of army training; this led to special service in Africa in Ashanti (1895) and Matabeleland (1896) but he returned to India in 1897 to command the 5th Dragoon Guards. During the South African War (1899–1902) his defense of Mafeking for 217 days made him a national hero; he was promoted major general and later was deputed to raise and train the South African constabulary. Baden-Powell became inspector general of cavalry in 1903. Finding that his book *Aids to Scouting* (1899) was being used for training boys, he ran a trial camp at Brownsea island, Dorset, in 1907 and published an outline scheme; Boy Scout troops (typically 20 to 40 boys) sprang up all over the country and *Scouting for Boys* was published the next year. Baden-Powell, promoted lieutenant general in 1907, left the army in 1910 to give all his time to the Boy Scouts. In the same year, the Girl Guides were founded. Both movements spread rapidly and Baden-Powell, acclaimed chief scout at the first international scout jamboree in 1920, toured the world several times to review scouts and guides, remaining active until his 80th year.

Baden-Powell was made a baronet in 1922, a baron in 1929 and was appointed to the Order of Merit in 1937. He married Olave St. Clair Soames in 1912; both she and his sister Agnes (d. 1945) did much to promote the Girl Guide movement. Baden-Powell died at Nyeri in Kenya on Jan. 8, 1941. *See* also BOY SCOUTS; GIRL GUIDES; GIRL SCOUTS.

See E. E. Reynolds, *Baden-Powell*, 2nd ed. (1957), *Boy Scout Jubilee* (1957). (E. E. RE.)

BADEN-WÜRTTEMBERG, a *Land* in the German Federal Republic, was established in 1952 after a popular referendum held in Dec. 1951 which indicated the desire of the inhabitants to merge the three postwar *Länder* of Württemberg-Baden, Württemberg-Hohenzollern and South Baden into one state under a single constitution and prime minister. It lies in the southwest between the frontier with France on the Rhine to the west and the *Land* of Bavaria to the east. Area 35,750 sq.km. (13,803 sq.mi.).

Physical Geography.—The *Land* embraces five major physical divisions: the Upper Rhine plain, the Black forest, the Neckar lowland, the Swabian Jura and the Danube plateau.

The Rhine flood plain from Basel to Karlsruhe is wide and wet and is mainly under waterlogged pasture (*Ried*). Low sandy terraces with pine woods cover most of it. The foothills of the Black forest are fertile and intensively cultivated on minute holdings. There the trees are mainly oak and beech and elm. The Black forest (*q.v.*) is a highland penetrated by many short valleys but with no easy through routes. The lower altitudes are clothed in beechwoods, but upper levels have spruce forest or open pastures on the southern summits. The highland passes northward to the Kraichgau, a rolling limestone upland that is predominantly cultivated.

The Neckar (*q.v.*) river drains a great V-shaped lowland widening from the south between the Black forest and the Swabian Jura. There are three types of country: (1) Lowlands, developed on horizontal limestones and frequently covered with fine loam soils, border the west of the V at the foot of the Black forest (*Gaue*). The bare limestone is the realm of scrub and rough pasture, but the loam soils are covered with treeless expanses of arable land and large compact villages. (2) A belt of wooded, sandstone hills with west- and north-facing scarps stretches through the middle of the basin. (3) A zone of clay plains (Lias) lies between the sandstone hills and the Swabian Jura. These lands are rolling and predominantly under cultivation. The Neckar and its tributaries are sunken below the level of these uplands and their slopes have vineyards on tiny holdings with many large villages and small active towns.

The Swabian Jura stretches from the southern end of the Black forest northeast to the Ries lowland. It is a dry limestone plateau with an average width of 40 km. (25 mi.) reaching a height of 600–1,015 m. (1,960–3,330 ft.). To the north it falls abruptly to the Fils valley. The plateau is crossed by several wide deep valleys, with, in places, outlying conical and flat-topped hills on which are situated medieval castles. At the foot of the slopes are orchards and vineyards and above are beechwoods and, at the top, crags of horizontal beds of limestone.

The Danube plateau includes the sheltered and flat stretches of the Danube and then the rolling plateau, dotted with wooded morainic hills, that becomes increasingly hilly toward the shores of Lake Constance.

Population and Administration.—The *Land* had a population of 7,759,154 in 1961 and a density of 562.1 per square mile. It is divided administratively into four districts (North Württemberg, North Baden, South Baden and South Württemberg-Hohenzollern) which comprise 9 urban, 63 rural districts and 3,382 communes.

Baden was established during the Napoleonic wars from a number of scattered counties and dukedoms. It had its beginnings in the margraviate of Baden in the 12th century. The grand duchy, with its approximate present boundaries, lasted until 1918, when the republic was established. Württemberg, one of the oldest states of Germany, had its nucleus in the Neckar valley and capital in Stuttgart, which is now the capital for Baden-Württemberg. The state is about half Catholic and half Protestant. The southern portion is mainly Catholic and looks to Ulm and Freiburg. There are three universities (at Heidelberg, Freiburg im Breisgau and Tübingen) and two technical high schools (Stuttgart, Karlsruhe). The University of Tübingen was renowned for its Protestant scholars and pastors. Stuttgart is the head of the Protestant church of the state, and during the 19th century it was one of the great liberal centres of the *Reich*. Both Baden and Württemberg have always been seats of liberalism.

The Economy.—The economy of Baden-Württemberg gives it a very distinct character. It is a land of predominantly tiny holdings with a large surplus of peasant labour, and of highly skilled industries that have developed through local enterprise with a very slender resource and power base. Yet it retains its traditional folk character in dialect, customs and craftsmanship.

The occupational structure of the *Land* is such that only about one-quarter of the population is dependent on agriculture and forestry. The majority of the inhabitants depend on industry and commerce in North Baden, across the southern half of North Württemberg (centred on Stuttgart, with extensions east to Heidenheim and Ulm, *qq.v.*) and south to Tuttlingen in South Württemberg. Elsewhere almost all the communes have more than two-thirds of their residents dependent on agriculture. The majority of the holdings are under 5 ha. (*c.* 12½ ac.) in extent and they are minutely subdivided with scattered strips. This arises from the practice in the Neckar and in Baden of dividing property equally among the descendants on the death of the owner. In Baden a diversity of crops is grown on the foothill zone (wheat, fruits, chicory, tobacco, vines), but arable farming predominates on the limestones in the northern section. In the Black forest dairying and cattle raising are practised and the high pasture is

used for cattle grazing from May to October. Cheese is one of the chief products. The peasant supplements his slender farm income from the tourist trade and handicrafts (clock making, wood carving, etc). In Württemberg, the Neckar valley is sheltered and has a precipitation of about 600 to 800 mm. (*c.* 23 to 31 in.) and a maximum temperature of 17° C. (62.6° F.) in July and a minimum of −1.8° (29° F.) in January. While wheat and barley predominate on the *Gaue,* vines and fruits are found in the Neckar valley and its tributaries as well as in the better-exposed slopes of the valleys.

Equal subdivision of holdings has long prevailed in this area and accounts for the tiny properties that are inadequate to support the peasants in work or income. Large numbers find occupations in industry in nearby towns as well as in Stuttgart, which has increased at an alarming rate. The law of primogeniture with compact and larger holdings prevails in most of the Black forest and the Danube plateau. The government has long made efforts to consolidate the holdings but there is still one-half of the farm land that is in need of such reform. Large numbers of workers travel to work outside their own villages. With the consolidation of holdings and increased mechanization of agriculture, there is a continuous shift to industry. In a belt from Karlsruhe (*q.v.*) through Stuttgart to Ulm, and around Mannheim (*q.v.*), more than 30% of all the workers (well over a half of the nonagricultural workers) travel to work daily outside the communes in which they live.

Most of the industries of Baden-Württemberg have had long histories based on local enterprise. Engineering and textile industries are the chief of these. There is no coal or lignite but some salt at Heilbronn, Rottweil and Hall. Power needs are met by imports of coal from the Ruhr and the Saar, but most of the power is derived from hydroelectric plants on the Rhine (Lörrach, *q.v.*, and Rheinfelden) and from the Bavarian Alps. Textile, leather, pottery, glass and woodworking industries are found in its many towns. Stuttgart is the industrial and financial heart of Württemberg. Mannheim is the main seat of industry in Baden as well as being a great river port for the import of goods upstream on the Rhine and their distribution throughout the southwest.

For history *see* BADEN; WÜRTTEMBERG.

See E. Schneider, *Württembergische Geschichte* (1896); H. J. Haas, *Schwabenland* (1914); N. Krebs, *Der Südwesten, Landeskunde von Deutschland* (1931). (R. E. Di.)

BAD GANDERSHEIM (GANDERSHEIM) a town of Germany, formerly in the dukedom of Brunswick and after partition of the nation following World War II, in the *Land* of Lower Saxony, Federal Republic of Germany, is situated in the deep valley of the Gande, 48 mi. S.W. of Brunswick. Pop. (1961) 6,115.

It became known for the 11th-century convent church (*Stiftskirche*), containing the tombs of famous abbesses, and the former abbey which was founded by Duke Liudolf of Saxony, who moved to Gandersheim in 852 the nuns who shortly before had been established at Brunshausen. His own daughter Hathumoda was the first abbess, and she was succeeded on her death by her sister Gerberga. Under Gerberga's government, Louis III granted a privilege by which the office of abbess was to continue in the ducal family of Saxony as long as any member of the family was found willing and competent to accept the same. Otto III gave the abbey a market, a right of toll and a mint. After the bishop of Hildesheim and the archbishop of Mainz had long contested with each other about its supervision, Pope Innocent III declared it altogether independent of both. The abbey was ultimately recognized as a holding of the Holy Roman empire, and the abbess had a vote in the imperial diet. The conventual estates were of great extent, and among the feudatories who could be summoned to the court of the abbess were the elector of Hanover and the king of Prussia. Protestantism was introduced in 1568 and Magdalena, the last Roman Catholic abbess, died in 1589; but Protestant abbesses were appointed to the foundation, and continued to enjoy their imperial privileges until 1803, when Gandersheim was incorporated with Brunswick. The last abbess, Augusta Dorothea of Brunswick, was a princess of the ducal house, and kept her rank until her death.

The memory of Gandersheim will long be preserved by its literary memorials. Hrosvitha (*q.v.*), the German dramatist and chronicler, was a member of the sisterhood in the 10th century; and the rhyming chronicle of Eberhard of Gandersheim is probably the earliest historical work composed in Low German. The chronicle, which contains an account of the first period of the monastery, was edited by L. Wieland in the *Monumenta Germ. historica* (1877), and was the object of a special study by Paul Hasse (1872).

The saline baths are located northeast of the town. Manufactures include toys, cigars, aluminum products, chemicals and glass.

BADGER, a carnivorous mammal related to the weasels (family Mustelidae).

The species *Taxidea taxus* occurs in western North America from northern Alberta to central Mexico, principally in open, fairly dry places. It is about 28 in. long, muscular, short-necked and flat-bodied and has a broad, flattened head and short legs and tail. The fur is long, grayish to reddish above and whitish below; the nose, top of head, the feet and spots before and behind the short ears are black. It is a solitary creature that feeds mainly on rodents, but it will eat almost any available animal food. It breeds in late summer but implantation is delayed until mid-winter. Usually two blind young are born in an underground chamber. The badger digs rapidly, easily outdistancing a man with a shovel. It can be a savage fighter; when cornered it turns on its back and rips at an attacker with tooth and claws. Except in extreme cold it does not hibernate but may remain underground for long periods. Badger fur is used commercially, the long, white-tipped hairs being glued into plain black pelts to give a frosted effect. Formerly the best shaving brushes were made with badger hair.

BY COURTESY OF U.S. FISH AND WILDLIFE SERVICE

AMERICAN BADGER (TAXIDEA TAXUS)

The species *Meles meles* occurs widely over Europe and northern Asia. The body is of a dark gray; the head is whitish with a blackish stripe on either side extending through the eye and ear. Although sometimes a pest, it, like the American species, is mainly beneficial because of its predation on rodents.

See CARNIVORE: *Mustelidae.* (K. R. KN.)

BAD GODESBERG (GODESBERG) is a garden city with a 5½ mi. promenade on the Rhine, Germany, which after partition of the nation following World War II was in the *Land* of North Rhine-Westphalia, Federal Republic of Germany. It is situated 4 mi. S. of Bonn on the Cologne-Frankfurt railway line. Pop. (1961) 65,119.

It is a modern spa town (developed in the late 19th century, chartered in 1935) and a popular resort for conferences. Across the Rhine is the Siebengebirge ("seven hills"), a scenic natural park. The federal government holds diplomatic receptions in La Redoute (a rococo mansion and former pump room, completed 1791), and the town is the headquarters of a number of ministries and foreign legations. It was the scene (Sept. 1938) of the preliminary conference between Neville Chamberlain and Adolf Hitler, prior to the Munich pact.

Buildings of historic interest include: St. Martin's church (*c.* 889); the ruined castle, founded by Archbishop Dietrich of Cologne in 1210 and destroyed in 1583 by Duke Ferdinand of Bavaria; and the Muffendorf foundation (1254), former headquarters of the Order of German Knights. Modern buildings include a municipal theatre (1952) and assembly hall with conference rooms (1955).

The industry, principally the manufacture of pharmaceutical products, is smokeless.

BAD HOMBURG (HOMBURG VOR DER HÖHE), a spa of Germany and after partition of the nation following World War II a headquarter town of a *Kreis* (county) in the *Land* of Hesse, the Federal Republic of Germany, lies at the foot of the Taunus mountains, 10 mi. (16 km.) N. of Frankfurt am Main by road.

Pop. (1959 est.) 36,085. The old town is dominated by the castle (1680) whose watchtower dates from the 12th century. Rediscovery in 1834 of the Elisabeth mineral spring led to the foundation of the casino (1841) and the building of the new town centred on the Luisenstrasse (1865). Homburg became an internationally fashionable spa and Edward, prince of Wales (later King Edward VII of England), in the 1890s popularized the Homburg hat of soft felt with dented crown. After 1918 Homburg expanded into a residential town with industries (textiles, leather goods, biscuits, machinery). Nearby is the Saalburg, a reconstructed Roman frontier fortress. (F. SA.)

BAD LANDS, a term originally applied in the middle 1800s to part of southwestern South Dakota, U.S., which the early French-Canadian trappers called *Les Mauvaises terres á traverser* ("the bad lands to cross"). More recently the term badlands has been applied to other areas exhibiting similarly eroded topography, as in North Dakota and other Great Plains states, and some foreign countries.

The South Dakota Bad Lands, also known as the White River Bad Lands and the Big Bad Lands, comprise an area of approximately 2,000 sq.mi. that stretches east and west for 100 mi. along the Jackson-Washabaugh and Pennington-Shannon county lines. The Bad Lands occur mainly on the south side of the White river in the eastern part of this area, but to the west they cross the upland to the Cheyenne river. The Badlands national monument, established in 1939, embraces most of the rugged terrain in Jackson and Pennington counties.

Typical badlands such as those in South Dakota are areas that have been cut into multitudes of deep, tortuous gullies with intervening saw-tooth divides, which extend from the main rivers back to the tablelands, 500 ft. higher. The gully bottoms increase in gradient from almost flat near the main rivers, to nearly vertical at the edges of the tablelands. Because the rocks are not uniform in character, differences in erosion result in stair-step profiles. The joining and separating of the gullies has caused many isolated irregular spires or small flat-topped buttes.

A view from the valleys of the main rivers presents an awesome spectacle of jagged, fluted, seemingly inaccessible hills against the skyline. In contrast, badlands may be approached from the tablelands above with little hint of their presence until the edge of the table is reached, whereupon there is a view of forbidding country just as withering as when seen from below.

Life.—Because of the low rainfall and severe topographic situation, little vegetation can grow except in the flat low areas and on the tablelands. Therefore animal life is also rather meagre. Nevertheless, songbirds, predatory birds, jack rabbits, coyotes and prairie dogs are present in the South Dakota Bad Lands, and within historic time larger grazing animals such as the bison, antelope and mountain sheep were not uncommon.

Geological Formation.—Badlands, although they develop in a semiarid to arid environment, are the result of erosion by water, not wind. The bedrock is poorly cemented, and the rainfall, which comes as summer showers generally of the cloudburst type, can therefore do its erosive work most efficiently. The water that percolates into the pores of the rock likewise does its share of both physical and chemical erosion. Because of the fine grain of the sediments, the dried granular surface material is swept clean from the slopes during showers, along with any small plants that may have gained a roothold since the last shower. Thus the slopes and gullies are nearly always bare.

The rocks of the Bad Lands of South Dakota are only a small remnant of the huge blanket of gravels, sands and clays that was once spread by streams eastward from the rising Rocky mountains, 25,000,000 to 50,000,000 years ago. The climate during much of this time was more humid than now, and the streams were thus able to carry the great quantities of material from the mountains eastward onto the plains.

The three main factors in the development of badlands are: (1) climate with low rainfall that is concentrated mainly in heavy showers; (2) scarcity of deep-rooted vegetation; and (3) poorly cemented, uniform, fine-grained sediments that are horizontally bedded. Any hard layer tends to resist erosion and thus irregularities are caused; the soft clays under the hard layers are cut away, thereby leaving a precipice. Concretionary masses caused by stronger cementation tend to weather into columns. Other irregularities result in the many box canyons and gullies, pinnacles and ridges. Bentonitic (expanding clay) beds tend to weather to rounded, humpbacked surfaces.

Fossils.—The sediments of the badlands areas are known as good fossil-hunting ground not so much because they contain more fossils per unit area, but rather because they are so well exposed to the collector by the badlands type of erosion. The South Dakota Bad Lands became famous for excellent collecting of vertebrate fossils in the early 1850s, and have yielded the remains of land animals that include reptiles (turtle, crocodile), birds and mammals (pig, deer, horse, rhinoceros, sheep, hippopotamus, camel, elephant, cat, dog and the extinct titanothere and oreodont).

See also Index references under "Bad Lands" in the Index volume.

See C. R. Swartzlow and R. F. Upton, "Badlands National Monument," *United States National Park Service Natural History Handbook Series*, no. 2 (1954). (A. F. A.)

BADMINTON, a village in the Cotswold hills, Gloucestershire, Eng., 26 mi. S. of Gloucester and 17 mi. E.N.E. of Bristol by road. Pop. (1951) 367. Badminton house, the seat of the dukes of Beaufort, stands in a park about 10 mi. in circumference. The manor of Badminton was acquired in 1608 from Nicholas Boteler (to whose family it had belonged for several centuries) by Thomas, Viscount Somerset of Cashel (d. 1650 or 1651), third son of Edward, 4th earl of Worcester. It was given by Thomas' daughter and heiress Elizabeth to her cousin's son Henry Somerset, 3rd marquess of Worcester and 1st duke of Beaufort (1629–1700), who built the present mansion (1682) in Palladian style on the site of the old manor house. The game of badminton, a London club, a species of claret-cup, a magazine and a sporting library derived their names from the village.

BADMINTON, a court or lawn game played with lightweight rackets and shuttlecocks. The name was adopted by a group of English army officers home on leave from India in 1873, who played the game at Badminton, the country estate of the Duke of Beaufort, in Gloucestershire, Eng. As a game, history accepts its inception in India by the English military in the early 1870s. They called it Poona. It may have derived from battledore and shuttlecock (*q.v.*). The Badminton association of England, formed in 1893, was the first national organization and the first All England championships for men were held in 1899.

The International Badminton federation (I.B.F.), the world governing body, was formed in 1934. In the second half of the 20th century its membership included 37 member nations and 5 associates. The Thomas cup was presented by Sir George Thomas in 1940 for men's international team competition to be managed by the I.B.F. The first contest was held in Nov. 1948 and the first champion nation was Malaya, winning in 1949. The Uber cup was presented by Mrs. H. S. Uber in 1957 to be competed for by international women's teams in much the same manner as the men's teams. The first competition was in March 1957 and the first champion nation was the United States. Matches are held every three years.

Equipment and Courts.—The badminton shuttlecock (called shuttle or bird) has 14 to 16 feathers with a 2⅛-in. to 2½-in. spread at the top, and weighs from 73 to 85 gr. The temperature and barometric pressure determine the proper weight to be used. Each grain adds four inches to the length of flight. Plastic shuttles are acceptable for general play. The racket (which is of no specified size) usually is strung with 20 gauge gut or high-test nylon and weighs around 5 oz. when strung. Net posts are set just outside the side lines. The net is 30 in. deep and the top line of the net should be 5 ft. 1 in. high at the posts, and 5 ft. in the middle.

The game, sometimes referred to as shuttlecock, consists entirely of volleying, meaning the shuttle must be struck in mid-air before it touches the floor or ground.

The measurements of the court are shown on the accompanying

plan.

The game is played indoors or out and in daylight or artificial light, with two players on each side (called doubles, or if one player is a woman and the other a man, mixed doubles), or with one player on each side (called singles).

It is common practice to mark out a court for both singles and doubles. The length is 44 ft. For doubles it is 20 ft. wide, for singles 17 ft. wide. The lines should be 1½ in. wide. For singles the outside side lines and the long service lines are ignored. For doubles the inside side lines are ignored. There is no legal height for indoor courts other than what a local organization may set. A recommended height is 24 ft. or more. The game often is played informally for exercise on lawns, driveways and beaches, with various adaptations of the rules.

The Game.—The official game is for 15 points except in women's singles when it is for 11 points. A match is the best two out of three games. At the start of a match a player spins a racket and an opponent calls the toss, like heads or tails on a coin. The winner has the choice of serving first or not serving first, or the choice of court ends. The loser has the remaining choice. After each game the opponents change ends, and the winner serves first. If a third game is played, ends are again changed when one side has won 8 points. In an 11-point game ends are changed at 6. A 21-point game may be played, but is not used in sanctioned tournaments. In this game ends are changed at 11 points. When ends are changed in doubles for a new game, either partner may serve or receive first.

There are four basic strokes: (1) the clear, a high shot to the base line; (2) the smash, a very fast, hard hit, downward-angled shot; (3) the drop-shot, a shot that falls rapidly upon crossing the net; and (4) the drive, a fast flat shot hit horizontally near net height. Deception is employed to produce a variation of any one of these basic shots, so that the opponent cannot anticipate what is coming. The velocity of the shuttle in flight reaches 110 m.p.h. but slows down rapidly. The qualified player uses that change of pace in all its varieties. It is a game of speed of action and judgment and great accuracy in placement and control.

For the singles or doubles serve the shuttle must land within the bounds of the proper service court that is being served to. Note that the front service line is the same but the long service and side lines are not. A shuttle hitting any part of a line is deemed to be good; this holds true throughout the game just as in service. The accepted basic serves are, high to the base line in singles and low to the front service line in doubles.

Serving.—The side that is serving is called the IN side, and the receiving side the OUT side. The server and receiver must be in their proper courts. The other two players in doubles may stand anywhere, provided they do not unsight or otherwise obstruct an opponent. In singles the server starts from the right service court and serves to the receiver in the opposite right service court. If the server wins the rally, he scores a point. The next serve is from the left service court to the receiver in the opposite left service court. This process of alternating courts continues as long as the server wins points. Players win points only when on the IN side, meaning serving. When a server loses a rally, he loses the serve (but not a point) and his opponent serves and alternates courts in the same manner. When a player wins the right to serve and his score is an even number, 0–2–4, etc., he starts serving from the right service court; if uneven, 1–3–5, etc., he starts serving from the left service court. In doubles, service always starts with the player properly in the right service court. He serves and alternates courts as long as his side wins. When his side loses the rally, the partner starts to serve. (The side starting the game has only one hand, or serve, in its first inning.) If the score for his side is even, the partners should be in the same service courts they were in when they started the game. The partner now serving serves from whichever service court he belongs in. The OUT side players remain in the service court they belong in when the IN side started to serve. The OUT side players do not alternate service courts. The player served to may alone receive the service.

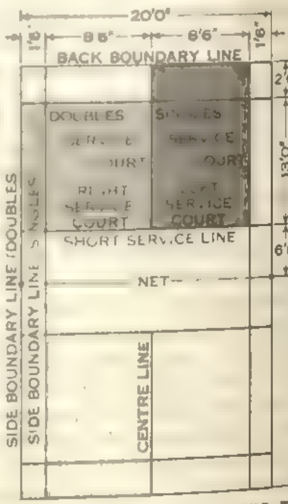
A foot touching a line by server or receiver is a fault. Preliminary feints or otherwise intentional balks are not allowed. The server or receiver may not move his feet until the shuttle has been struck by the server's racket. With the shuttle in play all players may move about the court at will, playing the shuttle back and forth across the net until the shuttle hits the floor, or a player's person or clothing, or fails to cross the net or is uncleanly hit by a player's racket. Either player on a side may hit the shuttle at any time after service, but if both players hit it, or a player hits it twice before it crosses the net, it is a fault (see *Faults*, below).

Setting.—When the score is deuced, that is, tied at 13 all or 14 all, setting is permitted except in women's singles when deuce is 9 or 10 all. When deuce is 13 all, the side reaching 13 first has the choice of setting or not setting. If (singles or doubles) they choose to set, the game then proceeds and the side who wins 5 points first is the winner. If deuce is 14 all and set is chosen, 3 points are played for. If deuce is 13 and set is not chosen, the game has not been altered and goes on to 15 points. However, if the score is then deuced at 14 the rule previously stated applies. If deuced at 9, set is 3 points, and at 10 set is 2 points. In a 21 point game, deuce at 19 is set at 5 and at 20 is set at 3.

Faults.—A fault is a playing violation which ends a rally. A fault made by a player of the IN side puts the side out (in doubles it counts as one hand out); if made by a player whose side is OUT, it counts a point for the IN side.

It is a fault:

1. If, in serving, the shuttle at the instant of being struck is higher than the server's waist.
2. If, in serving, the shuttle falls outside the service court lines.
3. If, either in service or play, the shuttle falls outside the boundaries of the court, or passes through or under the net or fails to pass the net, or touches the roof or side walls, or the person or dress of a player.
4. If the shuttle in play is struck before it crosses to the striker's side of the net.
5. If, when the shuttle is in play, a player touches the net or its supports with racket, person or dress.
6. If in play a player strikes the shuttle (unless he thereby makes a good return) or is struck by it, whether he is standing within or outside the boundaries of the court.
7. If a player obstructs an opponent or invades an opponent's court.



BADMINTON COURT, SHOWING THE MEASUREMENTS FOR SINGLES AND DOUBLES

A let means the play in question is invalidated, therefore played over without penalties. If in service the shuttle touches the net it is not a let provided the service is good otherwise. (If in the course of a rally the shuttle touches and passes over the net, it does not invalidate the stroke.) A let may be given for any unforeseen or accidental hindrance.

In tournaments play is continuous from the first service until the match is concluded, except that (1) in countries where climatic conditions render it desirable, there shall be allowed, subject to the previously published approval of the national governing organization concerned, an interval not exceeding five minutes between the second and third games of a match; and (2) when necessitated by circumstances not within the control of the players. Under no circumstances is play suspended to enable a player to recover his strength or wind, or to receive instruction or advice.

Bibliography.—Kenneth R. Davidson and Lealand R. Gustavson, *Winning Badminton* (1953); *Official Badminton Guide* (annual); *The International Badminton Federation Annual Handbook*. (L. R. G.)

BADOGLIO, PIETRO (1871–1956), Italian soldier who was commander in chief in the Italian conquest of Ethiopia and who led Italy from the German to the Allied side in World War II, was born at Grazzano Monferrato, Piedmont, on Sept. 28, 1871. He entered the army as an artillery officer and saw action in the Italo-Ethiopian War of 1896–97 and in the Italo-Turkish War. During World War I, when he rose to the rank of general, he

planned and carried out the successful attack on Monte Sabotino which preceded the fall of Gorizia in Aug. 1916. He also conducted the armistice preliminaries at Villa Giusti and signed the armistice on behalf of Italy. Having been chief of the general staff from 1919 to 1921, he went as ambassador to Brazil from 1924 to 1925. Made field marshal in June 1925, he again became chief of the general staff. From 1928 to 1933 he was governor general of Libya. In Nov. 1935 he was appointed commander in chief of the Italian forces in Ethiopia, where he was subsequently viceroy for a short time in 1936. Relieved of that office at his own request he was created duke of Addis Ababa. During World War II he was chief of staff from June to Dec. 1940, when he resigned in protest against the Italian invasion of Greece. On the fall of Mussolini (July 25, 1943), which he had been mainly instrumental in organizing, Badoglio was made prime minister. On Sept. 8, 1943, Italy's unconditional surrender to the Allies was announced. Badoglio dissolved the Fascist party, and on Oct. 13 Italy declared war on Germany. He resigned as prime minister in June 1944. Badoglio died at Grazzano Monferrato on Oct. 31, 1956.

See A. Tosti, *Pietro Badoglio* (1956).

BADRINATH, a village and celebrated pilgrimage place in Garhwal district, Uttar Pradesh, India, is 95 mi. N.E. of Hardwar. It lies on the Sarasvati or Vishnuganga river in rugged mountain country near Kamet (25,447 ft.), 17 mi. E. of the Badrinath peak (23,420 ft.). The temple, on a shoulder of the latter at 10,294 ft., contains a shrine of Badarinatha, a title of Vishnu. The place has been famous for over 2,000 years and is mentioned in the *Mahabharata* and several *Puranas.* The long and toilsome route to Badrinath enhances the merits of the pilgrimage.

See F. S. Smythe, *Kamet Conquered* (1932). (F. R. A.)

BADUI, a pagan tribe of about 2,000 persons living in semi-isolation in the mountainous area of Bantam residency in West Java province, Indon. There is little trustworthy information concerning them, but it is said that their religion stresses ancestor worship combined with many prohibitions against the use of ornaments and of foreign (*i.e.,* non-Badui) articles. (F.-C. Ce.)

BADULLA, a town of Ceylon, capital of Badulla district and of Uva province, lies 54 mi. S.E. of Kandy and 2,222 ft. above sea level, almost encircled by a river, the Badulu Oya, and surrounded by mountains, the Namunakuli range to the southwest rising to 6,679 ft. Pop. (1953) 17,043. The town is adorned with flowering trees and is the terminus of the main railway from Colombo. In Kandyan times it was at some periods the seat of a prince but no trace of the palace remains. There are two large Buddhist temples on ancient sites, and a Christian church.

Badulla is the centre of a highly distinctive hilly region of Sinhalese villages set among terraced paddy fields, of tea estates, and of open *patanas* ("grasslands"). The average rainfall is 78 in., with a marked dry season in June, July and August, and the average temperature 73° F. The district extends eastward into Bintenne, a sparsely populated part of the Ceylon dry zone, development of which was begun in the mid-20th century by means of irrigation and other works. (B. H. F.)

BAECK, LEO (1873–1956), leading rabbi, whose refusal to flee from danger during the Nazi regime climaxed his years of services to German Jewry, was born in Lissa, Posen (now Leszno, Pol.), on May 23, 1873, the son of the rabbi and historian Samuel Baeck. He was rabbi in Oppeln, Düsseldorf and Berlin (1912–43), where he also lectured at the Hochschule für die Wissenschaft des Judentums. He served as an army chaplain during World War I. His leadership in German Jewry is indicated by the fact that he was at various times president of B'nai B'rith, the Union of German Rabbis and the Reichsvertretung der Juden. In 1943 Baeck was imprisoned in the Theresienstadt concentration camp, where he lectured on philosophy. By his moral authority he prevented lynching of the guards at liberation in 1945, when he was one of the few survivors.

Baeck's *Essence of Judaism* (1905; English translation 1936, 1948) sees in ethics Judaism's permanent element, recognizes change in forms and stresses the religious paradox (*e.g.,* universalism-particularism), as, in his own life, he mediated between extremes. *Romantische Religion* (1922; English translation included in *Judaism and Christianity,* 1958) described Judaism as the "classical" religion, in contrast with "romantic" Christianity. *Dieses Volk* (1955–57), partly written in Theresienstadt, evaluates the Jews' role in history and deals with the problem of Jewish *Existenz.* A student of Midrash (*q.v.*) and New Testament backgrounds, his collected scientific essays appeared in *Aus drei Jahrtausenden* (1938; 2nd ed., 1958).

After liberation, Baeck lectured in London and at the Hebrew Union college in Cincinnati, O. He died in London on Nov. 2, 1956.

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BAEDEKER, the name of a German publishing house, issuers of a famous series of guidebooks. The founder of the firm, Karl Baedeker (1801–59), was born at Essen, Nov. 3, 1801, son of a printer and bookseller. In 1827 he started a firm at Koblenz and two years later brought out a guidebook to the town. It was in the second edition of a guide to the Rhine from Mainz to Cologne (which had appeared in 1828) that Baedeker evolved the system on which he based his series. His aim was to give the traveler the practical information necessary to enable him to dispense with paid guides. He checked the reliability of his publications by incognito journeys and consulted the best sources and experts. A notable feature of his guides was the use of "stars" to indicate objects and views of special interest, as well as reliable hotels. At his death (Koblenz, Oct. 4, 1859) much of Europe had been covered by his guidebooks. Under the ownership of his sons, Ernst (d. 1861), Karl (part-owner until 1878) and especially Fritz (1844–1925), the firm expanded still more. The first French edition appeared in 1846, the first English one in 1861. The house moved to Leipzig in 1872, in 1948 to Hamburg and in 1956 to Freiburg in Breisgau. A branch devoted to motor guides was opened in Stuttgart in 1952. (M. Kl.)

BAEKELAND, LEO HENDRIK (1863–1944), Belgian-born industrial chemist particularly well known for his discovery of Bakelite, was born in Ghent, Nov. 14, 1863. He taught at the University of Ghent after receiving his doctorate there with highest honours at the age of 21. In 1889 he went to the U.S. and joined a photographic firm; later, as a consulting chemist, he developed a photographic paper, which he called Velox, that could be developed in artificial light. When he sold his rights to George Eastman in 1899 he became independently wealthy. In 1905 he began research into methods of creating synthetic resins; the result was his discovery of Bakelite, a condensation product of formaldehyde and carbolic acid produced at high temperatures and pressures; it was one of the first modern plastics.

Baekeland died in Beacon, N.Y., Feb. 23, 1944; his patient and carefully planned researches had been richly rewarded with honours, wealth and the satisfaction of great and genuine accomplishment. (W. E. Hd.)

BAEL FRUIT, the fruit of the bael or bel fruit tree (*Aegle marmelos*), also known as Bengal quince, which is found wild or cultivated throughout India. *Aegle* is a genus of the rue or citrus family (Rutaceae) containing three species, two in tropical Asia and one in west tropical Africa. The trees bear strong spines; alternate, compound leaves, each with three leaflets; and panicles of sweet-scented white flowers. The tree is valued for its fruit, which is oblong to pyriform in shape, two inches to five inches in diameter and has a gray or yellow rind and a sweet, thick orange-coloured pulp. The unripe fruit is cut in slices, sun-dried and used as a remedy for dysentery; the ripe fruit is described as sweet, aromatic and cooling. The wood is yellowish-white and hard but not durable.

BAER, KARL ERNST VON (1792–1876), German pioneer in comparative embryology who discovered the mammalian ovum and the notochord, was born at Piep, Estonia, on Feb. 29, 1792. In his 18th year he entered Dorpat university as a medical student, but, attracted by the study of life history, he moved to

Germany, where J. I. J. Döllinger (1770–1841), father of the Catholic theologian, was professor of anatomy at the University of Würzburg. Döllinger gave a direction to Baer's studies that secured his future pre-eminence in the science of organic development. Baer collaborated with C. H. Pander (1794–1865) in researches on the development of the chick, the results of which were first published in K. F. Burdach's treatise on physiology. Continuing his investigations alone, Baer extended them to the development of organisms generally; and after a sojourn at Berlin he was invited by his old teacher Burdach, who had become professor of anatomy at Königsberg, to join him as prosector and chief of the new zoological museum (1817). Baer's discovery of the human ovum was the subject of his *Epistola de Ovo Mammalium et Homini Genesi* (1827), and in 1828 he published the first part of his *History of the Development of Animals* (*Über die Entwickelungsgeschichte der Thiere*), the second part following in 1837. In this work he demonstrated that the Graafian follicles in the ovary are not the actual eggs, but that they contain the true ovum. He next showed that in all vertebrates the primary stage of cleavage of the fertilized egg is followed by modification into leaflike germ layers (skin, muscular, vascular and mucous) from which arise the different organs of the body by differentiation. He advanced the "law of corresponding stages" concerning the development of vertebrate embryos. By deliberately leaving off the labels of specimens, he subtly demonstrated the similarity of stages in different classes. "I am quite unable to say to what class they belong. They may be lizards, or small birds, or very young mammalia, so complete is the similarity in the mode of formation of the head and trunk in these animals. The extremities are still absent, but even if they existed, in the earliest stage of the development we should learn nothing, because all arise from the same fundamental form." Baer further discovered the gelatinous, cylindrical cord, known as the notochord, which passes along the body of the embryo of vertebrates, in the lower types of which it is limited to the entire inner skeleton, while in the higher the backbone and skull are developed round it. In his *History of Development* he suggests, "Are not all animals in the beginning of their development essentially alike, and is there not a primary form common to all?" (i, p. 223). Notwithstanding this, the "telic" idea, with the archetypal theory that it involved, possessed Baer to the end of his life, and explains his inability to accept the theory of unbroken descent with modification.

The influence of Baer's discoveries was far reaching and abiding. Not only was he the pioneer of comparative embryology, but the impetus to T. H. Huxley's researches on the structure of the jellyfish came from him (*Life*, i, 163), and Herbert Spencer found in Baer's "law of development" the "law of all development" (*Essays*, i, 30).

In 1834 Baer was appointed librarian of the Academy of Sciences of St. Petersburg. In 1835 he published his *Development of Fishes*, and as the result of collection of all available information concerning the fauna and flora of the polar regions of the empire, he was appointed leader of an arctic expedition in 1837. The remainder of his active life was occupied in diverse fields of research, geological as well as biological, an outcome of the latter being his fine monograph on the fishes of the Baltic and Caspian seas. One of his last works was an interesting autobiography published at the expense of the Estonian nobles on the celebration of the jubilee of his doctorate in 1864. Baer died at Dorpat, Estonia, on Nov. 28, 1876. (J. Rm.)

BAER, WILLIAM JACOB (1860–1941), U.S. painter, who had much to do with the revival in America of the art of miniature painting, was born on Jan. 29, 1860, in Cincinnati, O. He studied at Munich in 1880–84. He turned to miniature painting in 1892, and was the first president of the Society of Painters in Miniature. Among his miniatures are "The Golden Hour," "Daphne," "In Arcadia" and "Madonna With the Auburn Hair." He died Sept. 21, 1941.

BAETYLUS (Baetulus), a Greek word of Semitic origin (= *bethel*) denoting a sacred stone or pillar. Numerous holy or fetish stones existed in antiquity, generally attached to the cult of some particular god and looked upon as his abiding place or symbol. They were, at any rate originally, meteorites worshiped as divine manifestations. The most famous example is the holy stone at Delphi, the omphalos ("navel"), which reposed in the temple of Apollo and marked the exact centre of the universe. A second stone at Delphi, near the sanctuary of Neoptolemus, was said to have been the one that Cronus (*q.v.*) swallowed; it was thought to be Zeus himself in his symbolic or baetylic form. Another famous stone was that of Cybele, at Pessinus (see Great Mother of the Gods).

ALINARI
MARBLE REPRESENTATION OF THE OMPHALOS AT DELPHI

In some instances, an attempt was made to give a more regular form to the original shapeless stones by forming them into pillars or into groups of three pillars. Such columns were sometimes placed before a shrine where the worshiper adored; others were used as mileposts and often shaped into human form. According to Ernest Gardner, baetyli in Aegean religion were probably representations in cult form of the divine mountain. In turn, the baetylus was the parent form for altars and iconic statuary. *See* also Herm. (T. V. B.)

BAEYER, (JOHANN FRIEDRICH WILHELM) ADOLF VON (1835–1917), German chemist, is best known for his investigations in organic chemistry and, in particular, synthetical studies by the aid of "condensation" reactions. He was born in Berlin on Oct. 31, 1835. His father was Johann Jacob von Baeyer (1794–1885), chief of the Berlin Geodetical institute from 1870. Baeyer studied chemistry under R. W. Bunsen and especially F. A. Kekulé, and in 1858 took his Ph.D. degree at Berlin, becoming *Privatdocent* in 1860. He headed the chemistry laboratory at the Berlin Gewerbeinstitut until 1872, when he was appointed professor of chemistry at Strasbourg. In 1875 he was called in the same capacity to Munich as successor to Justus von Liebig.

The Royal Society of London awarded Baeyer the Davy medal in 1881 for his researches on indigo, whose nature and composition he did more to elucidate than any other chemist, and which he also succeeded in preparing artificially, though his methods were not found commercially practicable. To celebrate his 70th birthday his scientific papers were collected and published in two volumes (*Gesammelte Werke*, 1905), and the names of the headings under which they are grouped give some idea of the range and extent of his chemical work: (1) organic arsenic compounds; (2) uric acid group; (3) indigo; (4) papers arising from indigo researches; (5) pyrrol and pyridine bases; (6) experiments on the elimination of water and on condensation; (7) the phthaleins; (8) the hydroaromatic compounds; (9) the terpenes; (10) nitroso compounds; (11) furfurol; (12) acetylene compounds and "strain" (*Spannungs*) theory; (13) peroxides; (14) basic properties of oxygen; (15) dibenzal-acetone and triphenylamine; (16) various researches on the aromatic series; and (17) the aliphatic series. He was awarded the Nobel prize for chemistry in 1905 "in recognition of his services in the development of organic chemistry and the chemical industry through his work on organic dyes and hydroaromatic combinations." Baeyer died at Starnberg near Munich on Aug. 20, 1917.

For detailed biographical accounts *see* W. Perkins, "Baeyer Memorial Lecture," *Journal of the Chemical Society* (1923); F. Henrich, *Journal of Chemical Education* (1930); E. Farber, *Nobel Prize Winners in Chemistry, 1901–1950* (1954). His autobiographical *Erinnerungen aus meinem Leben* (1905) covers only the first half of his life.

BÁEZ, BUENAVENTURA (1810–1884), president of the Dominican Republic, was born at Azua de Compostela in 1810. He believed that Dominican freedom from Haiti could be assured only by the establishment of a protectorate under a foreign power.

During the uprising of 1844 he joined Gen. Pedro Santana, whom he won over to his views. The Santana-Báez coalition controlled the country until a rift led to Báez' downfall in 1853. He spent several years in exile, returning after Santana's death to reoccupy the presidency briefly in 1865–66. As president again in 1868 he contracted a ruinous loan in London, and his attempt in 1869 to promote Dominican annexation or the lease of Samaná bay (*q.v.*) to the United States failed when the U.S. senate did not ratify the treaties in question. Overthrown in 1874, he regained the presidency for the fifth and last time in 1876. Another revolt forced his flight in March 1878 to Puerto Rico, where he died in 1884. *See* DOMINICAN REPUBLIC: *History*. (K. M. S.)

BAFFIN, WILLIAM (1584?–1622), English navigator and discoverer who searched for the northwest passage and gave his name to Baffin Island and Baffin bay, was probably born in London about 1584. He made numerous scientific and magnetic observations, one of which (the determination of longitude at sea by lunar observation) is said to have been the first of its kind on record, and he also made important surveys in the Red sea and the Persian gulf. The earliest mention of his name occurs in 1612 in connection with an expedition in search of a northwest passage under the orders of Capt. James Hall, whom he accompanied as chief pilot. During the two following years Baffin served in the Spitsbergen whale-fishery, at that time controlled by the Muscovy company. In 1615 he entered the service of the company and made another attempt to discover a northwest passage. He accompanied Capt. Robert Bylot as pilot of the little ship "Discovery," and they carefully examined Hudson strait. The accuracy of Baffin's tidal and astronomical observations on this voyage was confirmed in a remarkable manner by Sir Edward Parry when passing through the same area two centuries later (1821). In the following year Baffin again sailed as pilot of the "Discovery" and passing up Davis strait discovered the fine bay to the north that now bears his name, together with the magnificent series of straits which radiate from its head and were named by him Lancaster, Smith and Jones sounds, in honour of the patrons of his voyages. On this voyage he had sailed over 300 mi. farther north than his predecessor J. Davis, to about latitude 77° 45′. All hopes, however, seemed now ended of discovering a passage to India by this route, and in course of time even Baffin's discoveries came to be doubted until they were rediscovered by Captain Ross in 1818. In the service of the East India company, Baffin undertook a voyage to British India (1617–19), and on his return received the special recognition of the company for certain valuable surveys of the Red sea and Persian gulf which he had made in the course of the voyage. Early in 1620 he again sailed to the east, and in the Anglo-Persian attack on Qishm in the Persian gulf, preparatory to the reduction of Ormuz, he was killed on Jan. 23, 1622.

See *The Voyages of William Baffin 1612–1622*, ed. by Sir Clements Markham (1905).

BAFFIN ISLAND, an arctic island, lying between Greenland and the Canadian mainland, was named after the 17th-century English explorer William Baffin. Baffin Island (area 183,810 sq.mi.), a part of the district of Franklin, Northwest Territories, is separated from Quebec and Labrador by Hudson strait. It includes a northwestern plateau, east coast mountains (to 7,000 ft.), a southeastern plateau and a western lowland. The mountain region contains many glaciers. Amadjuak and Nettilling are the largest lakes. The population (3,387 in 1961) is largely coastal. There is an international airport beside Frobisher bay at the southern end of the island. Other settlements include Pangnirtung on Cumberland sound and Arctic bay on Admiralty inlet. Coal is mined and there is iron ore on the island.

Baffin Bay.—Separating Baffin Island from Greenland, Baffin bay merges in the south with Davis strait and in the north with Smith sound. Its maximum depth exceeds 1,500 fathoms. A mild ocean current flows up its east side and a cold one down its west side. Floating ice persists all summer in the west.

See also NORTHWEST TERRITORIES. (H. R. TN.)

BAG, one of the oldest forms of packaging (*q.v.*), being a direct outgrowth of handwrapping, the earliest method. The formation of a bag, or sack, from a flexible piece of packaging material was a logical development following the introduction of glue and sewing skills.

Originally, all bags were fabricated by hand from heavy fabrics, such as closely woven flax, jute and hemp. As paper came into general use, it became the most widely used bagmaking material and was fabricated into bags by craftsmen using such basic tools as a knife, a pot of glue and a brush.

Basic Manufacturing Process.—By the early 1960s practically all bags were made by machine. A bag is essentially a tube or rectangular cylinder with a bottom, and the basic equipment required for bag manufacture consists of a machine described as a tuber or "former" and a bottomer.

This machinery works from a continuous web coming from a roll of bagmaking material placed in front of the machine and threaded through rolls to a metal plate called the "former," which is as wide as the bag is to be and forms the material into the shape of a tube. The tube is cut off to the desired length, and the seam of the bag is fabricated on the machine. The next step, bottoming, is done on the bottoming cylinder. After pressure is applied to secure the seam and bottom, the bag is ready for use.

There are many variations of this process, depending upon the materials involved, the size of the bag, the type of seam and bottom (pasted, sewn, taped or heat-sealed) and the use made of the bag. However, the idea of a tube with a bottom is basic to all bag manufacturing.

Materials and Uses.—*Paper.*—Paper is the most widely used bagmaking material. Most paper bags are fabricated from kraft (brown) paper in natural or bleached form and range in variety from the standard grocery bag used for packaging consumer purchases to the large multiwall shipping sack consisting of three to six walls of paper (actually a combination of three to six bags in one). Multiwall bags have a capacity of from 25 to 100 lb. and are used for packaging grain, cement, fertilizers, chemicals, etc. Kraft paper is also fabricated into larger bags and covers for packaging such products as mattresses, furniture and automobiles.

Other types of paper, such as glassine, vegetable parchment and the waxed grades, are also used in bag manufacture for certain food and specialty packaging uses.

Cellophane.—Cellophane is commonly used for manufacturing transparent bags. It is durable, moisture resistant, and impervious to air, grease, odour and dirt. Because of its transparency, cellophane is used for packaging food products, dry goods and other products with eye appeal.

Plastic Film.—This material, including polyethylene, Pliofilm, polypropylene, Mylar and vinyl, has gained wide popularity for bags and sacks. The chemical and physical properties of these plastic films make them useful for a number of different types of bags. The fact that many of the films are chemically inert, light in weight, odourless, tasteless, moisture-proof, nontoxic and flexible at subzero temperatures adapt them for use in packaging produce, poultry, sea food, textiles, hard goods, granular products, frozen foods, etc.

Aluminum Foil.—The use of aluminum foil in bag manufacturing has greatly expanded because of the protection it provides against the spoilage effects of moisture and rancidity. Foods and many nonfood products such as powdered chemicals frequently are packaged in foil bags.

Textiles.—Textile bags are generally fabricated from burlap or cotton fabric. They are commonly made with a conventional sewn seam, although in some cases cemented seams are used. The types of product commonly packaged in textile bags are chemicals, certain types of produce, fertilizers and minerals. (W. V. D.)

BAGA, a Negro people numbering about 45,000 (1960s) who inhabit the swampy coastal region between Cape Verga and Conakry in the Republic of (former French) Guinea. They are said to speak a semi-Bantu tongue related to the Temne and Kissi languages. The women cultivate rice; the men fish and tend palm and kola trees. Political, social and religious authority reside in the Simo society with several grades. Marriage is said to be obligatory between (1) the husband's brothers and his wife's sisters and (2) the younger brother or nephew and the widow. Inherit-

ance passes in the maternal line. The dead are exposed, before burial in a sacred grove, and their houses, with some possessions, are burned. Most villages are Islamized. It is not unlikely that some villages of the *Baga foré* group on the Rio Nuñez and the Rio Pongo have remained animist, but it is doubtful whether the enormous *nimba* masks, formerly used in fertility rites during rice harvest time, are still in use. *See* also Los Islands.

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BAGASSE, the residue from the milling of sugar cane, consisting of the fibrous structure of the cane, some unextracted juice, and 40% to 50% water; also called "megass" (a word of unknown origin) in Australia and other areas of the British commonwealth. Formerly, the residue of beet-sugar manufacture was called bagasse, but the term "beet pulp" has replaced this usage.

The word bagasse (Spanish *bagazo*) comes from the French *bagage* and originally meant rubbish, refuse or trash. Applied first to the husks of olives, palm nuts and grapes after pressing, the meaning was extended to include the residues from other processed plant materials, such as sisal and the sugar cane and sugar beet. In modern usage, however, the word is almost invariably limited to mean the end-product of sugar-cane milling.

See Sugar: *Cane Sugar Manufacture: Bagasse.* (G. P. Me.)

BAGATELLE, a game probably of English origin, is very likely a modification of billiards, and is played on an oblong board or table varying in size from 6 ft. by 1½ ft. to 10 ft. by 3 ft. Ordinary billiard cues and nine balls, one black, four red and four white, are used. The black ball is placed upon a spot about 9 in. in front of hole 1, and about 18 in. from the player's end of the board. A line (the balk) is drawn across the board, from behind which the players shoot.

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BAGATELLE BOARD

The game is played with billiard cues and nine balls

Bagatelle Proper.—The black ball having been placed on the upper spot, the players "string" for the lead, the winner being that player who plays his ball into the highest hole. Any number may play. Each player in turn plays all eight balls up the table, no score being allowed until a ball has touched the black ball, the object being to play as many balls as possible into the holes, the black ball counting double. The game is decided by the aggregate score made in an agreed number of rounds.

Sans Egal.—This is a French form of the game. Two players take part, one using the red and one the white balls. After "stringing" for lead, the leader plays at the black, forfeiting a ball if he misses. His opponent then plays at the black if it has not been touched, otherwise any way he likes, and each then plays alternately, the object being to hole the black and his own balls. If a player holes one of his opponent's balls it is scored for his opponent.

The Cannon Game.—As in billiards, three balls are required. The object of the game is to make cannons (caroms), balls played into holes at the same time counting the number of the holes, but if a ball falls into a hole during a play in which no cannon is made the score counts for the adversary. A cannon counts two; missing the white object ball scores 1 to the adversary; missing the black, 5 to the adversary.

Mississippi.—This variation is played with a bridge pierced with nine or more arches; according to the size of the table, the arches being numbered from one upward. All nine balls are usually played, though the black is sometimes omitted, each player having a round, the object being to send the balls through the arches. This may not be done directly, but the balls must strike a cushion first. A ball, lying in front of the bridge, may be sent through by the cue ball if the latter has struck a cushion. If a ball falls into a cup the striker scores the value of the cup as well as of the arch.

Bell-Bagatelle.—Although the popularity of bagatelle has waned the principle of this version, played on an inclined board equipped with cups, stalls and arches hung with bells, has survived in many children's games using small inclined boards and marbles or small steel or plastic balls instead of billiard balls and a spring bolt, or plunger, instead of cue sticks. An elaboration is the coin-operated pinball machine, outlawed in many places as a gambling device. (F. Hn.)

BAGÉ (Bajé), a town in southern Rio Grande do Sul state, Brazil. It is 110 mi. by rail N.W. of Pelotas. Pop. (1960) 47,930. It is situated at an elevation of 774 ft. in the midst of gently rolling hills covered with tall prairie grass. The surrounding country is used chiefly for cattle and sheep ranching, and in Bagé there are meat-packing plants where the chief product is *xarque* or jerked beef. It is also a wool depot. Nearby there is an important government experimental farm where specialists on animal husbandry are developing better feeding techniques. Experiments in growing wheat in this area have been only moderately successful. The town can be reached by rail, highway or air. Located approximately 25 mi. from the Uruguayan border, it has long been a place of military importance. In 1827 it was captured by the Argentineans then invading southern Brazil. (P. E. J.)

BAGEHOT, WALTER (1826–1877), English economist, political analyst, sociologist and editor whom Lord Bryce described as "the most original mind of his generation." He was born at Langport, Somersetshire, where his family were general merchants, on Feb. 23, 1826. His mother was the sister of Vincent Stuckey, the head of the largest private bank in the west country. He was educated at Bristol college, then a brilliant centre of nonconformist teaching, and at University college, London, where he graduated with the university's gold medal in philosophy. A close friendship which he formed, while reading for the bar, with Arthur Hugh Clough, made him abandon the career and join his father in Stuckey's bank.

From 1852 to 1858 he lived the life of a country banker, but his association with the *Prospective Review,* edited by his closest friend, Richard Holt Hutton (later editor of *The Spectator*), gave him the opportunity to write during this period some of the finest of his literary essays. In 1858 he married the eldest daughter of Sir James Wilson, financial secretary to the treasury in Lord Palmerston's government, and the owner and founder of *The Economist.* When Sir James died in 1860, Bagehot assumed full control of the paper, making it the most influential economic weekly in Europe. Though he twice failed of election to parliament as a Liberal, his friendship with Gladstone, Cornewall Lewis, Carnarvon, Granville, Goschen and other Liberal and Conservative leaders gave him a position of discreet but considerable influence in London. He was closely consulted on economic questions by Gladstone and in the year of his death devised a new security, the treasury bill, to enable the British government to finance its short-term obligations.

Bagehot was a high-spirited man of great charm and humanity but with frail health and nerves which forced upon him the role of observer rather than combatant in the great controversies of his day, to which are owed the four books on which his reputation has come to rest. Of these, *The English Constitution* (1867) was the first effective attempt to distinguish between the real and formal centres of power in the British constitutional system. *Physics and Politics* (1872), the most original of his works, was an attempt to apply the concept of evolution to the origins and development of societies: it broke ground, particularly in the concept of unconscious imitation as a molding force. *Lombard Street* (1873), intended to explain the necessity for keeping a greater reserve in the hands of the Bank of England, really first formulated the modern theory of central banking. *Economic Studies* (1880) was a fragment of a larger book in which Bagehot had intended to explore the economic structure of the world of the 1870s as Adam Smith had done for his world a century earlier.

Bagehot's enduring gifts to English literature were a fresh and natural style which influenced letters and journalism both in Britain and the United States, and an approach to facts, economic, political or social, that was both imaginative and realistic. He died at Langport on March 24, 1877.

Mrs. Russell Barrington edited *The Works and Life of Walter Bagehot* in ten volumes (1915).

See Norman St. John-Stevas, *Walter Bagehot* (1959); William Irvine, *Walter Bagehot* (1939). (A. F. Bu.)

BAGGARA (properly *Baqqara,* or "cattle-men") are nomad Arabs who have been forced by circumstance to live in a part of Africa which will support the cow but not the camel—south of latitude 13° and north of latitude 10° from Lake Chad eastward to the Nile. Apart from the Seleim and their neighbours on the White Nile, who seem to have followed a more northerly route, the bulk of the present tribes are the descendants of Arabs who migrated west out of Egypt in the middle ages, turned south from Tunisia to Chad, and finally moved back eastward in the 18th and 19th centuries. They numbered about 5,000,000 in the 1960s.

As a result of association with local peoples such as the Fulani (*q.v.*) of Nigeria they have acquired a western appearance, a distinct dialect of Arabic and dark skins. Their characteristic weapon is a long broad-bladed spear and their wide-sleeved *jibba* in its patched form became the uniform of the Mahdi's army. The Khalifa Abdullah was himself a Ta'aishi Baggari and so were most of his emirs. The Baggara claim descent from Abdullah al-Guhani, but their tribal units are in fact the result of association. Gubarat and Salamat, tribes in their own right in the west, appear as subsections of eastern tribes, and Mahria, Nawaiba and Mahamid, camel-owners in Wadai, have Baggara sections among the Rizeigat.

They are a warlike, quarrelsome, fissiparous people, devoted to their cattle and horses, fond of fighting, hunting and dancing, and they cultivate crops, such as cotton, only as a means to the purchase of more cattle. Their women have much more freedom than those of the camel-owners. *See* also SUDAN, REPUBLIC OF THE: *History* and *The People;* BEDOUIN; DARFUR; KORDOFAN.

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BAGGESEN, JENS IMMANUEL (1764–1826), Danish writer, who reflects the tendencies of both classicism and romanticism, was born in Korsor, Den. (Feb. 15, 1764), of poor and religious parents. He was a gifted and extremely sensitive child. In 1782 he went to study in Copenhagen, where his personal charm and his early poems, especially the satirical *Komiske Fortaellinger* ("Comical Tales"; 1785), gained him entry to literary circles and to the homes of the liberal-minded nobility. After the failure of his opera *Holger Danske* he visited Germany, Switzerland and France (1789–90), giving an account of his travels in *Labyrinthen* (1792–93), an imaginative prose work reminiscent of Sterne, exceptional in the felicity of its language and thought. Baggesen was an impressionable, eager spirit in a period unusually rich in ideas. He was influenced by, and inveighed against, both 18th-century rationalism and the new romanticism. He became a disciple of Kant (whose name he adopted) and of Rousseau, was an ardent supporter of the French Revolution, but after 1800 was drawn to romanticism, as is evident in the self-critical poem *Gengangeren og han selv* ("The Ghost and Himself"; 1807). After 1813 however he embarked on a long controversy with the romantics.

Baggesen's life was as unsettled as his spirit; constantly on the move, he lived both in Denmark and abroad (especially in Paris, where he spent his last years), plagued by personal sorrows. He died in Hamburg, Oct. 3, 1826. Typically Danish in his wit and humour, he was a master of the rhymed epistle, though in *Thora fra Havsgaard* (1814–16) he turned to the epic form. Among his works in German, which he wrote with almost equal fluency, are *Parthenaïs, oder die Alpenreise* (1802), *Heideblumen* (1808) and two parodies of German romanticism, *Der Karfunkel- und Klingelalmanach* (1810) and *Der vollendete Faust* (see *Poetische Werke in deutscher Sprache,* i–v (1836).

See *Danske Vaerker,* 12 vol. (1827–32); *Poetiske Skrifter,* 5 vol. (1889–1903). *See* also A. Baggesen, *Jens Baggesens Biographi,* 4 vol. (1843–56); K. F. Plesner, *Baggesen-bibliografi* (1943). (S. M. K.)

BAGHDAD a *liwa* ("province"), one of the seven constituted from the Ottoman vilayet of Baghdad, Iraq. Pop. (1965) 2,124,-323. Area 7,692 sq.mi. It corresponds broadly to the cultivated zone on both sides of the Tigris river together with an irrigated area on the left bank of the Euphrates system, including associated irrigation and drainage channels, and is largely surrounded by a zone of uncultivated desert. The *liwa* has reasonable geographical unity, except that a stretch of desert between Mandali and Kut is included with Baghdad, thus separating the *liwas* of Diyala and Kut. In the west, irrigation comes from five major intakes from the Euphrates, which serve a region extending almost to the Tigris; east of the Tigris the canals come mainly from the Diyala system. Most of the inhabitants live by agriculture. In the *liwa* are the sites of the ancient cities of Ctesiphon, Seleucia, Sippar, Agade and Samarra (*qq.v.*). (W. B. Fr.)

BAGHDAD, the foremost city of Mesopotamia and the capital of modern Iraq and Baghdad *liwa* ("province"), is situated on the Tigris at the point where the river is nearest to the Euphrates (25 mi.). Pop. (1957) 355,958. The city was originally built on the west bank of the river, but for more than 1,000 years the greater part has been on the east bank. There is, however, a large and growing suburb on the west side, comprising the quarters of Al Karkh, Karradet Mariam and Al Mansur, and including the principal railway station and the airport as well as the parliament building. The main city is linked with these quarters by four road bridges, one of which also carries a railway. A fifth bridge leads to Kadhimain (Al Kazimiyah), north of Al Karkh, a considerable settlement which has grown up around the tombs of Musa al-Kadhim and Mohammed al-Jawad, the 7th and 9th of the 12 imams recognized as the true successors of the Prophet by the majority of Shi'ah Muslims. The tombs of the two imams, and the adjacent mosque, are among the most important centres of Shi'ah pilgrimage.

After World War II Iraq's oil revenues considerably increased, and the new wealth of the country is reflected in the capital, whose merchants are now concerned with the import and distribution, and to a lesser but growing extent the manufacture, of capital and consumer goods. Most of Iraqi industries are in Baghdad and include leather, silks, cotton stuffs, cement, tobacco products and arrack distilling (from dates and grapes). There are also railway workshops. Residential garden suburbs have grown up on both banks of the Tigris, and the crowded houses and shops of the old city, which were not for the most part of great antiquity or interest, are being replaced by wide streets and new office blocks, stores and hotels. The completion of the Tigris barrage at Samarra has

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MOSQUE AT KADHIMAIN (AL KAZIMIYAH), COMPLETED IN THE 19TH CENTURY

relieved Baghdad of the danger of disastrous floods, which caused severe damage on many occasions in its history.

The city is the cultural centre of Iraq and has a university (founded 1958, with a college of engineering at Bab al Mu'adhdham [Al A'zamiyah]), various research institutes, libraries and museums of antiquities.

In the course of the 19th century a number of schemes were put forward to improve the communications of Baghdad. A survey of the Euphrates and the lower Tigris by Col. F. R. Chesney in 1836 demonstrated the impracticability of steam navigation down the Euphrates, but was followed in 1860 by the establishment of a regular steamer service on the Tigris between Baghdad and Basra. Proposals for a Euphrates valley railway also proved impracticable, and Baghdad was not finally linked with Europe by rail until the completion, in 1940, of the line from Istanbul begun by the Germans before 1914 (*See* BAGHDAD RAILWAY). The 20th century saw the creation of new routes for trade and travel. A regular motor service between Baghdad and Damascus was instituted in 1923, and the Cairo-Baghdad airmail service, inaugurated in 1921, was followed by a passenger service in 1929. The airport is now an important staging point for many international airlines linking Europe with the far east and Australia.

History.—Many capital cities have stood in the vicinity of Baghdad, where the ancient trade routes of the Euphrates, Tigris and Diyala valleys converge: Agade, Babylon and Burj Aqarquf, the Kassite capital, lay to the west; Seleucia and Ctesiphon about 20 mi. to the south. In A.D. 750 the caliphate was established in Iraq with the foundation of the Abbasid dynasty by Abu 'l-Abbas, whose brother and successor Abu Ja'far known as Al-Mansur determined in 762 to build himself a new capital on the site of a Sassanian village, Baghdad. The Round City of Mansur, called Madinat al-Salaam, the City of Peace, stood on the west bank of the Tigris, but no traces of its buildings remain and its exact site is unknown. It was 3,000 yd. in diameter, with three concentric walls each pierced by four gates, through which passed highways radiating from the caliphal palace at the centre of the city to the four quarters of the empire. Bazaars were not permitted within the city, and a merchants' quarter, Al Karkh, developed outside the Basra gate. From the northeast gate the Khurasan road crossed the Tigris on a pontoon bridge, and beyond this on the east bank lay the palace of Al-Mansur's heir apparent, Al-Mahdi, around which grew up the three suburbs of Al Rusafah, Al Shammasiyah and Al Mukharrim, the earliest forerunners of the modern city. Baghdad reached the zenith of its prosperity under Harun al-Rashid (*q.v.*), son of Al-Mahdi, who accumulated in his capital the riches and learning of the known world. Many tales reflecting the glory of this period occur in the *Thousand And One Nights* (*q.v.*). Harun's death was followed by civil war between his two sons, during which the Round City was severely damaged. It was never fully restored; from 836 to 892 the caliphs abandoned Baghdad, where their unruly Turkish bodyguard had become unpopular, for a new capital at Samarra, and after their return they resided in Mukharrim on the east bank. In 1095 a new wall was built around east Baghdad, which survived with many restorations until the 19th century, when it was largely dismantled. One of the two surviving gates, the Talisman gate, was blown up by the retreating Turks in 1917; the second, Bab al Wastani or the Middle gate, still stands and was restored as an arms museum. A few other buildings survive from the Abbasid period, notably the so-called Abbasid palace and the Mustansiriyah, a large law college built and endowed by the caliph Mustansir in 1232; both have been restored as museums.

Despite the declining power of the later caliphs, Baghdad remained a great centre of trade and culture as long as the agricultural prosperity of Iraq continued. Its real downfall came when Hulagu the Mongol overran Mesopotamia and sacked Baghdad in 1258, killing the caliph Al-Musta'sim and, it is said, 800,000 of the inhabitants. The overthrow of the Abbasid government removed the authority which had secured the maintenance of the irrigation system and the protection of the cultivated land against nomadic tribesmen. With its political importance gone, its population decimated and the economic basis of its life destroyed, Baghdad never rose again above the status of a provincial city until the emergence of Iraq as an independent state after World War I. It remained subject to the Ilkhanid dynasty, successors of Hulagu, until 1340, when it achieved local independence under the Jalairids, who made some attempt to restore its fortunes; one notable group of buildings survives from this period, a mosque and college built in 1358 by Mirjan ibn Abdullah, governor of Baghdad, together with a fine vaulted khan which is now a museum of Islamic antiquities. In 1401 the city was sacked by the last of the Mongol invaders, Timur (Tamerlane), and in 1410 fell under the sway of the Black Sheep Turkomans, who gave way in 1469 to the White Sheep dynasty. They in turn were expelled by the Persians under Shah Ismail in 1508, and in 1534 Baghdad was taken for the first time by the Ottoman Turks under Suleiman the Magnificent. It was recaptured by the Persian Shah Abbas in 1623, but was recovered for Turkey by Murad IV in 1638; its frequent changes of allegiance were due in part to its geographical position between the two great empires, partly to the division of its inhabitants between the Shi'ah and the Sunni sects of Islam, the former favouring the Persian, the later the Turkish rule. During the 17th century a rapid succession of Turkish governors did little to restore the fortunes of Baghdad, depopulated and reduced to penury by two ruthless conquerors. The beginning of the 18th century, however, saw the appointment of two successive governors, father and son, Ahmed and Hassan Pasha, who reformed the administration by introducing the slave hierarchy of Circassian civil and military officials known as the Mamelukes, and raised the prestige of their capital until it controlled Mesopotamia from Basra to Mardin, owing only a formal allegiance to Istanbul. They were succeeded by a line of Mameluke governors until the abolition of the Mameluke system by Sultan Mahmud II in 1831. During the Mameluke period foreign, and notably British, influence became more marked in Baghdad. A British residency was established in the city in 1798, and in 1802 the resident was granted consular rank; under C. J. Rich (1808–21) and H. C. Rawlinson (1843–55) the prestige of the resident was second only to that of the governor. Baghdad was captured by British forces in 1917, and became the capital of the independent kingdom of Iraq in 1921. The city was the scene of an abortive revolt, inspired by anti-British feeling, in 1942, and of a successful *coup d'état* in 1958, when the monarchy was overthrown and Iraq became a republic. *See* IRAQ: *History; see* also Index references under "Baghdad" in the Index volume.

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(E. E. D. M. O.)

BAGHDAD PACT, a mutual security agreement among Turkey, Iraq, Iran, Pakistan and Great Britain, signed in 1955. The idea of organizing a middle eastern security system was not new. Prompted by Mussolini's threat in 1935, Turkey had formed the Sa'dabad pact (July 4, 1937), which included Turkey, Iraq, Iran and Afghanistan, but this soon became a dead letter. After World War II Britain hoped to rely on the Arab league (*q.v.*) and on bilateral treaties for the defense of the middle east. The Arab league, however, failed to create solidarity among the Arabs, and Great Britain reformulated its bilateral arrangements with the Arab states. Treaty relations with Jordan temporarily helped Britain to maintain an important strategic position; but its treaties with Egypt (1947) and Iraq (1948) proved abortive because of the rising tide of Arab nationalism and communist and anti-colonial propaganda.

The United States took increasing interest in the security of the middle east, as demonstrated by its participation with Britain and France in the tripartite declaration of May 25, 1950, regarding the sale of arms to Israel and the Arab states. The U.S. urged Britain to come to an understanding with Egypt, and this resulted in the Anglo-Egyptian agreement of 1954, by virtue of which Britain evacuated the Suez canal base. Egypt, however, failed to take part in organizing a regional security system, fearing that such an arrangement might be construed as the renewal of an alliance with Britain. Thus the middle east remained a weak spot in the fence with which the western powers hoped to surround the

U.S.S.R. Since Turkey and Greece had joined the North Atlantic Treaty organization (NATO), it was advocated that an arm of NATO be extended to the middle east from those states.

The initiative for approaching the Arab states to erect a security structure came from Turkey. Turkish attempts to enlist the co-operation of Egypt failed, but negotiations with Iraq, with which Turkey had entered into an agreement in 1946, were successful. The Turko-Iraqi (later called the Baghdad) pact was signed on Feb. 24, 1955. It was the first link in the "northern tier," later joined by Great Britain on April 5, Pakistan on Sept. 23 and Iran on Oct. 12.

The pact provided for mutual co-operation among its signatories in accordance with art. 51 of the United Nations charter. The member states pledged not to interfere in the internal affairs of one another, but agreed to co-ordinate their efforts in matters of defense and security. For this purpose a permanent council was provided, with a secretariat and a number of committees. The United States did not join the system but participated in various committees.

It was hoped that the other Arab countries would soon adhere to the pact, but Egypt immediately attacked it on the ground that it violated the Arab league security pact. Iraq replied that treaties with its neighbours did not contravene that pact and that Iraq had common interests with Turkey and Iran against communist infiltration no less than common interests with the other Arab countries against Israel. Iraq hoped that its central position between the northern tier countries and the southern Arab countries might permit it to initiate a more comprehensive regional security system co-ordinating the Baghdad pact with the Arab league security pact. The formation of rival federations in 1958—Egypt with Syria and Iraq with Jordan—seemed to frustrate this hope. After the overthrow of the Hashemite monarchy of Iraq later in the year by forces friendly to the United Arab Republic, Iraq ceased to participate in the pact and formally withdrew on March 24, 1959. The headquarters was meanwhile transferred from Baghdad to Ankara, Turk., and the name was changed to Central Treaty organization (CENTO). The United States in 1959 entered into bilateral defense agreements with Turkey, Iran and Pakistan. (M. Kı.)

BAGHDAD RAILWAY, the name given to the enterprise to connect Istanbul, the capital of the Ottoman Turkish empire, with the plains of Mesopotamia and the Persian gulf by railway. Of great importance for the economic development of the empire, it also aroused international rivalries in the years of tension preceding World War I as it threatened the monopoly previously held by the sea route between Europe, the middle east and India.

German activity on the enterprise began in 1888, when the Deutsche bank was granted a concession by the sultan Abdul-Hamid II to extend the existing line between Haidar Pasha and Ismid to Ankara, under the name of the Anatolian railway. The line to Ankara and another section of Eskisehir and Konya were completed in 1895–96. Great Britain, having recently acquired control over the Suez canal, was not interested.

The gradual extension of German influence in Turkey came about because the other powers were not concerned in the Baghdad railway. Russia notoriously wanted to break up the Ottoman empire; Great Britain thought mainly of protecting the Indian empire and the Persian gulf; and France was preoccupied with Syria. Germany thus appeared to the sultan to be the only country that would help him to develop the whole country and consolidate its economy, and in 1902 he granted to the Deutsche bank the concession to extend the existing Anatolian railway to Baghdad. Nevertheless, even in 1903 an agreement was reached for private British capital to participate in the enterprise, but the hostility of the British press and the British government's disapproval led to the abandonment of the proposal.

The railway thus became a joint Turko-German enterprise and the line was completed to Bulgurlu in 1904. The method of financing the construction was partly by a kilometric guarantee, and the Ottoman government's contribution was to have been secured by increases in the customs, for which the consent of the Ottoman Debt administration had to be obtained. As there was difficulty in obtaining this from France and Great Britain, the railway was partly financed by the issue of special bonds—the sale of which, however, was not allowed on the Paris Bourse. These difficulties and the cost of tunneling through the Taurus mountains made progress slow. By 1908, however, Turkish finances had sufficiently improved to pay the interest and sinking fund on the bonds. Moreover, the railways now running in Anatolia helped to increase internal trade and revenue. By 1912 the eastern section of the line was completed as far as the Euphrates.

As Germany grew more powerful, British opposition to the Baghdad railway increased. The revolution of the Young Turks (1908) made little difference to the attitude of the powers on the railway. Great Britain and France distrusted the Young Turks, while Germany supported them. Even so, the ground for an understanding between Great Britain, Germany and Turkey was prepared when the Deutsche bank, on behalf of the Baghdad Railway company, announced that it would not seek to extend the line beyond Baghdad to the gulf without Great Britain's approval. Subsequent negotiations led to a Franco-Turkish agreement in Feb. 1914 granting France railway concessions in northern Anatolia and to an Anglo-German agreement in June 1914 whereby the Baghdad railway between Basra and the gulf would not be built without the approval of the British, who were also to receive exclusive shipping rights on the Tigris and Euphrates. Thus a settlement between Great Britain, France, Germany and Turkey over the Baghdad railway was reached on the eve of World War I.

At the outbreak of war, the tunnels through the Taurus mountains were still not completed. By 1918, however, trains could run from the Bosporus to Nusaybin, only 300 mi. from Baghdad. The Turkish revolution after the war led to Turkey's taking over the old German concessions and to the creation in Anatolia of a Turkish National Railway system. The Arab succession states then took over the Syrian and Iraqi parts of the railway and in due course completed them. The railway thus runs from the Bosporus to the Persian gulf, its sections being operated by the states whose territory they cross. (M. P. P.)

BAGHLAN, a town in Kataghan province, Afghanistan, 35 mi. S. of Khanabad and about 3 mi. E. of the Kunduz river, lies about 1,700 ft. above sea level. Pop. (1960 est.) 20,000. It is a new industrial town and the centre of beet-sugar production in Afghanistan, being in the leading sugar-beet district of Afghan Turkistan. Cotton production and cotton manufacturing are also important in the region. (J. P. C. N. H.)

BAGLIONI, an Italian noble family dominant in Perugia between 1488 and 1534. Their ascendancy began with Malatesta Baglioni who helped to restore Perugia to the church after the death of Braccio (*q.v.*) in 1424 and was rewarded by the pope with the grant of Spello, to which other small communities (*e.g.*, Bettona and Bevagna) were subsequently added. This territorial power and wealth, increased by their pay as *condottieri*, enabled the Baglioni to prevail over their oldest rivals in Perugia, the Oddi, whom they expelled in 1488.

The Baglioni were typical members of their class, warlike and turbulent. They still took hire as *condottieri*, and a later Malatesta Baglioni betrayed his command as captain of the Florentines in 1530 by surrendering Florence to a besieging army in which others of the family were serving. The Baglioni were never formally created lords of Perugia, partly perhaps from deference to papal overlordship, which they publicly acknowledged before Julius II in 1506. They preferred to govern through a junta, the Dieci dell' Arbitrio, chosen from themselves and their clients. Under this regime, the chroniclers imply, the city suffered for many years from unchecked atrocity and crime. The family itself was rent by feuds and weakened by successive acts of domestic violence, the first of which, the "great betrayal" of 1500, was one of the bloodiest massacres in the dynastic annals of Italy. Even so the Perugians learned to regret the end of the reign of the Baglioni after Paul III banished them in 1534 and established direct papal rule.

The Baglioni continued to furnish captains of war until in the 17th century the several branches of the family declined or dis-

appeared.

See W. Heywood, *A History of Perugia* (1910). (P. J. J.)

BAGNACAVALLO (BARTOLOMMEO RAMENGHI) (1484–1542), Italian painter, whose work, considered to be inferior in point of design to some other productions of the school of Raphael, is distinguished by rich colouring and graceful drawing. He received the cognomen Bagnacavallo from the little village where he was born. He studied under Francia, and then in Rome as a pupil of Raphael, for whom he worked, with others, at the decoration of the gallery in the Vatican. His best works are the "Dispute of St. Augustine" and a "Madonna and Child" at Bologna.

BAGOAS, the Greek form of an Old Persian name often used for eunuchs. The best known of these became the confidential minister of Artaxerxes III. He was commander in chief of the Persian forces in the conquest of Egypt (343 B.C.) and gained wealth by selling back to the priests at an exorbitant price the sacred writings looted from the Egyptian temples. He worked in close partnership with Mentor of Rhodes and rose to such power that he became the real master of Persia, Artaxerxes doing nothing without his advice. In 338 or 337 B.C. he murdered Artaxerxes and all his sons save Arses, whom he placed on the throne. Two years later he murdered Arses and made a collateral, Darius III, king. When Darius asserted his independence, Bagoas attempted to poison him also, but the king had been warned and forced him to drink the poison himself. (*See* ARTAXERXES; DARIUS.)

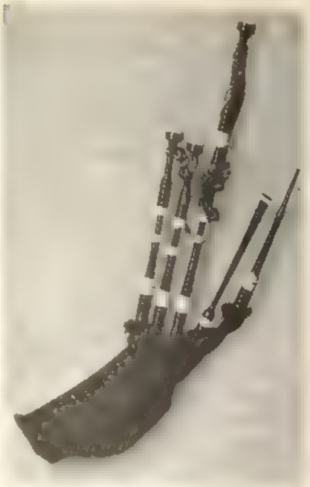
The eunuch Bagoas, the supposed favourite of Alexander the Great, appears to be an invention of the Peripatetic philosopher Dicaearchus.

See, for the second Bagoas, W. W. Tarn, *Alexander the Great,* vol. ii, pp. 320–322 (1948). (J. M. M.-R.)

BAGOBO, a pagan tribe living on the lower slopes of Mt. Apo and the adjacent coast of southern Mindanao in the Philippines, numbering about 18,000 (1960s). At the head of the tribe is a warrior known as *datu.* Below him are petty *datus*—the rulers and judges of districts. Their power is great but they must operate within the customary law handed down by the ancestors. Next to the rulers are the magani, red-suited warriors who obtain valour by eating the hearts and livers of slain foes and who rank according to the number of lives to their credit. Workers in various crafts—weaving, metal casting, iron working—make up the next level of the hierarchy, all members of which are under the protection of guardian spirits. Below these are commoners and slaves. The Bagobo believes in a vast number of spirits, ranging from a creator, to guardian spirits, to shades of the dead, to beings who inhabit most natural objects. Each human being has multiple souls inhabiting various parts of the body. These may be induced to wander; hence soul snatching and soul catching become important in daily life. Many ceremonies are celebrated. Until prohibited by United States authorities, the most important of these was the yearly human sacrifice held to furnish companions for the souls of the dead. Daily activities are carried out with attention focused on the spirit world. Thus the manufacture of metal objects, the building of a house, the preparation of fields, planting and harvest, all require ceremonies and offerings. An unorganized priesthood directs these activities. Its members possess some knowledge of the treatment of sickness, and at times they act as mediums. Both sexes wear many ornaments in addition to hemp garments covered with intricate designs produced by the tie-and-dye method. Dry-land rice and Manila hemp are grown in sufficient quantity to allow some trade with the coast.

See F.-C. Cole, *Wild Tribes of Davao District* (1913), *Peoples of Malaysia* (1945); L. Benedict, *A Study of Bagobo Ceremonial, Magic and Myth* (1916); A. Manuel, "A Survey of Philippine Folk Epics," *Asian Folklore Studies,* vol. 22 (1963). (F.-C. CE.)

BAGPIPE, a wind instrument consisting of two or more pipes sounded by reeds to which wind is fed by arm pressure on a skin bag. The pipes are held in wooden sockets or stocks tied into the bag, which is inflated either by the mouth through a blowpipe provided with a leather nonreturn valve, or by bellows strapped to the body and worked by the arm not applying the pressure. The melodies are played upon the fingerholes of the melody pipe or chanter, while one or more other pipes or drones sound single notes carefully tuned against the chanter before performing by means of extendable joints. To articulate the melody and to reiterate notes, a piper employs the technique of gracing; *i.e.,* rapidly interpolating notes outside the melody to give an effect of detached notes in the latter.



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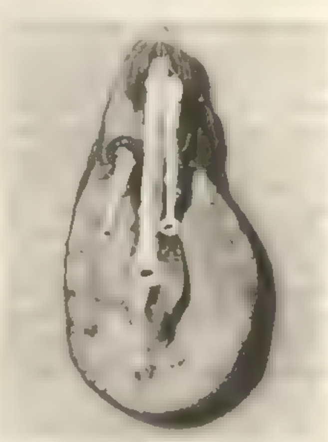
SCOTTISH HIGHLAND BAGPIPE, 19TH CENTURY

Bagpipes of numerous types, primitive and advanced, existed in Europe in the 13th century, and the instrument is alluded to in the 9th. Earlier evidence is less than is often claimed, and amounts to scarcely more than four Greek and Latin references of *c.* A.D. 100 (*e.g.,* Suetonius's mention of Nero as *utricularius*) and, without certainty, an Alexandrian terra cotta of *c.* 100 B.C. (at Berlin). Today the instrument's indigenous range extends across Europe to India. Primitive bagpipes typically employ for the bag a whole sheep- or goatskin less the hindquarters, and for the chanter two small cane pipes placed parallel, the one often sounding a drone or other accompaniment to the other. Most have cowhorn bells, being bag versions of hornpipes; they are found in north Africa, Arabia, the Aegean, the Caucasus and among the Marii in the Soviet Union. Other double chanters are made in east Europe (Serbia, Hungary, Ukraine, etc.) in a single piece of wood, keeping the cylindrical bore natural to cane pipes and the primitive single reeds of cane or elder. One of the two bores is a drone with a fingerhole for changing the note to the fourth below. There is also a separate bass drone tuned, like most bass drones, two octaves below the chanter keynote. The Bulgarian *gaida* and Czecho-Polish *dudy* (*koza*) have a single chanter, and in the *dudy* this carries a huge cowhorn bell, as does the drone.

The typical west European bagpipe has a conically bored chanter sounded by a double reed. Drones are cylindrical with single reeds, as in those described above. The Scottish highland bagpipe, now played widely over the world, has two tenor drones and a bass drone an octave below, and, as with many bagpipes and other folk instruments, its scale preserves traditional intervals foreign to learned musical systems. Once, like other European bagpipes, a pastoral and festive instrument, its military use with drums dates from the 18th century. The elaborate gracing technique is codified in tutors for the instrument. The Scottish lowland bagpipe, played *c.* 1750–1850, was bellows-blown, and had a softer sound, with the three drones in one stock. Akin to this were the bagpipes played up to the 18th century in Germany, the Netherlands and England, with two small parallel drones variously tuned to a fifth or an octave. These were also known in Ireland, but the modern two-droned Irish war-pipe is a modified highland bagpipe introduced *c.* 1905, followed by Henry Starck's "Brian Boru" model with three drones and keys on the chanter to extend its compass. The bagpipe of northwest Spain, *gaita gallega,* resembling the highland, usually has the bass drone only. The Breton *biniou* is a half-sized version played in duet with the pipe *bombarde* (*q.v.*) and is being supplanted by a copy of the highland bagpipe.



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FRENCH CORNEMUSE BAGPIPE, 18TH CENTURY

The cornemuse of central France is distinguished by a tenor drone held in the chanter stock beside the chanter; it is often bellows-blown and without bass drone. The Italian *zampogna* is unique, with two chanters, one for each hand, arranged for playing in harmony, often to accompany a species of *bombarde*; the chanters and two drones are held in one stock and all have double reeds.

The bellows-blown musette, fashionable in French society under Louis XIV, had a cylindrical chanter, beside which Jacques Hotteterre, *c.* 1750, placed a short stopped chanter with six keys giving notes above the main chanter compass. It employed a "shuttle" drone: a short cylinder bored with about 12 narrow channels variously connected in series to supply four drones, each sounded with a double reed and tuned or silenced by slider-keys moving in the slots through which the bores vented to the exterior. Partly offshoots of the musette are the British small-pipes (*c.* 1700) of which the bellows-blown Northumbrian small-pipe is played today. Its cylindrical chanter, with seven keys, is stopped at the bottom so that when all holes are closed it is silent, thus providing the means for true articulation and staccato. The four single-reed drones are in one stock and used three at a time. A complex species of similar date is the bellows-blown Irish union-pipe, with a chanter that is stopped on the knee both for staccato and to jump the reed to the higher octave, giving this bagpipe a melodic compass of two octaves. The three drones are held in one stock with three accompanying pipes or regulators. These resemble the chanter in bore and reeds, but are stopped below and have four or five keys struck with the edge of the player's right hand and arranged thereby to sound simple chords in support of the melody.

See A. Baines, *Bagpipes*, Pitt-Rivers Museum, Occasional Papers in Technology (1960); W. A. Cocks, "Bagpipe," *Grove's Dictionary of Music and Musicians*, 5th ed. (1954). (A. C. Ba.)

BAGRATION, PETR IVANOVICH, Prince (1765–1812), Russian officer, one of the famous generals of the Napoleonic wars. Descended from the noble Georgian family of the Bagratids, he was born at Kizlyar in the Chechen area north of the Caucasus. He entered the Russian army in 1782 and served for some years in the Caucasus. He was engaged in the siege of Ochakov (1788) and in the Polish campaign of 1794, being present at the taking of Warsaw and at the subsequent massacre. His merits were recognized by A. V. Suvorov, whom he accompanied in the Italian and Swiss campaign of 1799, winning distinction by the capture of Brescia. In the campaigns of 1805–07 he increased his reputation. With a small force of 6,000 men he successfully resisted the repeated attacks of Joachim Murat's 30,000 at Hollabrunn, and, though half his men fell, the retreat of the main army under M. I. Kutuzov was thereby secured. At Austerlitz he was engaged against the left wing of the French army, and at Eylau, Heilsberg and Friedland he fought with courage. In 1808, by a daring march across the frozen Gulf of Finland, he captured the Aaland Islands. In 1809 he commanded against the Turks in Bulgaria. In 1812 he commanded the 2nd army of the west, and, though defeated at Mogilev (July), rejoined the main army under Barclay de Tolly and led the left wing at Borodino (Sept. 7). There he received the wounds of which he died, at Simy, in the province of Vladimir, on the following Sept. 24 (new style; Sept. 12, old style). A monument was erected in his honour by the emperor Nicholas I on the battlefield of Borodino.

BAGUIO, CITY OF, capital of the subprovince of Benguet on the island of Luzon, Philippines. Pop. (1960) 27,251. The site was probably visited by Spaniards about 1829, and a small military contingent was stationed near there (La Trinidad); but the locality was little known until U.S. occupation of the islands began after the Spanish-American War (1898). Governor Taft and the early U.S. officials intended Baguio to be a summer capital, but the idea was never carried out by the Filipinos. Meanwhile it became a popular summer resort because of its location in the mountains at an elevation of 4,500 ft., with pine forests and other scenic features. Many hotels, cottages and homes have been built there to accommodate people from the lowlands during the hot season. Both the Philippine government and the U.S. embassy maintain accommodations there. The local administration is in the hands of a mayor and council. The city is about 160 mi. N. of Manila. To reach it a railway runs to a point beyond Dagupan. There are two automobile routes—the Baguio zigzag road and the Naguilian road. During the rainy season, from May or June until November, there is a heavy rainfall (annual mean, 181 in.), but the weather during the rest of the year is ideal. The native population consists largely of Igorots (*q.v.*); Episcopal missions in Baguio and elsewhere in Mountain province have done much to improve the condition of these non-Christian people. Baguio is an important gold-mining centre. It was occupied by the Japanese in Dec. 1941 and retaken by Allied forces in May 1945. John Hay base, a U.S. armed forces rest camp for the far east, is adjacent to Baguio. (An. C.)

BAGUIRMI, a former sultanate of north central Africa roughly conterminous with the modern prefecture of Chari-Baguirmi in the Republic of Chad (*q.v.*), lying southeast of Lake Chad, with an area of 33,591 sq.mi. The prefectural capital is Massénya.

The population ([1958 est.] 275,452) of Baguirmi is extremely mixed. In the southern and central sections of the country, particularly along the Shari river, live Negro tribes known as the Boua-Kara, Seroua, Babalia and Kotoko. However, the chief element of the population, the Baguirmese, consists of a mixture of Negroes, apparently of the Kenga tribe, and Arabs. Remnants of the Bulala, once the masters of the country, live south of Lake Fitri. The Baguirmese, who are divided into many small tribal groups (the Fulani, Arabs and Hausa), are Muslims, while the Negro tribes of the south, adhering to their traditional religious beliefs, are referred to as pagans. Many of the Baguirmese are skilled craftsmen who offer their textiles and metal work for sale in their local markets, which are held regularly in all towns and large villages. During the 19th century, when wars were frequent, the Baguirmese built large cities protected by walls.

The early history of the country is unknown. In the 15th century it was inhabited mainly by agricultural Negroes. During the 16th century it was invaded by tribes coming from the east (perhaps the Bulala or Kenga) who established themselves as its rulers. The Baguirmi dynasty appears to have been established in 1522; the rulers as well as many of their followers accepted Islam during the reign of the fourth sultan, Abdullah (about 1600). Europeans first learned about the existence of Baguirmi and the other powerful states of central Africa (Wadai, Bornu-Kanem) when Dixon Denham penetrated the Lake Chad region in 1823. Details became known particularly from Heinrich Barth, who was imprisoned by the Baguirmese in 1855, and from Gustav Nachtigal in 1872. During the 19th century Baguirmi was constantly at war with its neighbours, particularly Bornu and Wadai, and the various sultanates were temporary victors. Thus, in 1871 large sections of Baguirmi were tributary to the sultan of Wadai. All these states were rather wealthy as a result of the slave trade which they controlled. When in 1895 the French began to expand toward Lake Chad, most of these territories were subdued by Rabah Zubayr (*q.v.*). Sultan Gaourang of Baguirmi, whose power had been destroyed by Rabah, was willing to accept French protection and signed a treaty with Émile Gentil in 1897. The sultan agreed to supply French troops with food, and the autonomy of his people was recognized. After Rabah's defeat in April 1900, a new agreement was made in 1903. The sultan ceded his claim to the left bank of the Shari and renounced the right to levy slaves from his vassal people. In return he received 100 horses, 100 head of cattle and 1,000 thalers (silver coins). A final treaty was made in 1912, when part of the sultan's administration was placed more strongly under French control. During the administration of Governor Merllit, appointed in 1915, many of the sultan's former functions, such as jurisdiction over criminal cases and the collection of taxes, were taken over by the French. When Gaourang died in 1918 he was succeeded by Abd el-Kader, who in turn was followed by Youssouf in 1935.

Bibliography.—G. Nachtigal, *Sahara und Sudan* (1879–89); E. Gentil, *La Chute de l'Empire de Rabah* (1902); P. O. Lapie, *Mes Tournées au Tchad* (1943); D. Westermann, *Geschichte Afrikas*, pp.

163–168 (1952). (H. A. Wf.; J. D. F.)

BAHA AL-DIN (Beha ud-din or Bohaddin; Arabic Abu al-Mahasin Yusuf ibn Rafi' ibn Shaddad Baha' -al-Din) (1145–1234), Arab writer and statesman, author of the *Sirat Salah-al-Din* ("Life of Saladin"), was born at Mosul in 1145. He was first a teacher at Baghdad and then professor at Mosul. In 1187, after making the pilgrimage to Mecca, he entered the service of Saladin, who was waging war against the Christians in Palestine. Baha al-Din sought his favour by urging him to the vigorous prosecution of this war and presented him with his treatise on the laws and discipline of sacred war. He remained constantly attached to the person of the sultan, and was employed on various embassies and in departments of the civil government, being appointed judge of the army and judge of Jerusalem. After Saladin's death Baha al-Din remained the friend of his son Malik al-Zahir, who appointed him judge of Aleppo. There he employed some of his wealth in the foundation of colleges. When Malik al-Zahir died, his son Malik al-'Aziz was a minor, and Baha al-Din had the chief power in the regency, using it for the patronage of learning. He lived in retirement after the abdication of Malik al-'Aziz.

For an annotated Eng. trans. of *Sirat Salah-al-Din*, *see* C. W. Wilson and C. R. Conder, *The Life of Saladin*, in vol. xiii of the Library of the Palestine Pilgrims' Text Society (1897). For list of other extant works *see* C. Brockelmann, *Geschichte der arabischen Literatur*, vol. i, pp. 316 ff. (1898).

BAHA AL-DIN ZUHAYR (Abu al-Fadl Zuhair ibn Mohammed al-Muhallabi) (1186–1258), Arab poet at the court of the Ayyubid sultans of Egypt, was celebrated as the best writer of prose and verse and the best calligraphist of his time. His poetry consists mostly of panegyric and brilliant occasional verse distinguished for its elegance.

For the text of his poetry *see* E. H. Palmer, with Eng. verse trans. (1871). For his life *see* M. G. de Slane's Eng. trans. of Ibn Khallikan's biographical dictionary, vol. i, pp. 542–545 (1842).

BAHADUR SHAH I (1643–1712), Mogul emperor of India from 1707 to 1712, the second son of Aurangzeb (*q.v.*), was born at Burhanpur on Oct. 14, 1643. As Prince Muazzam he learned dissimulation during seven years of confinement by his suspicious father and deceived his younger brother, Azam Shah, into believing that he was not a contender for the throne. When Aurangzeb died in 1707, he forestalled Azam Shah in the seizure of the Agra treasuries and destroyed him at Jajau. In 1708, Kam Bakhsh, Aurangzeb's fifth son, was also defeated, near Hyderabad. Bahadur Shah maintained much of the power of the great Moguls. In 1707 and 1710, by force or conciliation he overcame unrest in Rajasthan, and between 1710 and 1712 a Sikh rising under "Guru" Banda was subdued though not extinguished. He died at Lahore on Feb. 27, 1712.

See William Irvine, *Later Mughals* (1922). (P. H.)

BAHADUR SHAH II (1775–1862), titular Mogul emperor of India from 1837 to 1858, was born on Oct. 24, 1775. A pensioner of the East India company, he had dignity without power, except over Indian imaginations, maintaining from his modest pension the palace, princelings and etiquette of the great emperors. As a poet and patron he presided over a flowering of Urdu literature and a revival of the arts. His court provided a school of manners for Hindustan, an embodiment of traditional culture. During the Indian mutiny (1857) he at first declined to lead the mutineers, but, unable to resist or escape, he became their rallying-point, even though they threatened his counselors and dignity. He succeeded in preventing Hindu-Muslim conflict within Delhi. In June he offered to open the city gates if granted honourable terms. Captured in September by Maj. William Stephen Raikes Hodson (*q.v.*) after the city's fall he was tried in 1858 and unjustly condemned. He was treated as a raree show before being exiled to Rangoon, Burma, where he died on Nov. 7, 1862.

See T. G. P. Spear, *Twilight of the Mughuls* (1951). (J. B. Ha.)

BAHA'I FAITH is the name of the religion founded in the 19th century by Mirza Husain 'Ali, known as Baha'u'llah (*q.v.*; "Glory of God"). Baha'u'llah was a follower of the Bab (*q.v.*) who, some years after the Bab's execution in 1850, claimed leadership of his community. In 1867 (or 1863) Baha'u'llah publicly proclaimed himself "him whom God should manifest," a divine spirit foretold by the Bab. The Baha'is believe Baha'u'llah to be the latest of a series of past and future divine manifestations that include Jesus, Mohammed, Zoroaster, and the Buddha. His teachings are believed to initiate a new dispensation for our age.

The cornerstone of Baha'i belief is the conviction that the Bab and Baha'u'llah are manifestations of God, who in his essence is unknowable. The Bab was the forerunner who announced a greater one to come. When Baha'u'llah proclaimed himself, the Bab's short dispensation was fulfilled. The third important figure in the Baha'i Faith was 'Abdu-l-Baha' ("Servant of the Glory"; 1844–1921), eldest son of Baha'u'llah and the perfect exemplar and infallible interpreter of his teachings. The writings and spoken words of these three central figures of the Baha'i Faith form its sacred literature.

Other important Baha'i tenets are the unity of religions and the unity of mankind. Baha'is believe all the founders of the great religions to have been manifestations of God and agents of a progressive divine plan for the education of the human race. Despite their apparent differences the great religions, according to Baha'is, teach an identical truth. Baha'u'llah's peculiar function was to overcome the disunity of religions and establish a universal faith. Similarly, the Baha'is believe in the brotherhood of all men and devote themselves to the abolition of racial, class, and religious prejudices. The great bulk of Baha'i teachings is concerned with social ethics; the faith has no priesthood and does not observe ritual forms in its worship.

The Baha'i world headquarters is in Haifa, Israel, and includes the shrine of the Bab, an archives building, and an administrative centre. From 1921 until his death the world community was headed by Shoghi Effendi Rabbani (1896–1957), who was appointed by his grandfather, 'Abdu-l-Baha', as guardian of the faith. Baha'is are organized into local and national spiritual assemblies, and through these bodies they conduct an extensive work of missions, publication, education, and general philanthropy. Worldwide leadership was assumed in 1963 by the Universal House of Justice, a nine-member body elected by members of the national spiritual assemblies.

During its early years the Baha'i Faith was confined almost exclusively to Iran. The religion was introduced to the Western world in the 1890s, and by 1920 the United States was its stronghold. There are Baha'i communities in approximately 300 separate states and dependencies, and Baha'i literature has been translated into about 370 languages. In the later 1960s there were four Baha'i houses of worship, in Frankfurt, Ger.; Sydney, Austr.; Kampala, Uganda; and Wilmette, Ill. *See* also Babism.

Bibliography.—*The Dawn Breakers; Nabil's Narrative of the Early Days of the Baha'i Revelation*, trans. by Shoghi Effendi, 2nd ed. (1953). The works of Baha'u'llah, the Bab, 'Abdu-l-Baha' and Shoghi Effendi Rabbani as well as numerous books about the faith are obtainable from the U.S. National Baha'i headquarters in Wilmette, Ill. The best source for current Baha'i activities is the biennial publication of the Baha'i Publishing Trust, Wilmette, Ill., *The Baha'i World*. (C. J. A.)

BAHAMAS, a self-governing British colony in the West Indies (*q.v.*), consisting of a chain of islands, islets, and reefs, which stretches for 760 mi. (1,223 km.) SE from Grand Bahama about 50 mi. (80 km.) off the east coast of Florida to Inagua off the eastern end of Cuba. The group comprises about 700 islands, about 30 of which are inhabited, and more than 2,000 cays (islets), with a total land surface of 4,406 sq.mi. (11,409 sq.km.). New Providence (58 sq.mi.), though one of the smaller islands, is the most important and contains the capital, Nassau (*q.v.*); the others are known collectively as the Out Islands, of which the larger and more populous are Andros (1,600 sq.mi. [4,144 sq.km.]), Great and Little Abaco (776 sq.mi.), Inagua (560 sq.mi.), Grand Bahama (430 sq.mi.), Eleuthera (164 sq.mi.), Cat, Acklins, Long, Exuma, Crooked, Mayaguana, San Salvador (Watling), Rum, the Biminis, Harbour, Spanish Wells, Ragged Island, and the Berry Islands.

The islands rise from two broad submarine banks that form an extension of the continental shelf off Florida; consequently the surrounding sea is generally shallow. The islands are, however,

separated into groups by several deep-water channels, the most pronounced of which—Crooked Island Passage—is used by ships sailing between North American east coast ports and the Panama Canal. Along the northeast margin of the archipelago, facing the open Atlantic, the sea floor descends rapidly to depths of more than 2,000 fathoms.

Relief and Geology.—The islands are for the most part flat and low. The highest elevation—about 400 ft. (122 m.)—is on Cat Island, but few islands rise much more than 200 ft. and some reach no more than 10 ft. above sea level. They are built principally of coralline and oölitic limestone of Pleistocene age—which provides useful building stone—and of wind-blown deposits. Active coral reefs fringe the coasts, which consist largely of coral sand beaches of dazzling whiteness. There are few stream-courses; the only permanent river is on Andros and the only large lake on Inagua. The soil is generally shallow and typically consists of reddish clay on higher, more freely drained land, and black, humus-rich loam and white sandy soil in low-lying areas.

Climate.—Lying within the subtropical high pressure belt and washed by the warm Gulf Stream in the north, the islands enjoy an equable climate with much sunshine. Together with the fine beaches the climate is the basis of the flourishing tourist trade. Temperature varies little through the year, from winter averages of 70°–75° F (21°–24° C) to summer averages of 80°–90° F (26°–32° C). The highest recorded temperature is 94° F and the lowest 51° F. Rainfall varies from 40 to 60 in. in the different islands and occurs, in association with southerly winds, mainly between May and September; hurricanes also occur occasionally at this season, usually in September. Hurricane Flora did much damage in 1963. The trade winds, from east and northeast, blow freshly during the winter dry season.

Vegetation and Animal Life.—The vegetation of the Bahamas has been greatly altered since the islands were discovered by Christopher Columbus. Probably at that time they were thickly wooded, but now considerable forests remain only on Abaco, Grand Bahama, Andros, Mayaguana, and some of the smaller islands. Caribbean pine dominates much of the woodland and provides lumber for domestic and export markets. Among native hardwoods lignum vitae, cedar, sabicu, madeira, and satinwood are commercially valuable. Many alien species have been introduced; some, such as logwood, have become naturalized and spread widely, while others, such as poinciana and casuarina, are planted as ornamentals. Low scrub covers extensive areas, and mangrove swamp fringes sheltered stretches of coast.

Animal life is comparatively scarce. Raccoons live on several islands and lizards, iguanas, and chameleons occur. The only large animals are feral horses, donkeys, cattle, and pigs, which abound on some of the remote islands, particularly Inagua. Birds are more numerous and more than 200 species and subspecies have been recorded. Preeminent among them are the flamingoes, which breed principally on Inagua and Andros. Marine life is varied and abundant, though less so than formerly. The West Indian or monk seal, now almost extinct, was once common. In 1688 Hans Sloane (*q.v.*) reported that "the Bahama Islands are filled with seals; sometimes fishers will catch 100 in a night." Turtles also have been much reduced in number, though the edible green turtle is still marketed locally and "tortoise shell" from the hawksbill is exported in small quantities. Fishing is a major occupation of the local population and is an increasingly popular sport among visiting tourists who are attracted by the wide variety of big-game fish. Crayfish and sponges are valuable export items, though the sponge industry has declined since the beds were attacked by disease in the 1930s.

History.—On Oct. 12 (old style), 1492, Christopher Columbus landed on an island called by its native inhabitants Guanahani. He renamed it San Salvador. Its actual identity is still in dispute, but it is generally believed to have been the island now known as Watling Island. The natives of the Bahamas, whom Columbus called Lucayans, were Arawak Indians. They also inhabited the Greater Antilles and were peaceful folk. Between 1492 and 1508 Spanish raiders carried off about 40,000 natives to work in the mines of Hispaniola (Haiti and the Dominican Republic), and the islands had become uninhabited more than a century before the first English settlement took place.

Though Columbus took formal possession of the islands with pomp and ceremony in the name of Spain, and though under the papal bull of demarcation of 1493 (and subsequent bulls) the islands were held to come within the Spanish sphere, the Spaniards made no attempt to settle them.

British interest began in 1629 when Charles I granted Sir Robert Heath, attorney general of England, territories in America including "Bahama and all other Isles and Islands lying southerly there or neare upon the foresayd continent. . . ." But there is no evidence that Heath made any effort to settle the Bahamas. In the 1640s Bermuda was troubled by religious disputes similar to those which at that time were disturbing England, and in 1644–45 a group of dissidents there sent two ships south to seek an island on which they might settle and worship as they pleased. In 1647 leadership in this enterprise was taken by Capt. William Sayle, who had twice been governor of Bermuda. In July of that year the Company of Eleutherian Adventurers was formed in London "for the Plantation of the Islands of Eleutheria, formerly called Buhama in America, and the Adjacent Islands." Sayle and about 70 prospective settlers, consisting of Bermuda Independents and some persons who had come from England, sailed from Bermuda for the Bahamas some time before October 1648. The place of their landing is uncertain, but modern belief is that they settled on Eleuthera, then known as Cigatoo. The settlement did not prosper. Some of the settlers returned to Bermuda as early as 1650. Sayle himself returned in 1657, being again appointed governor of Bermuda in 1658.

New Providence was first settled in 1656 by a fresh group of Bermudans. In 1663 South Carolina was granted by Charles II to eight of his friends as lords proprietors and they appointed Sayle as the first governor. Both Sayle and certain of those who had interested themselves in the settlement of New Providence independently drew the attention of the lords proprietors to the possibilities of the Bahama Islands, and in consequence the duke of Albemarle and five others acquired a grant of the islands from Charles II in 1670, and they accepted nominal responsibility for the civil government.

The proprietors did not take a very active interest in the settlement or development of the islands. In 1671 they appointed John Wentworth as the first governor, but thereby merely confirmed an election previously made by the existing settlers. Although elaborate instructions for the government of the colony were issued and a parliamentary system of government was instituted, the lot of both governors and settlers was far from easy. New Providence was more than once overrun by the Spaniards alone or in combination with the French, while any governor attempting to institute a semblance of law and order received short shrift from the settlers, who had found piracy the most lucrative profession. In 1684 the king himself intervened and required that a law be passed against the pirates, but apparently it had little effect.

Early in the 18th century official representations, supported by petitions from English merchants, were being made for direct crown control. Action was at last taken in 1717 when the lords proprietors surrendered the civil and military government to the king and leased the islands to Capt. Woodes Rogers, whom the king commissioned as the first royal governor. When he arrived in 1718, armed with the royal commission and a disciplined troop of soldiers, about 1,000 pirates surrendered and received the king's pardon, while eight of the unrepentant were hanged. His measures were so effective that in 1728 the colony was able to adopt the motto, *Expulsis piratis restituta commercia.*

Meanwhile, even in the troubled days of the lords proprietors there had been an attempt at peaceful settlement and in 1660 the present site of the capital was known as "Charles Towne" in honour of Charles II. Ever ready to pay lip service to the crown, these early settlers saw fit to change the name to Nassau when William and Mary came to the throne. With the restoration of order following the establishment of the royal government the settlers demanded an assembly. In 1729 after due inquiry Woodes

Rogers, acting under authority from the crown, issued a proclamation summoning a representative assembly and from then on, apart from the brief interruptions caused by foreign invasion, the government of the colony carried on in an orderly manner.

In 1776 Nassau was captured by the United States Navy, but after a few days the place was evacuated. In May 1782 the colony surrendered to Spain and, though it was restored to Britain by the Peace of Versailles in January 1783, it was brilliantly recaptured by Col. Andrew Devaux in April of that year before news of the treaty had been received. On the conclusion of the American Revolution many Loyalists emigrated from the U.S. to the Bahamas under very favourable terms offered by the crown. Among the newcomers was Lord Dunmore, formerly governor of New York and of Virginia, who served as governor of the Bahamas from 1786 to 1797. In 1787 the proprietors surrendered their remaining rights for £12,000.

The early years of the 19th century were largely occupied by the efforts of the assembly to thwart the attempts of the executive to ameliorate the conditions of the slaves, until the United Kingdom Emancipation Act came into force in the colony on Aug. 1, 1834. A Legislative Council was created by royal letters patent in 1841. The mid-19th century was taken up with a struggle for full recognition on the part of the dissenters against the established church, which was backed by the government and the upper classes; the struggle ended with disestablishment in 1869. From that time no incidents of particular political importance occurred until May 1963 when a conference was held in London to consider a new constitution for the islands. It was then agreed that the colony should have full internal self-government, the governor retaining reserved powers only for foreign affairs, defense, and internal security. The new constitution came into force on Jan. 7, 1964 (*see* also *Administration* below).

At a general election held on Jan. 10, 1967, Lynden Pindling's Negro Progressive Liberal Party and the mainly white United Bahamian Party (which had formed the previous government) each won 18 seats in the Bahamian House of Assembly. With the support of one of the two other successful candidates (the second was the speaker of the House of Assembly), Pindling formed the first Negro government of the colony. (The election had been called by the premier after it had been alleged that ministers were involved with U.S. criminal interests said to be concerned with a gambling casino on Grand Bahama.)

Population.—None of the original Arawak population survives. Following the first British settlement the population grew slowly until, with the arrival of the American Loyalists and their slaves, the white population, estimated at 1,760, was nearly doubled and the Negro population almost trebled. During the first half of the 20th century there was a marked increase in the population of New Providence and a slow decline in that of the Out Islands; by 1953 well over half the population was concentrated on New Providence. But after that year, with development of the tourist trade, population in the Out Islands increased. From 1931 to the 1960s the population of New Providence increased from about 20,000 to 80,000, while in the same period the Out Islands increased from 40,000 to 50,000. The total population of the colony (1963 census) was 130,220. About 85% of the total population is Negro.

Administration.—The colony achieved full internal self-government in January 1964 (see *History* above). The constitution then introduced provided for a governor, a Cabinet of at least eight members headed by a prime minister, and a bicameral legislature consisting of a Senate and a House of Assembly. The Senate has 15 members, eight appointed by the governor after consultation with the prime minister, five on the advice of the prime minister, and two on the advice of the leader of the opposition. The Senate has delaying powers over money and taxation bills. The House of Assembly consists of 38 elected members, of whom not less than 18 nor more than 22 were to represent the Out Islands, and not less than 16 nor more than 20 were to represent New Providence. Full adult suffrage was provided.

Education is compulsory between the ages of 5 and 14. There were about 150 government and 60 other elementary schools, 5 government and 10 other secondary schools in the mid-1960s.

Economic Development.—The earliest economic attraction of the Bahamas was as a source of slaves, tropical woods, turtles, and seals. The islands also served as a base for buccaneers harassing Spanish shipping. From the time of English settlement persistent attempts were made to develop plantation agriculture but with little success. The Loyalists who immigrated after the American Revolution stimulated the production of cotton, but the resultant prosperity did not last as pests destroyed the plants in 1788 and 1794 and the shallow soil was rapidly eroded by plantation methods of cultivation. Emancipation of the slaves in 1834 finally eliminated cotton production and an attempt to revive it in 1864 failed. In 1888 sisal hemp was introduced as a plantation crop but it also failed after a promising start. The Bahamas have in fact never had a staple item of export or permanent trade of any magnitude. During the American Civil War and later during the era of prohibition, the lucrative professions of blockade-running and bootlegging brought the islands two brief periods of unprecedented prosperity.

Agricultural production mainly serves local needs. Small holdings owned by peasant farmers produce a variety of vegetables and fruit, among which only tomatoes and okra are exported in quantity. Most of the livestock is owned by the peasant farmers, though there is a modern dairy and poultry farm at Hatchet Bay, Eleuthera. Forestry is an important activity on the islands of Grand Bahama, Abaco, and Andros where the pine forests are cut for lumber and, since 1956, for pulpwood. These products now constitute the Bahamas' most valuable export and are marketed respectively in Caribbean territories and Florida. Salt and crayfish are other leading exports.

The growing prosperity that the Bahamas have enjoyed since the beginning of the 20th century is due almost entirely to the development of the tourist trade. This began as early as 1860 with the building of the Royal Victoria Hotel at Nassau to accommodate winter visitors. Progress was slow at first but since 1945 the islands have become established as one of the premier resorts of the Caribbean area, particularly for visitors from the United States. In 1957 there were nearly 200,000 visitors from abroad, most of whom stayed in Nassau, though increasing interest was being shown in the more accessible of the Out Islands where there are many new hotels, clubs, and guesthouses. By the mid-1960s the number of visitors had risen to more than 800,000, of whom more than 500,000 went to Nassau and about 300,000 to the Out Islands.

Communications to and within the islands, both by sea and air, are good, and there are motor roads on New Providence, Eleuthera, and Grand Bahama. Asphalt roads were being built in many of the Out Islands in the mid-1960s. On Grand Bahama a deep-water harbour known as Freeport was being developed in the 1950s and 1960s in association with a tax-exempt industrial and commercial area and in 1964 its airport was modernized. Adjacent Lucaya, a beach resort with its gambling casino, marina, and 18-hole championship golf course, was a major tourist centre by the late 1960s. Freeport provides major bunkering facilities for shipping in the West Indies. International shipping and airlines from the United States, Canada, Great Britain, and elsewhere use the harbour and airport at Nassau and there are also internal services by sea and air to most of the Out Islands.

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BAHA'U'LLAH (MIRZA HUSAIN 'ALI NURI) (1817–1892), the founder and central figure of the Baha'i Faith was born at Teheran, Persia, Nov. 12, 1817. In his youth he was an ardent supporter of the claims of the Bab (*q.v.*) and some years after the Bab's execution in 1850 became the leader of one of the factions into which his community split (*see* BABISM). In 1867 Baha'u'llah announced himself publicly to be "him whom God should mani-

fest," a divine figure whose coming had been foretold by the Bab. Baha'u'llah's followers believed him to have been a manifestation of God (a divine figure), the new revelation for that age, and Baha'u'llah in his writings and speeches repeatedly made reference to himself in terms that support their conviction.

Baha'u'llah's religious movement came into conflict with the Persian authorities who were disturbed by some of its revolutionary activities. He was banished to Baghdad in 1852 and from there was sent by the Turkish government first to Constantinople, then to Adrianople and finally to Akka (Acre) in Palestine, where he passed the remainder of his life in internment, dying in May 1892. The period after the announcement of the claim to be "him whom God should manifest" was marked by bitter controversy, even violence, between Baha'u'llah's followers and those of his half brother, Mirza Yahya, chosen by the Bab to be his successor. Akka became a centre of pilgrimage for Baha'is from Persia and America, to which the religion spread in the late 19th century.

Baha'u'llah's religious teachings were largely practical and ethical. He sought to establish a universal religion that urged social uplift and world peace. *See* BAHA'I FAITH. (C. J. A.)

BAHAWALPUR, a town, district, division and former princely state in West Pakistan, situated on the Sutlej, Panjnad and Indus rivers. The nawabs of Bahawalpur originally came from Sind and assumed independence after the first expulsion of Shah Shuja from Kabul in 1809. The state acceded to Pakistan on Oct. 7, 1947, and in 1955 became the basis of Bahawalpur division. The region which comprised Bahawalpur state can be divided longitudinally into three strips: (1) the western, called Sind, irrigated by flood water, is the most fertile, with numerous groves of date palms. It is an alluvial tract scored by deep depressions, remnants of old river courses. (2) The central section, called Pat, consists of fertile loam brought under cultivation by the Sutlej canals and yielding rich crops of wheat, cotton and sugar cane. (3) The eastern, called Rohi or Cholistan, lying beyond the irrigation boundary, is a barren sandy desert—an expansive wilderness of 13,000 sq.mi. It is separated from the central tract by a depression running parallel to the Sutlej. There are mounds of ruins of old settlements, called *Thers,* along its high banks. Wells are the only places in the desert where life is possible. The sources are so limited however that the inhabitants must be constantly on the move, and the subsoil water is salty. The people are mainly shepherds. A shrub known as khar (*Salsola griffithii*) is abundant and is burned to make carbonate of soda for soap and medicines. The average rainfall in the region is less than 5 in. a year.

BAHAWALPUR TOWN, formerly the capital of Bahawalpur state, and the headquarters of the district, lies on the main railway line from Peshawar to Karachi. Pop. (1961) 84,377. It is important for its location at the head of the Empress bridge, the only railway bridge over the Sutlej in West Pakistan. In A.D. 1748 Nawab Bahawalpur I raised a wall around the village of Nawab Mohammad Panah Khan Ghumrani and within it built the town which bears his name. It is situated on the riverside at a raised point in the midst of a flood-irrigated area. The town is surrounded by gardens and is encircled by a metaled road with avenues of trees and parks. Originally there were five gates, but three have been demolished. There are two main bazaars, one crossing the other. Noteworthy monuments include Bahawalgarh palace built by Nawab Bahawalpur II in 1791 and now used as government offices, and the residency and new palace built by Sir Sadiq Mohammad. The chief modern buildings include the central library, Dring stadium, Sadiq Egerton college, Jama-i-Abbasia (a renowned Muslim theological institute), and a large hospital. There is a zoological garden and museum and an Urdu academy. Bahawalpur has a large soap factory; cotton is woven and embroidery and pottery are made.

BAHAWALPUR DISTRICT. When the new district of Bahawalnagar was formed in 1953 Bahawalpur district was also reconstituted. In 1961 the population was 735,524 and the area was 9,587 sq.mi.

The district includes the central portion of the former state, with the districts of Bahawalnagar and Rahim Yar Khan, one at each end. The greater part is desert, inhabited by nomadic graziers. In the rest of the district agriculture and small-scale cottage industry are the principal economic activities. The language, known as Bahawalpuri, is identical with Multani. There are many shrines and ruins of old forts. Uch, about 30 mi. to the southwest of Bahawalpur, marks the site of an ancient town going back to Indo-Scythian times.

BAHAWALPUR DIVISION. On the integration of states and provinces into one unit of West Pakistan in 1955, Bahawalpur with Bahawalnagar and Rahim Yar Khan districts was made a division. Area 17,508 sq.mi. Pop. (1961) 2,574,066 with a density of 147.0 persons per square mile. About 80% of the cultivated area (approximately 4,000,000 ac.) is irrigated. Wheat, millets and sugar cane are the chief crops. (K. S. AD.)

BAHIA (BAÍA), an Atlantic state of Brazil, bounded north by the states of Piauí, Pernambuco, Alagôas and Sergipe, east by Sergipe and the Atlantic, south by Espírito Santo and Minas Gerais, and west by Goiás. Pop. (1960) 5,990,605. It ranks 6th in size among the states of Brazil with an area of 216,612 sq.mi. From east to west the state is divided into three distinct geographic regions: a narrow coastal plain characterized by a tropical rain forest (*mimosa*); a somewhat broader zone of rising, broken lands (*agreste*) suitable for a wide range of agriculture; and a semibarren plateau, about 3,000 ft. above sea level, which comprises most of the interior (*sertão*). The plateau is traversed from southwest to northeast by the São Francisco river. The climate varies from hot and humid along the coast to hot and dry throughout the interior. Cattle raising and mining are the principal industries in the *sertão*. The leading agricultural products of Bahia are cacao, produced near Ilhéus; sugar, grown in the Recôncavo, a fertile coastal district near the city of Salvador; and tobacco, raised in the *agreste* zone. Exports include cacao, sugar, tobacco, sisal fibre, castor beans, hides, mangabeira rubber, cabinet woods and rum. The bulk of the population, largely of mixed Negro and white racial origin, is located within 100 mi. of the coast. There is little immigration, while emigration to the industrial areas of the south tends to restrict the rate of population growth.

The capital, Salvador (*q.v.*) or Bahia (pop. [1960] 630,878), is the only large city in the state. Important towns are: Feira de Santana, inland from Salvador on the edge of the *sertão,* celebrated for its cattle fairs; Ilhéus, on the southern coast; Vitória da Conquista, on the highway to Minas Gerais and southern Brazil; Juàzeiro, on the São Francisco river; and Santo Amaro, in the Recôncavo. None of these towns exceeds 35,000 population. As a captaincy general from 1549, Bahia was the seat of the colonial government in Brazil for over 200 years. It retained its leading position as long as the colonial economy was based on sugar production.

Following the discovery of gold in Minas Gerais in 1695, the economic centre of the colony shifted to the south. The capital was transferred to Rio de Janeiro in 1763 and Bahia entered a gradual decline. It became a province of the empire in 1823 and a state in the republic in 1889. By the mid-20th century Bahia had not kept pace with the industrial and political growth of states to the south. In the late 1950s, however, with the inauguration of direct rail and highway connections to the south and the availability of electric power from the Paulo Afonso hydroelectric project, there were signs of appreciable increase in the rate of industrial development in Bahia. (R. E. P.)

BAHIA (city), Brazil: *see* SALVADOR.

BAHÍA BLANCA, city and third port of Argentina, located in the extreme southern part of the province of Buenos Aires. Pop. (1960) 136,137. Major rail systems and airlines as well as highways closely link it to the national capital of Buenos Aires, 400 mi. N.E. The bay of the same name forms a natural harbour, one of the best on the Argentine coast, for the city located 4 mi. upstream on the shallow Napostá river. The increased settlement and development of the area of the Colorado, Neuquén and Negro rivers (provinces of La Pampa, Neuquén and Río Negro) have contributed to the rapid growth of the port.

The city was founded in 1828 as a military outpost against Indian attacks and foreign encroachment on the unsettled southern

Argentinian coast. Its importance as a commercial centre began in 1885 when the first rail connection to Buenos Aires was completed. A grain industry was established in the last decades of the 19th century by immigrants, largely Italian. The port then became a commercial necessity for the region.

Bahía Blanca possesses modern port facilities. The naval station serves as the principal base of the Argentinian fleet, with dry docks capable of handling the largest battleships. The commercial facilities include subsidiary ports: Puerto Belgrano, developed by the Rosario-Puerto Belgrano railroad to handle exports; Puerto Ingeniero White, equipped with grain elevator capacity of 120,000 tons; and Puerto Galván, constructed by the Pacific railroad to handle the cargoes of wheat, wool and cattle from La Pampa. (Js. R. S.)

BAHMANI, the name of a Muslim sultanate in the Deccan (*q.v.*), India, was founded in 1347 by Ala ud-Din Hasan Bahman Shah supported by other military leaders in rebellion against the sultan of Delhi, Mohammed ibn Tughluq. It attained its apogee during the vizierate (1466–81) of Mahmud Gawan but dissolved into the five successor powers of Bijapur, Ahmednagar, Golconda, Berar and Bidar (*qq.v.*) between 1490 and 1518. Between 1347 and *c.* 1424 its capital was Ahsanabad (Gulbarga [*q.v.*]) and thereafter Mohammedabad (Bidar).

The Bahmani sultanate's main foes, in its efforts to extend itself securely over the Deccan tableland, were the Hindu rulers of Vijayanagar, Telingana and Orissa and the Muslim rulers of Khandesh, Malwa and Gujarat. In the north, by 1468 a *modus vivendi* with Malwa had been achieved. In the south, war with Vijayanagar over the fertile Krishna-Tungabhadra doab was endemic until Krishna Deva Raya succeeded, between 1510 and 1520, in incorporating the area in Vijayanagar. To the east, the Bahmanis often warred with the Hindu chiefs of Telingana who were usually allied to the rajas of Orissa. In the west, the Bahmanis were unable to control the coastal region beyond the Western Ghats, although Mahmud Gawan temporarily occupied Sangameshwar and Goa in 1471 and 1472.

The division of the Bahmani sultanate into four *taraf* (provinces) encouraged an autonomy which the reforms of Mahmud Gawan failed to combat. The continuing employment of Muslim adventurers from overseas often antagonized older Muslim settlers and disturbed the loyalty of the military classes toward the dynasty. The political domination of Muslim groups in a predominantly Hindu area was facilitated by mutual noninterference between the various religious communities. The Bahmani sultans often encouraged a fusion of Deccan cultures.

See H. K. Sherwani, *The Bahmanis of the Deccan* (1953). (P. H.)

BAHORUCO, a province in southwestern Dominican Republic (area, 532 sq.mi.), pop. (1960) 52,800. It extends from the high Sierra de Neiba in the north to the below sea level basin of Lake Enriquillo. Large, irrigated sugar cane plantations account for one-third of the cultivated area. Other significant crops are plantains, bananas, coffee, corn and beans. The province was created in 1943 from the western part of Barahona province and was later reduced in size by the formation of Independencia province. The capital city, Neiba (pop. [1960] 4,620), was founded at the beginning of the 18th century. (D. R. D.)

BAHR, HERMANN (1863–1934), Austrian author and playwright, whose keen interest in cultural movements makes his career a guide to literary developments in Austria during his lifetime, was born at Linz, Upper Austria, July 19, 1863, and after studying at Austrian and German universities settled in Vienna, where he worked on a number of newspapers.

Zur Kritik der Moderne (1890) and *Die Überwindung des Naturalismus* (1891) illustrate the first phase of his career in which he attempted to reconcile naturalism with romanticism. In 1907 he published *Wien*, a remarkable essay on the soul of Vienna, which, however, was banned. Later, under the influence of Maurice Maeterlinck, Bahr became a champion of mysticism and symbolism. His comedies, including *Wienerinnen* (1900), *Der Krampus* (1901) and *Das Konzert* (1909), are superficially amusing.

In 1903 Bahr was appointed director of the Deutsches Theater, Berlin, and in 1918 he was for a short time director of the Vienna Burgtheater. During World War I, under the influence of Catholicism, his novel *Himmelfahrt* ("The Ascension"; 1916) represented the staunchly Catholic school of thought in his country. His later critical works, which show his interest in the social effects of creative art, include *Dialog vom Marsyas* (1904) and *Expressionismus* (1914). Bahr died at Munich on Jan. 15, 1934.

See A. Fuchs, "H. Bahr," *Moderne österreichische Dichter* (1946); H. Kindermann, "H. Bahr," *Wegweiser durch die moderne Literatur in Österreich* (1954). (A. Gs.)

BAHRAICH, a municipal town, tehsil and district in the Fyzabad division of Uttar Pradesh, India. The town (3 sq.mi.; pop. [1961] 56,033) is 65 mi. N.W. of Lucknow. It is a place of pilgrimage, the tomb of the 11th-century warrior-saint Salar Masud Ghazi being visited by Muslims and Hindus alike. A large fair takes place every summer. The most prominent buildings are a Muslim monastery and the ruined palace of the nawabs of Oudh. The town is connected with Lucknow by the Northeastern railway metre-gauge line via Gonda (113 mi.). The continuation of the line northwestward to the Nepal frontier has made Bahraich a centre for trade with that country, mainly in grain, sugar, timber and tobacco. About 22% of Bahraich's population depends on commerce, 18% on nonagricultural production, 13% on cultivation and 5% on transport employment.

BAHRAICH DISTRICT (2,620 sq.mi.; pop. [1961] 1,499,929) is a wedge of territory between the Gogra river (*q.v.*) and Nepal, with which it has a common frontier of about 80 mi. It comprises (1) a central triangular highland zone projecting southeast from the Himalayas for about 50 mi.; (2) the great Gogra plain on the west, at an average of 40 ft. below the highland; and (3) on the east, the lesser basin of the Rapti river and its branch, the Bhalka. Within the district the forests and marshes of the southern Himalayan slopes give place to drier land; stream beds become deeper and typical Ganges plain country is reached in the south and southwest. The Gogra forms the district's southwestern boundary for 114 mi. Most of the population depends on farming and farm labour; the main crops are rice, maize, wheat, gram and sugar cane.

Little was known of the district before the half-legendary invasion of the Muslims under Salar Masud in A.D. 1033. They consolidated their rule there only in the 13th century, and the district was later held wholly or partly by the Raikwars (a Rajput clan), Nepal, Mogul Oudh and the British. (B. Sı.)

BAHRAIN (BAHREIN), an archipelago and independent sheikhdom under British protection, named after the largest island in the Gulf of Bahrain, an inlet of the Persian gulf, lies between the Qatar peninsula and the Hasa coast of Saudi Arabia. Bahrain Island extends 27 mi. north to south by 10 mi. east to west and is a low, generally level expanse of sand and bare rock, with Jebel Dukhan (450 ft.) the highest of a cluster of small rocky hills in the centre. Structurally the island is an upfold of limestone, marls and sandstone of Tertiary and Cretaceous age, similar to other oil-bearing structures in the Persian gulf area. Muharraq to the north and Sitra to the east are low-lying and are connected by causeway to the main island. Other islands are Umm An-Nasaan, Jidda and the Hawar group off Qatar. The climate is hot and rather humid in summer, but pleasant during the short winter season. Mean midday temperatures from May to September exceed 90° F. The scanty winter rain (3 in.) excludes agriculture save in the extreme north where copious fresh-water springs permit irrigation. The water probably originates in central and western Arabia.

The fauna of Bahrain is very limited in number and includes gazelles, hares, jerboas, mongooses and lizards. Among the birds (some of which are winter visitors) are ravens, sparrows, bulbuls, pigeons and flamingoes. The commonest domestic animals are donkeys, salukis and camels.

History.—Numerous ancient burial mounds in the northern and western upland slopes of Bahrain Island indicate early human habitation. These may be Sumerian. For a long time the archipelago was probably of local commercial and strategic value, but its recorded history started with the Portuguese occupation in 1507. In 1602 Arab subjects of the shah of Persia seized and

held Bahrain intermittently until 1783. In that year it was conquered by Arabs of the Ataiba or Utub tribe from the Arabian shore, whose paramount family, the Al-Khalifahs, became the independent sheikhs of Bahrain. Following a series of agreements between Great Britain and the ruling sheikhs from 1820 to 1892 the state became a British protectorate. In return for British support and protection the sheikh of Bahrain bound himself to refrain from "the prosecution of war, piracy or slavery" (1861); and in subsequent treaties and agreements the sheikhs agreed not to enter into any relationship with a foreign government (including restraint from granting fishing, pearling or oil concessions) without British consent. During the 19th century Britain intervened several times to defeat attempts to assert dominion over the islands by the sultan of Oman, the Wahhabis of Arabia, Turkey, Persia and Egypt, as well as to prevent piracy by the Bahrainis. Britain's special relationship with Bahrain was recognized by King ibn Sa'ud of Saudi Arabia in 1927. Iran has periodically advanced claims to sovereignty over Bahrain, but these were never recognized by Britain. British interest in Bahrain was first represented by the East India company, then by the government of British India.

Population and Social Conditions.—The land area of Bahrain is 231 sq.mi. and the population in 1959 was 143,213 including several thousand nationals of other Arab states, Iranians, Indians and Pakistanis. There are about 750 British and Americans, mostly employed in the oil industry. Manama, the capital, on Bahrain Island, had a population of 61,837 and Muharraq town 32,279. The Arab population is almost equally divided between the Sunni and Shi'a sects, but the ruling family and the wealthy classes are mainly Sunnis.

Until 1952, the sheikh's personal rule was virtually unquestioned, and local politics took the form of Sunni-Shi'a quarrels, but after that time there were demands for reforms in the legal code, administration and labour laws. Pan-Arab and antiwestern feeling increased the opposition to British influence and the traditional system of government. There is a British secretary of government and some British officials in the police and administration. Bahrain is the headquarters of the British political resident who represents the crown vis-à-vis the Arab states of the Persian gulf. There is a small British naval base at Khor Kaliya, and the civil airfield on Muharraq Island is also used by the Royal Air Force. Oil royalties enabled the government to provide extensive social services including free medical attention and free primary, secondary and technical education. Manama, Muharraq, Hidd and Rifa'a have municipal councils.

The Economy.—Dates, citrus fruit and irrigated vegetables are grown in the north of Bahrain Island. The traditional industries of dhow building, the manufacture of sail cloth and reed mats are still carried on. The once important pearl fishing fleet has dwindled from about 1,000 boats (1930) to about 30 in the early 1960s, largely because more profitable work is available. Of government revenue about 70% now comes from oil royalties and 30% from customs duties. Oil was first discovered in 1932, and since 1948 production has remained steady between 1,500,000 and 2,000,000 tons per year. The oil concession (55 years from 1940) is held by Bahrain Petroleum company, an American syndicate (consisting of Standard Oil of California and the Texas Oil corporation) registered in Canada, and technically a British company. There is a refinery with an annual capacity of 10,000,000 tons per year at Ahwali, refining local production and crude oil sent by underwater pipeline from the Aramco fields in Saudi Arabia. The tanker loading jetty is on the east of Sitra Island.

There is an important coastal trade in general cargo, and by virtue of its good harbour and early development Manama, which was declared a free transit port in 1958, is the main entrepôt for the Persian gulf. There are weekly steamer services to Karachi and Bombay. Muharraq international airport is the most important in the gulf. The main towns, villages, harbours and oil installations are connected by metaled roads, and there is a good bus service. Since World War I Bahrain's currency has been the Indian rupee. *See* also ARABIA.

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BAHRAM (VARAHRAN, from older *Verethragna*, name of an Iranian deity), the name of six kings of Iran in the Sasanian period.

BAHRAM I (reigned A.D. 274–277; or 273–276 by T. Nöldeke's chronology, 271–274 by W. B. Henning's) was a son of Shapur I, under whom he governed the province of Gilan. His succession to his brother Ormizd I strengthened the Zoroastrian clergy, at whose instance in Bahram's third year the prophet Mani, founder of Manichaeism, was cruelly executed. Subsequent persecution of this sect involved also Christians and Buddhists. His characteristic radiate crown, known from coins, distinguishes Bahram in a rock-sculpture at Bishapur, though his name in the inscription was erased by Narses.

BAHRAM II (reigned A.D. 277–294; or 276–293 by Nöldeke's chronology, 274–291 by Henning's), son of Bahram I, soon had to defend his throne against a brother, Ormizd, viceroy of the eastern provinces. In A.D. 283, exploiting Bahram's preoccupations, the Roman emperor Carus invaded Mesopotamia unopposed and entered Ctesiphon. However Carus' mysterious death forced a Roman withdrawal, and, soon after, the overthrow of Ormizd made Bahram secure. Influential in this reign was the *mobed*, Kartir, a militant Zoroastrian reformer, honoured with the title "mobed of the deceased Varahran (I)." Numerous southern Persian rock-sculptures depict Bahram in his winged crown, and several include his queen (also figured on coins). Since female portraits are rare in Sasanian art, she must have been a major dynastic personage.

BAHRAM III (reigned A.D. 294; or 293 by Nöldeke's chronology, 291 by Henning's), Bahram II's son and successor, was designated Sakanshah (viceroy of Seistan) in youth to celebrate the father's eastern victory. Deposed after four months by a great-uncle, Narses, he is nevertheless shown by an inscription to have issued coins.

BAHRAM IV (reigned A.D. 388–399), a son of Shapur II, was Kermanshah (governor of Kerman) before succeeding his brother Shapur III. Kermanshah, the well-known city in Kurdistan, was named for him, as also Kermanshahan near Yazd. The partition of Armenia with Rome, often ascribed to Bahram, is better dated to A.D. 387.

BAHRAM V (A.D. 420–438), surnamed GOR, "the Wild Ass," was celebrated in literature, art and folklore for his chivalry, romantic adventures, and the huntsmanship recalled in Edward Fitzgerald's *Rubaiyat* (1859). Educated at the court of al-Mundhir, Lakhmid Arab king of Hira, whose military support gained him the throne, Bahram tended to delegate administrative cares to his minister Mihr-Narseh, whose zealotry motivated both persecutions deplored by Christian writers and benefactions in his home province, Fars (described by al-Tabari and a surviving Pahlavi inscription). An inconclusive war with Byzantium (421–422) was soon ended. Bahram's martial qualities were unimpaired by gracious living; in 427 he crushed an invasion of Khurasan by the Hephthalites (*q.v.*), extending his influence into central Asia, where his portrait survived for centuries on the coinage of Bukhara.

For BAHRAM VI *see* BAHRAM CHOBIN.

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BAHRAM CHOBIN (perhaps "Bahram the Javelin") (6th century A.D.), Persian general and head of the house of Mihran at Rayy, by attaining the throne as Bahram VI (A.D. 590–591) performed a feat exceptional for one not of Sasanian—though claiming Arsacid—royal blood. Prominent as master of the household (*darigbed*) in Ormizd IV's Byzantine wars, Bahram received the supreme command in Khurasan, repelling a Turkish invasion. Re-

verting to the west, he sustained a defeat and was harshly disgraced by Ormizd. Still sure of his army, Bahram rebelled; in the disorder Ormizd was assassinated by another hand. Khosrau II, Ormizd's successor, marched against the irreconcilable general, but the royal troops mutinied, and Khosrau fled to the Byzantines. Bahram then proclaimed himself king, but was never secure. In 591, with Byzantine support, Khosrau triumphed and regained the throne. Bahram escaped to Turkistan, to perish by assassination. His colourful career became the subject of a Middle-Persian popular romance. (A. D. H. B.)

BAHR EL GHAZAL (Bahr al Ghazal), a province of the Republic of the Sudan. Area 82,529 sq.mi. Pop. (1956) 991,022. The province does not coincide with the whole Bahr el Ghazal river system but only with the Lol, Jur and Tonj basins, south of the Bahr al 'Arab, north of western Equatoria, and west of the Sudd, of which a part is included.

The whole area west of the Bahr el Jebel consists of a plateau tilted gently northeastward from the Congo watershed at a height of 2,000–2,500 ft. to where at about 1,000 ft. it passes under the level clays of the Sudd basin of which Lower Bahr el Ghazal is a part. The basement platform of ancient gneiss and schists with granitic inselberg (*q.v.*) is exposed in hills and river beds, but its name of "Ironstone plateau" is derived from its thick outer covering of "hard-pan" and ferruginous earths formed in the laterite soils and now patchily covered with more recent red loams and sands, masking any possible mineral wealth. There are potential copper deposits at Hufrat an Nahas on the upper Bahr al 'Arab.

The temperatures reach their highest and lowest (100° and 60° F.) during the dry season from November to March and otherwise range between 70° and 85° F. The rainfall is sufficient for woodland or long-grass savanna. However the grass is burned to extend cultivation, to improve grazing or to destroy the tsetse fly; this prevents tree growth and destroys timber. Sudan mahogany (*Kaya senegalensis*) and shea butter trees are among the patches that survive, and Wau is a centre of conservation services as well as of sawmills exploiting *Kaya* and other timber. Game abounds and includes elephant, giraffe, lion and buffalo, as well as many large and small antelope. The Sudd region of the northeast, especially Lake Ambadi, teems with waterfowl, and some rare swamp birds like the shoebill stork (*Balaeniceps rex*) are common there.

Of the population, 92% are Nilotes (*q.v.*), chiefly the Dinka, 875,000 of whom raise cattle in the grass flats, swamps and lower valleys, migrating seasonally to and from the river line. About 10% are fishers, crocodile and hippopotamus hunters. Women and children grow millet, bananas and gourds near the permanent villages. The tribes of the plateau and upper valleys are Sudanics, of the N'dogo, Bongo (*q.v.*) and Baka, who beside hunting and collecting fruits, seeds and wild honey for trading, grow millet, sesame and peanuts, cassava and sweet potatoes. There are a few Arab Sudanese (officials, clerks and traders) and foreigners. Trade is undeveloped, though Bahr el Ghazal hides and skins are prominent in the Sudan's export of these goods. Oilseeds, timber and wood fuel, bananas and some ivory are also shipped down-river.

The Bahr el Ghazal was first penetrated by Arab slavers and ivory hunters. Their old trading posts are now district centres, but of the four rural headquarters with councils and commissioners only Wau (pop. 8,009), the provincial capital, can be considered a town. Rumbek (2,944) has the largest secondary school in southern Sudan but illiteracy is widespread throughout the province. The other rural district councils are Aweil and Tonj.

From 1936 to 1956 the Bahr el Ghazal territory was joined to Equatoria, and under the governor in Juba. Progress in direct communications with Khartoum through development of roads and motor transport and through the airport at Wau made it more practical in the independent Sudan to have a governor in Wau directly responsible to the government for the mainly Nilotic peoples of Bahr el Ghazal. *See* also Sudan, Republic of the.

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BAHR EL GHAZAL RIVER (Gazelle river), the chief western affluent of the Nile, 445 miles long, joins the Upper Nile (Bahr el Jebel) in latitude 9° 30′ N., longitude 30° 30′ E., through Lake No. It then flows eastward as the al Bahr al Abyad, or White Nile. Vaguely known to Greek geographers who thought it to be the source of the Nile, the Bahr el Ghazal was mapped as early as 1772 by J. B. d'Anville, and played an outstanding part both in exploration and in Sudanese history.

The large catchment area (328,750 sq.mi.) extends from south Darfur and Kordofan to the Republic of the Congo (former Belgian Congo) border, and from the frontier of the Central African Republic (Shari watershed) almost to the Bahr el Jebel, from which it is separated first by a narrow strip of plateau, and then by low, grassy plains and swamps of uncertain drainage direction, part of the Sudd. The river is called the Bahr el Ghazal only after it has been joined by its main affluents. These are the Jur, the Tonj (both from the south) and the Bahr al 'Arab (from the north and west). Northern tributaries from the Darfur hills are intermittent, some never reaching their main stream on the surface at all. Only the main Bahr al 'Arab and Lol are fed from areas with rainfall over 35 in., and also retain more water, the Lol being largely permanent as the Jur (or Sue) and the Tonj. These cut well-marked valleys across the southwestern Ironstone plateau before entering the clay plain of Lower Bahr el Ghazal. At their sources, the rainy season with about 50 in. annual precipitation lasts from March to November and rocks are mainly impermeable. Hence the largest rivers are permanent, though variable in depth with rapids and shoals, and attract settlement for both water supply and fish, an important food in the protein-deficient south. The smaller affluents, from areas of more rapid runoff are fished out early in the dry season.

The Jur is navigable for 170 mi. for shallow-draft steamers up to Wau, the provincial capital (pop. [1956] 8,009), from July to October or November. When Wau is inaccessible by river, the head of navigation is at Mashra'ar Raqq, on a backwater south of the Jur mouth, a famous centre for the traders and explorers in the 18th and 19th centuries. The total navigable distance on the Bahr el Ghazal above Lake No is 305 mi. to Wau, or 144 mi. to the Mashra'ar Raqq.

The Jur mouth is actually Lake Ambadi, 10 mi. by 1 mi. at low river, but of vast size in the flood, though with only a 3-ft. increase of depth, a characteristic of the Sudd region. Although free from papyrus and ambatch thickets, Lake Ambadi like Lake No is encumbered with reeds, and since 1957 with the water hyacinth. Evaporation and transpiration by aquatics and swamp plants so reduce the water that in spite of its huge catchment area the Bahr el Ghazal discharges at Lake No a maximum of about 1,800 cu.ft. per second and often nothing at all. *See* also Nile.

See H. E. Hurst, *The Nile* (1952), *A Short Account of the Nile and Its Basin* (1925), and with P. Phillips *et al.*, *The Nile Basin* (periodical, 1931–). (M. T. P.)

BAHYA BEN JOSEPH IBN PAKUDA, Jewish religious philosopher, was active in Muslim Spain in the second half of the 11th century. Around 1080 he wrote, in Arabic, a *Guidebook to the Duties of the Heart*. Practical rather than speculative in purpose, clear in language and filled with examples, the book, in a 12th-century Hebrew translation, became a widely read classic of Jewish philosophic and devotional literature.

Critical of his predecessors who, of the two requirements of religion, had emphasized the "duties of the body" to the neglect of the "duties of the heart," Bahya wrote his book to restore the proper balance. The "duties of the body" are for him those obligations which manifest themselves in man's outward actions, namely in religious ritual and ethical practice, while the "duties of the heart" are those obligations which manifest themselves in the state of his soul, namely in his attitudes and intentions. Each of the ten chapters of the book is devoted to one fundamental duty of the heart. Considering correct belief as the foundation of religion, Bahya begins by discussing the unity of God. He proceeds to an examination of the world which exhibits God's goodness, the gratitude for which leads to his service. This service should be accompanied by trust in God, sincerity, humility, re-

pentance, self-examination and asceticism. The goal is the love of God which consists of the soul's turning from the world and attaching itself to its creator.

Bahya supports his discussion with citations from scriptural and rabbinic authorities and with rational argument. He draws freely upon relevant non-Jewish sources. An English translation of the work was made by Moses Hyamson. (A. H.)

BAÍA (state), Brazil: *see* BAHIA.

BAIAE (modern BAIA), 10 mi. W. of Naples, Italy, an ancient city of Campania, on a bay on the west coast of the Gulf of Puteoli (Pozzuoli), traditionally named after Baios, helmsman of Ulysses. Perhaps originally the harbour of Cumae (*q.v.*), it was in early Roman times called Aquae Cumanae because of its curative sulfur springs. Its mild climate and luxuriant vegetation made it a fashionable watering place during the later years of the Roman republic and under the empire, and by the 1st century A.D. it was as large as Puteoli. Many magnificent villas were built there; *e.g.*, those of Julius Caesar (probably on the ridge above the 16th-century castle) and Nero (probably on the castle site). The emperor Hadrian died in Caesar's villa in A.D. 138. Extensive remains of bathing establishments include three large domed buildings, popularly called temples. Since the level of the sea has risen about 12 ft., part of the ancient site is now submerged. Baiae was devastated by the Saracens in the 8th century A.D. and entirely deserted because of malaria in 1500. South of Baiae was the resort of Bauli (perhaps the modern Bacoli), where Pompey and the orator Q. Hortensius possessed villas, the latter the scene of the dialogue in Cicero's *Academica Priora*. Later this villa became imperial property and was the scene of Agrippina's murder by Nero. In the neighbourhood are remains of a small theatre, called the tomb of Agrippina, and of two great water reservoirs (Cento Camerelle and Piscina Mirabile).

See A. Maiuri, *The Phlegraean Fields*, Eng. trans. (1947). (H. H. SD.)

BAIA MARE (Hung. NAGYBÁNYA), a town in northwestern Rumania, chief town of Maramureș region, is situated 34 mi. S.E. of Satu Mare. Surrounded by mountains, it is a mining and industrial centre whose population rose from 12,780 in 1921 to 46,312 in 1963. It was founded in the 12th century by Saxon immigrants, when it was known as Neustadt. Zinc, lead, gold and silver were extracted there. Hungarian until World War I, Baia-Mare became Rumanian in 1918. It was reoccupied by Hungary from 1940 to 1945. After World War II production increased with planned industrialization. Apart from zinc and lead smelting plants, sulfuric acid and synthetic fertilizers are produced. Until 1948 Baia Mare was the see of a Uniate bishop.

BAÏF, JEAN ANTOINE DE (1532–1589), French poet, was the most learned member of the Pléiade (*q.v.*). Born at Venice, Italy, in 1532, the natural son of Lazare de Baïf, (then French ambassador there, whose elegant Latin verse and translation of *Electra* [1537] won him fame as a humanist), the son received a classical education. In 1547 he went with Pierre de Ronsard to study under Jean Daurat at the Collège de Coqueret, Paris, where they planned, with Joachim du Bellay, to transform French poetry by imitating the ancients and the Italians. To this program Baïf contributed two collections of Petrarchan sonnets and epicurean lyrics, *Les Amours* (1552) and *L'Amour de Francine* (1555). In 1567 *Le Brave*, Baïf's lively modernized adaptation of Plautus' *Miles Gloriosus*, was played at court and published.

Baïf enjoyed royal favour and received pensions and benefices from Charles IX and Henry III. His *Euvres en rime* (1573) reveal great erudition: Greek (especially Alexandrian), Latin, neo-Latin and Italian models are imitated for mythological poems, eclogues, epigrams and sonnets. His verse translations include Terence's *Eunuchus* and Sophocles' *Antigone*. Baïf was a versatile, inventive poet who was always experimenting: for instance, he invented and used a system of phonetic spelling. With the musician J. Thibault de Courville, who gave him the idea of composing quantitative verses modeled on Greek metres and setting them to music, Baïf founded an *Académie de poésie et de musique* to promote certain Platonic theories on the union of poetry and music. Charles IX granted letters patent in 1570 and attended the concerts and discussions, as did Henry III, in whose reign it was called the *Académie du Palais*.

Baïf's metrical inventions included a *vers baïfin* of 15 syllables. His theories were exemplified in *Etrénes de poézie fransoèze an vers mezurés* (1574), without music, and *Chansonnettes mesurées* (1586), with music by Jacques Mauduit. He also translated the Psalms into quantitative verse, for which Mauduit and C. Le Jeune composed music. Baïf's *Carmina* (1577) are Latin poems. His *Mimes, enseignemens et proverbes* (1576; augmented 1581, 1597) are considered his most original work; some of the *mimes* are outspoken satires on the unhappy conditions produced by the religious wars. He died in Paris in Oct. 1589.

Like Ronsard, Baïf is a personal poet and gives autobiographical information. His misfortune was to have a noble passion for poetry without the highest poetic gifts. His best quality is a talent for vivid realistic description, particularly in scenes of country life and in satire. Baïf's works were edited by C. Marty-Laveaux (Paris, 1881–90).

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BAIGA, a tribe of India, about 30,000 people in the 1960s, in Mandla and adjacent districts of Madhya Pradesh. Baigas speak various Indo-Aryan dialects of Chhattisgarhi and Bundeli, as do their peasant and tribal neighbours. They appear allied in physique with other tribes and low Hindu castes of the region. Historically, Baigas seem to have retreated from the denser forest and are now mainly settled in remote valleys and hills. There they prefer to practise shifting agriculture under mythical sanction; they use iron axes and hoes, but not plows, cutting and burning fresh millet patches in the jungle every two or three years, as far as permitted under governmental regulation. Hunting, fishing and collecting of forest products are also main sources of subsistence. Mahua flower liquor is much valued. Villages are of wattle and thatch in a three-sided plan. The tribal costume is an abbreviated version of regional Hindu peasant costume, although Baigas are noted for their proscription of the Hindu custom of cleansing with water after defecation. The tribe has its own priesthood and a varied pantheon of gods whose names are Hindu but whose personal traits and good humour are unique.

Baigas have a cultural identity but are divided socially into at least 11 territorial subtribes which do not intermarry freely. Descent is traced patrilineally through indigenous localized lineages and also through a system of nonlocalized clans evidently imitated from surrounding peoples. Kinship usages generally resemble those of peasants of middle India, except that cross-cousins on both sides are approved for marriage.

See V. Elwin, *The Baiga* (1939); D. S. Nag, *Tribal Economy* (1958); J. H. Hutton, *Caste in India*, 4th ed. (1963). (M. MA.)

BAIKAL, LAKE (OZERO BAYKAL), lies in eastern Siberia, within the Buryat Autonomous Soviet Socialist Republic, U.S.S.R., and Irkutsk *oblast*. It is the third largest lake of the U.S.S.R. and the eighth largest in the world, with an area of 12,162 sq.mi. The outline of the lake is long and narrow, its length (roughly northeast to southwest) being 395 mi. and its width varying from 15 to 49 mi. Its surface is 1,486 ft. above sea level. The lake is walled in by mountains, extensions of the Sayan mountains. Along the northwestern shore are the Primorski and Baikal ranges and along the southeastern lie the Khamar-Daban, Ulan-Burgasy and Barguzinski ranges, separated by the major valleys of the Selenga and Barguzin rivers. There are 18 islands in the lake, the biggest being Olkhon Island, the steep mountain sides of which rise to 4,186 ft. The others form the Malyye Ushkani island group off the Svyatoi Nos peninsula, which juts out into the lake from the southeastern shore. Transbaikalia (Zabaykalye) is the region between Lake Baikal and the Upper Amur river.

The origins of the lake are tectonic, the deep depression in which it lies being formed by faulting. The fringing mountains rise up steeply to a maximum height of 8,445 ft., while the lake has a maximum depth of 5,715 ft., making it the deepest in the

world (in April 1960, it was announced that new soundings had not confirmed the formerly believed maximum depth of 5,714 ft.). The lake bottom can be divided into three basins. The most south westerly, which reaches 4,528 ft. deep, was formed during the Upper Jurassic period; the central basin, between the Selenga delta and Svyatoi Nos, is the deepest and was formed in the Tertiary period, at which time the first basin was deepened; the third basin, up to 2,992 ft. deep was formed at the very end of the Tertiary, when the two earlier basins sank still farther. Movement is still continuing and earthquakes occur around the lake. In the 1862 earthquake over 73 sq.mi. of the Selenga delta sank beneath the lake to form the Proval gulf.

Lake Baikal has 336 tributary rivers, several of which are of considerable size—the Selenga, Barguzin and Upper Angara. These larger rivers have formed sizable deltas in the lake, the only significant breaks in the mountain walls along the 1,240-mi.-long shoreline. The outlet for the lake is the Angara, a tributary of the Yenisei. A large hydroelectric station was completed in 1956 on the Angara at Irkutsk, about 36 mi. below the lake.

Baikal is characterized by low annual average temperatures of the surface water, 40° F. in the south, 37° F. in central Baikal. Maximum temperatures occur in September and only in rare years pass 50° F. Below about 700 ft. the water temperature remains constant at about 39° F. Until the lake surface freezes over in late December Baikal has a marked warming influence on the climate of the vicinity, up to 18° warmer than Irkutsk. Similarly, the lake has a cooling influence in summer.

The lake is remarkable for the richness of its fauna and flora. Of the 1,700 species identified there, 1,083 are not found anywhere else in the world. These include 773 plant species, 210 protozoa and 710 other animal species. The lake is rich in plankton. The one mammal is the Baikal seal (*Phoca sibirica*). The genus of amphipod crustaceans (*Gammarus*) or sand hoppers is represented by 292 species and 66 subspecies.

Fishing is important, although the catching of certain fish is now limited, and in the case of the sturgeon prohibited. The *omul* of the salmon family makes up about half the annual catch of 100,000 tons. Baikal is used for navigation and timber rafting, but losses of timber are high. This is attributed largely to the frequent severe storms on the lake, together with the lack of sheltered harbours. Most river mouths have bars which impede navigation. There are steamer services between the lake ports of Listvyanka, Babushkin, Ust-Barguzin and Nizhne-Angarsk. In winter, ice roads usable by vehicles are established across the lake. The trans-Siberian railway and a motor road follow the shore at the southern end of the lake. (R. A. F.)

BAIKIE, WILLIAM BALFOUR (1825–1864), Scottish explorer, naturalist and philologist, whose travels into central and northern Nigeria helped to open up the country to British trade. He was born at Kirkwall, Orkney Islands, on Aug. 27, 1825. After studying medicine at Edinburgh, he joined the navy as an assistant surgeon and was invited to take part in the Niger expedition, sponsored by Macgregor Laird with government support, which was to sail up the Benue river and attempt to make contact with the explorer Heinrich Barth (*q.v.*). On Capt. John Beecroft's death at Fernando Po, Baikie took command of the expedition and penetrated 250 mi. further up the Benue than anyone previously. In 1857 he returned, as British consul, to explore the Niger in the steamer "Dayspring." She was wrecked in the rapids above Jebba and although the expedition broke up Baikie continued his work. At Lokoja, at the confluence of the Niger and the Benue, he founded a settlement for trading on the rivers and overland. There Baikie ministered to medical and all other needs, compiled various African vocabularies and translated parts of the Bible and Prayer Book into Hausa. In 1862 he made a journey to Bida, Zaria and Kano, a distance of about 250 mi. Baikie's early writings were on Orkney and throughout his life he contributed to learned journals. He recorded his first expedition in *Narrative of an Exploring Voyage up the Rivers Kwo'ra and Binue . . . in 1854* (1856). He died at Sierra Leone en route for home leave on Dec. 12, 1864. (R. M. P.)

BAIL, in Anglo-American law, refers to the procedure by which a judge or magistrate sets at liberty one who has been arrested and imprisoned in connection with a legal matter, criminal or civil, upon receipt of security to ensure the released prisoner's later appearance in court for further proceedings in the matter. The security itself is also called bail. The principal use of bail is to secure the release, pending trial, of one arrested and charged with a criminal offense. Its use in civil cases has diminished along with the decline of imprisonment for debt; but bail is used to secure the release of an alien pending deportation proceedings or of a juvenile awaiting a hearing on a petition charging delinquency. So too a material witness, imprisoned to ensure his presence at a trial, may be released upon furnishing bail. (For the various means of furnishing bail, and for the relationship of the arrested person to his sureties, *see* RECOGNIZANCE.)

United States.—Three-fourths of the states have constitutional provisions guaranteeing that "all persons are bailable by sufficient sureties except for capital offenses where the proof is evident or the presumption great"; in the other states and in the federal system, where the constitution grants no such absolute right to bail, the judicial officers who administer bail have a greater discretion regarding the granting of bail in particular cases. In addition the U.S. constitution and the constitutions of almost all states contain provisions forbidding excessive bail; *i.e.*, requiring bail, when granted, to be fixed at a reasonable amount. *See* also BILL OF RIGHTS, UNITED STATES.

The purposes of bail pending trial in criminal cases are to avoid inflicting punishment upon an innocent person (the accused may be later acquitted) and to permit the unhampered preparation of the defense, at the same time minimizing the risk that the accused will not appear for his trial. Theoretically, the amount of bail should be set in the light of all the factors which bear upon the risk of the accused's nonappearance for trial: the seriousness of the offense, the strength of the evidence, the accused's character, history, reputation, roots in the community and his financial ability to secure bail. In practice, the magistrate who fixes the amount of bail seldom has the benefit of the comprehensive study which would reveal all these matters; thus bail is generally set solely according to the nature of the offense charged.

Bail after conviction pending appeal is generally held not to be a constitutional right. The reasons for bail after conviction are naturally weaker than for bail before conviction. Nevertheless, most U.S. jurisdictions allow bail after trial pending appeal unless the appeal is frivolous.

In the United States the sureties on bail undertakings are generally surety companies and professional bondsmen who charge fees for their services, rather than (as in England) the accused's friends and relations. Much of the criticism concerning bail in the U.S. has been directed at unscrupulous bondsmen for their excessive fees and financial irresponsibility; at the professional bondsman who, in practice, exercises little supervision over the accused; at the lack of financial deterrent upon the accused to abscond, since the surety, not the accused, is expected to pay upon default; and at the fact that the indigent accused, who may deserve pretrial freedom, cannot secure it, whereas the professional criminal finds it relatively easy to do so. A few jurisdictions have made it a separate criminal offense to "jump bail" instead of appearing as required, thus creating a personal deterrent to absconding. (A. W. St.)

England.—In England bail is obligatory in all summary cases. Bail may be granted in all cases other than treason, but it is not usually granted in cases of murder or attempted murder. The granting of bail to accomplices has been held to be improper because of the danger of their absconding. The sureties must be sufficient in the opinion of the court to answer for the sum which they are bound, and, as a rule, only householders are accepted; an accomplice of the person to be bailed or an infant would not be accepted. In cases of treason, bail can be granted only by a secretary of state or by the queen's bench division. The power of admitting a prisoner to bail is judicial and not ministerial, and the exercise of the discretion must not be punitive, the chief consideration being the likelihood of the prisoner's failing to appear at the trial. This must be gauged from the nature of, and the

evidence in support of, the accusation, the position of the accused and the severity of the punishment which his conviction will entail, as well as from the independence of the sureties. The Bail act of 1898 gives a magistrate power, where a person is charged with felony or certain misdemeanours, or where he is committed for trial for any indictable offense, to dispense with sureties if in the magistrate's opinion this dispensation will not tend to defeat the ends of justice.

A surety may be examined on oath as to his means, while the court may also require notice to be given to the plaintiff, prosecutor or police. A person who has been taken into custody without a warrant, for an offense not apparently of a serious nature, and who cannot be brought before a court of summary jurisdiction within 24 hours, may be admitted to bail by a police officer of superior rank or by the officer in charge of the police station; and this can be done while inquiries are being made (Criminal Justice acts, 1914 and 1925).

Where magistrates have refused bail, application may be made to the queen's division, and the court of trial has power to grant bail when necessary. Bail may be granted to a convicted person who has been granted leave to appeal, and this power has been enlarged in certain respects by s. 37 of the Criminal Justice act, 1948. *See* also ARREST. (W. DE B. H.; W. T. Ws.)

BAILEY, GAMALIEL (1807–1859), U.S. abolitionist, was the editor of *The National Era*, the first U.S. abolitionist journal (1847–1860). Born at Mount Holly, N.J., on Dec. 3, 1807, he graduated from the Jefferson Medical college in Philadelphia in 1827. In 1834 he was a lecturer on physiology at the Lane Theological seminary, Cincinnati, O., when the Lane seminary debates on slavery occurred. These stirred him to become an ardent abolitionist. In 1836 he joined James G. Birney in editing the *Cincinnati Philanthropist*, the first antislavery organ in the west and, soon becoming sole proprietor, continued it despite his printing office being wrecked three times and the entire building being destroyed by proslavery mobs. In 1843 he launched a daily paper, the *Herald*.

In Jan. 1847 Bailey became editor of *The National Era*, established in Washington, D.C., by the American and Foreign Anti-Slavery society. This paper had a considerable circulation and exerted a strong political and moral influence. Nathaniel Hawthorne, John Greenleaf Whittier and Theodore Parker were contributors, and in it Harriet Beecher Stowe's *Uncle Tom's Cabin* first appeared as a serial in 1851–52. In 1853 Bailey's health began to decline, and on June 5, 1859, while on a voyage to Europe for his health, he died.

BAILEY, LIBERTY HYDE (1858–1954), U.S. botanist, horticulturist and educator, who pioneered in transforming American horticulture from a craft to an applied science, was born at South Haven, Mich., on March 15, 1858. He graduated from Michigan Agricultural college in 1882 and served as an assistant to Asa Gray at Harvard university and as professor of horticulture at Michigan State college (1884–88). At Cornell university, Ithaca, N.Y., he became professor of horticulture in 1888. As dean of the New York State College of Agriculture at Cornell (1903–13), chairman of Theodore Roosevelt's Commission of Country Life (1907–08) and editor successively of three periodicals, Bailey provided national leadership in developing agricultural education and in improving farm living. As botanist he was an authority on the classification of the genera *Carex*, *Rubus*, *Brassica* and tropical American members of the palm family. In addition he founded (1920), and was director (1935–51) of, the world's first botanical institution devoted to studies on the classification and identification of cultivated plants, the Bailey hortorium, later a division of the New York State College of Agriculture at Cornell. He also was author of 63 books and editor of 4 encyclopaedic works in the fields of botany, horticulture and agriculture. He died in Ithaca on Dec. 25, 1954.

Bailey was a man of driving energy. As a diversion from administrative burdens and research in science he wrote two volumes of poetry and nine in the fields of rural sociology, religion and philosophy.

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BAILEY, PHILIP JAMES (1816–1902), English poet, was leader of the "spasmodic" school of poets, which included also S. J. Dobell and Alexander Smith. It was so named by W. E. Aytoun who parodied its style. Bailey was born in Nottingham, April 22, 1816, and educated at Glasgow university. He became a barrister of Lincoln's Inn, but in 1836 retired to write *Festus*, a version of the Faust legend which despite the typical "spasmodic" faults of turgidity and plagiarism, had, as Tennyson said, "very grand things in it." It appeared in 1839 and made a great impression. Its 50 scenes of blank verse dialogue, 20,000 lines in the first edition, were swelled by additions from Bailey's other and less successful works to 40,000 lines in the 11th edition of 1889. Typical of its mid-Victorian sentiment and style are the lines, "We live in deeds, not years . . . we should count time by heart-throbs." Bailey's other works included *The Angel World* (1850), *The Mystic* (1855) and *The Universal Hymn* (1867). He died at Nottingham, Sept. 6, 1902.

BAILEY, SAMUEL (1791–1870), English economist and philosopher whose chief contribution to economic analysis was his argument that value is a relationship and that it implies a state of mind, was born at Sheffield. He founded the Sheffield Banking company (of which he eventually became chairman) in 1831 and unsuccessfully sought to enter the house of commons in 1832 and in 1834.

His published works, which range over a wide field, include pamphlets on parliamentary reform, on the right of primogeniture and on currency restrictions, the most important of which are: *Essay on the Formation and Publication of Opinions* (1821), in which he argued that an individual's opinions are independent of his will; its sequel, *Essays on the Pursuit of Truth and on the Progress of Knowledge* (1829); *A Critical Dissertation on the Nature, Measures and Causes of Value* (1825; new ed., 1931), a criticism of the Ricardian school of political economy; *Review of Berkeley's Theory of Vision* (1842); and *Letters on the Philosophy of the Human Mind*, 3 vol. (1855–63).

In Bailey's economic theories may be traced germs of a subjective theory of value. He also emphasized the influence of monopoly in value formation; and his discussion of the various degrees of skill accruing to labour foreshadowed the rent-of-ability concept. He denied the reciprocal relationship between wages and profits, stressed the productivity of labour and sought to eliminate the pessimistic implications of David Ricardo's doctrines. His philosophical writings bore witness to his lively and critical intelligence but suffered from a limited knowledge of other schools. In politics he was a utilitarian radical opposed to state interference. He died on Jan. 18, 1870. (I. C. B.)

BAILIFF AND BAILIE. A bailiff is usually a minor court official with police authority to protect the court and with the power to serve and execute legal process. In earlier times it was a title of more dignity and power. The vestiges of the earlier meaning may be found in the use of the word in England to mean the chief magistrate of a village and in Scotland to denote an official appointed to exercise a local delegated jurisdiction, civil or criminal ("bailie"). In France, the word *bailli* once had the same meaning as seneschal, the primary representative of the feudal lord, who often exercised judicial functions. *See* JUDICIARY AND COURT OFFICERS. (P. B. K.)

BAILLIE, LADY GRIZEL (1665–1746), Scottish poet known for her songs "And werena my heart licht I wad dee" and "The ewe-buchtin's bonnie," was born at Redbraes castle, Berwickshire, on Dec. 25, 1665, the eldest daughter of Sir Patrick Hume (or Home), later earl of Marchmont. At the age of 12 she carried letters from her father to the imprisoned Scottish conspirator, Robert Baillie of Jerviswood (*q.v.*). During Baillie's trial, Sir Patrick spoke in his defense and was therefore himself regarded with suspicion. Redbraes castle was occupied by the king's troops and he was forced to hide in Polwarth church, where Lady Grizel brought him food. After Baillie's execution (1684) the family fled to Holland, where they remained until they could

return to Scotland at the revolution. In 1692 Lady Grizel married George Baillie, Robert Baillie's son. She died on Dec. 6, 1746.

Although Lady Grizel is known to have written several songs, only two are extant: "The ewe-buchtin's bonnie," which may have been inspired by her father's hiding in Polwarth church, and the well-known "And werena my heart licht I wad dee," which first appeared in *Orpheus Caledonius* (1725) and which was included in Allan Ramsay's *The Tea Table Miscellany* (4 vol., 1724–37).

See Lady Grizel Murray's (her daughter) *Memoirs . . . of the Right Honourable George Baillie of Jerviswood, and of Lady Grisell Baillie* (1822); R. S. Moncrieff (ed.), *The Household Book of Lady Grisell Baillie, 1692–1733,* Scottish Historical Society (1911).

BAILLIE, JOANNA (1762–1851), Scottish poet and dramatist who was a friend of Sir Walter Scott, was born at Bothwell, Lanarkshire, on Sept. 11, 1762. She was the younger sister of Matthew Baillie (*q.v.*). In 1784 she left Scotland with her mother, a sister of William and John Hunter, and her sister Agnes. Later the two sisters settled at Hampstead, where they passed the remainder of their lives. In 1790 Joanna Baillie published anonymously her *Fugitive Verses* and in 1798 the first volume of her *Plays on the Passions.* These, the title page explains, "attempted to delineate the stronger passions of the mind, each passion being the subject of a tragedy and a comedy." The second and third volumes were published in 1802 and 1812. At this period Joanna Baillie met Sir Walter Scott who wrote a prologue for the production of her play, *The Family Legend,* at Edinburgh in 1810 and of whom she became a lifelong friend. Earlier, in 1800, John Kemble and Sara Siddons acted in her play *De Montfort* at Drury Lane. At a later production of this play the leading part was taken by Edmund Kean. In 1804 her *Miscellaneous Plays* appeared. A complete edition of her dramatic and poetical works was published in 1851. She also wrote songs, some of which are adaptations of dialect folk songs. She died at Hampstead on Feb. 23, 1851.

BIBLIOGRAPHY.—*Dramatic and Poetical Works of Joanna Baillie* (1851); M. S. Carhart, *The Life and Work of Joanna Baillie* (1923). *See* also for Joanna Baillie's songs, C. Rogers, *The Modern Scottish Minstrel,* vol. i (1855).

BAILLIE, MATTHEW (1761–1823), Scottish pathologist whose *Morbid Anatomy,* published in 1793, was the first publication in English on pathology as a separate subject, was born at Shotts, Lanarkshire, on Oct. 27, 1761. He was educated at Balliol college, Oxford, and settled in London, where he practised medicine and taught anatomy. He was a nephew of William and John Hunter, the great anatomists, and a brother of poetess Joanna Baillie (*q.v.*). He died at Duntisborne, Gloucestershire, on Sept. 23, 1823.

See MEDICINE AND SURGERY, HISTORY OF: *Medicine in the 18th Century.*

BAILLIE, ROBERT (1599–1662), Presbyterian minister who represented Scotland at the Westminster assembly (1643) and was noted for his learning and moderation, was born in Glasgow. As minister of Irvine he refused to support the introduction of Laud's prayer book in Scotland (1637), though he was a moderate member of the Glasgow assembly (1638) at which the Church of Scotland broke away from the English episcopal system. He became professor of divinity at Glasgow (1642), and in 1661 was made principal of the university. He died in July 1662 in Glasgow. His *Letters and Journals,* edited by D. Laing (1841–42), are of great historical interest.

BAILLIE, ROBERT (BAILLIE OF JERVISWOOD) (*c.* 1634–1684), Scottish landowner and conspirator, was from 1676 associated with political and ecclesiastical disaffection in Scotland. Despairing of prospects there, he associated himself in 1683 with plans for a settlement in South Carolina which brought him into communication, in London, with the duke of Monmouth, Lord William Russell and their faction. Although, after the discovery of the Rye House plot (1683), he denied knowledge of or complicity in the plot, he admitted that an insurrection in Scotland was discussed. After six months' imprisonment in London he was sent back to Edinburgh, where the privy council fined him £6,000 for treason; then, by an irregularity which startled his contemporaries, he was indicted before the court of justiciary on the same charge, found guilty, and hanged on Dec. 24, 1684. (GN. D.)

BAILLOU, GUILLAUME DE (BALLONIUS) (1538–1616), French physician, studied and taught medicine in Paris. He has a place in the history of epidemiology because of two books posthumously published (1640) on epidemics, in which he revived the Hippocratic doctrine of "epidemic constitutions" which seems to have influenced the work of Thomas Sydenham (*q.v.*). Baillou first described whooping cough (1578), and he differentiated between rheumatism and gout, as Hippocrates had done.

His works include *Definitionum medicinalium liber* (1639), a glossary of Hippocratic terms; *Consilia* (1635–49); treatises on gynecology (1643) and gout (1643); and two books on epidemics and diseases (1640).

See MEDICINE AND SURGERY, HISTORY OF: *Early Greek and Roman Medicine.*

BAILLY, JEAN SYLVAIN (1736–1793), French astronomer and politician, born at Paris on Sept. 15, 1736, calculated an orbit for the comet of 1759 (Halley's), reduced N. de Lacaille's observations of 515 zodiacal stars, and was, in 1763, elected a member of the Academy of Sciences. His *Essai sur la théorie des satellites de Jupiter* (1766), was followed by *Sur les inégalités de la lumière des satellites de Jupiter* (1771) and by a series of important works on the history of science.

The Revolution interrupted his studies. Elected deputy from Paris to the states-general, he was chosen president of the Third Estate (May 5, 1789), led the famous proceedings in the Tennis Court (June 20), and acted as mayor of Paris (July 15, 1789, to Nov. 16, 1791). The dispersal by the national guard, under his orders, of the riotous assembly in the Champ de Mars (July 17, 1791), rendered him obnoxious to the infuriated populace, and he retired to Nantes, where he composed his *Mémoires d'un témoin de la Révolution* (published by Berville and Barrière, 1821–22), an incomplete narrative of the extraordinary events of his public life. Late in 1793, Bailly quitted Nantes to join his friend Pierre Simon Laplace at Melun; but was there recognized, arrested and brought (Nov. 10) before the revolutionary tribunal at Paris. On Nov. 12 he was guillotined.

See H. B. Sawyer-Hogg, *J. R. Astr. Soc. Can.,* vol. 48 (1949).

BAILMENT, a delivery of specific goods by one person, called the bailor, to another person, called the bailee, for some temporary purpose such as storage; transportation; deposit for sale; loan for use, with or without compensation; pawn or pledge; or repair. The Anglo-American law formerly divided bailments into three classes: (1) for the benefit of the bailor; (2) for the benefit of the bailee; and (3) for the benefit of both parties. In the first instance the bailee was said to owe only a duty of slight care to preserve the property concerned; in the second he owed a duty of great care; in the last he owed a duty of ordinary care. Correspondingly, if the chattel was lost or damaged he was liable in the first situation only for gross negligence, in the second for even slight negligence and in the third for ordinary negligence.

Logical difficulties involved in ascertaining and applying three degrees of care and negligence have caused juristic thinkers to generalize that the bailee owes such duty of care as becomes the reasonably prudent man "under the circumstances." The purpose and advantage anticipated from the bailment are considered as "circumstances" governing the extent of care owed by the bailee.

The bailee is usually not permitted to deny the right of the bailor to direct the disposition of the chattel when the purpose of the bailment has been completed unless he has been required to deliver it to one having a right to possession superior to that of the bailor. However, the burden of proof is upon the bailee to establish the better right of this third party.

Common types of bailments have been similar under most systems of law, and they were designated by specific names in the Roman law. Some of them have characteristic legal consequences; *e.g.*, the bailee for repairs has a lien which entitles him to retain possession until he has been paid for his service, as does the bailee for transportation.

See also AFFREIGHTMENT; FACTOR; LIEN; PAWNBROKING; PERSONAL PROPERTY; PUBLIC UTILITIES. (C. M. U.)

BAILY, FRANCIS (1774–1844), English astronomer who detected the phenomenon known as "Baily's beads," was born at Newbury, Berkshire, on April 28, 1774. He made a fortune on the stock exchange, and acquired a great reputation for his actuarial calculations. He retired from business in 1825. He had already, in 1820, taken a leading part in the foundation of the Royal Astronomical society; and its gold medal was awarded him in 1827, for his preparation of the Astronomical society's catalogue of 2881 stars. The reform of the *Nautical Almanac* in 1829 was set on foot by his protests; he recommended to the British association in 1837, and in great part executed, the reduction of Joseph de Lalande's and Nicolas de Lacaille's catalogues containing about 57,000 stars; he superintended the compilation of the British association's catalogue of 8,377 stars (published 1845); and revised the catalogues of Tobias Mayer, Ptolemy, Ulug-Beg, Tycho Brahe, Edmund Halley and Hevelius.

His notice of "Baily's beads," during an annular eclipse of the sun on May 15, 1836, at Inch Bonney in Roxburghshire, started the modern series of eclipse expeditions. The phenomenon, which depends upon the inequalities of the moon's limb, was so vividly described by him as to attract an unprecedented amount of attention to the totality of July 8, 1842, observed by Baily himself at Pavia. He completed and discussed H. Foster's pendulum-experiments, deducing from them an ellipticity for the earth of $\frac{1}{289}$; corrected for the length of the seconds-pendulum by introducing a neglected element of reduction; and was entrusted, in 1843, with the reconstruction of the standards of length. His laborious operations for determining the mean density of the earth, carried on by Henry Cavendish's method (1838–42), yielded for it the authoritative value of 5.66. Baily's *Account of the Rev. John Flamsteed* (1835) is of fundamental importance to the scientific history of that time. It included a republication of the British catalogue. Baily died in London on Aug. 30, 1844.

See J. Herschel, *Mon. Not. R. Astr. Soc.*, xiv (1844).

BAILY'S BEADS, a phenomenon seen during a total eclipse of the sun. Just before the moon's disk completely covers the sun the narrow crescent of sunlight is broken in several places, giving an appearance roughly compared to a string of beads. This is due to irregularity (mountains and valleys) on the edge of the moon's disk. These "beads" were named after Francis Baily (*q.v.*).

BAIN, ALEXANDER (1818–1903), British philosopher, chiefly distinguished for his work on psychology but influential also in the improvement of education in Scotland, was born at Aberdeen on June 11, 1818. The son of a weaver, he worked for some years at his father's trade but studied diligently in the evenings and, in 1836, won a bursary at Marischal college, Aberdeen. Graduating in 1840, he began to contribute to the *Westminster Review*, thus coming into contact with John Stuart Mill and his circle in London, who soon became his close friends. After some unsuccessful attempts to find a permanent appointment in Scotland, Bain accepted Edwin Chadwick's offer of a post under the board of health in London (1848–50). After this he held various other posts in London (in education or the civil service) for the next ten years. Two important publications of his in this period were *The Senses and the Intellect* (1855; 4th ed., 1894) and *The Emotions and the Will* (1859; 4th ed., 1899).

In 1860 Bain was appointed to the new chair of logic and English at Aberdeen. At this post he conscientiously set himself to promoting the reform of teaching methods in Scotland, with particular regard to his own two subjects. A series of books on English grammar and rhetoric (1863, 1866, 1872, 1874) was accompanied by a two-volume work on *Logic* (1870), notable for its detailed account of the application of logic to the natural sciences. His *Education as a Science* appeared in 1879.

Bain's practical services to education, which were recognized by the award of a doctorate of laws from Edinburgh university as early as 1869, did not preclude his pursuing his interest in psychological theory, which he further expounded in *On the Study of Character* (1861), *Mental and Moral Science: a Compendium of Psychology and Ethics* (1868) and *Mind and Body: the Theory of Their Relation* (1873; 5th ed. 1876). Moreover, it was he who founded the philosophical periodical *Mind*, which first appeared in 1876, with his pupil George Croom Robertson as editor.

Bain resigned his professorship in 1880, but was twice subsequently elected rector of his university (1881 and 1884). His later books included *James Mill: a Biography* (1882), *John Stuart Mill: a Criticism, With Personal Recollections* (1882), *Practical Essays* (1884), *On Teaching English* (1887), *Dissertations on Leading Philosophical Topics* (1903) and the posthumous *Autobiography*, edited by W. L. Davidson (1904). Bain died in Aberdeen on Sept. 18, 1903.

In ethics Bain followed John Stuart Mill's utilitarianism, but in logic he modified Mill's doctrine in some respects. To association psychology (*see* PSYCHOLOGY, HISTORY OF; and ASSOCIATION, MENTAL) he made important contributions. Adopting a rigorously scientific attitude to problems that earlier British philosophers had treated metaphysically, he presented mind not as a number of "faculties" but as a psychophysical unity and led the way in insisting on the need for investigation of those physical conditions (processes in the brain and in the nervous system) which play "a concurring part" in many mental states.

BAINBRIDGE, JOHN (1582–1643), English astronomer and physician, known for his work on comets, was born at Ashby-de-la-Zouch, Leicestershire. He started as a physician and practised for some years. Sir Henry Savile appointed him in 1619 to the Savilian chair of astronomy just founded by him at Oxford; Bainbridge was incorporated of Merton college and became in 1631 and 1635 respectively, junior and senior reader of T. Linacre's lectures. He wrote *An Astronomical Description of the late Comet* (1619); *Canicularia* (1648); and translated Proclus's *De Sphaera*, and Ptolemy's *De Planetarum Hypothesibus* (1620). Bainbridge died at Oxford on Nov. 3, 1643. Several manuscript works by him exist in the library of Trinity college, Dublin.

BAINBRIDGE, WILLIAM (1774–1833), U.S. naval officer, was born at Princeton, N.J., May 7, 1774. After considerable experience in merchant service he became an officer in the newly organized U.S. navy in 1798. He served in the war upon the Barbary states, being in command of the frigate "Philadelphia" when it was captured by the Tripolitans. He was a prisoner for a time, and upon his release returned to service in the merchant marine. At the outbreak of the second war with England in 1812 he was again commissioned in the U.S. navy, succeeding to the command of the frigate "Constitution." His notable victory in the South Atlantic was the capture of the British frigate "Java." After the close of the war and his retirement, he served as a member of the board of naval commissioners. He died July 27, 1833. (E. E. R.)

BAINVILLE, JACQUES (1879–1936), French political writer and historian, a member of the Académie Française from 1935 and a leading exponent of conservative ideals between World Wars I and II. Born at Vincennes, on Feb. 9, 1879, of a republican family, he early embraced the royalist cause under the influence of Maurice Barrès and Charles Maurras. He was closely associated with the royalist papers, *Gazette de France* and *Action française*. After a visit to Germany, he published a work on Bismarck (1907), emphasizing the German statesman's support of French republicanism.

His *Histoire de deux peuples* (1915, rev. 1933) dealt with the recurrent German invasions of France. His *Conséquences politiques de la paix* (1920), a reply to J. M. Keynes' *The Economic Consequences of the Peace*, attacked the treaty of Versailles and forecast the German menace. His *Histoire de France* (1924; Eng. trans. 1926) was later republished with other studies under the title *Heur et Malheur des Français*. His studies of German history were collected as *L'Allemagne romantique et réaliste*. Other historical studies, illustrating both his traditional outlook and his psychological insight, dealt with Napoleon and the mentality of dictators. His political philosophy, which found growing support toward the end of his life, opposed both plutocracy and democracy. In *Histoire de la III^e République* (1935; Eng. trans., *The French*

Republic, 1936) he predicted a German attack and a national revolution. He published a study of English political history, *L'Angleterre et l'Empire britannique* (1938). His essays, tales and prefaces were collected in *Jaco et Lori* (1927) and *Le Jardin des lettres* (1929). He died in Paris, Feb. 9, 1936.

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BAIRAM, an Osmanli-Turkish word meaning "festival," applied in Turkish to the two canonical festivals of Islam. The first of these according to the calendar is the Lesser Bairam, in Arabic *'id al-fitr* ("Festival of Breaking Fast"), which follows immediately the fasting month Ramadan, occupying the first three days of the tenth month, Shawwal. Official receptions are held on it, and private visits paid; friends congratulate one another, and presents are given; new clothes are put on, and the graves of relatives are visited.

The second, Sacrifice Bairam, in Arabic *'id al-adha,* falls on the tenth, and three following days, of the last month of the year. Throughout the Muslim world, all who can afford it sacrifice at this time a legal animal, and either consume the flesh themselves or give it to the poor, commemorating the ransom of Ishmael with a ram. *See* also FEAST AND FESTIVAL.

See articles "Bairam," "'Id," "'Id al-Adha," and "'Id al-Fitr" in *Shorter Encyclopaedia of Islam* (1953).

BAIRD, JOHN LOGIE (1888–1946), British inventor and television pioneer, born on Aug. 13, 1888, at Helensburgh, Scot., was educated at Larchfield academy, the Royal Technical college and Glasgow university. He was the first to achieve television over any distance, he reproduced objects in outline (1924); transmitted recognizable human faces (1925); and in 1926, at the Royal institution, London, demonstrated the first true television. He produced the "noctovisor" for seeing in the dark (1927); he televised images from England to the "Berengaria" in mid-Atlantic (1928). In 1929 the German post office gave him facilities to develop a television service based on his system and two months later the British Broadcasting corporation lent its transmitter for him to continue his experiments. When the B.B.C. television service began in 1936 his system was in competition with another promoted by Marconi Electrical and Musical Instruments. Both continued side by side for some months, but in Feb. 1937 the B.B.C. adopted the Marconi E.M.I. system exclusively. Baird demonstrated television in natural colours (1939) and in 1946 was reported to have completed his researches on stereoscopic television. He died at Bexhill-on-Sea, Eng., on June 14, 1946.

(D. McK.)

BAIRD, SPENCER FULLERTON (1823–1887), U.S. naturalist, in his time the best informed man on the vertebrate fauna of North America, was born at Reading, Pa., Feb. 3, 1823. In 1838 a meeting with John J. Audubon, who gave Baird part of his own collection of birds, turned the young man's interest to ornithology. A year after his graduation from Dickinson college, Carlisle, Pa. (1840), he made an ornithological excursion through the mountains of Pennsylvania. After studying medicine for a time, Baird became professor of natural history in Dickinson college (1845).

From the time he began his studies in natural science, Baird saw the pressing need for raw materials. By the time he was 27 he had accumulated 3,500 skins of birds and collections of reptiles, embryos, skeletons and skulls of North American vertebrates. This became the nucleus of the vast collection of North American fauna which he assembled after he became assistant secretary of the Smithsonian institution in 1850. The great labour of correspondence, examination, description and editing of reports for the Smithsonian collection was accomplished by Baird, in connection with the publication of the 13 volumes of reports. In addition, Baird worked nights on the preparation of the volumes on birds, mammals and reptiles. His great monographs at once became classics of systematic zoology. With the appearance of his volume on birds began what Elliott Coues (*Popular Science Monthly*, vol. xxxiii, p. 553) calls the Bairdian period of American ornithology, lasting nearly 30 years. This volume, says Coues, "marked an epoch in the history of American ornithology."

In 1878 Baird succeeded Joseph Henry as secretary of the Smithsonian institution. Through Baird's efforts, congress created the commission of fish and fisheries in 1874 and placed Baird at its head, in which position he did work worth millions of dollars to the country and organized fish culture in the United States so well that it has been widely copied as a model by other countries.

Baird died at Woods Hole, Mass., Aug. 19, 1887.

His important works were: *Birds* (1858); *Mammals of North America* (1859); *History of North American Birds* (1875–84).

BAIRNSDALE, a town of Victoria, Austr., about 170 mi. E. of Melbourne by road or rail, lies on the Mitchell river near the head of Lake King (a lagoon). Pop. (1961) 7,427. It developed originally as a port for the shipment of produce from eastern Gippsland and the Monaro plains, but shipping services have been replaced by road and rail transport. Nearby are the resort areas of Gippsland lakes, Lakes Entrance and Ninety Mile beach.

Bairnsdale shire (area 948 sq.mi.) is chiefly pastoral and agricultural, with dairying, sheep and cattle grazing, fruit and corn growing, timber and freestone quarrying. There are tanneries and sawmills, and butter, soap and cordials are produced.

BAIUS (BAJUS), **MICHAEL** (MICHAEL DE BAY) (1513–1589), Flemish theologian, whose work powerfully influenced that of Cornelius Jansen (*q.v.*), was born at Melin in Hainaut. Educated at Louvain, he studied philosophy and theology and held various university appointments there. About 1550, with John Hessels, he began to advance revolutionary doctrines of grace and justification, founded on a new interpretation of St. Augustine. Baius' numerous short treatises on theological subjects incurred censures by ecclesiastical authorities; in 1567 Pius V condemned 79 propositions in the bull *Ex omnibus afflictionibus.* Baius submitted, but indiscreet utterances by himself and his supporters led to a new condemnation in 1579 by Gregory XIII. Baius, however, kept his professorship, and became chancellor of Louvain in 1575; he died there on Sept. 16, 1589. The most distinctive features of "Baianism," which are found also in some Protestant writers, concern the fall of man. Baius held that the innocence of Adam and Eve was part of their nature, so that the first sin destroyed intrinsic principles of human nature.

His principal works were published in collected form in 1696. *See* F. X. Jansen, *Baius et le Baianisme* (1927). (N. J A.)

BAIXO ALENTEJO, a province of southern Portugal formed in 1936 from parts of old Alentejo and Estremadura (*qq.v.*) provinces, includes the district of Beja and part of Setúbal (*qq.v.*). Pop. (1950) 375,147; area 5,322 sq.mi. Most of the province is composed of a vast, rolling plain 450–600 ft. above sea level, forming the watershed between the Guadiana and Sado. It is characterized by large estates, nucleated settlements at infrequent intervals and extensive sericulture. The richest lands centre on Beja, with extensive cork oak forests on the west and evergreen oak woodlands east of the Guadiana in Além-Guadiana. The pasturage of the Cotenda de Moura, formerly communal to both Spanish and Portuguese shepherds, was eventually divided in 1893. The lower Sado valley has one of the most important irrigation and settlement schemes of Portugal. Beja (pop. 1950, 14,028) is the capital and chief agricultural centre but other towns are small and widely scattered; *e.g.*, Serpa (7,193), Aljustrel (5,783), Mértola (6,368) and Cuba (4,387).

(J. M. Ho.)

BAJA, a town of south Hungary, lies a little to the east of the Danube main stream on the low, sandy terrace above the flood plain of the river. Pop. (1960) 30,355. It has an established importance as a rail and road intersection point, since the Danube a few miles away is crossed by a rail bridge. Before the partition of the Austro-Hungarian empire it was the main export centre of the Bačka farming region (now part of Yugoslavia). Baja trades in corn, cattle and wine, and has some manufacture associated with farming and some textile industries. The traditional German and Jewish groups in the town disappeared after World War II.

(H. G. S.)

BAJA CALIFORNIA: *see* CALIFORNIA, LOWER.

BAJA VERAPAZ, a department in central Guatemala. Area 1,206 sq.mi.; pop. (1964) 95,663. Its capital is Salamá. This department is located in the structural valley drained by the Polochic river, there called the Panimá, and extends over the intervening ridge to the Motagua valley. Its few inhabitants raise maize, beans, coffee, sugar cane and fruit. It is reached by road to Cobán, or down the Polochic river. A proposed road would give it access directly southward to Guatemala City. (P. E. J.)

BAJAZET: *see* BAYAZID I and BAYAZID II.

BAJER, FREDRIK (1837–1922), Danish author and politician, was born in Vester Egede in Zealand on April 21, 1837. He entered the army, but was discharged when it was reduced after the 1864 war with Prussia. He then started working for the emancipation of women, Scandinavian co-operation and the peace movement. He was a founder of the Danish Women's association in 1871 and established in 1882 the Association for the Neutralization of Denmark (named in 1885 the Danish Peace association and after World War II the Danish United Nations' association or the Danish Peace association).

As a left-wing liberal member of the Danish parliament 1872–95 he was an advocate of international arbitration treaties and had a considerable influence on the development of the Danish policy of neutrality. He took the initiative in the first Scandinavian peace conference in 1885 and in the formation of the International Peace bureau in Bern, Switz., in 1891; he was president of the bureau until 1907. He also actively supported Danish participation in interparliamentarian conferences. The Nobel peace prize was conferred on him in 1908.

Bajer died in Copenhagen Jan. 22, 1922.

See *Fredrik Bajers Livserindringer udgivne af hans Sön* (1909). (H. LN.)

BAKELITE, a synthetic resin developed in 1909 by L. H. Baekeland in the U.S. It has many industrial applications, chiefly as an electrical insulator. It is prepared by the chemical interaction of phenolic substances, such as phenol and cresol found in coal tar, and aldehydes such as formaldehyde, a derivative of methyl alcohol obtained either synthetically or by the distillation of wood.

BAKER, AUGUSTINE (baptismal name DAVID) (1575–1641), monk of the English Benedictine congregation, important writer on ascetic and mystical theology, was born at Abergavenny, Eng., on Dec. 9, 1575, and died in London on Aug. 9, 1641. On the basis of his personal experience and much reading, Baker, a convert to Roman Catholicism, evolved an ascetical doctrine that could lay no claim to originality but that was none the less vigorously attacked. There was nothing novel in his summarizing the ascetic life under the headings of mortification and prayer. The attack was in fact directed not so much against his teaching on the first of these as against that concerning the second, for he was explicit in relegating "method," which in the 15th and 16th centuries had come to be emphasized more and more, to a subordinate role. Even more serious in the opinion of some was his teaching on the subject of spiritual direction, for guidance came to the soul, he taught, from God himself and was to be sought and found in prayer. On this point, too, he may be said to represent a reaction against certain exaggerated tendencies of his time.

Baker's ascetic doctrine was committed to writing after his appointment in 1624 to the post of spiritual director of the English Benedictine nuns at Cambrai, France, and in his voluminous works, of which comparatively few have been published, he has in mind primarily what he calls "interior" souls. For this class of persons, dedicated to the contemplative life in the cloister, he finds "method" for the most part a hindrance rather than a help. He advises beginning with "affective" prayer. As a help to those who sought his counsel or were entrusted to his care, he recommended especially two English works of the 14th century: the anonymous *Cloud of Unknowing* and Walter Hilton's *Ladder of Perfection*. This recommendation is in full accord with his insistence on aspirations and acts of the will.

Several years after his death there was compiled from more than 40 treatises he had left in manuscript a systematic work entitled *Sancta Sophia*, which covers the entire range of ascetic and mystic theology (2 vol., 1657; reprinted in one volume, 1876; under the title *Holy Wisdom*, 1911; an abridgment, *Contemplative Prayer*, by Benedict Weld-Blundell, appeared in 1907, and the first volume of a projected three-volume re-edition of this same abridgment was published in 1927). Other of his writings available in print are *Secretum*, a commentary on the *Cloud of Unknowing*, of which the first section is a kind of spiritual autobiography, published by Justin McCann under the title *The Confessions of Venerable Fr. A. B.* (1922); the second section is an exposition of the *Cloud* itself, edited by McCann (1924 and later); and *The Inner Life and Writings of Dame Gertrude More*, 2 vol., published by Weld-Blundell (1910).

BIBLIOGRAPHY.—A register of his writings and a list of printed books deriving from him are included in *The Life of Fr. A. B.* by Peter Salvin and Serenus Cressy (two distinct biographies in one volume), ed. by J. McCann (1933); a catalogue of manuscripts is to be found in *Memorials of Fr. A. B. and Other Documents Relating to the English Benedictines*, ed. by McCann and Hugh Connolly (1933). *See* also Abbot Cuthbert Butler, *Downside Review*, 51:577–595 (1933); Norbert Sweeney, *Life and Spirit of Fr. B.* (1861); David Knowles, *The English Mystics* (1927); Ursmer Berlière, *L'Auteur de "Sancta Sophia," Dom A. B.* (1929; offprint from *Revue liturgique et monastique XIII–XIV*); *Dictionnaire de Spiritualité*, vol. i, 1205–06 (1937). (AM. S.)

BAKER, SIR BENJAMIN (1840–1907), English civil engineer responsible for designing the railway bridge over the Firth of Forth, Scot., was born at Keyford, Somerset, on March 31, 1840. At 16 he was apprenticed at the Neath Abbey ironworks and in 1862 became an assistant to the consulting engineer Sir John Fowler, whose partner he became in 1875. Baker was made responsible in 1869 for the construction of the London underground district railway from Westminster to the city and, with Fowler and later associates, was consulted on the building of the city and south London, Central London and Bakerloo tube railways, which were all bored deep in the London clay. He also undertook work on the docks at Avonmouth and at Hull, and arranged the transport by sea of Cleopatra's Needle from Egypt in a cylindrical vessel and its re-erection on the Thames embankment in London.

Among Baker's greatest works was the design of the Forth bridge, erected by W. Arrol, and on its completion Baker was knighted. He served on government commissions and boards, including that on storing the waters of the Nile for irrigation, and he was consulting engineer on the Aswan dam in Upper Egypt. In the United States he was consulted by James B. Eads on the construction of the St. Louis bridge over the Mississippi river and by the promoters of the first Hudson river tunnel. Baker was president of the Institution of Civil Engineers in 1895–96, contributed valuable papers to its *Proceedings*, and was a vice-president of the Royal society from 1896. He died at Pangbourne, Berkshire, on May 19, 1907.

See *Minutes of Proceedings of the Institution of Civil Engineers*, clxx, p. 377 (1907). (S. B. HN.)

BAKER, GEORGE FISHER (1840–1931), U.S. financier and philanthropist, was born in Troy, N.Y., March 27, 1840. When the national banking system was created in 1863, Baker joined with John Thompson and sons to establish the First National Bank of New York city. He started out as a teller and a small stockholder, and in 1865 was made cashier and active head of the bank. As a young man of 25, he was frequently consulted by the U.S. secretary of the treasury. In 1877 he became president of the bank and under his direction it became one of the strongest in the United States. By 1910 Baker ranked with J. P. Morgan and James Stillman as a force in American finance, and served as director of many corporations. His benefactions included large gifts to the Metropolitan Museum of Art and the American Red Cross. Among his largest gifts was $6,000,000 for the graduate school of business administration of Harvard university. He died May 2, 1931. (J. R. LT.)

BAKER, GEORGE PIERCE (1866–1935), teacher of some of the most notable United States dramatists, was born on April 4, 1866, at Providence, R.I. During his 36 years on the Harvard faculty (1888–1924), he lectured on dramatic history and theory and taught such playwrights as Eugene O'Neill, Phillip

Barry, Sidney Howard and Thomas Wolfe in his "47 Workshop" playwriting laboratory. Emphasizing practical construction and creative individuality, Baker fostered an imaginative realism observable in Barry's comedies and O'Neill's *Long Day's Journey Into Night*. From 1925 until he retired in 1933 Baker was professor of history and technique of drama at Yale, founding there the Yale drama school and directing the University theatre. Many critics relate the most modern techniques in theatre, motion-picture and television production to Baker's work at Yale. He was a pioneer in the Little Theatre movement and American Folk Dance society, and his annual illustrated lecture tours, following a 1907 Sorbonne lectureship, introduced many Americans to European ideas of theatre art. His Elizabethan productions employed the platform stage as early as 1891 and revolving and wagon stages after 1926. He also was first president of the National Theatre conference (1932) and long advocated an American National Theatre and Academy. Baker's belief in the unity of all the arts in the theatre produced the Harvard Theatre collection and stimulated the professional stature of university theatres. Of his writings, the best known are *The Development of Shakespeare as a Dramatist* (1907) and *Dramatic Technique* (1919). He died Jan. 6, 1935.

See W. P. Kinne, *George Pierce Baker and the American Theatre* (1954). (W. P. K.)

BAKER, HENRY (1698–1774), English naturalist and poet, was born in London on May 8, 1698. His invention of a system for instructing the deaf-mute brought him to the notice of Daniel Defoe, whose youngest daughter, Sophia, he married in 1729. A year before, under the name of Henry Stonecastle, he was associated with Defoe in starting the *Universal Spectator and Weekly Journal*. He contributed many memoirs to the *Transactions* of the Royal society, and in 1744 received the Copley gold medal for microscopic observations on the crystallization of saline particles. Baker was one of the founders of the Society of Arts, in 1754. He died in London on Nov. 25, 1774. His name is perpetuated by the Bakerian lecture of the Royal society, for the foundation of which he left by will the sum of £100. Baker's verse—of which several volumes, including translations from Latin and French, were published—was characterized by T. F. Henderson as "spirited and rhythmical, but the sentiments are hackneyed, and the wit artificial."

BAKER, NEWTON DIEHL (1871–1937), lawyer, political leader and U.S. secretary of war in World War I. He was born at Martinsburg, W.Va., Dec. 3, 1871, and was educated at Johns Hopkins university and at Washington and Lee university. In 1897 he began the practice of law in his home town, moving later to Cleveland, O. There he soon distinguished himself as an able lieutenant of Mayor Tom L. Johnson in the latter's long struggle for municipal reforms. He was appointed city solicitor by the mayor in 1902 and held that office by election from 1904 to 1912. Elected thereafter mayor of Cleveland, he served for two terms, 1912–16.

On the floor of the Democratic national convention of 1912 he fought successfully to have the votes of districts recognized as independent of the instructions of the state conventions, thereby contributing substantially toward the nomination of Woodrow Wilson. He declined Wilson's offer of the post of secretary of the interior in order to push forward his efforts on behalf of municipal reforms in Cleveland. Three years later, on March 7, 1916, Baker was appointed secretary of war. Although he was, as he himself said, so much of a pacifist that he "would fight for peace," he soon submitted to congress a plan for universal military conscription; and, backed by the president, he remained at the head of the war department throughout World War I and to the end of Wilson's term of office. In Jan. 1918, administration policies relating to the conduct of the war were severely criticized, in part, at least, on a partisan basis, by the senate committee on military affairs. Baker defended his record before the committee, and contended that never in history had an army of similar size been raised, equipped and trained so quickly. President Wilson thereafter issued a strong public statement in Baker's defense.

At the close of the Wilson administration Baker resumed the practice of law in Cleveland. In the Democratic convention in 1924 he made a strenuous but losing fight for a strong League of Nations plank. Four years later (1928) he was appointed by President Coolidge to the Permanent Court of Arbitration at The Hague; in 1929 President Hoover appointed him to membership on his Law Enforcement commission; and in 1936 he published a book entitled *Why We Went to War*. To the end of his life Baker maintained his concern with civic affairs and national welfare. He died in Cleveland, on Dec. 25, 1937. (K. E. Bd.)

BAKER, RAY STANNARD (pen name, DAVID GRAYSON) (1870–1946), U.S. author, was born in Lansing, Mich., April 17, 1870. He graduated from Michigan Agricultural college in 1889 and after further study in law and literature at the University of Michigan, turned his attention to writing, becoming a reporter for the *Chicago Record* in 1892. He soon began writing also for *Outlook*, *McClure's*, and other magazines. He left the *Record* in 1898 to become a free-lance writer and thereafter spent some years on the staff of *McClure's*. In 1906 he joined Lincoln Steffens, Ida M. Tarbell and others of the so-called muckraker group in establishing and editing the *American Magazine*. Meanwhile he had been experimenting with a different kind of writing, and in 1907 published *Adventures in Contentment*, the first of his books to appear under the pen name David Grayson. These homely essays, and others of the same nature which followed through the years, were widely read in many countries. In 1910 Baker moved his family to Amherst, Mass., which remained his base of operations to the end of his life, though he continued to range the world widely. At President Wilson's request he headed the American Press bureau at the Paris peace conference, 1919; and in later years he gained increasing recognition as an authority on Woodrow Wilson. Among his 18 books on the Wilson period was the 8-volume authorized Wilson biography (1927–39). Upon publication of the final volume of this series, covering the war years, Baker received the Pulitzer prize for biography. He died at Amherst, July 12, 1946.

The main body of the Ray Stannard Baker papers is in the manuscript division of the Library of Congress; a small group of his papers is in the library at Princeton university; and hundreds of warmhearted letters from people all over the world, addressed to David Grayson, are, with other books and memorabilia, in the Ray Stannard Baker memorial room at the Jones library, in Amherst, Mass. *See* also Baker's autobiographical volumes, *Native American* (1941); *Under My Elm* by David Grayson (1942); and *American Chronicle* (1945). (K. E. Bd.)

BAKER, SIR RICHARD (*c.* 1568–1645), English writer and author of the *Chronicle of the Kings of England*, was educated at Hart hall, Oxford, studied law in London and traveled abroad. A member of parliament in 1593 and 1597, he was living at Highgate, Middlesex, in 1603, when he was knighted, but later settled at Middle Aston, Oxfordshire, and was high sheriff of that county, 1620–21. He married soon afterward. Encumbered by the debts of his wife's family, the Mainwarings of Shropshire, Baker was reported a crown debtor in 1625 and his property seized. He was imprisoned in the Fleet prison about 1635 and remained there, devoting himself to literary work, until his death on Feb. 18, 1645.

His best-known work, which included translations from Cato (1636), *Meditations on the Lord's Prayer* (1637) and a series of meditations on the psalms (1639), was *Chronicle of the Kings of England* (1643). This, though of small historical value, was once popular and is often referred to by Addison and Steele. He also wrote *Theatrum Redivivum*, an answer to William Prynne's *Histriomatrix*, published posthumously in 1662. (Rd. C. G.)

BAKER, SIR SAMUEL WHITE (1821–1893), English explorer, shares with John Hanning Speke the distinction of having discovered the sources of the Nile. He was born in London on June 8, 1821, the son of a West India merchant. After an unconventional education, partly in Germany, he spent two years in Mauritius (1843–45), then eight in Ceylon (1846–55) where he founded an agricultural settlement which was later developed into a tea garden. He traveled in the near east from 1856 to 1860. In 1861 he went to Africa and, after a year spent exploring the Nile tributaries on the Sudan-Abyssinian border, sailed up the White

Nile to Gondokoro. There he met Speke and J. A. Grant who had come from Zanzibar via Lake Victoria and, guided by the information which they gave him, on March 14, 1864, he reached the lake which he named "Albert," and which proved to be part of the Nile system. Baker returned to England in Oct. 1865 and was knighted in the following year. In 1869, at the request of the khedive Ismail, he undertook the command of a military expedition to the equatorial regions of the Nile, with orders to put down the slave trade, and to annex new territory of which he was appointed governor-general for four years; his successor in this post was Col. Charles George Gordon. Returning to England in 1873, he settled at Sandford Orleigh in south Devon and died there on Dec. 30, 1893. Baker was an authority on firearms and a prolific writer. His chief books are *Rifle and Hound in Ceylon* (1853), *Eight Years' Wanderings in Ceylon* (1855), *Albert Nyanza* (1866), *The Nile Tributaries of Abyssinia* (1867), *Ismailia* (1874). He was twice married, first to Henrietta Martin who died in 1855, and in 1860 to Florence von Sass, an intrepid Hungarian lady who accompanied him on his African travels.

See T. Douglas Murray and A. Silva White, *Sir Samuel Baker* (1895); Dorothy Middleton, *Baker of the Nile* (1949). (D. MN.)

BAKER ISLAND, a coral atoll in the central Pacific ocean (lat. 0° 12′ N., long. 176° 29′ W.) with a land area of less than 1 sq.mi. Capt. Elisha Folger of Nantucket discovered it in 1818. It was rediscovered by Capt. Michael Baker of New Bedford in 1839, and his name replaced the earlier "Nantucket" or "New Nantucket." It was worked for guano by U.S. interests from 1857 to 1876 and by a British company between 1883 and 1890.

The U.S. government landed a "token" colony of Hawaiians there in 1935, and on May 13, 1936, Pres. Franklin D. Roosevelt placed it under the jurisdiction of the department of the interior. There were intermittent Japanese attacks beginning Dec. 8, 1941, and the four U.S. colonists were evacuated on Jan. 31, 1942. United States forces landed on Baker island Sept. 1, 1943, and built an airstrip which was an important staging point for air search and photo reconnaissance until Jan. 1, 1944. The civilian colony was not re-established after World War II. (J. H. K.)

BAKERSFIELD, a city of California, U.S., in the southern San Joaquin valley, 292 mi. S. of San Francisco and 113 mi. N. of Los Angeles; seat of Kern county. The town was founded along the Los Angeles and Stockton road in the mid-1860s by Thomas Baker, who reclaimed swamplands along the nearby Kern river. It was an agricultural trade centre for the mines of the Sierra Nevada and the Owens valley in the 1860s and 1870s. Bakersfield became the seat of government for Kern county in 1874, when the county seat was moved from Havilah, where it had been located since 1866. The Southern Pacific railroad reached the town in 1874, and the Santa Fe, in 1898. Both companies established shops at Bakersfield. Incorporated in 1873 and disincorporated in 1876, the town was reincorporated in 1898. San Francisco capitalists, acquiring large-scale landholdings, helped to develop a canal system to distribute the water of the Kern river. Upon the settlement of a water controversy in the 1880s, the region became important in the production of grain, alfalfa and livestock. The discovery of the Kern river oil fields in 1899 brought an extensive petroleum industry, which centred at Bakersfield. The town was quickly rebuilt after a fire destroyed the business section in 1889; and again after an earthquake brought widespread damage in 1952. Bakersfield grew steadily throughout the 20th century with increasing production of petroleum products, livestock raising and mechanized farming of potatoes, grapes, alfalfa and grain. The population was scarcely 5,000 in 1900; in 1960 it was 56,848. Pop. (1960) standard metropolitan statistical area (which comprises Kern county) 291,984. (For comparative population figures *see* table in CALIFORNIA: *Population.*)

Bakersfield is the home of Bakersfield college, a junior college, the Kern County Philharmonic orchestra, the Kern County Musical association, the Kern County museum, the Bakersfield Community theatre, the Kern County Free library and the Cunningham Art gallery. (W. H. Bo.)

BAKER STREET IRREGULARS, an informal society of lovers of the "Sherlock Holmes" stories by Sir Arthur Conan Doyle (*q.v.*). Named after the "detective police force" of that name appearing in the stories and composed of young boys ("street Arabs") employed by Holmes to ferret out obscure information in the London underworld, the society was founded in New York on June 5, 1934, with the writers Christopher Morley and Elmer Davis as the leading spirits. The B.S.I. meets once a year on Holmes's birthday, the first Friday after Jan. 1, and has a membership limited to 60 (the number of Sherlock Holmes stories). The first officers elected were Christopher Morley ("Gasogene-cum-Tantalus") and Edgar W. Smith ("Buttons-cum-Commissionaire"). The society publishes the *Baker Street Journal,* "An Irregular Quarterly of Sherlockiana" containing studies of the "Canon," and has over a dozen affiliated ("Scion") societies in the United States, besides others in England, Canada and Denmark. (D. MD.)

BAKEWELL, ROBERT (1725–1795), outstanding English pioneer in livestock breeding, was born in 1725 at Dishley, Leicestershire, and spent his life there. His experiments on the improvement of the breed of cattle and sheep were particularly successful. Previously the interest had been in getting sheep bearing large fleeces and cattle large and strong for work; Bakewell, however, bred for meat and was among the first to do so. Production was to be economical; the animals were to fatten quickly without making too much bone or offal. He chose the Leicestershire longhorns as his subject and had remarkable success with them as meat producers. They were not, however, good milkers and were eventually supplanted by the Durham shorthorns bred at Ketton by Charles Colling, who had studied Bakewell's methods. Bakewell's sheep, the Leicesters, were more permanently successful. He jealously guarded the secrets of his guiding principles, but his methods are known to have included selection, inbreeding—then an innovation—and culling. He refused to sell his sires though he would let them out by the season, and so famous did they become that in 1789 he received a total of 3,000 guineas in letting fees. He was equally successful with his general farm management and the irrigation of his meadows. Visitors came from home and abroad to see and to learn and were entertained lavishly in his bachelor establishment. He died on Oct. 1, 1795.

See H. Cecil Pawson, *Robert Bakewell* (1957). (E. J. R.)

BAKHCHISARAI, a town in the Crimean *oblast* of the Ukrainian Soviet Socialist Republic, U.S.S.R., lies along the narrow, winding valley of the Churuk-Su, on the Simferopol-Sevastopol railway. The population in 1959 was 10,852. Before passing to Russia in 1783 it was the capital of the Crimean khanate. The town is picturesque, with many buildings of historical and architectural interest, making it an important tourist centre. The palace of the Tatar khans built in 1519 by Abdul-Sahal-Girai, destroyed in 1736 and restored by G. A. Potemkin, is now the Suvorov museum. The vicinity is mountainous and east of Bakhchisarai is the deserted cliff city of Chufut-Kaleh, once the centre of the Karaite Jews. (R. A. F.)

BAKHTIARI, one of the great nomad tribes of Persia (Iran), occupying the plains and mountains between Shushtar and Isfahan (east-west) and from the Dezful river to Behbehan (north-south). This area of roughly 25,000 sq.mi. lies in the Bakhtiari-Chahar Mahall and Khuzistan regions. The Bakhtiari population was estimated at 400,000 in the 1960s, one-third being still nomadic. They speak the Luri dialect of Persian and are Shi'ah Muslims.

As pastoral tent dwellers, they depend on their flocks of sheep, goats and cattle; for the sake of these they migrate annually 150 mi. between winter pastures in the plains and summer pastures in the mountains. Agricultural products are obtained by trade, or as tax from dependent villages. The tribe consists of two patrilineal groups, Haft Lang and Chahar Lang, each subdivided into sections under hereditary chiefs. Until 1949 all were united under one paramount chief, the Ilkhan, with a deputy, the Ilbeg. These offices were elective from the chiefly families, subject to approval by the shah. Bakhtiari chiefs have long been influential in Persian politics. In 1905–06 they pressed for constitutional reform. The chief Sardar Asad, former minister of war, opposed Riza Shah's suppression of nomadism in the late 1920s. Unrest followed his

imprisonment and execution, and during World War II many settled tribesmen resumed nomadism. Subsequently, many Bakhtiari held prominent public office. *See* also LURISTAN; IRAN: *The People;* KHUZISTAN.

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BAKI (MAHMUD ABDÜLBAKI) (1526–1600), the most representative Turkish poet of the classical era and recognized as the greatest gazel (lyric) writer in Turkish literature, was born in Istanbul in 1526, son of a muezzin. After a period of apprenticeship to a saddler, he studied law and, rising rapidly in his profession, mixed with men of letters and became accepted at the court of Suleiman the Magnificent. His gazels constantly expound a favourite theme of the divan poets—the ephemeral nature of this world's joys. The beauties of nature, youth, happiness, high estate are all doomed; love, drink and be merry while you may. Baki's mastery of form expresses itself in perfect versification, a meticulous choice of words and a skilful use of onomatopoeic effect by which he achieves great musicality. His masterpiece, the famous elegy on the death of Suleiman, combines grandeur of style with sincere feeling. He died in Istanbul on April 7, 1600.

See E. J. W. Gibb, *A History of Ottoman Poetry*, vol. iii (1904) and J. Rypka, *Baki als Ghazeldichter* (1926). (F. I.)

BAKING: *see* BREAD; FOOD PREPARATION.

BAKST, LÉON NIKOLAEVICH (LEV SAMUILOVICH ROSENBERG) (1866–1924), Russian painter, who revolutionized the application of the decorative arts of the theatre, passed his childhood in St. Petersburg (Leningrad). He attended the Imperial Academy of Arts, but left after painting a too realistic "Pietà." A member of the Society of Painters in Water Colours and a teacher to the children of the grand duke Vladimir, he succeeded both as a court painter and in the fashionable world. From 1900 he was scenic artist, first at the Hermitage court theatre and afterward at the Imperial theatres. He designed the scenery and accessories for the tragedies of Sophocles in the spirit of the Greek theatre and in the archaic style of the Aegina sculptures. He made a voyage to Greece and Crete of which he wrote an account, and his famous picture "Terror Antiquus" expresses his vision of mythic Greece. In 1906 he exhibited in the Russian section of the Salon d'Automne in Paris. Two years afterward he achieved considerable fame as the chief painter of scenery for the Russian ballets produced by Diaghilev. "Cleopatra," "Scheherazade" (1909) and "Daphnis and Chloe" were among his most notable achievements. He returned to Russia and founded a liberal school of painting.

Afterward he settled in Paris, where he designed the setting of the tragedies of D'Annunzio and of a play of Émile Verhaeren. He painted the scenery and designed the costumes for the "Sleeping Princess," the fairy ballet of Tchaikovsky produced in London in 1921. He also produced several plays at the Paris Opéra, among them the "Bewitched Night." Bakst aimed at unity of impression. The influence of his genius may also be seen in the costumes of the time. He died in Paris on Dec. 24, 1924.

See André Levinson, *The Story of Léon Bakst's Life* (1921). (A. LE.)

BAKU, capital of the Azerbaijan Soviet Socialist Republic, U.S.S.R., and fourth city of the Soviet Union, lies on the western shore of the Caspian sea, around the head of the semicircular Baku gulf, on the southern side of the Apsheron peninsula. The gulf, sheltered by the islands of the Baku archipelago, provides the best harbour of the Caspian, while the Apsheron peninsula gives protection from the violent "Baku northers" of winter, when wind speeds often exceed an average of 40 m.p.h. The name Baku is supposed to derive from *Bad-kyy*, "Town of Winds."

The first historical reference to Baku dates from A.D. 885, although there is archaeological evidence of settlement there several centuries B.C. In the ancient fortress of Baku there still survives the mosque Syny-Kala, dating from 1078–79. Also believed to be of the 11th century is the oldest part of the palace of the Shirvan shahs, whose capital was there. From the 12th century dates the 90-ft. tower of Kyz Kalasy. Peter the Great captured Baku in 1728, but in 1735 returned it to Persia. Russia finally captured the town in 1806. In 1920 it became the capital of the new Azerbaijan republic. The population, 2,235 in 1806, rose to 300,000 in 1917 and in 1959 was 642,507 in Baku city itself and 971,058 in the 13 districts of Greater Baku, which includes almost all the Apsheron peninsula under one city council.

The city's great importance lies in petroleum. Some wells occur in Baku itself, but most are on the Apsheron peninsula or out in the Caspian. The presence of oil has been known since early times, but large-scale working did not begin until 1873. Now oil must be obtained at increasingly great depths, down to 16,700 ft. A network of pipelines links the drilling "suburbs" with the refineries and processing plants of the city. Baku exports oil by pipeline to the Batumi refineries or by tanker across the Caspian and up the Volga. In addition to pipe and sea links, Baku has rail connections to Rostov-on-Don and central Russia, to Tbilisi and to Yerevan. Other industries include the manufacture of oil-industry machinery (20 plants) and electrical machinery, shipbuilding and repair, chemicals, and the production of cement, textiles, footwear and food. Industries are located chiefly at the eastern (Black Town) and western (Bibi-Eybat) ends of the city.

Baku is a major cultural centre, with an academy of sciences, a university, a number of other higher educational institutions and eight theatres. (R. A. F.)

BAKU, SECOND: *see* SECOND BAKU.

BAKUFU, the military headquarters and, by extension, the government of the shogun (*q.v.*), *de facto* rulers of Japan from A.D. 1192 to 1868. The term is most commonly rendered "shogunate" in western literature. Three *bakufu* were established: the first by Minamoto Yoritomo (*q.v.*) at Kamakura (1192–1333), the second by Ashikaga Takauji (*see* ASHIKAGA) at Muromachi (1338–1573), and the third by Tokugawa Ieyasu (*q.v.*) at Edo (1603–1868). Legally the *bakufu* exercised authority delegated by the emperor through the office of shogun. This authority was in theory limited to the military forces of the country, but the increasingly feudal character of Japanese society created a situation in which control of the military class became tantamount to control of the country. By the 17th century the *bakufu* exercised civil and military authority over all domestic and foreign affairs; the emperor remained in his palace in Kyōto chiefly as a symbol of sovereignty behind the shogun.

Minamoto Yoritomo set the pattern of *bakufu* organization. In 1185 he gained military hegemony of Japan, and in 1190 received the title General of the Right Imperial Guards. He named his Kamakura headquarters *bakufu*. When in 1192 he became shogun the term *bakufu* became identified with this office. Yoritomo's government was designed chiefly to exercise control over the warrior aristocrats. When possible, however, he sought to enlist members of the warrior class as his housemen, or vassals, bound to him personally by oath and his reciprocal grant of protection over land rights. Eventually most military men of the Kantō region of eastern Japan became his housemen; elsewhere his vassals were more thinly scattered among military houses still loyal to the imperial court or the great Buddhist monasteries.

The Kamakura *bakufu* had a central administration consisting of a chief administrator, a military office, an administrative office and a judicial office. Some officials were delegated as superintendents with specific functional duties. Outside of Kamakura the *bakufu* maintained deputies and garrisons in Kyōto, the imperial capital, and in northern Kyushu. *Bakufu* authority in the provinces was based on two classes of officials. Military governors (*shugo*), selected from among the shogun's more powerful housemen, assumed supreme military and police powers in each province. Land stewards were assigned to military and fiscal affairs of the separate estates into which the provinces were divided. This combination of central headquarters and the system of military governors and stewards provided an effective nationwide administrative network centred on Kamakura. The *bakufu* functioned as a government for much of Japan, although the imperial government and its related religious institutions still held the

preponderance of territory and continued as the recognized legal government.

Ashikaga Takauji attempted to revive the *bakufu* form of government after the fall of Kamakura in 1333. The provincial military houses, chiefly *shugo*, however, had come to dominate military and civil affairs within their respective provinces. Although the Ashikaga family secured the allegiance of these *shugo* houses, its hold over them was insecure. The Ashikaga *bakufu* served as the centre of a precarious coalition between the uncertain central authority of the shogun and the increasingly powerful and independent *shugo* houses. To assure control of the emperor, the shogun established his headquarters in Kyōto. A chief administrator, selected from among the most loyal *shugo*, was placed under the shogun in Kyōto. Provincial administration was delegated entirely to the *shugo*. In the Ashikaga *bakufu* the important central posts were also taken by *shugo*, creating the precarious condition in which powerful local families could dominate the shogun. The establishment of the *bakufu* in Kyōto and the extension of *shugo* powers in the provinces brought to an end the political power of the emperor and the imperial bureaucracy. By the 16th century, as the Ashikaga *bakufu* lost its power to govern Japan, the country became divided into the private domains of local magnates, the successors of the *shugo*, known as daimyo (*q.v.*).

In 1600 Tokugawa Ieyasu gained hegemony over the daimyō thus laying the foundation for the third shogunate. The Edo *bakufu* was much more soundly built as an effective national government. The shogunal domains comprised about one-quarter of the entire country and embraced all the important cities. The shogun's private housemen numbered over 22,000 men. Of the nearly 200 daimyo, joined to the shogun by oath in 1614, nearly one-half were either kinsmen or former housemen.

The Tokugawa *bakufu* functioned at two main levels. On the one it maintained a machinery of control over the emperor, the daimyo and the religious establishments; on the other it provided an administration for the management of its lands and the handling of its national responsibilities. The shogun placed the emperor under a set of restrictions which effectively isolated him from political influence. A *bakufu* military governor of Kyōto was appointed to keep watch on imperial affairs. Daimyo were obliged to pledge allegiance to the shogun's fundamental code, which among its provisions made *bakufu* law supreme in the land and set up the alternate attendance system. Under this system the daimyo were obliged to reside periodically in Edo, leaving their families as hostages when they returned to their domains. *Bakufu* inspectors frequently toured the daimyo domains, which otherwise were made autonomously responsible for local administration.

The administration of the Edo *bakufu* was centred on the great castle of Edo, now the location of the Imperial palace in Tokyo. A senior council of five or six members selected from among the shogun's foremost house-daimyo exercised jurisdiction over foreign policy, general domestic affairs, the affairs of the daimyo, relations with the imperial court and other important matters. A junior council of four or five supervised the affairs of the shogun's retainers and the military guards. Under these councils were a variety of officers with specific responsibilities such as: superintendents of finance, inspectors general, superintendents of temples and shrines, and city magistrates of Edo. Outside of Edo the *bakufu* maintained administrative and garrison headquarters at Sumpu, Osaka and Kyōto. Shogunal magistrates were set over all towns and cities. The magistrate of Nagasaki had the additional duty of supervising foreign trade. The far-flung shogunal territories were administered directly by intendants who reported to the superintendents of finance.

After 1862 the Tokugawa *bakufu* underwent drastic remodeling under French inspiration, but in 1868 the last shogun, Yoshinobu, lost control of the country. The *bakufu*, both in terms of the central administration in Edo and the provincial administrations of the daimyo, provided a foundation for Japan's modern government. *See* also JAPAN: *History: The Development of Feudalism.*

(J. W. H.)

BAKUNIN, MIKHAIL ALEKSANDROVICH (1814–1876), Russian revolutionary agitator, the leading spirit of 19th-century anarchism and a bitter opponent of Marxism, was born at Premukhino, in the Tver province, on May 30 (new style; May 18, old style), 1814, the eldest son of a retired diplomat and landowner. After three years of study as a military cadet in St. Petersburg, he was commissioned in 1832 to serve with an artillery regiment in eastern Poland, but resigned his commission in 1834. He explained to his father that, consumed by boredom, he had resolved to study philosophy and meanwhile to earn his living as a teacher of mathematics. In fact he chose the easier alternative of borrowing money from his generous friends and in 1840 departed for Berlin university, where for a year and a half he studied Hegel. This finally cured him of the "prevailing philosophic disease," as he described it, and in 1841 under the influence of Arnold Ruge, editor of the *Deutsche Jahrbücher*, he turned to revolutionary agitation. Feeling that he had been duped by Hegel, Bakunin now announced that true philosophy ought to be a negation of all philosophy and found for the first time that real religion lay in "political action and the social struggle."

His departure from Berlin marked the start of Bakunin's long career as the mendicant monk of a nonexistent revolutionary church and as a reckless conspirator who aspired to lead an international anarchist army. He met Karl Marx in Paris and complained that Marx corrupted honest workmen by making them cerebral. It may be that the French anarchist Pierre Proudhon, whom he also met, gave him his pet idea of federal republics springing up spontaneously from below and putting an end to all sovereign states and wars between them, but Bakunin transformed this into his own favourite project for a vast Slavonic federation to replace the Austrian and Russian empires.

Bakunin took an active part in the Paris rebellion of 1848 and the Dresden insurrection of 1849. He was arrested in Dresden on May 10 and sentenced to death, but in 1851 was handed over to the Russian government. In the Petropavlovsk prison he wrote an abject confession of his political crimes and madness, for the benefit of the emperor Nicholas I. Transferred to a penal settlement in eastern Siberia in 1857, he escaped in 1861. Through Japan and the United States he made his way to London, where he started to write for A. I. Herzen's free Russian journal *Kolokol* ("The Bell").

The failure of the Polish rising in 1863 marked a major practical *débacle* for Bakunin. Henceforth he became absorbed in a campaign for universal anarchy. In 1865 he started schemes for a worldwide organization, a so-called International Brotherhood, divided into "national families" but secretly controlled by an "international family." He described the state socialism of his rival Marx as "the vilest and most formidable lie which our century has engendered, official democracy and red bureaucracy." From 1868 Bakunin's struggle with Marx to win leadership of the International Working Men's association (known as the First International) began in earnest. He tried to get his own International Social Democratic alliance incorporated into the International. In the controversy that ensued between Marx and him the charge of concealed dictatorship, which both hurled at one another, was more substantially true about Bakunin. Marx accused Bakunin of violating his obligations as a member of the International by founding a secret society with statutes hostile to it.

In his pamphlet *The Knouto-German Empire and International Socialism* (1871), Bakunin identified the Marxian German school of socialism with the worst religious and political despots of the past, those who had tried to make a school of thought the sole source and guide of living. He identified every strong state with a despotic lust, bound to mutilate its subjects mentally and morally. A weak state, he grudgingly admitted, might be virtuous, but he believed that the days of nation-states were numbered. He pointed out that former manual workers, once they had become rulers and representatives, tended to despise the so-called working class.

After the Franco-German War, during the rebellion at Lyons, which started a short-lived local commune, Bakunin rushed to throw in his lot with the insurgents. The cruel lesson taught him by his disciple, the sinister S. G. Nechaev (1847–82), who in 1872 murdered another of Bakunin's pupils for betraying their cause, seems to have shattered Bakunin's more ambiguous revolutionary

beliefs. Meanwhile Bakuninist "cells" were spreading within Russia, and outstanding Narodniki like P. B. Akselrod and Vera I. Zasulich claimed to be his followers. But though Bakunin influenced many Russian revolutionaries and had devoted followers in Italy and Spain, his repeated attempts to organize revolts had all failed.

While remaining a militant atheist, Bakunin seems ultimately to have lost his old faith in spontaneous popular insurrection as the only sure method of destroying state governments. He died at Bern, Switz., on July 1, 1876. There is an edition of his collected works, in Russian, edited by Y. Steklov, four volumes (1934–35).

See E. H. Carr, *Michael Bakunin* (1937); Richard Hare, *Portraits of Russian Personalities Between Reform and Revolution* (1959).

(R. Ha.)

BALA (Y Bala), a market town and urban district of Merionethshire, north Wales, lies 40 mi. S.W. of Chester by road. It is near the confluence of the Tryweryn and the Dee, at the outlet of the latter from the northern end of Bala lake, the largest natural lake in Wales (*bala*, Welsh for "outlet"). Pop. (1961) 1,604.

The name Bala was originally given to a fortified mound of the motte-and-bailey type, still known as *Tomen-y-Bala*, the biggest of a series of such mounds at strategic positions along the upper Dee valley. The town was founded in the 14th century as a market centre and its burgesses were granted trading rights and protection against the warlike tribesmen of Penllyn. By the 18th and 19th centuries it had become a prominent centre for woolen cloth, especially flannel and hosiery. From the 18th century it also became a centre of Welsh cultural and religious activity. Eisteddfodau were held in the taverns, and the printing presses produced important works in Welsh prose and verse. A grammar school was founded in 1712 and a Calvinistic Methodist college in 1837, both of which are active. Great Methodist assemblies were formerly held on "the Green." Statues in the town commemorate Thomas Charles (Charles of Bala, 1755–1814), Methodist divine and one of the founders of the British and Foreign Bible society; Lewis Edwards (1809–87), theologian, educationalist and man of letters; and Thomas Edward Ellis (1859–99), Liberal leader and patriot. Elizabeth Davies Jones (1789–1860), pioneer nurse, and Michael D. Jones (1822–98), promoter of a Welsh colony in Patagonia, were born there.

The first sheep dog trials in the country were held there in 1873 and still take place annually. There is good grouse-shooting and fishing, including salmon, trout and the white-scaled gwyniad peculiar to Bala lake. Flooding in the Dee valley was checked by widening and deepening the channels at the head of the lake.

(T. H. Wi.)

BALAAM, a non-Israelite prophet in the Bible, who was asked by Balak, king of Moab, to curse Israel. The main passage about Balaam is in Num. xxii–xxiv, and consists of material from the Yahwist (J) and Elohist (E) traditions (*see* Pentateuch), together with seven poetic oracles and a few editorial additions.

The Yahwist narrative and its associated poems (indicated below by numerals in italics) is found in Num. xxii, 3b–7 (omitting the words "at Pethor, which is near the River" in verse 5), 11, 17, 18, 22–35a, 36a, 39; xxiv, 1, 2, *3–9*, 10–14, *15–19, 20, 21–22, 23–24,* 25. Balak, alarmed at the rapid advance of Israel, and having heard of Balaam's efficacy in benediction and malediction, sends emissaries to him with adequate payments and the request that he come and curse Israel. Balaam states that he will be able to speak only what Yahweh inspires, but accompanies the messengers to Balak. An angel of Yahweh meets him on the way, seen by his ass, but not by himself. When finally Yahweh opens Balaam's eyes, he allows him to continue his journey. Balak meets Balaam, who, after seeing Israel, blesses its people. Balak remonstrates with him, but Balaam blesses them again. Indeed Balaam blesses Israel three times, and returns home. The poetic oracles embedded in the J narrative celebrate the glory and conquests of the monarchy (xxiv, 3–9) and announce the coming of a king (possibly David) who is to conquer Edom and Moab (xxiv, 14–19).

The E narrative with its associated poems is found in Num. xxii, 2, 3a, 5b (*i.e.,* the words "at Pethor, which is near the River"), 8–10, 12–16, 19–21, 35b, 36b–37a, 38, 40, 41; xxiii, 1–6, *7–10,* 11–17, *18–24.* Balak sends princes to invite Balaam to his maledictory task. God appears to Balaam in a dream and forbids him to go to Balak, and the princes are therefore sent back. In another dream God permits Balaam to go to Balak, on condition that he speak only what God imparts. Balaam communicates this condition to Balak when they meet. Balak offers sacrifices, but Balaam is constrained to bless Israel. Balak remonstrates, is reminded of the divine condition of Balaam's prophesying, and then proceeds to sacrifice again, evidently seeking the possibility of a differently toned prophecy. But again Yahweh constrains Balaam to bless Israel. After further expostulation and explanation Balaam returns home. The two poems woven into the Elohist narrative tell of the unique exaltation of Israel (xxiii, 7–10) and extol the moral virtue of Israel, its monarchy and its conquests (xxiii, 18–24).

In the light of later developments of the tradition it is interesting to note the differences between J and E. In J, Balaam sets out willingly enough with Balak's messengers, though he tells them that his prophetic utterances will be limited to what Yahweh inspires. On the journey he is met by an angel of Yahweh (*i.e.,* Yahweh himself in theophany) who, having indicated divine displeasure with Balaam's decision to accompany Balak's messengers, permits him to continue provided that he speaks only what Yahweh commands. In the event, Balaam is faithful to Yahweh and blesses Israel. In E there is a slight contrast, for Balaam is first forbidden to accompany the Moabite princes, but later is permitted to join them. In his mission for Balak he is, as in J, faithful to Yahweh in actual utterance, though he seems to acquiesce in the second sacrifice by Balak, and thus in his desire to receive other than a benediction for Israel. It would seem that this is a beginning of a denigration of the character of Balaam.

This tendency continues. The reference to Balaam in Deut. xxiii (D), 3–6, condemns both Ammonites and Moabites for hiring Balaam to curse Israel, and adds the comment "but the Lord . . . turned the curse into a blessing," a not wholly unambiguous reaffirmation of the tradition that Balaam uttered nothing but blessings upon Israel. Josh. xxiv, 9, 10 (E) reads as if Balaam uttered a blessing upon Israel only when malediction had not been endorsed by Yahweh. The Priestly tradition (Num. xxxi, 8, 16) states that Balaam advised the Midianites how to bring Israel to idolatry at Baal-Peor, and that he was later slain in battle.

By New Testament times Balaam had become the type of avarice (II Pet. ii, 15, 16; Jude 11) and of enticement to idolatry (Rev. ii, 14). Jewish tradition shared this denigratory trend. It seems that a later Jewish exclusiveness caused the earlier virtue of Balaam to be overshadowed; and it is therefore the more important that the evident appraisal of both J and E should be restored: that Balaam is an outstanding and early example of the truth that God remains sovereign in his freedom to call to his service whomsoever he will.

(Jo. M.)

BALADHURI, AL- (Ahmad ibn Yahaya) (d. 892), one of the earliest Arab historians, and the best authority for the period of the formation of the Arab empire, was a native of Baghdad. His chief work, *Futuh al-Buldan*, gives an account of the conquest of Arabia, Syria, Mesopotamia, Armenia, Egypt, north Africa, Spain, the Mediterranean islands, Nubia, Persia and Media. A second work, *Ansab al-Ashraf* ("Lineage of Nobles") deals with the genealogies of the early Arab aristocracy.

For Eng. trans. of *Futuh al-Buldan* see P. K. Hitti, *The Origins of the Islamic State* in the Studies in History, Economics and Public Law series of Columbia university (1916). *Ansab al-Ashraf* was ed. by G. Flügel (1835), and part of it was ed. by S. D. F. Goiten and M. Schloessinger, with indices and annotations, 3 vol. (1936–40).

BALAENA, the genus of whales to which the Greenland right whale and bowhead belong. *See* Whale.

BALAENICIPITIDAE, the family of shoebills, or whale-headed storks, placed with herons, true storks, etc. in the order Ciconiiformes. Only one species, the African *Balaeniceps rex*, is known (*see* Stork).

See also Bird; Ornithology.

BALAENOPTERA, the genus name of the group of whales known as the rorquals, finbacks and fin whales. With the closely

allied genus *Sibbaldus* (blue whale, etc.) they form the main object of pursuit in modern whale fisheries. *See* WHALE.

BALAGHAT, a municipal town and district in Madhya Pradesh, India. The town is near the east bank of the Wainganga river, 95 mi. S. of Jabalpur. Pop. (1951) 16,291. It is on the Satpura narrow-gauge line of the Southeastern railway, connecting northward with Jabalpur and southward with Gonda junction (25 mi.) on the main line.

BALAGHAT DISTRICT (3,573 sq.mi.; pop. [1961] 806,620) is divided by the eastern Maikal hills from the Chhattisgarh plain to the east. It contains gneissic and metamorphic rocks with a few Deccan trap outliers in the north. The rocks belong to the Gondite series containing slates, phyllites and quartzites, and crystalline manganese oxides, the source of economically important manganese ore. Some hilltops of the central plateau (Baihar) contain important bauxite deposits. The Satpura range, of considerable scenic beauty, crosses the north of the district; the average annual rainfall is 62 in. The forest (comprising 13% of the district's area) is the habitat of nilgai, swamp deer and wild cattle, and yields teak, sal, bamboos, lac and myrobalans (*q.v.*). The forest products are collected by Gond aboriginal tribespeople (*see* GONDWANA) who form one-third of the district's population. There is also a small community of Baiga (*q.v.*) tribesmen (2%), who are skilled woodmen: they make bamboo mats and collect tendu leaves for manufacturing *bidis*, the ubiquitous cheap cigarettes of India. The northern rivers, tributaries of the Narbada, have limited rich soil-areas used for tobacco and sugar cane cultivation. In the Wainganga valley in the south and southwest rich soil-areas are more extensive. Rice is the chief crop (about 40% of total sown area) followed by the small millets *kodon* and *kutki*, and pulses. Cattle are raised on the excellent pastures of the Baihar plateau. Waraseoni (pop., 9,556) and Lalburra are cattle markets. (D. G. NA.)

BALAGUER, VICTOR (1824–1901), Spanish writer and politician, who played a major part in the revival of Catalan nationalism during the 19th century. He was born at Barcelona on Dec. 11, 1824, and educated at the university of his native town. Most of his early life was spent in encouraging the development of local patriotism. He wrote for several newspapers and produced poetical works in Catalan, the first being the *Oda á la Verge de Montserrat* (1857). A few years later he moved to Madrid, but his political views were too progressive and he was obliged to emigrate to Provence. Returning after the revolution of 1868, he became a member of the constituent *Cortes* in 1869 and minister for colonies two years later. Subsequently he became president of the *Tribunal de Cuentas* and president of the Council of State. He died at Madrid on Jan. 14, 1901.

Outside Catalonia he is remembered mainly as the author of *Historia de Cataluña y de la Corona de Aragón* (1860–63), but although he has few literary merits other than those of a pioneer, his works did great service for the cause for which they were written and in Catalonia his name will endure.

BALAKIREV, MILI ALEKSEEVICH (1837–1910), Russian composer of orchestral music, piano music and songs, and dynamic leader of the nationalist group in the third quarter of the 19th century, was born at Nizhni-Novgorod on Jan. 2, 1837 (new style; Dec. 21, 1836, old style). His early musical education was received from his mother, John Field's pupil Alexander Dubuque and Karl Eisrich, music-director to A. D. Ulibishev, author of well-known books on Mozart and Beethoven. Balakirev had the use of Ulibishev's music library and at 15 began to compose and was allowed to rehearse the local theatre orchestra. From 1853 to 1855 he studied mathematics at the University of Kazan and wrote, among other things, a piano concerto. In 1855 Ulibishev took him to St. Petersburg and introduced him to Glinka and other leading musicians.

During 1857 to 1859 Balakirev made a number of appearances as a concert pianist, composed an *Overture on Russian Themes*, music to *King Lear* and his earliest published songs, and became the mentor of two young officers who were amateur composers: C. A. Cui and Mussorgsky. During 1861 and 1862 his circle of disciples was joined by Rimski-Korsakov and Borodin, and in 1862 he threw himself into a new venture, the Free School of Music, opened by G. Y. Lomakin in opposition to the St. Petersburg conservatory, and soon became principal conductor of its public concerts. During the 1860s Balakirev was at the height of his influence and his varied activity. He collected folk songs up and down the Volga, published them and introduced them in a *Second Overture on Russian Themes*, which ultimately became the symphonic poem *Russia;* he spent summer holidays in the Caucasus, gathering themes and inspiration for his brilliant piano fantasy *Islamey* (1869) and his symphonic poem *Tamara* (1867–82); he published the works of Glinka and visited Prague to produce them; and for a time (1867–69) he conducted the symphony concerts of the Russian Music society.

His despotic nature and his tactlessness made innumerable enemies, so that even his friends and disciples came to resent his tutelage; and a series of personal and artistic misfortunes led to his almost complete withdrawal from the world of music (1871–76) and his taking a humble post as a railway clerk. He had passed through a period of acute depression ten years earlier; now he underwent a more severe crisis from which he emerged a totally changed man, a bigoted and superstitious Orthodox Christian. He gradually returned to the musical world, resumed the directorship of the Free school, and from 1883 to 1894 was director of the imperial chapel. He also resumed composition, completing works, including a symphony, abandoned many years before, and wrote new ones, including his Piano Sonata (1905), a Second Symphony (1908) and numerous piano-pieces and songs. The last decade of his life was spent in almost complete retirement, and he died in St. Petersburg on May 29 (N.S.; 16, O.S.), 1910.

It has been said that it was Balakirev, even more than Glinka, who set the course for Russian orchestral music and lyrical song during the second half of the 19th century. He developed an idiom and technique—based on the one hand on Glinka, Russian folk music and Caucasian folk music, and on the other on Schumann, Berlioz and Liszt, yet ultimately most personal and idiosyncratic—which he imposed on his disciples (above all on Rimski-Korsakov and Borodin, and to some extent on Tchaikovsky) not only by example but by constant autocratic supervision of their own earlier works. His music is superbly colourful and imaginative, but his creative personality was arrested in its development after 1871 and his later work is couched in the idiom of his youth.

See V. Muzalevsky, *Balakirev* (1938). (G. AB.)

BALAKLAVA (BALACLAVA), **BATTLE OF,** an engagement fought on Oct. 25 (new style; 13, old style) 1854, during the Crimean War (*q.v.*), when British, French and Turkish forces resisted a Russian attack on Balaklava, their supply port on the Black sea, lying about 6 mi. S.E. of Sevastopol. The cavalry charge of the Light brigade, which made the action famous, took place in a valley running in an east-west direction and bounded by the Fedyukhin heights on the north and by the Vorontsov or "Causeway" heights on the south. Russian movement was from the northeast.

In the opening stages of the battle, Russian infantry and artillery occupied positions along the Fedyukhin heights almost unopposed and also forced small, unsupported Turkish forces to retire from artillery strong points along the Causeway heights. The fate of Balaklava depended on about 500 men of the 93rd Highland regiment and on the Heavy (900 men) and Light (670 men) brigades of cavalry. Lord Raglan and his British staff, who had taken up position on the heights above Sevastopol, saw two large-scale Russian cavalry advances—involving about 3,000 men—beaten off, the one by a furious charge of Gen. Sir James Scarlett's Heavy brigade, and the other by the determined stand and disciplined fire of Sir Colin Campbell's Highlanders. From these actions, which undoubtedly saved Balaklava, the Light brigade, under Lord Cardigan (*see* CARDIGAN, JAMES THOMAS BRUDENELL, 7TH EARL OF), held aloof. The Russians then began to withdraw the guns from the captured artillery posts on the Vorontsov heights. Raglan, through an aide-de-camp, issued two orders with the intent of disrupting the Russian removal by means of an attack by the Light brigade. A combination of circumstances resulted in a fatal confusion in relaying the final order, and when

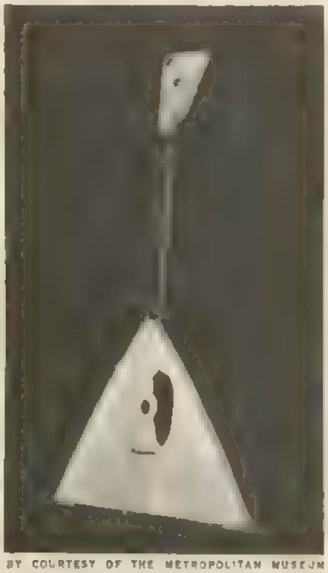
the Light brigade, led by Cardigan, swept forward it moved eastward down the valley between the heights rather than toward the isolated Russian activity on one flank.

Despite heavy loss the charge was completed, leaving an impression of crass stupidity and magnificent courage, which prompted the remark of Gen. Pierre Bosquet, *"C'est magnifique mais ce n'est pas la guerre."* The cost to the Light brigade in manpower was about 40% of the participants. Had it not been for a gallant and timely supporting charge by the French Chasseurs d'Afrique on the Fedyukhin heights the losses might have been even more severe.

There the battle ended. The Russians had not captured Balaklava, but the British had lost control of their best supply road connecting Balaklava with the heights. The legends arising from the charge of the Light brigade, while properly commemorating brave men, have undoubtedly contributed to an overestimation of the importance of the battle of Balaklava. Lord Tennyson immortalized the action of the cavalry in his poem "The Charge of the Light Brigade." (D. M. Sc.)

See F. A. Whinyates, *From Corunna to Sebastopol* (1883).

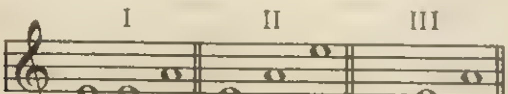
BALALAIKA, a stringed musical instrument. The modern instrument is a sophisticated version of a Russian folk instrument introduced by the musician and impresario V. V. Andreyev of Bejètsk, who made a first public appearance with a band of these improved instruments in 1888.



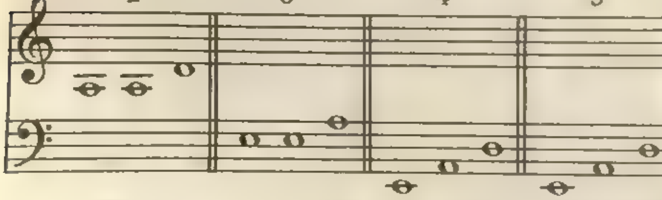
BY COURTESY OF THE METROPOLITAN MUSEUM OF ART, GIFTS OF MRS. JOHN CROSBY BROWN, 1904

RUSSIAN TENOR BALALAIKA, 20TH CENTURY

The balalaika is made in five sizes from treble to double bass, forming a complete, self-contained ensemble. Its characteristic shape is with a triangular table or belly, widest at the bottom and tapering to the neck, and having a small round sound hole in the upper part. The body is vaulted and usually constructed in six sections or ribs, fanning out from the neck to the bottom of the body, which is flat. There are three gut strings, hitched to the bottom and stretched over a pressure bridge. The neck is long and slender, and carries up to 19 metal frets. The type-instrument is the *prima*, tuned in one of the following ways:



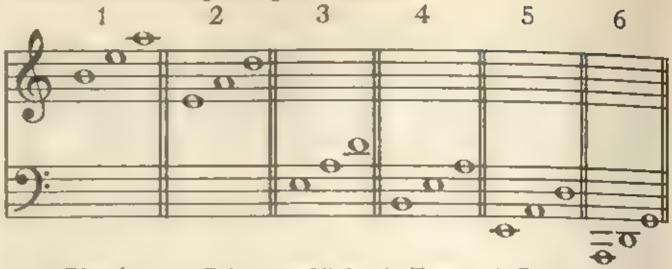
The remaining members of the group, with their tunings, are



2. Secunda 3. Viola 4. Bass 5. Double Bass

The instrument is plucked by the fingers.

To this group Andreyev added another, the oval-bodied domras, also three-stringed instruments strung with gut, which he developed from the ancient prototype found in the Viatka region. The chief difference from the balalaika was the tuning in regular fourths throughout the family and the use of a plectrum. This group also included a sixth member, the diminutive "piccolo" domra. The tunings are given below:



1. Piccolo 2. Prima 3. Viola 4. Tenor 5. Bass 6. Double Bass

(E. HA.)

BALANCE, an instrument for comparing the weights of two bodies, usually for scientific purposes, to determine the difference in mass. The equal-arm types for technical and scientific uses are discussed in this article. Mechanisms for weighing goods and commodities are discussed in the article WEIGHING MACHINES.

The invention of the equal-arm balance dates back to the time of the ancient Egyptians, possibly as early as 5000 B.C. In the earliest types, the beam was supported at the centre and the pans were hung from the ends by cords attached through vertical holes in the beam. This design was improved by drilling the holes so that the end cords were pulled tightly against the ends of the beam by the loads on the pans. A later improvement in design was the use of a pin through the centre of the beam for the central bearing, introduced by the Romans about the time of Christ. The invention of knife-edges in the 18th century led to the development of the modern precision balance. By the end of the 19th century the balance had been developed in Europe into one of the world's most precise types of measuring devices.

The balance consists, essentially, of a rigid beam that oscillates on a horizontal central knife-edge as a fulcrum and has the two end knife-edges parallel and equidistant from the centre. The loads to be weighed are supported on pans hung from bearings, usually planes, supported by the end knife-edges. For the best design two or more additional knife-edges should be located between the end bearing and the pan, one to prevent tilting of the plane and another to fix the centre of load at a particular point on the end knife-edge. An arresting mechanism prevents damage during loading by separating the knife-edges from their bearings. The deflection of the balance may be indicated by a pointer attached to the beam and passing over a graduated scale or by reflection from a mirror on the beam to a distant scale.

Many models of balances have mechanisms for interchanging the loads on the pans without opening the balance case. In some models, the controls can be operated from a distance by means of rods. In each case the rest point of the beam is determined from readings of turning points on the image of a distant scale reflected into a telescope by a fixed prism and a mirror on the beam.

Weighing Procedure.—The most obvious method of using a balance is known as direct weighing. The material to be weighed is put on one pan with sufficient known weights on the other pan so that the beam will be in equilibrium. The difference between the zero reading and the reading with the pans loaded indicates the difference between loads in scale divisions. This difference may be evaluated by comparison with the deflection resulting from a small known weight being added to one of the loads. Such a direct weighing requires that the arms be of equal length. New analytical balances are often required to have the two arms equal within one part in 100,000. With such balances weighings within a precision of about one part in 100,000 can be made by direct weighing methods.

When the error resulting from unequal arms is greater than the required precision the substitution method of weighing may be used. In this method counterpoise weights are added to one pan to balance the unknown load on the other. Then known weights are substituted for the unknown load. This method requires only that the two arms of the beam maintain the same

lengths during the weighing. Any effect of inequality is the same for both loads and is therefore eliminated.

For higher precision the loads should be weighed twice and reversed on the pans for the second weighing. Such a method, known as transposition weighing, in effect makes the balance twice as sensitive as compared with the direct or substitution weighings. Also, if the zero point or the arm ratio is shifting in one direction, then the average of two reversals will tend to eliminate these effects. A series of transpositions may be made to increase the precision.

Since the balance will respond to any force acting on the beam or pans the observer must assure himself as a part of the weighing procedure that any extraneous forces have smaller effects than the required precision. Causes of such disturbances include air currents, heating effects, changes in relative humidity, magnetic influences, vibration, air buoyancy effects, arrestment and release, and swinging of the pans. For precise work the balance should, therefore, be mounted on a rigid support free from vibration in a room with very constant atmospheric conditions.

In many laboratories nonuniform magnetic fields may be caused by electrical equipment or by steel framework in the building. If the balance beam contains magnetic material such nonuniform fields may cause irregular changes in the rest point of the balance. Throughout the dimensions of a balance the earth's field may be considered as practically uniform but not constant. Changes in such a uniform field will not have a translatory effect on the loads or beams but can result in rotation (or torque) provided two magnetic poles in the beam are at different distances from the central knife-edge.

Since the buoyant force of the air affects the balance directly, its effect must be either eliminated or correctly evaluated in order to obtain correct results of weighings. The effect of changes in air density may be reduced by avoiding large differences in volume for the two loads, but for the most precise work the actual volumes and the actual air densities must be used to compute the air buoyancy effects. On brass, for example, the buoyant effect of the air is about $\frac{1}{7,000}$ as large as the force of gravity. Since heating effects will cause convection currents and since the relative humidity changes with changes in temperature, these effects are always intermingled.

Performance of Balances.—Under ideal conditions the highest obtainable precision with the best balances is a little better than one part in 100,000,000 with loads of about 1 kg. The highest relative precision is less than this for both larger and smaller loads. With loads of 20 kg. a precision of about one part in 20,000,000 has been obtained. With loads of 1 g. the limit seems to be about one or two parts in 10,000,000. Such precision can be obtained only with balances of the best designs and under the best conditions. In other cases the possible precision may be restricted by lack of ideal weighing conditions and by improper design.

Weighings of high precision are useful in proving the constancy of standards of mass, and in such problems as determining whether mass changes by appreciable amounts as a result of chemical reaction, or whether the mass of a crystalline structure changes as the crystalline structure is rotated to different positions with respect to its velocity through space.

Standard Weights.—For reference standards of the highest precision the best material is still considered to be the alloy of 90% platinum and 10% iridium used by the International Bureau of Weights and Measures for the international kilogram and the various national prototype kilograms. Retests show that these standards can be relied upon to remain constant for many years within a few parts in 100,000,000.

Standards to be used to check brass or bronze weights should preferably be of about the same density as the weights under test in order to avoid troublesome computations of air buoyancy effects each time they are used. Brass or bronze that is free from holes or pits and plated with gold, platinum or rhodium may make very good standards. The alloy of 80% nickel and 20% chromium has proved to be very satisfactory; but because of difficulty in machining, weights of this material are not ordinarily available.

One-piece weights with their volumes determined by hydrostatic weighings are generally required for work of an accuracy of one part in 1,000,000 or better, but weights of screw knob construction may be entirely satisfactory for less accurate work.

Both lacquered weights and electroplated weights of screw knob construction may prove to be variable with changes in the relative humidity of the air. Most lacquers absorb appreciable amounts of water but are free from the extremely large variations found when electroplating salts are left under the knobs of plated weights. Well-made plated weights are, however, generally less variable with humidity changes than well-made lacquered weights.

For fractions of a gram, weights of platinum and tantalum are superior to those of gold because of the poor wearing qualities of gold. Aluminum is a satisfactory material for the smaller fractional weights.

Design of Beam.—The beam should be designed so as to provide, with a minimum of weight, a rigid support for the three knife-edges. The forces acting on a balance beam are illustrated in fig. 1. The forces exerted by gravity on the mass of the beam and on the two loads are M_1, L and R. The resultant of L and R is M_2 and is so located that $LX_3 + RX_4 = M_2X_2$.

In order for the balance to be in equilibrium, M_0, the resultant of M_1 and M_2 on the vertical Y axis through C, must be located below C. If either M_1 or M_2 is located far enough above C so that M_0 is also above C, there will be no restoring force to bring the beam into equilibrium and the beam will not oscillate. In order to avoid erratic behaviour M_1 should be far enough from the fulcrum C so that the changes in distance resulting from irregularities in the fulcrum are small in proportion to the distance between M_1 and the fulcrum. The point M_2 is brought near the vertical Y axis by equalizing the two loads.

The sensitivity of the balance may be defined as the change in rest point for unit mass added to one of the loads. If a small weight be added to the load R the resulting force will tend to rotate M_1 and M_2 to new positions about C. The sensitivity depends, therefore, on both M_1 and M_2. The effect of M_1 on the sensitivity is independent of the load on the pans. The force M_2 is the resultant force of the loads on the end knife-edges and changes with the loads. In the ideal balance, A, B and C lie in the same plane and A and B are equidistant from C. In this case, with equal loads on the pans M_2 is located at C, and X_2 and Y_2 are equal to zero. Rotation, therefore, does not change the position of M_2 and the sensitivity is entirely dependent on M_1, being constant for all loads.

Discrepancies between repeated rest points for the same loads are necessarily caused by any shift in the position of M_1 or M_2 with reference to the three knife-edges. Refinements in design should, therefore, be directed toward locating the loads in exactly the same places each time the arrestment is released.

The period or time of one swing to and fro of the balance is determined by the arm length of the beam, mass of the loads, mass of the beam and moment of inertia of the beam. The longer

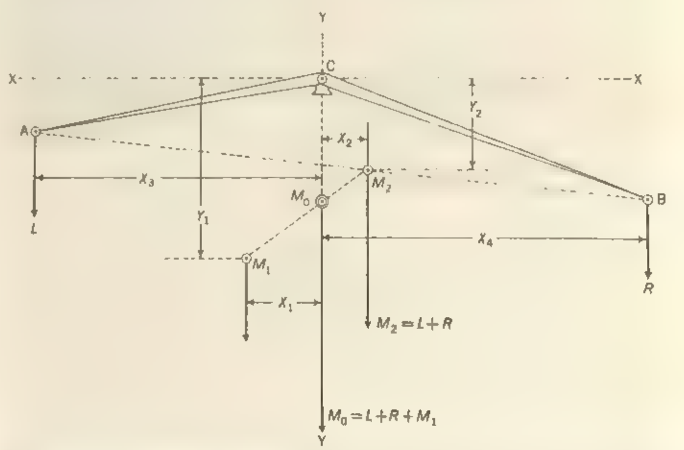
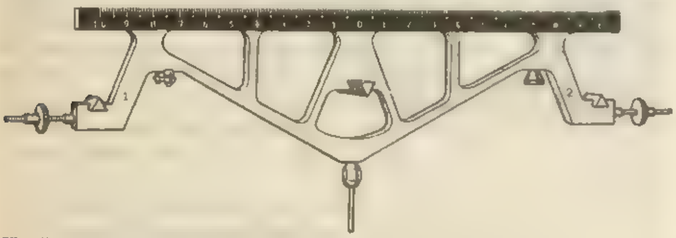


FIG. 1.—FORCES ACTING ON A BALANCE BEAM THAT IS IN EQUILIBRIUM. (*See* TEXT)

the arm length and the heavier the load the greater will be the period. For a particular balance with constant loads the period is also inversely proportional to the square root of the sensitivity. It is desirable that the material for balance beams should have great strength, a great modulus of elasticity, a low density, a low coefficient of expansion, a high specific heat, high thermal conductivity, and it is essential that it be nonmagnetic. In selecting a material some compromise must be made. Consideration of densities and moduli of elasticity indicate that a beam of aluminum alloy should be more rigid than a beam of copper alloy of the same weight and same length of arms. The effect of large coefficients of expansion of aluminum alloys is offset to some extent by the high specific heats of such materials. Copper alloys, on the other hand, will have a smaller surface to absorb heat, a smaller coefficient of expansion and a greater thermal conductivity. They can, therefore, be expected to equilibriate more quickly from thermal disturbances than aluminum alloys. Another consideration of prime importance is that the material must maintain its dimensions with great accuracy over a period of years. Beams constructed of aluminum alloys and also of copper alloys in balances at the national bureau of standards have shown changes in the ratio of the arms averaging from one to four parts per 1,000,000 per year, and in some cases continuing for more than 25 years.

The material finally selected by the German Normal-Eichungs-Kommission is a type of magnalium that consists of about 86% aluminum, 13% magnesium, and impurities of silicon, iron and copper. A. H. Corwin, however, recommends a copper-beryllium alloy that contains about 95% copper, 4% beryllium and 1% nickel. Brasses, bronzes and various alloys of aluminum have been used. Typical beams for analytical balances are shown in fig. 2 and 3.

Pivots, Knife-Edges and Bearings.—Since the beam rotates through only a few degrees it is possible to combine in the pivots the strength of a large shaft and the frictional effects of a very small shaft. This is accomplished by grinding two optically flat



BY COURTESY OF WM. AINSWORTH AND SONS, INC.

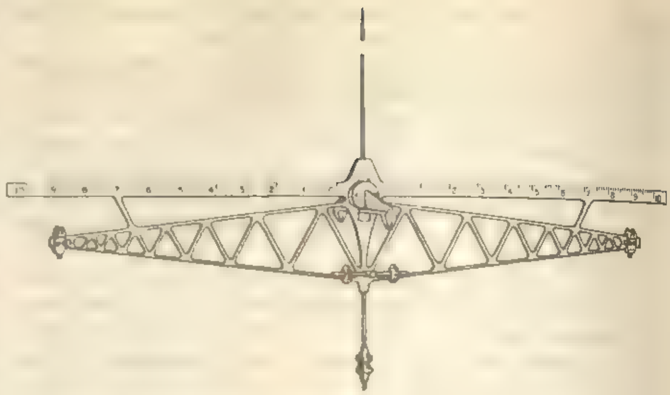
FIG. 2.—BALANCE BEAM OF 200 G. CAPACITY

planes along one edge of a block, usually of triangular shape, the intersection of the two planes forming the knife-edge. Such a knife-edge becomes rounded under pressure. The end bearings may be curved or grooved so that they will not slide off the knife-edge, but for most accurate results the bearing must have a plane surface. Such plane bearings and the planes forming the knife-edge can be constructed with very great accuracy, and their flatness can be easily tested by interference methods with small optical flats. When plane bearings are used it is necessary that the beam and bearings be supported by the arrestment while loading and unloading the balance.

The knife-edges may be adjusted to the proper position by screws bearing on the pivot or they may be wedged into the beam and their position adjusted by bending or twisting parts of the beam. Strains set up in this way frequently cause slow changes in the position of the knife-edges that may continue for years.

Another method, devised by A. Hasemann of Berlin, is to grind the end knife-edges after the pivots are fastened to the beam. This apparatus can be adjusted so that by reference to an accurately flat bed the grinding of the planes will be stopped at the proper places so as to produce a beam with equal arms and with constant sensitiveness for all loads.

The material for the pivots and bearings must be hard and durable. Steel has been used for pivots in the finest balances



BY COURTESY OF NATIONAL BUREAU OF STANDARDS

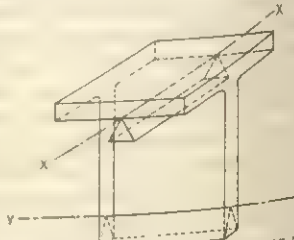
FIG. 3.—BEAM OF ASSAY BALANCE OF 1 G. CAPACITY

in spite of the danger that it might become magnetized. Agate has been much used for both bearings and pivots but has the serious disadvantage that it is hygroscopic. Pieces of similar size and shape may vary by quite different amounts and may cause the balance to change its rest point with changes in relative humidity and changes in temperature. Corwin recommends boron carbide for both the pivots and plane bearings because it is nonmagnetic, harder than synthetic sapphire or agate, is not hygroscopic, and is claimed to maintain a sharp edge much better than agate.

As the balance swings, successive swings become shorter because of friction. The amount of falling off for successive swings has long been recognized as being proportional to the velocity. Since the period remains constant for deflections of different amplitudes the falling off is also proportional to the length of the swing. The ratio of the lengths of successive swings in the same direction is known as the damping constant. The logarithm of the damping constant is useful in computing the mean rest point and is known as the logarithmic decrement. This kind of damping is found with liquids, gases and magnetic and electrical fields. If the bearing friction were due to solid-to-solid contact it might be supposed that the friction would follow some other law. Experiments by Harald Rossi at Johns Hopkins university have indicated that a moisture film separates the knife-edge from the bearing. These experiments offered the first explanation of the fact that knife-edge friction obeys the same laws as the friction of liquids and gases.

Intermediate Suspensions.—It is not possible to construct a balance beam with the end knife-edges exactly parallel to the fulcrum. Improper design or construction of the intermediate suspensions between each end pivot and pan allows erratic and systematic errors to occur because of the skew position of the end knife-edges or because of tilting of the end bearing. The purposes of the intermediate suspensions are, first, quite obviously, to transmit the load from the pan to the end bearing; second, to prevent tilting of the bearing; third, to prevent erratic shifting of the centre of load along the skew end knife-edge; and fourth, to minimize the systematic effect of skew end knife-edges with motion of the beam.

The centre of load on the end knife-edge is the point vertically above the centre of gravity of the load. Points A and B, fig. 1, are located at the centres of load on the end knife-edges. If the end bearing were fastened rigidly to the pan, then shifting the load on the pan parallel to the end knife-edge would result in a corresponding shift in the centre of load. This effect is avoided by including an intermediate knife-edge in the suspension perpendicular



FROM MAX RAUDNITZ, "DIE KONSTRUKTION DER VON HAND BEDIENTEN WAAGEN"

FIG. 4.—ARRANGEMENT OF KNIFE-EDGES TO AVOID SHIFTING OF CENTRE OF LOAD

The intermediate knife-edge, YY, fixes the load on the end knife-edge XX at the point vertically above YY

to the end knife-edge as in fig. 4.

Under the pressure of the end bearing, the knife-edge takes on a rounded form and has a narrow strip of contact with the plane bearing. With tilting of the bearing this narrow strip wanders along the tilting plane surface with both horizontal and vertical components of motion. This effect, while small, is appreciable in balances of moderate or higher precision and causes changes in the position of M_2 (fig. 1). The tilting of the end bearing is prevented by locating another intermediate knife-edge, ZZ, parallel to and directly below XX as shown in fig. 5.

If, as an experiment, the reader will mount on the circumference of a wheel a crosspiece which is definitely askew with reference to the axle of the wheel and then examine the motion of the skew crosspiece with rotation of the wheel it will become apparent that the skew crosspiece tilts continuously as the wheel rotates. Similarly the skew end knife-edge, XX, tilts continuously as the beam swings. This tilting produces a rotation of the stirrup that hangs in a vertical plane from the end knife-edge. If the intermediate knife-edge, YY, is separated vertically from the skew end knife-edge, XX, then rotation of the stirrup with motion of the beam will cause systematic shifting of the vertical from YY along XX. This causes systematic complications of the sensitivity because of the changes in arm length and in the distance from M_2 (fig. 1) to the fulcrum, C. This effect is eliminated by making the vertical distance between XX and YY equal to zero, that is, by locating them in a common plane.

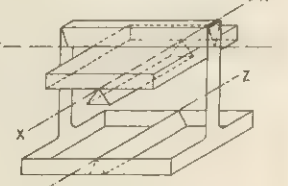
In order to be stable ZZ must be located below XX. The imperfections in the knife-edge ZZ will cause slight shifting; therefore ZZ should be far enough below XX to minimize any such effect.

Neglect of proper design of the loose joints in the suspension is often the source of large errors in analytical balances. Although the principles involved have long been known, having been developed mathematically by Max Thiesen of Berlin in 1883, it is the exception rather than the rule for the pan suspensions to conform to the theoretical requirements. Other designs of suspensions have proved satisfactory.

In practice it is common to minimize the effect of shifting of the vertical from YY along XX by adjusting the XX axis accurately parallel to the central knife-edge. This may be satisfactory unless strains left in the beam cause the knife-edges to become askew. The substitution of cylindrical pins for the YY and ZZ knife-edges is, however, to be deplored since this type of joint develops appreciable friction under loads. The resulting stiff joints permit shifting of the centre of load and tilting the plane with resulting inaccuracies.

Arrestment.—As was shown above, if the stirrup be shifted in any direction on the knife-edge, the position of M_2 will be changed with resulting changes in arm length and sensitiveness. Therefore a primary purpose of the arrestment mechanism is to replace the bearings and knife-edges precisely in the same position each time.

In balances of the highest precision the pans, stirrups and beam are all supported. With balances of medium precision or better, all three bearings are separated from their knife-edges while in less precise balances the central bearing alone may be separated. In the more precise types the central plane bearing is rigidly mounted and the beam and stirrups are raised to the arrested position by a group of supporting points.



FROM MAX RAUDNITZ, "DIE KONSTRUKTION DER VON HAND BEDIENTEN WAAGEN"

FIG. 5.—ARRANGEMENT OF KNIFE-EDGES TO ELIMINATE TILTING OF END BEARING

The knife-edge YY fixes the centre of load at one point on the skew end knife-edge XX. Knife-edge ZZ prevents tilting of XX

In the type with a single horizontal arrestment arm that moves vertically the arrestment and release occur in the following order: (1) the stirrups are lifted; (2) the beam is lifted; (3) the beam is lowered onto the central bearing; (4) the stirrups are lowered onto the end knife-edges.

The best order to be followed in the arrestment and release is a controversial matter. The single-arm type is, however, generally considered deficient for several reasons. For example, during arrestment and release when the beam rests on the central knife-edge with the end bearings still supported by the arrestment, the end knife-edges may chatter or bounce against the end bearings with resulting damage. Also since the beam is free to oscillate as the end bearings are lowered on to the knife-edges, contact may not occur in the same line on successive releases. Another deficiency arises from the fact that the arrestment falls away from the stirrups along a vertical path while the end of the beam follows a circular path about the fulcrum. If the first contact between the arrestment and stirrup occurs with the beam tipped from the horizontal there will be a tendency to slide the bearings sideways on their knife-edges into the vertical line of motion of the arrestment contact points. With this sequence it is an advantage to arrest the pans first, bringing the beam into a horizontal position before it is arrested. This sequence, 1, 2, 3, 4, is used with the additional precautionary provision that the loads are lifted from the pans by the transposing mechanism before the stirrups are lifted and replaced after the stirrups are lowered on to the end knife-edges. Special care in operation is required with this sequence. In less precise balances the effect of the deficiencies of the sequence 1, 2, 3, 4 may be largely masked by other shortcomings.

The sequence 2, 1, 4, 3 has been considered more desirable and is achieved by separating the arresting mechanism into two vertically moving crossarms, one part for the two stirrups and one for the beam. Many arrestments of this type have contact points for the beam about midway between the centre and end knife-edges. A serious defect becomes apparent when such a balance is accidentally released with only one pan loaded. When this occurs the point of support for the beam nearest the loaded pan becomes the fulcrum, and the beam and stirrups may be thrown violently out of position. This can be avoided by locating points of support for the beam vertically below the end bearings. This sequence necessitates caution to avoid bouncing the loaded beam from one side to the other before the beam is lifted, unless the pan arrest brings the beam into a horizontal position.

In the arc type of arrestment, which is intended to obviate the shortcomings inherent in the single-arm type, two swinging arms are pivoted about a point in line with the central knife-edge. Since the points of contact for the beam are located between the fulcrum and the end knife-edges and have a shorter radius of motion than do the stirrup contacts it is possible to adjust their position so that the beam is arrested first. When this is done the end points will still overtake the stirrups since their greater radius causes more rapid motion. The sequence 2, 1, 4, 3 can, therefore, theoretically be obtained. If, however, the beam is lifted first, then both end bearings must make contact at precisely the same instant; otherwise with a load at only one end, the beam will be tipped and hammering of the knife-edges and displacement of the bearings will result.

The claim has been made that this type of arrestment eliminates any tendency for the bearings and knife-edges to slide during arrestment and release, since the beam and arresting arms rotate about a common axis. This does not necessarily apply to the stirrups, which hang in a vertical plane. The only points on the stirrup that remain a constant distance from the central knife-edge as the beam swings are points on a line with the end knife-edge. If the order of arrestment is 1, 2, 3, 4, then the contact points on the stirrup should be in line with the end knife-edge, a point often overlooked. Use of three points of contact on the stirrup is precluded unless the order 2, 1, 4, 3 is used, or unless the beam is brought into a horizontal position by the pan arrestment previous to the sequence 1, 2, 3, 4.

Since the contact points for the beam follow a circular path the motion is vertical at only one point on the circular path. The contact points on the beam must, therefore, be in the same plane with the three knife-edges if the beam is to be raised vertically from the central bearing. It is very difficult to have this type of arrestment in perfect adjustment. A further dis-

advantage is found in the relatively small central bearing for the swinging arms. Very slight wear will allow the beam and stirrups to be replaced in different positions with successive releases of the arrestment. This type of arrestment is not used in the finest balances.

In one type of arrestment, the stirrups are lifted by three points, which prevents erratic tilting of the bearing plane, the points making contact with a socket, groove and plane, respectively, thereby locating the stirrup in the same position each time. The stirrup arrestment arm is rigidly attached at the back, a flexible section allowing motion and eliminating possible play from loose bearings. The beam has four points of contact with the arrestment, one below each end knife-edge and a socket and groove, respectively, at the two ends of the central knife-edge. The pointer brake, a light wire that touches the pointer during arrestment and release, reduces vibration of the beam. Metal-to-metal contact with resultant sticking is avoided by making the contact points of Pyrex glass.

Quick Weighing Devices.—Various devices are used to speed up the process of weighing. They include adjustable sensitiveness, keyboard-controlled weights, the chain and magnetic damping or air damping.

Sensitiveness can be reduced by a factor of 100 by suspending a highly polished ball from the beam below the central knife-edge. The loads are then balanced to the nearest 10 mg. With the lowered sensitivity the observed difference in scale divisions gives directly the difference between loads in tenths of a milligram. The rider is then set to the correct tenth milligram setting, and the ball removed from the beam. At the increased sensitiveness the difference in scale divisions is numerically equal to thousandths of a milligram. In this way much time is saved by avoiding repeated trials with different rider settings.

Keyboard-controlled weights may be added to a carrier on the stirrup. This device speeds up the weighing process by avoiding disturbing air currents resulting from opening the door of the balance case.

The chain weighing device consists of a chain hung from an additional knife-edge on the beam, with the other end hung from a graduated column or dial adjusted so that the graduations can be read directly in milligrams. Because of errors resulting from friction between links of the chain, time is saved at the expense of accuracy.

By recording turning points, the rest point of a freely swinging balance may be determined at least twice as accurately as with a balance that is damped so as to be dead beat. Since the damped balance must be read a second time to assure that it has stopped moving, time is not necessarily saved by adding such a device to the usual analytical balance. If, however, the period is greatly speeded up and the higher sensitivity obtained by a microscopic scale or other device, then time will be saved.

Microbalances.—Small quartz microbalances with capacities of less than a gram have been constructed with a reliability much greater than is ordinarily found with small assay type balances having a metal beam with three knife-edges. Microbalances are used chiefly to determine the densities of gases, particularly of gases obtainable only in small quantities. Both the torsion and knife-edge types of quartz balance have been used with success. The balance usually operates in a gas-tight chamber and a change in weight is measured by the change in the net buoyant force on the balance due to the gas in which the balance is suspended, the pressure of the gas being adjustable and measured by a mercury manometer connected with the balance case.

In one successful design the beam was suspended from two vertical quartz fibres that take the place of the fulcrum knife-edge used in some earlier types. Hans Pettersson has been able to detect differences in weight of only 0.25×10^{-6} mg. in a load of 250 mg. (L. B. M.)

BIBLIOGRAPHY.—For theory and details of design and construction, *see* George A. Owen, *A Treatise on Weighing Machines* (1937); Sir Richard Glazebrook, "Balances" in *A Dictionary of Applied Physics*, vol. iii (1923); Ernst Brauer, *Die Konstruktion der Waage* (1906; Eng. trans. by H. C. Walters, *The Construction of the Balance*, 1909); *See* "Design and Test of Standards of Mass," United States National Bureau of Standards *Circular No. 3* (1918). For sources of weighing errors, *see* A. H. Corwin, "Microchemical Balances, Errors of the Kuhlman Balance," *Industr. Engng. Chem. (Anal.)*, vol. 16, no. 4, p. 285 (April 1944); P. A. Guye, "Contributions à l'étude des causes d'erreur affectant les determinations de poids atomiques," *J. Chim. phys.*, vol. 14, p. 25 (1916).

Ultramicrobalance.—The ultramicrobalance is any weighing device that serves to determine the weight of smaller samples than can be weighed with the microbalance; *i.e.*, total amounts as small as one or a few micrograms (1 microgram = 1 γ = 0.001 mg. = 10^{-6} g.). It must show a detectable response to a weight of 0.01 γ or less. The ordinary methods of constructing delicate laboratory balances of the knife-edge type, already discussed, are not satisfactory in the ultramicro range and have been entirely replaced by designs based on other principles. A knife-edge narrow enough to yield necessary sensitivity would have so small an area of contact as to preclude any known material for its construction.

The principles on which ultramicrobalances have been successfully constructed include elasticity in structural elements, displacement in fluids, balancing by means of electrical and magnetic fields and combinations of these. Measurement of the effects produced by the minute masses weighed has been made by optical, electrical and nuclear radiation methods of determining displacements, and optical and electrical measurements of forces used to restore a displacement caused by the sample being weighed.

Simple Elastic Balances.—The preponderance of successful balances has been based on the elastic properties of certain suitable materials, especially quartz fibres, which have great strength and elasticity and are relatively independent of the effects of temperature, hysteresis and inelastic bending. Glass fibres are also useful and were employed before fused quartz became generally available. Elastic balances are advantageous because of their inherent simplicity and sensitivity, and because they measure the weight directly and independently of geographical variations in the gravitational field at the earth's surface.

In 1901 E. Salvioni described a very simple elastic balance constructed from a single glass fibre, mounted horizontally with one end held rigidly, and with a tiny pan suspended from the other (free) end. The application of a load on the pan caused bending of the fibre the amount of which was measured against a stationary scale. Modern modifications of this simple design tend to employ a quartz fibre heavy enough to yield a small amount of bending, the magnitude of which is determined sensitively with a microscope. The weighing range of the Salvioni-type balance is always restricted by the fact that the weight of the pans is usually considerably greater than the weight of the sample. The unloaded pan will then cause a greater deflection than the additional deflection produced by adding the sample to the pan. The subtraction of the large initial deflection from the total deflection leaves only a comparatively small range for the sample, with corresponding difficulty in reading the small movement accurately. The deflection of the fibre caused by its own weight is also quite significant and greater as the length is increased or the diameter reduced.

Quartz fibres, much longer than are practical with the simple design of Salvioni, are often wound into a helix or spring. By increasing both the diameter of the fibre, to increase the possible load, and its length, to increase the sensitivity, greater range of weighing may be achieved. J. W. McBain and A. M. Bakr early constructed such balances manually and employed them extensively in studies of adsorption of vapours on solid adsorbents. P. L. Kirk and F. L. Schaffer developed mechanical means of constructing similar helix balances with superior uniformity of fibre and of helix, and this type of construction was used in commercial helix balances.

Helix balances suffer from some lack of linear response with change of load. Stretching the helix produces moments of both bending and torque in the fibre. Since these moments are not the same function of the diameter of the quartz fibre, and do not retain a constant ratio at different degrees of stretch, a correction must be applied for very accurate weighing. For similar reasons, the helix is somewhat sensitive to temperature differences that also must be corrected for high-accuracy weighing. The helix

balance is therefore of greatest utility for rapid weighings of medium accuracy. It has a relatively high ratio of load to sensitivity as compared with straight fibre balances.

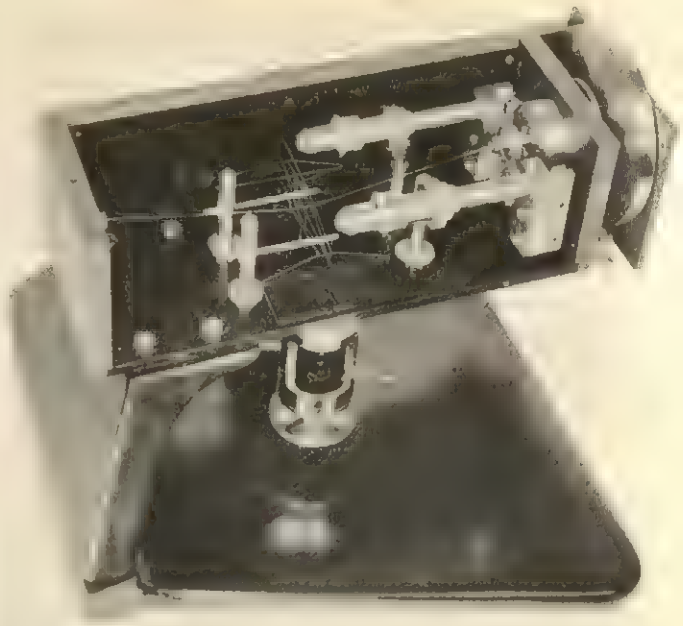
Other designs of simple elastic balances constructed of fused quartz or glass include the flat spiral, which gives an effect similar to an elongated Salvioni fibre but in a compact space, and the quartz circle, which is distorted toward the oval by suspending a weight from its lower portion. If two small mirrors are mounted on opposite sides near the top and facing each other, the distortion produced in the circle serves to deflect greatly a beam of light passed from one mirror to the other in a Z-shaped pattern. This deflection aids in measuring sensitively a very small distortion of the circle caused by the load.

Torsion Balances.—The most successful and practical ultramicrobalances have been based on the principle of balancing the load by applying torque to a quartz fibre. A simple design described by H. V. Neher utilized a rigid fibre as a horizontal beam, supported at its centre by a stretched horizontal quartz torsion fibre sealed to it at right angles. On each end of the beam a pan was suspended, one counterbalancing the other. The deflection of the beam caused by adding the sample to one pan was restored by rotating the end of the torsion fibre until the beam was again in its horizontal position and the full range of torsion in the suspending fibre could be applied to the measurement of the load added to one pan. The amount of torsion necessary for restoration was read by means of a dial attached to the end of the torsion fibre. The weight was obtained by calibrating the balance against known weights, and reading the value from the calibration chart of weight *v.* torsion.

Unlike direct displacement balances that rely only on the elasticity of the structural members, the torsion balance allows gravity to balance the largest component of the load, *i.e.*, the pans, and results in greatly increased load capacity.

The simple design of Neher was limited by: (1) incomplete rigidity of the beam, which allowed some lowering of the centre of gravity with increased load; (2) inexact determination of the rotational position of the beam; (3) uncertainty of the effective beam length; and (4) inexact determination of the amount of torsion. It was also subject to erratic behaviour caused by small air currents resulting from unequal heating by conduction through the case and by radiation through the glass of the case. High sensitivity achieved by using a fine torsion fibre resulted in a large sacrifice of load capacity. With consideration of these limitations of an otherwise favourable principle, P. L. Kirk, R. Craig, J. E. Gullberg and R. Q. Boyer produced a refined version of the torsion balance that became widely accepted as standard for ultramicro weighings and was the model of most ultramicrobalances. Rigidity was increased in the beam without great increase in weight by constructing the beam as a simple truss, 10 cm. in length, with light tension braces from a central vertical support fibre to each end. A second horizontal fibre, parallel to the main beam fibre and only 15 μ in diameter, was mounted on the beam to serve as a sensitive indicator for positioning the beam. Close to each end of this indicator fibre a rigidly mounted microscope objective was focused on the fibre. The images from the two objectives were converged by prisms and brought into a common ocular field so that the two ends of the indicator fibre appeared on the two halves of the visual field of the ocular. The ocular image was projected on a ground glass screen for easy viewing. The beam could be placed in a highly reproducible horizontal position by adjusting its rotation so that the two images were prolongations of each other. Total sag of the beam under increased load did not affect the determination of rotational setting but only lowered both images in the microscope field.

Pans were suspended on fine quartz fibres of the type previously developed by D. Steele and K. Grant as a substitute for knife-edges. Fibres of about 5 μ diameter were sealed at the level of the beam torsion suspension to extensions of the main beam fibre at either end. A fibre of less than 6 μ diameter can be shown to bend so flexibly within a rotation of 1° as to introduce no measurable resistance to the rotation at a sensitivity level of 0.005 γ. Its tensile strength is such as occasionally to support as much as 1 to 5 g. of weight, though not without hazard of fracture. It is, at this diameter, invisible to the human eye and its fusion to the beam must be performed entirely under the microscope. The exact limit of diameter is not immutable and heavier fibres have been employed for carrying heavier loads, but only with some sacrifice of rotational limits or of sensitivity. The fact that the beam is restored to a predetermined setting after loading does not remove the restriction of essential knife-edge behaviour in the pan suspension, since otherwise the beam response is made sluggish and it is no longer possible to set the torsion wheel accurately.



BY COURTESY OF J. RODDER

FIG. 6.—COMMERCIAL QUARTZ TORSION ULTRAMICROBALANCE. (NOTE: THE EXTREMELY FINE QUARTZ FIBRES HAVE BEEN ACCENTUATED)

The torsion fibres and their mounting were highly critical. The diameter required close control because the rigidity of the fibre was approximately a fourth power function of the diameter, whereas the tensile strength was approximately a square function. Very minute differences in diameter gave rise to relatively very great differences in flexibility and consequently sensitivity. A fibre of about 23 μ diameter yielded the usual sensitivity desired, $\pm 0.005\ \gamma$, and reducing the diameter to about 17 μ increased the sensitivity to about $\pm$ 0.001 γ. The fibres were mounted to thickened projections of the beam in two portions, each of about 5 cm. length, one in front and one to the rear of the beam, and at the rotational centre. The rear fibre was supported by a quartz bow of considerable strength which maintained an approximately constant tension on it regardless of the load applied. The bow was held in a spindle mounted in the rear of the case framework, the attachment being made with molten selenium. The spindle was adjustable in a rotational direction or axially with respect to the torsion fibre to permit altering the total tension on the fibre. The front segment of torsion fibre was attached also by a thicker mounting fibre to a wheel by which torsion was applied and its magnitude determined. A suitable wheel was developed from a surveyor's vertical transit wheel by graduating it in a full circle with 2,000 markings. The graduations could be read by vernier to one minute of arc, and required engraving to a somewhat greater degree of accuracy.

Construction of the pans for the torsion as well as for other ultramicrobalances presents several difficulties. They must be strong, noncorrosive and light. Platinum is ideal in its stability and ease of forming, but with a density of 21.5 it is difficult to retain enough strength in a really light pan. The torsion balance was equipped with small platinum pans of about 6 mm. diameter, pressed from 0.001 in. thick foil and weighing about 25 mg. These could also be used as reaction vessels, making unnecessary any transfer in a series of chemical transformations. Pans as heavy as this are not practical for most other designs of ultramicrobalance

for which thin quartz pans are probably most satisfactory. Aluminum foil and even cellophane have been used for pan construction with less favourable types of balance.

On the torsion balance, the pans were suspended from very fine suspension fibres by means of heavier fibres and a quartz stirrup. These suspensions were made long enough so that the pans were held below the floor of the balance case in a metal well equipped with a rotating closure; thus, the pan was accessible without opening the case or disturbing the remainder of the balance. This design was original with H. Pettersson.

The performance of the torsion balance was not seriously affected by vibration because the natural period of the suspension was very different from common vibration periods of the environment and therefore allowed rapid damping of such disturbances. The enclosure of the balance was critical, not because of the balance design but because of the extreme sensitivity combined with high load capacity, which made the balance susceptible to minute air currents caused by minor irregularities of heating. A double case with shielding against conducted and radiated heat maintained uniform temperature. Simple remote control was also installed to avoid direct handling of the balance by the operator with its attendant heat disturbances. Under these conditions the operation was rapid and reliable.

The general design and basic principles applying to the balance described have been utilized in various modifications. The torsion wheel may be moved to the rear of the housing, allowing space for a more direct light path in the optical system with resulting simplification of the optics. The reading and remote control systems are subject to many modifications for convenience or personal preference and the quartz system has been modified for greater load capacity and other reasons.

A number of designs based on similar principles but with significant modifications have been developed. O. H. Lowry described a torsion balance in which no restoration of the beam is employed, but the deflection produced by the sample and opposed by the suspending torsion fibres is measured with a cathetometer. The pans could be counterbalanced, and by avoiding the difficult mechanical construction of the torsion wheel bearings, the construction was greatly simplified. The capacity was 50 to 100 mg. and the sensitivity was 0.1 microgram.

Pettersson described a most ingenious balance in which the beam itself was suspended from fine vertical fibres in a manner similar to the pan suspension described above and which was first utilized by Steele and Grant. His balance did not utilize torsion for restoration of the beam but fine quartz riders were employed for partial balancing, and the residual displacement of the beam was measured.

The sensitivity of the Pettersson balance was of the order of 0.001 γ and the load capacity was comparable with that of the torsion balance of Kirk *et al.*, described above. Its chief limitation was a serious susceptibility to minute vibrations that were transmitted readily through the vertical suspensions. Quartz torsion balances have been constructed inside of relatively large horizontal glass tubes by using very short pan suspensions, and making appropriate modifications in the torsion fibres. Such balances can be operated *in vacuo* or in a controlled atmosphere.

Magnetic Balances.—Following the early magnetic balance of F. Emich and others, a number of delicate balances have utilized a magnetic field to balance a load. The weight is determined in terms of the current necessary to offset the effect of gravity. While such balances have some advantages, they have not been successful in attaining the high load capacity combined with great sensitivity that characterizes the elastic balances. When it is considered that a quartz torsion fibre can restore a load at least 100,000 and possibly nearer to 1,000,000 times greater than the sensitivity with which this restoration can be measured, it is apparent that it is likely to be difficult to apply any other principle as successfully. Measurement of electric current, for example, is difficult when the ratio of total current to the limiting detectable current is greater than 1,000 to 1 and cannot be measured when the ratio is over 10,000 to 1. Since this ratio determines the ratio of the total load to the smallest detectable fraction of the load, it is evident that the load restored will be small as compared with the limiting sensitivity.

Measurement of Deflection.—Numerous procedures other than the use of direct mechanical scales have been attempted in measuring small deflections in elastic types of balance. Some of these are theoretically better than the direct measurement of torsion, *e.g.*, the use of the ultramicrometer which consists of a small condenser with one movable plate controlling a tuned circuit in series with a large capacity condenser. Incredibly small movements of the variable plate throw the oscillating circuit out of resonance, and the alteration in the large condenser necessary to restore the oscillation is a measure of the submicroscopic movement. The practical difficulty of mounting the variable plate to an elastic system subject to variable weight loads had proved unsurmountable as of the sixth decade of the 20th century, but its solution should ultimately increase the refinement of measuring minute masses.

Radioactivity has been employed in determining distortion of elastic systems, by making use of special geometry and some type of Geiger-Müller counter. Since the distance of the radioactive sample from a collector electrode in the counter affects the counting rate, it is possible to so arrange the sample and the electrode that very small movements can be detected and measured. The effectiveness of this device must be considered as questionable in the field of ultramicrobalances for several reasons. The problem of containing safely a sufficient quantity of radioactivity involves masses that are unfavourable.

The emission of the radiation is a statistical function of the atoms involved, and thus a rather large amount of emitting material must be used to guard against random fluctuations in the emission. The necessary arrangements and equipment are also far greater in complexity and amount than is desirable, especially since their presence does not simplify or eliminate the delicate weighing mechanism.

Calibration of all ultramicrobalances is necessary and difficult. Small known weights must be constructed as from wire or quartz fibre using a proportionality factor between length and total weight of the long piece to obtain the small weight. Measured quantities of dilute solutions of known strength may be evaporated to obtain a known solid content. Ultramicrobalances require skill and ingenuity both for their construction and for their operation. *See* GRAVITATION; PHYSICAL UNITS; WEIGHTS AND MEASURES.

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BALANCE OF POWER. This term has been used since the 16th century to denote a type of international relations in which one nation or group of nations protects itself against another nation or group of nations by matching its power against the power of the other side. While the term came into general use only in modern times, the practice itself was referred to by ancient writers (*see*, for instance, Demosthenes, *For the People of Megalopolis*, 25 to 32; Polybius, i, 83). The most detailed analysis of the mechanics of the balance of power was written by the Indian political philosopher Kautilya in the 4th century B.C.

As a fact of social experience, the balance of power is a universal phenomenon, by no means limited to international relations. Wherever a number of autonomous social units seek to maintain their autonomy in relation to each other, they must do so by pitting their power, either individually or jointly, against that of their competitors. Thus the U.S. system of government is referred to as a system of checks and balances, and it is said that a certain group in congress, in a political party or in any other kind of organization holds the balance of power.

In international relations, the basic pattern of the balance of power is that of direct opposition between nations *A* and *B*. *A* tries to impose its will upon *B*, and *B* tries to defend itself against *A* and may try to impose its will upon *A*. *B*, in order to defend itself against *A*, must have power at least equal to that of *A*. *A*, in order to defend itself against *B*, must similarly have power at

least equal to that of *B*. An increase in the power of *A* requires a corresponding increase in the power of *B*, and vice versa. Thus both nations, in order to defend themselves against each other, must embark upon a policy of balance of power. They can pursue that policy in two different ways: by increasing their own power—and then they engage in an armaments race or in the competitive acquisition of territory—or by adding to their own power that of other nations—and then they embark upon a policy of alliances.

20th-Century Changes.—The balance of power after the beginning of the 20th century underwent drastic changes that for all practical purposes destroyed the state system as it had existed since the end of the middle ages. During that period, the political world was composed of a number of balance-of-power systems, such as the European, the American, the Indian and the Chinese, which were relatively independent of each other and of which the European was the dominant one. Within the European balance of power, Great Britain played the role of the "balancer" or "holder of the balance." It was not permanently identified with the policies of any European nation. Its only objective was the maintenance of the balance itself. Thus it would throw its weight at one time in this scale, another time in the other scale, guided only by one consideration—the relative position of the scales. Naval supremacy and virtual immunity from foreign attack enabled Great Britain to perform this function, which made the European balance of power both flexible and stable.

The balance of power that emerged from World War II was world-wide in two different respects. All the nations of the world were members of one single balance-of-power system, into which the formerly independent systems were integrated. Furthermore, at the outbreak of World War I in 1914, the main weights in the balance were still predominantly European: Great Britain, France and Russia in one scale, Germany and Austria in the other. At the end of World War II, the principal weights in each scale were either entirely non-European, as in the case of the United States, or predominantly non-European, as in the case of the Soviet Union. The centre of world politics had shifted from Europe to America and Asia.

Bipolarity of Power Following World War II.—This shift in the location of the principal weights in the balance of power went hand in hand with a drastic reduction in the number of the principal weights, until only two weights of the first magnitude were left: the United States and the Soviet Union. Thus there came about what may be called bipolar balance of power. This reduction in the number of first-rate powers greatly affected the operation of the balance of power. The greater the number of active players, the greater the number of possible combinations and the greater also the uncertainty as to the combinations that will actually oppose each other and as to the role the individual players will actually perform in them. Under such circumstances, no player can go very far in his aspirations for power unless he is sure of the support of at least one or the other of his coplayers, and before World War II nobody could generally be too sure of that support. In addition, the approximately equal distribution of power among a multiplicity of nations effectively restrained the aspirations of any one of them.

The bipolarity of power destroyed this restraint that the mechanics of the traditional balance of power imposed upon the principal players. It also destroyed the flexibility that all players formerly enjoyed. Because of the great disparity of power between the two superpowers and all the other nations, the latter lost that freedom of movement that previously had made for a flexible balance of power. Instead, the allies, clustered around the two superpowers, tended to transform themselves into two stable blocs, opposing each other across a rigid boundary line. In these conditions the only element of flexibility stemmed from the ability of the so-called uncommitted nations to join one or the other bloc.

In consequence of these developments, the balance of power, following World War II, had no place for a "balancer," a "holder of the balance." Not only had Great Britain lost the decisive position that it held in the European balance of power for about four centuries, but the concentration of power in the hands of two nations made it impossible for any other nation or combination of nations to perform that decisive function. The result was again loss of restraint and flexibility.

Ideological Struggle.—A final, and perhaps decisive, difference between the post-World War II balance of power and that preceding it lay not in the sphere of the mechanics of power but in the moral realm. Edward Gibbon, in the 18th century, pointed to this factor when he suggested

> . . . to consider Europe as one great republic, whose various inhabitants have attained almost the same level of politeness and cultivation. The balance of power will continue to fluctuate, and the prosperity of our own or the neighbouring kingdoms may be alternately exalted or depressed; but these events cannot essentially injure our general state of happiness, the system of arts, and laws, and manners, which so advantageously distinguish, above the rest of mankind, the Europeans and their colonies . . . In peace, the progress of knowledge and industry is accelerated by the emulation of so many active rivals; in war, the European forces are exercised by temperate and indecisive contests.

This moral consensus was replaced in the mid-20th century by a fierce ideological struggle between two hostile and incompatible political philosophies and ways of life. In consequence, the "temperate and indecisive contests" of times past were replaced by intemperate contests the stake of which was the domination of the world. The old balance of power, while extremely unstable in detail, had sufficient flexibility to survive changes in the distribution of power by adapting itself to them. The new balance of power, while stable in detail, was so rigid that any change in the distribution of power threatened the system itself with destruction.

See ALLIANCE; EUROPE: *History: The Great Age of Monarchy, 1648–1789: Balance of Power;* SPHERE OF INFLUENCE; *see* also references under "Balance of Power" in the Index.

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BALANCE SHEET: *see* BOOKKEEPING; FINANCIAL STATEMENT.

BALANCHINE, GEORGE (GEORGI MELITONOVITCH BALANCHIVADZE) (1904–), Russian-U.S. choreographer, founder and artistic director of the New York City Ballet, was born on Jan. 9, 1904, in St. Petersburg, Russia, and graduated from the Soviet State Ballet school in 1921. During a western European tour, in 1924, he joined the Diaghilev Ballet Russe, and soon became its principal choreographer. His first production was Stravinsky's *Le Rossignol*, which marked the beginning of a long, fruitful collaboration with this composer. For Diaghilev, Balanchine also staged *La Chatte*, *Le Fils Prodigue*, and Stravinsky's *Apollo*, which ranks as a masterpiece.

In 1933, at the invitation of Lincoln Kirstein, Balanchine went to the United States to join him in establishing the School of American Ballet and organizing the American Ballet company, of which the New York City Ballet, established 1948, is the direct descendant.

Balanchine prefers to work in the pure classic dance idiom and many of his finest ballets, such as *Serenade*, *Symphony in C* and *Agon*, have no dramatic themes, but consist of highly original and imaginative dance patterns. Responsible for most of the New York City Ballet's extensive repertoire, Balanchine also created works for the American Ballet Theatre, Royal Ballet, Paris Opéra Ballet and other major companies. A trained musician, he became one of the few choreographers who could read a conductor's score.

In 1964 the U.S. dance world was stirred when the Ford Foundation, awarding nearly $8,000,000 to strengthen professional ballet in the United States, presented the entire amount to the New York City Ballet, its affiliated School of American Ballet, and six other ballet companies—all under the direct or indirect influence of Balanchine. Concern was expressed that a dance monopoly by Balanchine and his followers would be the result.

Balanchine married, successively, five ballerinas: Tamara Geva, Alexandra Danilova, Vera Zorina, Maria Tallchief and Tanaquil

LeClercq, whose brilliant career was cut short by an attack of poliomyelitis in 1956. (Ln. Me.)

BALARD, ANTOINE JÉRÔME (1802–1876), French chemist, best known for his discovery of bromine, was born at Montpellier on Sept. 30, 1802. He graduated from the Montpellier École de Pharmacie in 1826. In 1842 he became professor of chemistry at the Sorbonne and in 1851 at the Collège de France. He died in Paris on March 30, 1876.

In 1824, while studying salt marsh flora, Balard observed sodium sulfate crystals in the mother liquid of common salt. Saturating these bitterns with chlorine and distilling the product, he discovered the only liquid nonmetallic element, bromine (1826). Its resemblance to chlorine and iodine enabled Balard to determine the properties and compounds of this new element. Later he proved the presence of bromine in sea plants and animals.

Although Balard found that the concentration of salts in seawater is low, he correctly pointed out the potential value of the sea as a source of chemicals. He devoted considerable time to the problem of obtaining soda and potash from seawater economically, but his efforts were nullified by the discovery of rich deposits at Stassfurt, Ger., in 1858. Until the discovery of these deposits, all bromine used for photographic plates was manufactured by Balard's method. He also discovered hypochlorous acid and the composition of Javelle water, a bleaching agent. (V. Bw.; X.)

BALASH (Valakhsh), Sasanian king of Iran from A.D. 484 to 488, succeeded his brother Firuz. Threatened from the start by the dominance of the invading Hephthalites (*q.v.*), Balash was able, with support from Zarmihr, a feudal chief, to suppress his rebel brother Zareh. Subsequently abandoned by Zarmihr, he was blinded after being deposed in favour of a nephew, Kavadh. (A. D. H. B.)

BALASHOV, a town of Saratov *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., and from 1954 to 1959 the centre of an *oblast* now abolished, stands on the Khopër river, at the junction of railways to Tambov, Penza, Kamyshin on the Volga, and the Ukraine. The census of 1959 reported a population of 64,349. The good communications and the rich agricultural area around the town have led to the development of food industries. It is the location of a state pedagogical institute. (R. A. F.)

BALASORE, a town in Orissa, India, headquarters of Balasore district, lies 98 mi. N.E. of Cuttack. Pop. (1961) 33,931. The town is 16 mi. up the Budhabalang (Burabalang) river, 7 mi. from the Bay of Bengal. The roadstead and river anchorage attracted English merchants in 1631–34. Their trading settlement, established 1642–51, was followed by those of the Dutch (before 1664), and of the Danes and French in about 1676. The Dutch and Danish settlements were ceded to the British before 1850 but the 38-ac. French holding remained until 1947. Balasore declined as a port in the 18th century because of silting, but became the centre of an expanding rice trade and salt industry. Fakir Mohan college (1944) is affiliated to Utkal university.

Balasore District is an alluvial strip from 9 to 34 mi. broad, watered by six rivers (Subarnarekha, Panchpora, Burabalang, Jamka, Kansabansa and Dhamra), lying between the (Orissa) Nilgiri hills and the sea. Area 2,500 sq.mi. Pop. (1961) 1,415,923. Its natural divisions are: (1) A narrow coastal salt tract rising toward the beach in sandy ridges 50–80 ft. high, extending inland into prairies of long coarse grass and scrub jungle with patches of rice cultivation; (2) the main arable tract, a dry lagoon with level rice fields and depressions near the riverbanks; (3) an undulating submontane tract of red soil cut by ravines skirting the hills and covered with sal jungle. Coastal and high-level canals run the length of the district; intended for navigation between the Hooghly and Mahanadi, they are now mainly drainage canals. The Calcutta-Madras highway and the Southeastern railway from Calcutta (Howrah) serve Bhadrak and other towns. Bhadrak (pop. [1961] 25,285), 39 mi. S.S.W. of Balasore, takes its name from the 4th-century Bhadrakali temple. It also has a college (1948) affiliated to Utkal university, and an engineering school. The only port, Chandbali on the Dhamra river 53 mi. S. of Balasore, is used by coastal steamers. The district, whose population has been decreasing since 1901, exports jute, mats, metal and stone utensils and dried fish. (Ma. M.; N. K. S.)

BALASSI (Balassa), **BALINT** (1554–1594), was the greatest Hungarian lyric poet of his time and remained unrivalled until the end of the 18th century. Born (Oct. 20, 1554, at Zólyom, Hung.) into one of the richest Protestant families of the country, Balassi led a life of adventure, fighting with equal gusto the Turks and his own relatives, out to despoil him of his heritage. He became a Catholic, spent some years in Poland and died of wounds received during the siege of Esztergom (May 30, 1594). At first, his poetry was conventional, but his powerful personality soon broke through the narrow barriers of contemporary humanism and his poetry began to reflect a depth and an intensity of feeling which he had acquired as a result of his experiences. Balassi wrote vividly about the beauty of the countryside, the joys of the dangerous life of a soldier fighting for his country. There is nothing artificial about his later love poems: the feelings are sincere, the expression original. He was the inventor of a stanza form, copied by later poets. Though he knew that happiness was unattainable in this life and peace could be found only in God, he was determined to enjoy to the full what life could offer.

The best edition of his works is by Sándor Eckhardt, *Balassi Bálint összes müvei*, I–II (1951). (Ds. Sr.)

BALATON (Ger. Plattensee), the largest lake (approximately 232 sq.mi.) in central Europe, lies at the foot of the Bakony hills in Trans-Danubian Hungary. It is 48 mi. long from southwest to northeast, but only 9 mi. across at its broadest section: it is almost cut in two by the hilly peninsula of Tihany where it is less than a mile broad. More than 50 streams enter the lake, but the only one of considerable volume is the Zalá at the southwestern extremity. The Sió river on the southern side of the lake connects it with the main stream of the middle Danube. The shallowness of the lake is striking, the maximum depth being only 35 ft. Its level varies considerably, however, with a marked rise in spring due to melting snow and a fall in the dry weather of early autumn. It is completely frozen in winter. The northern and southern banks of the lake are sharply contrasting. The fault-line scarp of the Bakony hills rises steeply to the north with some fine basalt crags near the water's edge, whereas the south bank is flat and sandy with a hinterland of rolling down country in the north and east. On the north side viticulture is a traditional occupation, explained by the rich volcanic soils and by the shelter from the north. On the south side fishing villages are the oldest form of settlement. Both shores attract visitors from Budapest, as the proximity of the lake to the capital has produced a number of summer resorts. Rail and road approaches to the lake are well established. (H. G. S.)

BALBI, ADRIANO (1782–1848), Italian geographer and statistician who was, like C. Malte-Brun (*q.v.*), a successful systematizer and disseminator of the geographical advances of his time and a critical compiler of reliable information and statistics. Balbi was born in Venice in 1782, was first a teacher, visited Portugal in 1820, passed some years in Paris where his books were published, and in 1832 went to Vienna as Imperial counsellor for geography and statistics. He died in Venetia on March 13, 1848. His work was praised by Alexander Humboldt (*q.v.*), and his *Essai statistique sur le Portugal . . .* (1822) remained standard for the rest of the century. His most substantial work, *Abrégé de Géographie . . .* (1832), ran into many editions in a number of languages: an eighth German edition, much enlarged, appeared as late as 1893. The *Abrégé* was much used in the important *System of Universal Geography* published in 1842 and largely written by James Laurie. Balbi's minor works were published by his son Eugenio Balbi (1812–84), professor of geography at Pavia.

See E. Balbi, *Adriano Balbi: ricordi biografici* in *Bollettino della Societa Geografica Italiana* (1881). (A. F. Ma.)

BALBINUS (Decimus Caelius Calvinus Balbinus) (d. A.D. 238), Roman emperor in 238. A patrician, he was a Salian priest under Commodus, consul and proconsul of Asia under Septimius Severus and consul for the second time in Jan. 213 under Caracalla. In 238, when the senate led a rebellion of the Italian cities against

the military emperor Maximinus, it placed the government in the hands of a board of 20, of whom Balbinus was one, and then chose as joint emperors Balbinus and Pupienus Maximus. Maximus, as a former city prefect, was extremely unpopular with the commons of Rome who besieged the senate and its emperors in the Capitol. The situation was saved by associating with the emperors the young Gordian, grandson of the original leader of the revolt, as Caesar.

Balbinus stayed in Rome while Maximus went to defeat Maximinus. When Maximus returned with a German bodyguard, Balbinus quarreled with him, fearing that he intended to make himself sole ruler. The praetorian guards in the city took advantage of the emperors' dispute to kidnap them and, when pursued by the German guards, murdered them both. Gordian was thereupon proclaimed sole emperor. (JN. R. M.)

BALBO, CESARE, CONTE (1789–1853), Piedmontese nobleman whose political writings had an important influence during the Italian Risorgimento was born in Turin on Nov. 27, 1789. He grew up while Piedmont was annexed to France and began his career by entering the Napoleonic bureaucracy. His service in various posts meant that he could later benefit from a wider knowledge of Italy than that of many other Risorgimento leaders. At the restoration of the house of Savoy to the kingdom of Sardinia in 1814 his service to Napoleon was held against him; he himself despised the mediocrity of the restored regime, but though he had friends among the young liberals of Turin, he was loyal to the dynasty. His own views were already marked by a realistic constitutionalism and he disapproved of revolutionary programs. Nevertheless, he fell into disgrace with the regime because of his association with some of the leaders of the 1821 revolution and his attempts to persuade Charles Albert (*q.v.*) to assume the leadership of a constitutional movement. He withdrew for nearly a decade from Turin and began to write. His first book, a justificatory memoir on the events of 1821, was followed by several literary and historical works. His most famous book, *Speranze d'Italia* ("The Hopes of Italy"), appeared in 1844. Its key ideas were that the liberation of Italy was desirable but that the interests of the papacy should be safeguarded and that, after Austria had been compensated in the Balkans, a confederation might be the best answer to Italy's needs. Though this program was patriotic and liberal it was also antirevolutionary, and Balbo's *Lettere di Politica* (1847) called for the formation of a specifically moderate Italian party. His actions in 1848 reflected these cautious views. Charles Albert's grant of the constitutional *statuto* seemed to him to meet the necessary demands for reform, and he became the first prime minister of a constitutional Piedmont (March 13). Alarmed by the democratic agitation of Italy, he resigned in July and was later sent to Gaeta as a Piedmontese emissary to Pius IX. Soon he was defending the temporal power whose abolition he had accepted in 1809. He refused the premiership in 1852 and died at Turin on June 3, 1853.

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BALBO, ITALO (1896–1940), Italian soldier and airman, an early Fascist leader who built up the Italian air force between World Wars I and II, was born at Ferrara, on June 6, 1896. He served as an officer in the Alpini (Alpine corps) during World War I and after the war joined the Fascist movement. He was put in charge of the blackshirt militia and in 1922 led the march on Rome. He was made a general of the militia in 1923. He then took a hand in the reorganization of the air force and after becoming a pilot led several long-distance formation flights. He was appointed undersecretary of state for air in 1926, air minister in 1929 and was promoted to marshal in 1933. He was by then becoming unpopular with Mussolini, as he showed friendly sentiments toward Great Britain and was not in favour of co-operation with Hitler. Mussolini also thought that he was becoming too ambitious, and the same year he was sent to Libya as governor general. He was killed in June 1940 when an aircraft in which he was flying crashed at Tobruk, shot down, it was stated, by Italian gunfire after failure to give correct recognition signals. (E. B. BN.)

BALBOA, VASCO NÚÑEZ DE (*c.* 1475?–1519), Spanish conquistador and discoverer of the Pacific, was born at Jerez de los Caballeros about 1475. He was the impecunious descendant of ancient Galician nobility. In 1501 he sailed with Rodrigo de Bastidas, discoverer of the Colombian coast and the northern coast of the Isthmus of Panama, settling thereafter in Hispaniola, the island today occupied by Haiti and the Dominican Republic. Physically striking ("of very gallant mien, and handsome . . . tall, clean-limbed and strong") and a mighty swordsman, Balboa was to prove a great leader and a wise and magnanimous conqueror. As a pioneer farmer, however, he was conspicuously unsuccessful, and in 1510 he escaped his creditors only by hiding in a cask and being carried aboard a caravel carrying reinforcements to Alonso de Ojeda's new mainland colony at San Sebastián on the Colombian coast. Finding Ojeda gone and, of his company, only 41 survivors (led by Francisco Pizarro), the expeditionaries—on Balboa's advice—crossed from Urabá to the less hostile Isthmian coast. There, in Darién, they founded the first stable settlement of continental America: Santa María de la Antigua. By March 1510, Balboa was in command, elected at the expense of two ousted claimants: Ojeda's chief justice, Martín Fernández de Enciso (thenceforth Balboa's implacable enemy), and Diego de Nicuesa (*q.v.*), the governor of Veragua. On Dec. 23, 1510, King Ferdinand V appointed Balboa interim governor of Darién.

During his explorations, Balboa became convinced that the long-sought "Other Sea" with its fabulous kingdoms lay not far distant. He so informed the king, adding that the Indians said its discovery would require 1,000 fighting men. This, and other reports of the riches of *Tierra Firme* (the Isthmus of Panama), inspired creation of an ambitious crown colony (Castilla del Oro); 2,000 new colonists were recruited, and Pedro Arias de Avila, called Pedrarias, was made governor. (*See* ARIAS DE AVILA, PEDRO.)

Warned of his impending replacement, Balboa determined to forestall his successor and himself find the other sea (the *Mar del Sur*, or South sea) before Pedrarias' arrival. Setting out on Sept. 1, 1513, with 190 Spaniards (half the strength of Darién) and 800 Indians, he crossed the Isthmus and on Sept. 25 (or 27), 1513, gaining a hill near the Gulf of San Miguel, he saw the Pacific for the first time; on Sept. 29, he succeeded in reaching the sea at the Gulf of San Miguel and took possession of the "South Sea" and all its coasts for the kings of Castile. Storms prevented a crossing to the Pearl Islands; turning inland, Balboa penetrated almost to the site of present-day Panamá before returning across the isthmus to Darién (Jan. 19, 1514).

Impressed by Balboa's achievement King Ferdinand named him *adelantado* (governor) of the South sea and of Panamá and Coiba. Pedrarias, bitterly envious, contrived to nullify the award, confining Balboa in Darién and harassing his rival in every way possible. Later, forced to license Balboa to return to the Pacific, he prudently married one of his daughters (by proxy) to his hated but potentially important rival, whose departure he delayed until 1517. The marriage, however, did not put an end to the enmity between the two men. Late in 1518, before Balboa could profit by the ships which he and his followers had laboured to build, Pedrarias lured him to Acla and there compassed his judicial murder. Condemned on spurious charges of treason, his right of appeal denied, Balboa was beheaded in Jan. 1519. *See* also PANAMÁ: *History*.

See Kathleen Romoli, *Balboa of Darién* (1953), which contains an extensive bibliography of sources, and C. L. G. Anderson, *Life and Letters of Vasco Núñez de Balboa* (1941).

BALBOA, Pacific terminal port, town and territorial subdivision of the Panama Canal Zone, named for Vasco Núñez de Balboa, discoverer of the Pacific. The town, lying between the docks and Ancón hill, is about 1 mi. from Panamá city, which is not a seaport. Pop. (1960) 3,139. Balboa Heights, adjacent to Balboa, is administrative headquarters for the Panama Canal company and Canal Zone government. The Balboa district (pop. [1960] 30,623, area 222 sq.mi.) comprises the southeast section of the zone. *See* PANAMA CANAL.

BALBUS, literally "stammerer," the name of several Roman

families. Of the Acilii Balbi one, Manius Acilius, was consul in 150 B.C., another in 114. To another family belonged T. Ampius Balbus, a supporter of Pompeius, afterward pardoned by Julius Caesar. We know also of Q. Antonius Balbus, praetor in Sicily in 82 B.C., and Marcus Atius Balbus, who married Julia, a sister of Caesar, and had a daughter Atia, mother of Augustus. The most important of the name were the following two Cornelii Balbi, natives of Gades (Cádiz).

Lucius Cornelius Balbus (called Major) was born early in the 1st century B.C. Pompeius conferred Roman citizenship on him and his family for his services against Sertorius in Spain. Becoming friendly with all parties, he had much to do with the formation of the first triumvirate and was one of the chief financiers in Rome. He won the favour of Caesar and went with him as *praefectus fabrum* ("chief engineer") to Spain (61) and Gaul (58). His position as a naturalized foreigner, his influence and his wealth naturally made Balbus many enemies, who in 56 put up a native of Gades to prosecute him for illegally assuming the rights of a Roman citizen, a charge directed against the triumvirs equally with himself. Cicero, Pompeius and Crassus all spoke on his behalf, and he was acquitted.

During the civil war he tried to get Cicero to mediate between Caesar and Pompeius. Balbus became Caesar's private secretary and, after Caesar's murder, attached himself to Octavian; he was praetor in 43 or 42 and consul—an honour then first conferred on a provincial—in 40. The year of his death is not known. Balbus kept a diary of the chief events of his own and Caesar's life (Suetonius, *Caesar*, 81). The 8th book *De bello Gallico*, probably written by his friend Hirtius, was dedicated to him.

Lucius Cornelius Balbus (called Minor), nephew of the above, received the Roman citizenship at the same time as his uncle. During the civil war he served under Caesar. He also took part in the Alexandrian and Spanish wars. He was rewarded by being admitted into the college of pontiffs. In 43 B.C. he was (?pro-)quaestor in further Spain, where he made a fortune by plundering the inhabitants. In the same year he crossed over to Bogud, king of Mauretania. He is not heard of again until 21, when he was proconsul of Africa. On March 27, 19, Balbus, who had defeated the Garamantes, celebrated a triumph, which was then for the first time granted to one who was not a Roman citizen by birth, and for the last time to a senator. He built a theatre, which was dedicated at Rome in 13. Balbus wrote a play on his visit to Lentulus in the camp of Pompey at Dyrrhachium and, according to Macrobius, a work called *Exegetica*, on the gods and their worship.

BALCH, EMILY GREENE (1867–1961), U.S. economist and political scientist, received the Nobel prize for peace in 1946 jointly with John Mott (*q.v.*). She was born at Jamaica Plain, Mass., on Jan. 8, 1867, and educated at Bryn Mawr college, Bryn Mawr, Pa., from which she graduated in 1889. She later studied in Paris and Berlin. She taught at Wellesley college, Wellesley, Mass., from 1897 to 1918. She engaged in extensive public welfare activities, notably child welfare and the settlement movement and was a member of Massachusetts commissions on industrial relations (1908–09) and immigration (1913–14) and the city planning board of Boston (1914–17).

As a member of the Society of Friends (Quakers), she took an active part in the peace movement following World War I. She was a delegate to the International Congress of Women at The Hague (1915) and was secretary of the Women's International League for Peace and Freedom at Geneva, Switz. (1919–22), and later honorary international president. Aside from her writings on peace, her most important publication was *Our Slavic Fellow Citizens* (1910), the most sympathetic and thoroughgoing study of Slavic immigrants ever made, for which she traveled extensively in Europe and the U.S. to study Slavic backgrounds and the assimilation of Slavic peoples in the U.S. She died at Cambridge, Mass., on Jan. 9, 1961. (A. E. Wd.)

BALDACHIN, also called Ciborium, in architecture, the canopy over an altar or tomb, supported on columns, especially when free standing and disconnected from any enclosing wall. Early examples of the baldachin are found in the basilicas of Ravenna and Rome. The usual form consists of four columns supporting entablatures which carry miniature colonnades topped by a pyramidal or gabled roof. In Romanesque work arches generally replaced the entablatures, and gables frequently topped the four sides, as in S. Ambrogio in Milan. Few baldachins of the Gothic period remain, and their use, outside Italy, seems to have been spasmodic; there is, however, a rich Gothic example in the Ste. Chapelle at Paris (1247–50), reconstructed by E. E. Viollet-le-Duc in the 19th century, which shows great richness of carving, gilding, jeweling and the use of coloured enamels. In the Renaissance the use of the baldachin became commoner, probably as a result of the influence of the enormous bronze baldachin which Bernini designed for the altar of St. Peter's in Rome. These late Renaissance examples make frequent use of the spiral column supporting canopies of extremely fantastic design. *See* also Altar; Canopy. (T. F. H.)

BALDER (Baldr), in Scandinavian mythology, is the son of the chief god Odin and his wife Frigg. Balder is beautiful and just; most legends about him concern his death. Icelandic stories tell how he was slain by the mistletoe which the blind god Hödr, deceived by the evil Loki, hurled at him. Some scholars believe that the passive, suffering figure of Balder was influenced by that of Christ, but the Danish historian Saxo Grammaticus (*c.* 1200) depicts him very differently as a warrior engaged in a feud over the hand of a woman. (G. T.-P.)

BALDINUCCI, FILIPPO (*c.* 1624–1696), Italian art historian. Like Giorgio Vasari he was a Florentine partisan, but he was the first historian to make full use of documents. He was also the first to realize the importance of drawings in the study of painting; the great collection of drawings in the Uffizi palace in Florence is the result of his efforts. (P. J. My.)

BALDNESS (Alopecia) means the lack or loss of hair. Two primary groups of processes leading to baldness can be distinguished: (1) those causing permanent hair loss by destroying hair germ centres; and (2) those causing temporary hair loss by inflicting transitory damage on these centres.

The common patterned early male baldness occurring to some degree in more than 40% of men belongs in the first category. Heredity, age and male sex hormone are three factors recognized in the causation of this type of baldness. Dandruff, a frequently associated condition, seems to play no clearly causative role. No practical remedy for this common baldness is available. Other causes of permanent baldness include many scar-producing skin diseases and injuries, inborn lack of hair development and severe injury to hair germ centres by chemical or physical agents.

Temporary hair loss occurs fairly commonly after conditions accompanied by high fever. Loss of hair usually commences three months after the fever and generally regrows within a year. X-rays, metals and drugs (*e.g.*, thallium, tin and arsenic), malnutrition, some inflammatory skin diseases, chronic wasting diseases and endocrine disorders also can cause temporary excessive hair loss. Furthermore, alopecia areata, a fairly common disorder of unknown cause characterized by sharply outlined patches of sudden complete baldness, also usually causes only temporary injury to hair germ centres.

Finally, hair shaft disorders and fungous infections as well as mechanical factors such as rubbing can cause the appearance of baldness by breaking hairs off close to the skin surface. *See* also Hair. (A. L. Lz.)

BALDOVINETTI, ALESSO (Alessio) (1425?–1499), Florentine painter whose works typify Florentine academic painting of the later 15th century, appears to have been born in Florence on Oct. 14, 1425, and died there on Aug. 29, 1499. He is presumed to have been an assistant to Domenico Veneziano, whose influence is reflected in his earliest surviving works, three narrative scenes begun by Fra Angelico for the SS. Annunziata and an altarpiece painted about 1453 for the Medici villa of Cafaggiolo. It was followed, about 1457, by an altarpiece of the Annunciation for S. Giorgio sulla Costa, and by Baldovinetti's masterpiece, a fresco of the Nativity in the forecourt of the SS. Annunziata (1460–62), which has an important place in the history of Florentine landscape painting. To the same period belong

two panels in which a half-length Virgin is set in front of an extensive landscape, and the "Portrait of a Lady" (National gallery, London) sometimes ascribed to Paolo Uccello. Baldovinetti did two strips of mosaic decoration over Lorenzo Ghiberti's doors on the Baptistery in Florence (1453–55) and a St. John the Baptist over the south doorway of Pisa cathedral (1462). He also prepared designs for wood intarsias and for stained glass. As a painter he forms a link between Domenico Veneziano and Uccello on the one hand and Andrea del Verrocchio and Domenico Ghirlandajo on the other. Influenced by the Florentine naturalists, but himself devoid of a strong naturalistic bent, he was an artist of great sensibility, practising a static style.

See Ruth W. Kennedy, *Alesso Baldovinetti* (1938).

(J. W. P.-H.; X.)

BALDPATE, the common name for a North American duck (*Mareca americana*), allied to the European widgeon; also called "whistler" from the whistle of its wings in flight. *See* also Duck.

BALDRIC, a belt worn over one shoulder, diagonally across the body and under the other arm. It served either as an ornament or as a support for a sword, bugle, etc.

The shoulder belt (balteus) and the waist girdle (cingulum) supported the short sword of the Roman soldier. The baldric was a familiar object during the middle ages. Of the yeoman who attended the "parfit gentil knight" of the *Canterbury Tales*, Chaucer wrote, "A horn he bar, the bawdrik was of grene." To later generations it became a badge of rank. In the 17th century, the broad baldric that supported the rapier of the period was worn only by the nobility. It was richly embroidered and the ends were finished in a deep silk fringe. The baldric was partially covered by a handsome waist sash, below which the fringed ends were allowed to show. (E. L. Y.)

BALDUNG (Grün, Grien), **HANS** (*c.* 1484–1545), German painter, a contemporary of Dürer whose work is typical of the south German painting of the period, was probably born in Schwäbisch Gmünd in the winter of 1484–85. His youth was spent in Strasbourg, where he was the pupil of an imitator of Martin Schongauer. Between about 1503 and 1505 he was in Nürnberg as assistant to Dürer, who with Mathias Grünewald chiefly influenced his style. In 1509 he acquired "burgher's rights" of Strasbourg, but moved in 1512 to Freiburg im Breisgau, where he painted his masterpiece for the high altar of the cathedral and also a smaller altarpiece. In 1517 he returned to Strasbourg where he became official painter to the episcopate and also a member of the town council. He was an early supporter of the Reformation, and in a woodcut of 1521 represented Martin Luther protected by the Holy Ghost in the shape of a hovering dove. He died at Strasbourg in 1545.

Baldung was equally distinguished as draftsman and painter. A complete sketchbook of his is preserved in the printroom at Karlsruhe. He made numerous woodcuts, and glass paintings by him are in Freiburg cathedral, the church at Elzach and the museums of Basel, Karlsruhe, Cologne, Freiburg and Nürnberg. He also designed tapestries. His choice of subjects was varied. Besides religious pictures he painted portraits and fantastic allegories, particularly on the theme of "death and the maiden." His forms are full of energy and grace, his colours cool and delicate. In some of his representations of the Virgin Mary, landscape, figures, light and colour combine in an impression of magical serenity. His portrayals of age on the other hand have a sinister, demonic character and show a mannered virtuosity.

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BALDWIN I (1172–1205), the first Latin emperor of Constantinople, was the son of Baldwin V, count of Hainaut, and Margaret of Alsace, countess of Flanders. He succeeded his mother (as Baldwin IX) in 1194 and his father (as Baldwin VI) in 1195. In the feudal politics of the age he joined with the Plantagenets and the Welfs and fought as an ally of Richard I of England against Philip II Augustus of France. In 1199 Pope Innocent III imposed a truce and ordered the preaching of a crusade. Baldwin took the cross and joined the other leaders of the expedition at Venice in 1202. He was present at the conquest of Constantinople in 1204 and, on May 9, was elected emperor of the new Latin state, being crowned on May 16. Boniface of Montferrat, the leader of the crusade, appeared to be a stronger candidate; but the Venetians, seeing in one so able and popular a possible rival to their own ambitions, supported Baldwin.

During his brief reign Baldwin faced a multitude of problems. His empire, which outside Constantinople had still to be conquered, was formally divided. The Venetians were allotted three-eighths of its capital and of its territories; one of their number became patriarch of Constantinople; and they were to be independent of Baldwin's authority. The other western magnates remaining in Byzantium became Baldwin's vassals for their lands there, the new state being based on feudal institutions; in Aug. 1204 he enfeoffed 600 knights. His authority over his great subjects was, however, insecure. Boniface of Montferrat claimed Thrace with Salonika, the second city of the empire, as his capital. Baldwin resisted these ambitions to the point of civil war, but was compelled, after baronial arbitration, to give way.

A revolt of the native population in Thrace provided the final crisis of the reign. The Greek rebels gained the assistance of the Bulgarian tsar Kaloyan. On March 25, 1205, Baldwin led a small force from his capital to besiege Adrianople, where he was joined by the Venetians under Enrico Dandolo. Kaloyan brought a large army to relieve the town, and on April 14 the Latins gave battle and were heavily defeated. Baldwin was taken prisoner and, despite Innocent III's intercession on his behalf, was murdered on the orders of Kaloyan.

In 1225 a pseudo-Baldwin appeared in Flanders and received much noble and popular support, being regarded as a saviour by the peasantry. In 1226, however, the imposture was exposed and the pretender executed.

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BALDWIN II (1217–1273), Latin emperor of Constantinople from 1228, was a younger son of Yolande, sister of Baldwin I. Her husband, Peter of Courtenay, the third Latin emperor, had been followed by his second son Robert, upon whose death in 1228 the succession passed to Baldwin. The barons chose John of Brienne (titular king of Jerusalem) as emperor-regent for life: Baldwin was to rule the possessions of the empire in Asia when he reached the age of 20, to marry John's daughter Mary and, on John's death, to acquire the full imperial sovereignty. The marriage took place in 1234, but when John died (1237) the realm to which Baldwin succeeded was little more than the city of Constantinople. His lifelong task was to preserve his inheritance and to attempt its restoration to its former extent; but he was fatally hampered by crushing poverty.

In 1236 Baldwin had visited Rome, France and Flanders, trying to raise money and men, and in 1240 he was able to bring a considerable army back to Constantinople. But he could accomplish nothing with this help and traveled again in 1245 to Italy and then to France, where he spent two years. The empress Mary and Philip of Toucy governed during his absence. Louis IX of France bought some relics from him and redeemed his son Philip, whom Baldwin had had to give to some merchants as security for loans; but Baldwin spent most of his reign in inglorious mendicant tours.

In July 1261 Constantinople was captured by Michael VIII Palaeologus, ruler of the Greeks of Nicaea. Baldwin escaped in a Venetian galley to Negropont and then proceeded to Athens, whence he passed to Apulia and finally to France, still in quest of help from the western powers. He went to Italy in 1267 and, in May, induced Charles of Anjou to sign a treaty for the reconquest of Constantinople and to pension himself and his son Philip. In Oct. 1273 Philip married Beatrice, daughter of Charles, at Foggia. A few days later Baldwin died.

See works cited under BALDWIN I; also W. Norden, *Das Papsttum und Byzanz* (1903).

BALDWIN I (1058–1118), count of Edessa from 1098 to 1100 and king of Jerusalem from 1100 to 1118, was the son of Eustace II count of Boulogne and Ida of Lower Lorraine. Educated for the Church, he became canon of Reims, Cambrai and Liège, but in 1096 set off on the 1st crusade with his brother Godfrey of Bouillon. He and Godfrey parted company, however, in Asia Minor, when Baldwin answered the appeal of the Armenians of Cilicia for protection. There he came into conflict with the ambitions of Tancred (*q.v.*), and both he and Tancred gave up their original intentions. But Baldwin kept contact with the Armenians and established himself first at Turbessel (Tell-Bashir) in 1097, on the invitation of an independent Armenian community in the Euphrates valley and then at Edessa, on the invitation of the Armenian prince Thoros, who adopted him as his son. When Thoros was assassinated, Baldwin became the master of Edessa. He married the daughter of another Armenian leader and imposed his authority throughout the region (1098). Holding Edessa against a month's siege by the governor of Mosul, he enabled the other crusaders to take Antioch, but did not join their southward march, postponing his pilgrimage to Jerusalem till the end of 1099.

When Godfrey of Bouillon died, his knights invited Baldwin to take his place as "advocate of the Holy Sepulchre." Overcoming the intrigues of Tancred and the patriarch Daimbert, Baldwin compelled the latter to crown him king of Jerusalem (Dec. 25, 1100). He left his county of Edessa under his cousin Baldwin of Bourcq. As king he had to contend with Daimbert's claim to suzerainty over Jerusalem and Jaffa; in 1102 Baldwin succeeded in having Daimbert deposed by the papal legate, Maurice, thus consolidating the royal power in Jerusalem. Galilee was entrusted to him by Tancred, who had become regent of the principality of Antioch, and Baldwin successfully intervened in the affairs of other Latin states.

Baldwin conducted the war against the Muslims with vigour. He drove back a number of attacks from Egypt, imposed a truce on the prince of Damascus and repelled the counterattack by Mawdud, governor of Mosul. Taking advantage of the arrival of Italian, English and Norwegian fleets, he conquered the coastal towns (Arsuf, Caesarea, Acre, Beirut and Sidon). He also encouraged immigration of Christians from surrounding Muslim lands into his kingdom. Baldwin repudiated his Armenian wife and married, in 1113, Adelaide, the mother of Roger II of Sicily, but the patriarch compelled him to break with her in 1117. This cost him the friendship of the Norman kingdom of Sicily. He had no children by either marriage. He died on April 2, 1118, on the way back from an expedition against Egypt in which he had taken the town of Farama (Pelusium).

The kingdom of Jerusalem was Baldwin's creation. The royal power was made strong and the territory under Frankish rule had been considerably extended by the time of his death. He earned the title of "founder of the kingdom" assigned to him by his chaplain and biographer Fulcher de Chartres.

See P. Gindler, *Graf Baldwin I von Edessa* (1901); R. Grousset, *Histoire des croisades et du royaume franc de Jerusalem*, vol. i (1934); S. Runciman, *History of the Crusades*, vol. i and ii (1951–52).

(J. B. R.)

BALDWIN II (d. 1131), count of Edessa from 1100 to 1118 and king of Jerusalem from 1118 to 1131, was the son of Hugh, count of Rethel, and was first known as Baldwin of Bourcq (from Bourcq castle in the Ardennes; the usual form of the designation, Baldwin of Bourg, is wrong). Setting out on the first crusade with his cousin Godfrey of Bouillon, he accompanied him to Jerusalem but then retired to northern Syria, where, in 1100, Baldwin I, king of Jerusalem, handed over to him his county of Edessa. Captured by the Muslims in 1104 and held prisoner until 1108, he was only able to re-enter Edessa after a war with Tancred (*q.v.*), who had been appointed regent. The Muslim princes took advantage of this struggle until Baldwin I of Jerusalem mediated a reconciliation. In 1110 the governor of Mosul besieged Edessa and massacred the Armenians living to the east of the Euphrates, but Baldwin repelled further attacks from Mosul (1114–15) and was able to annex the last remaining independent Armenian principalities.

On the death of Baldwin I, in 1118, the barons of Jerusalem offered the throne to Baldwin, being persuaded by his cousin Joscelin of Courtenay to overlook the claims of Eustace III of Boulogne, brother of Baldwin I; Edessa was then transferred to Joscelin. Baldwin, however, had little opportunity to devote his energies to his new kingdom. The disaster of the "Field of Blood," in which the army of Roger of Antioch was destroyed, required Baldwin to undertake the defense of Antioch (1119), and he defeated the Muslims at Danith. When Joscelin was captured by the Muslims in 1122, Baldwin became regent of Edessa but he was himself captured in 1123. Released in 1124, he had to take part in the siege of Aleppo. He was not relieved of the regency of Antioch until 1126, when he married his daughter to the young prince Bohemund II. During his second captivity the regent of Jerusalem, Eustace Granier, with Venetian help, had conquered the port of Tyre (1124) and repelled an Egyptian attack. In 1129 Baldwin himself tried to seize Damascus.

The internal affairs of his kingdom were troubled by the patriarch Étienne of Chartres, who revived the claims of his predecessor Daimbert on the holy city; but on his death these were abandoned.

Baldwin initiated some important legislation: at the council of Nablus (1120) he achieved a series of decisions assuring the exercise of justice and determining the rights of the Church in the kingdom, with the recognition of the bishops' claim to tithes on the revenues of the king and nobles; and his later "Establishment" defined the degrees of treason and the liability of the barons to forfeit their lands for it.

Baldwin had no sons by his wife, an Armenian lord's daughter whom he had married before becoming king. His eldest daughter Melisande was married to Fulk V, count of Anjou, who succeeded him on his death (Aug. 31, 1131). Baldwin was the hero of a *chanson de geste* entitled *Baudouin de Sebourc*.

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(J. B. R.)

BALDWIN III (1130–1163), king of Jerusalem from 1143 to 1163, was the eldest son of King Fulk (Fulk V of Anjou), whom he succeeded in Nov. 1143. His mother, Baldwin II's daughter Melisande, was at first crowned jointly with him (Dec. 25, 1143) and governed as regent with the support of the constable Manasses of Hierges, while Baldwin's brother Amalric inherited the county of Jaffa. At Easter 1150(?), Baldwin had himself crowned as sole ruler, but he had to divide the kingdom with Melisande. Shortly afterward, however, he entered into war with her. Having besieged Manasses in his castle Mirabel and taken him prisoner, he then besieged the queen in Jerusalem. Melisande finally yielded Jerusalem to the king and retained only Nablus as her dower (1151 or 1152).

The opening of the reign was marked by the advance of the Turkish ruler of Mosul, Zangi, and his son Nureddin in northern Syria. Edessa fell in 1144 and the second crusade was diverted from the reconquest of that county to an attack on Damascus, which Fulk had regarded as an ally against Zangi. Baldwin took part in the profitless siege of Damascus (1148) but finally renewed friendly relations with its prince. After Raymond of Poitou had been killed in battle against Nureddin, Baldwin had to go to the assistance of Antioch and decided to cede the remnants of Edessa, together with Turbessel (Tell-Bashir) and Marash, to the Byzantine empire (1150). In 1152 he had again to go to the assistance of Antioch and, on the death of Raymond II of Tripoli, to take over the regency of that county also.

Taking advantage of a lull on his northern frontier Baldwin put an end to Egyptian domination over Ascalon, which had long been a base for operations against the crusaders. Having already in 1150 built the castle of Gaza for the blockade of Ascalon, he captured the latter, after a siege, in 1153. He exacted a tribute from the Fatimid caliph in 1161 and had moreover laid the basis for the Egyptian campaigns of his successor.

Baldwin's efforts in the region of Damascus met with less success. Nureddin took Bozrah (Busra), which in 1151 the crusaders

had tried to recover for the prince of Damascus, and in 1154 he took Damascus itself. A truce was concluded between Nureddin and Baldwin, but Baldwin in 1156 treacherously attacked a nomad tribe protected by Nureddin. War began again, and Baldwin, coming to the help of the besieged Baniyas, was defeated at Jacob's Ford (1156). In 1157 he besieged Shaizar on the Orontes and then seized Harim (near Antioch). In 1158 he defeated Nureddin at Butaiha.

In 1158 Baldwin married the Byzantine princess Theodora Comnena. This enabled him to act as mediator between the Byzantine emperor Manuel I and the prince of Antioch, Raynald of Châtillon, when Manuel tried to subdue Cilicia and Antioch. He established friendly relations with the emperor, who imposed a peace treaty on Nureddin (1159). Baldwin was obliged to return to Antioch to settle the regency (1160) for Bohemund III, entrusting the government to the patriarch; he died in Feb. 1163, leaving no children.

Baldwin III was highly respected by his contemporaries, above all by the historian William of Tyre. Well educated, he had a love of history and was expert in customary law. "Courteous and eloquent," he imposed his authority on his barons without resorting to force and behaved with great generosity toward the church. He moreover avoided imposing oppressive taxes. He was anxious to give a good example to his subjects in his personal life, avoiding excesses in food and drink and conducting himself irreproachably as a husband; his courage in war was matched by his diplomatic skill. His qualities gained him the love of his subjects, the friendship of the emperor Manuel and the esteem of his enemy Nureddin. He failed, however, to prevent Nureddin from unifying Muslim Syria, lost Edessa and only with great difficulty maintained the integrity of other Latin states north of Jerusalem.

BIBLIOGRAPHY.—R. Grousset, *Histoire des croisades et du royaume franc de Jerusalem*, vol. ii (1935); S. Runciman, *History of the Crusades*, vol. ii (1952); K. M. Setton (ed.), *History of the Crusades*, vol. i, "The First Hundred Years," ed. by M. W. Baldwin (1955).

(J. B. R.)

BALDWIN IV (1161–1185), king of Jerusalem from 1174 to 1185, was the son of Amalric I by his first wife, Agnes of Courtenay. Educated by William of Tyre, he came to the throne in July 1174 at the age of 13. His succession created two problems; first, that of regency; the second, because he was a leper, that of succession. His kinsman Raymond III of Tripoli became regent, while the king's sister Sibyl was the lawful heiress. Sibyl in 1176 married William of Montferrat, to whom she bore a son (later Baldwin V), but William died in 1177, and in 1180 Sibyl married a young knight from the west, Guy of Lusignan. Henceforward the reign was troubled by dissensions of increasing bitterness between the court party (Sibyl and Guy, the queen mother Agnes, Agnes' brother Joscelin, and Raynald of Châtillon) and a baronial party led by Raymond of Tripoli. When Raynald of Châtillon took advantage of the position of his fortress of Krak, which lay on the great route of trade from Damascus and Egypt, to plunder the caravans (1182), he broke the truce of 1180 and thus precipitated an attack by Saladin (*q.v.*). In 1183 Guy of Lusignan was made regent by Baldwin IV, but, when Saladin launched a second attack, he declined battle and in November 1183 was deposed both from his regency and from his right of succession, Sibyl's son Baldwin being then proclaimed heir to the kingdom. For a time Baldwin IV resumed the government. Despite his disease, he showed all the great qualities of his predecessors, especially in military affairs; but early in 1185 he had to hand over the regency to Raymond of Tripoli, and in March 1185 he died.

BIBLIOGRAPHY.—The narrative of William of Tyre concludes with Baldwin IV's transfer of the regency to Raymond of Tripoli. *See* also S. Runciman, *History of the Crusades*, vol. ii (1952); M. W. Baldwin, *Raymond III of Tripolis and the Fall of Jerusalem* (1936).

BALDWIN V (1177–1186), nominal king of Jerusalem from 1185 to 1186, was the son of Baldwin IV's sister Sibyl by William of Montferrat (d. 1177). Proclaimed heir in March 1183, he came to the throne in March 1185 under the regency of Raymond of Tripoli. His reign was marked by the advance of Saladin and by dissensions between the government and Guy of Lusignan, Sibyl's second husband. Baldwin died in Sept. 1186.

BALDWIN, FRANK STEPHEN (1838–1925), U.S. inventor, best known for his creation of the Monroe calculating machine although his inventions ranged from railroad self-couplers to a metal lace latch for shoes, was born on April 10, 1838, in New Hartford, Conn.

Baldwin patented his first calculating machine in 1875, introducing a mechanical principle that enabled the device to add, subtract, multiply or divide in a direct and simple manner. In 1874 the machine was awarded the John Scott medal by the Franklin institute in Philadelphia as the most meritorious invention of the year. But it did not become a commercial success until after Baldwin became associated with Jay R. Monroe in 1911. From Baldwin's 1908 model the two men developed the Monroe calculator in 1912. The Monroe Calculating Machine company, organized that year, then became an important manufacturer of calculating machines. Baldwin was its research director until his death on April 8, 1925, at Denville, N.J. (M. Mo.)

BALDWIN, JAMES MARK (1861–1934), U.S. philosopher, was born at Columbia, S.C., Jan. 12, 1861, and educated at Princeton and several German universities. He was professor of philosophy in the University of Toronto (1889–93), of psychology at Princeton (1893–1903), of philosophy and psychology in the Johns Hopkins university (1903–09) and in the National University of Mexico until 1913. After lecturing at Oxford and the French provincial universities, he became professor at the École des Hautes Études Sociales, Paris, in 1919. Prominent among experimental psychologists, he received many honours from learned societies in America and Europe. His works include: *Handbook of Psychology* (1889–91); *Elements of Psychology* (1893); *Story of the Mind* (1898); *Mental Development in the Child and the Race* (1896); *History of Psychology* (1913); *Between Two Wars* (1926); and contributions to the *Dictionary of Philosophy and Psychology* (1901–05) and the *Psychological Review*, both of which he edited.

BALDWIN, MATTHIAS WILLIAM (1795–1866), U.S. locomotive manufacturer, was born in Elizabethtown, N.J., on Dec. 10, 1795, and was trained as a jeweler. Because of his skill with tools he was asked to build a locomotive, later named "Old Ironsides," for the Philadelphia and Germantown railroad in 1832. From this start came the Baldwin Locomotive Works.

Baldwin made a number of significant improvements in steam locomotives, notably a steam-tight metal joint that permitted his engines to use steam at 120 pounds pressure while others were limited to 60. His company built more than 1,500 locomotives during his lifetime.

He was also a philanthropist with a special interest in the welfare of the Negro. His abolitionist sympathies, in fact, led to the boycotting of Baldwin locomotives in the south. He died in Philadelphia, Pa., on Sept. 7, 1866.

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(J. B. RA.)

BALDWIN, ROBERT (1804–1858), Canadian statesman, joint leader of "the great ministry" (1848–51) that established the principle of responsible, or cabinet, government in British North America, was born at York (Toronto), Upper Canada (Ontario) on May 12, 1804. He was called to the bar in 1825 and entered into partnership with his father, William Warren Baldwin (1775–1844), a prominent lawyer, physician and politician. In 1829–30 he sat in the parliament of Upper Canada for the town of York. In 1836 he was nominated to the executive council, but, with the entire council, resigned within a month. Though a Reformer, he strongly disapproved of the rebellion of 1837–38. On the union of Upper and Lower Canada he became (1841) a member of the executive council under Lord Sydenham, but soon resigned on the question of responsible government and, having been elected to represent Hastings in the assembly, went into opposition. In 1842 he formed under Sir Charles Bagot a largely Liberal administration with Louis (afterward Sir Louis) Lafontaine, which held office until nine of the ten ministers resigned in

1843, after a quarrel with Bagot's successor, Sir Charles Metcalfe. At the general election which followed, the governor general was sustained by a narrow majority, but in 1848 the Liberals were again returned to power, and he and Lafontaine formed their second administration under Lord Elgin which embodied the principle of responsible government and carried numerous important reforms, including the freeing from sectarian control of the University of Toronto and the introduction into Upper Canada of effective municipal self-government.

Internal dissensions soon began to appear in the Liberal party, and in 1851 Baldwin resigned after an attempt to abolish the court of chancery of Upper Canada, whose constitution was due to a measure introduced by Baldwin in 1849. The attempt, though defeated, was supported by a majority of the representatives from Upper Canada. On seeking re-election in York, he declined to give any pledge on the burning question of the Clergy Reserves (*q.v.*); he was defeated and retired to private life, devoting himself to bringing about better understanding between the English- and French-speaking inhabitants of Canada. In 1858 the Liberal-Conservative party, formed in 1854 by a coalition, attempted to bring him out as a candidate for the upper house, which was at that date elective, but though he had broken with the advanced reformers, he could not approve of the tactics of their opponents and refused to stand. He died at Toronto on Dec. 9, 1858.

(J. M. S. C.)

BALDWIN OF BEWDLEY, STANLEY BALDWIN, 1st Earl (1867–1947), British statesman, who was prime minister both during the general strike of 1926 and at the time of Edward VIII's abdication, owed his political success largely to the skill with which he presented himself to the public as a plain man, modest and unsophisticated. He was born at Bewdley on Aug. 3, 1867, the only son of Alfred Baldwin, chairman of the Great Western railway and head of the iron and steel manufactories and collieries known as Baldwins Ltd. After being educated at Harrow and at Trinity college, Cambridge, Baldwin went into his father's business; and when his father became member of parliament for Bewdley in 1892, Stanley Baldwin became virtually the head of the concern. For nearly 20 years the business was the central interest of his life. In 1906 he served his apprenticeship to politics by unsuccessfully contesting Kidderminster in the Conservative interest. Two years later his father died and Stanley Baldwin succeeded to the representation of the Bewdley division of Worcestershire. For nine years his record was that of a modest, unobtrusive back bencher.

Official Career.—In Dec. 1916, however, Andrew Bonar Law made him his parliamentary private secretary, and from that moment Baldwin's advancement was rapid. In Jan. 1917 he became a junior lord of the treasury, and in June joint financial secretary, in which capacity he gave valuable assistance in debate to Bonar Law and Austen Chamberlain, successively chancellors of the exchequer. In 1921 he became president of the board of trade. It was there that he first gave proof of his ability, but in party politics he was still almost an unknown factor.

His chance came in 1922. Support for Lloyd George's coalition government was by this time imposing too great a strain on the political allegiances of many Liberals and most Conservatives. Lloyd George and his personal followers were anxious to appeal again to the electors as a coalition. The majority of the Conservatives were opposed to them. The crisis came in Oct. 1922 when a meeting of the Conservative M.P.s was called at the Carlton club on Oct. 19. Austen Chamberlain presided, and his weight, with that of almost all his colleagues in the cabinet, was thrown into the scale of the coalition. A vigorous debate followed with momentous implications for the Conservative party's future.

The outcome was determined pre-eminently by two men, Bonar Law and Baldwin. Baldwin, with everything to lose politically by a false step, took his courage in both hands and made a speech characteristically brief and direct. He went at once to the "root of the whole difficulty—the position of the prime minister," and expressed his conviction that if the "present association" were continued, the disintegrating process in the Conservative ranks, already far advanced, would "go on inevitably until the old Conservative party was smashed to atoms and lost in ruins." Accordingly he declared himself "prepared to go into the wilderness" rather than continue the connection.

By 187 to 87 the meeting voted with Bonar Law and Baldwin. Austen Chamberlain and other Conservative leaders went into the wilderness (out of office)—temporarily—while, after a Conservative victory at the ensuing general election, Bonar Law became prime minister and Baldwin chancellor of the exchequer. A month later (Jan. 1923) Baldwin was sent to Washington, D.C., to negotiate a settlement of war debts. The terms he secured were less favourable than British opinion hoped for, and he was widely criticized for them. Nevertheless, when Bonar Law resigned his post as prime minister in May 1923, it was Baldwin, not the more experienced and distinguished Conservative, Lord Curzon, whom the king asked to form a government. For six months, in face of uneasy developments abroad, such as the Italian seizure of Corfu, and mounting unemployment at home, Baldwin's government pursued a tranquil course. Then, in October, Baldwin publicly announced his belief in protection as an economic cure and in November appealed to the country for a mandate to reverse Bonar Law's free-trade policy.

The mandate was refused. The Conservatives lost 107 seats and, though still the largest single party in the house of commons, were inferior to the Liberals and Labour combined. Baldwin resigned and Ramsay MacDonald formed a Labour government with Liberal support. At the end of nine months in office, however, MacDonald's government fell (Oct. 1924). The election that followed was bitter, with the Communist issue playing a larger role than the "safeguarding of industry" which Baldwin advocated. It was a resounding success for the Conservatives, giving them a majority of 211 over all other parties combined.

Baldwin formed a cabinet of Conservative reunion. He brought back Austen Chamberlain and Lord Birkenhead and, a year later, Arthur Balfour. Most surprisingly of all, he appointed Winston Churchill, still a free-trader, to the exchequer. When Churchill's first budget announced (along with a return to the gold standard) the restoration of the wartime McKenna duties and the silk tax, these were defended, not as tariffs, but as "revenue duties." These economic reforms did not, however, prevent a further slump in the coal trade and the threat of a stoppage of work over the owners' threat to reduce wages or lengthen hours. Baldwin initially refused to authorize a subsidy to the industry but subsequently agreed to one during the nine months while a royal commission was investigating the problem. The commission, however, failed to produce any alternative to a cut in wages. Rather than accept this, the miners went out on strike on May 4, 1926, and the Trades Union congress declared sympathetic strikes in such vital industries as transport, printing and engineering. Baldwin responded to the general strike by proclaiming a state of emergency, organizing volunteers to maintain all essential services and refusing all further negotiations with labour until the strike was called off. But although he was firm he avoided provocation, and the freedom from violence which marked the nine days' stoppage was in large measure a result of his wise policy. The collapse of the strike did not mean the end of the mines dispute. In June 1926, in face of bitter opposition, the government carried a bill which permitted a return to the eight-hour day, but it was November before the miners succumbed. Finally, in 1927 Baldwin sponsored the Trades Disputes act designed to curb the power of the unions in various ways.

Foreign affairs were of less interest to Baldwin, and the substitution of the Locarno agreements for the Geneva protocol, mainly the work of Austen Chamberlain, constituted the principal diplomatic achievement of these years. At home, Baldwin's administration continued without any notable event until 1929. Then, on the slogan of "Safety First," he appealed to the electorate. Hostility to the Trades Disputes act and concern over mounting unemployment impelled the Labour party to victory and put Baldwin back on the opposition front bench.

In 1931 Baldwin's chance came again. The collapse of the Labour government in the financial crisis led the king to invite MacDonald to form the National government, in which Baldwin

accepted the lord presidency of the council. Under the National banner an overwhelmingly Conservative house of commons was returned, in which Baldwin, though ostensibly subordinate to MacDonald, was in fact the dominant figure. It was his influence that determined Conservative endorsement of the Indian Round-Table conferences (at the price of the withdrawal of Churchill's support), and he was the moving spirit behind the 10% ad valorem tariff and the Ottawa agreements of 1932 which established protectionism and, by forcing Liberal resignations, largely destroyed the national character of the government. In these years there began the progressive decline in British support for collective security and national defense which were the keynote of the 1930s, and while Baldwin cannot be held directly and positively to blame for the misfortunes, national and international, which ensued, his sins of omission explain many of the disasters which marked the end of the decade.

In June 1935 MacDonald resigned from public life and Baldwin succeeded to the title as well as to the realities of power. In October he fought an election on a program of support for the League of Nations and businesslike reform at home. He retained the National government's large (and overwhelmingly Conservative) majority and formed a cabinet principally notable for the appointment of Anthony Eden as minister for League of Nations affairs. Within a month, however, the administration was involved in the discredit of the Hoare-Laval deal (*see* English History), from which only the resignation of Sir Samuel Hoare extricated them. In 1936 there occurred the German reoccupation of the Rhineland, the completion of the Italian conquest of Ethiopia and the beginning of German-Italian intervention in the Spanish Civil War. All these events left Baldwin seemingly unruffled, but the crisis simultaneously developing at home over the attachment of the new king, Edward VIII, to Mrs. Wallis Simpson presented him with a challenge better suited to his powers. Intuitively responsive to public feeling, both in Great Britain and the empire, over such an issue, Baldwin made it his aim to settle it so as to preserve imperial unity and the prestige of the monarchy unimpaired. A unique responsibility rested on him as virtually sole intermediary on this issue between the king and his people, a responsibility which he discharged with delicacy and resolution. To Baldwin, more than to any other man, goes the credit for avoiding a disastrous breakdown in the functioning of the constitution.

On May 28, 1937, Baldwin resigned the premiership to Neville Chamberlain and, on his retirement from the house of commons, accepted elevation to the peerage. He played virtually no part in politics after this and died in retirement on Dec. 14, 1947.

Personality and Character.—The career thus outlined is one of the most remarkable in English political history. Fortune was undoubtedly kind to Baldwin, but he was also a man of remarkable qualities. His public spirit was well illustrated by his action in June 1919 in anonymously presenting to the exchequer for cancellation £150,000 of the new war loan, a sum representing approximately 20% of his total fortune. He hoped, in this way, to set an example of personal sacrifice.

There was also in his make-up a latent puritanism. He combined indifference to the trappings of power with a remarkable adroitness in its exercise. With the years his intellectual laziness and administrative laxity increased, but his modesty and apparent simplicity won him to the end of his political career an easy indulgence for faults not usually found pardonable in the holders of great offices. He scorned all the obvious devices of publicity yet projected his personality with extraordinary success at a time when the public craved, above all else, an assurance of security, normality and peaceableness. He had a deep love for the English countryside and a literary capacity above the ordinary; when the two were combined as in his volume of nonpolitical addresses *On England* (1926) the result could be singularly attractive.

Bibliography.—Baldwin's printed speeches include the following collections: *Employment, Trade, and Empire Development* (1923); *Peace and Goodwill in Industry* (1925); *Our Inheritance* (1928); *This Torch of Freedom* (1935); *Service of Our Lives: Last Speeches as Prime Minister* (1938); *An Interpreter of England: The Falconer Lectures* (1939). *See* also G. M. Young, *Stanley Baldwin* (1952); A. W. Baldwin, *My Father: the True Story* (1956).

(J. A. R. M.; H. G. N.)

BALE, JOHN (1495–1563), English bishop, dramatist and Protestant controversialist, notable for his antiquarian researches and his part in the religious strife of the 16th century, was born at Cove, near Dunwich, Suffolk, on Nov. 21, 1495. He was educated at the Carmelite convent in Norwich, and Jesus college, Cambridge, where he took his B.D. in 1529. He was prior of Carmelite convents at Maldon, Doncaster and Ipswich at various times, but became a Protestant, and at some date (probably 1533) left his order, married and obtained the living of Thorndon, Suffolk. Frequently attacked and once imprisoned for his religious views, he took refuge on the continent in 1540 upon the fall of his protector, Thomas Cromwell. In 1548 he returned to England, and was made rector of Bishopstoke, Hampshire (1551), and bishop of Ossory, in Ireland (1552). On the death of Edward VI in 1553 he fled abroad once more, returning after the accession of Elizabeth. In 1560 he received a prebendal stall at Canterbury, where he died in Nov. 1563.

Bale's voluminous writings are characterized by a fiercely partisan spirit, crude but vigorous satire and frequent scurrility. His plays, only five of which survive, published as *The Dramatic Writings of John Bale*, ed. by J. S. Farmer (1907), are thought to belong, in their first version at least, to the early 1530s. They employ the old forms of miracle and morality play as vehicles of Protestant propaganda. The most vehement in its attack on the Roman church is *A Comedy concernynge the 3 Lawes of Nature, Moises and Christe, Corrupted by the Sodomytes, Pharyses and Papistes Most Wicked* (1562). *Kynge Johan*, which identifies the personified abstractions of the morality play with real persons such as Pandulph and Stephen Langton, is often claimed as the first English history play.

Bale wrote many other polemical works, chief among which are the *Brefe Chronycle concernynge Syr Johan Oldecastell* (1544), *The Actes of Englysh Votaryes* (1546), the *First Examinacyon* (1546) and *Lattre Examinacyon* (1547) of Anne Askewe, and *The Image of Bothe Churches* (1548). But it was his search for "Englandes Antiquitees" which won Bale the esteem of scholars, both English and continental, and his passion for collecting and listing old books that produced his most monumental work, three biographical catalogues of English writers: the *Illustrium Majoris Britanniae Scriptorum, hoc est, Angliae, Cambriae, ac Scotiae, Summarium* (1548); the revised and much expanded *Scriptorum Illustrium Majoris Britanniae . . . Catalogus* (1557–59); and the autograph notebook, first published in 1902 by R. L. Poole and M. Bateson as *Index Britanniae Scriptorum quos . . . collegit Joannes Baleus*. Though marred by inaccuracy and Protestant bias, these volumes are invaluable to students of the medieval and early Tudor period, and form the first, rudimentary history of English literature.

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BALEARIC ISLANDS (Islas Baleares), an archipelago of five islands, with a number of islets, in the western Mediterranean, lie 50 to 190 mi. off the east coast of Spain, of which they form a province. Pop. (1960) 443,327. Area 1,936 sq.mi. The archipelago, which lies between 38° 40′ and 40° 6′ N., and 1° 22′ and 4° 25′ E., comprises two distinct groups. The eastern and larger group, the Balearics proper, contains the two principal islands, Majorca (Spanish, Mallorca) and Minorca (Menorca), and the small island of Cabrera, south of Majorca. The western group, formerly known as the Pine Islands (Las Pitiusas; ancient Pityusae), comprises Ibiza (Iviza) and Formentera, with several islets. Majorca, Minorca and Ibiza are described in separate articles, and Formentera with the last named.

Physical Geography.—The Balearic Islands are, structurally, the continuation of the Andalusian mountains which end on the Spanish mainland at Cabo de la Náo, a little more than 50 mi. west of the Pityusae. They are the emergent portions of two submarine

plateaus which are separated from each other by a considerable marine depression. The seas separating Ibiza from Formentera and Majorca from Minorca are, however, relatively shallow, and a fall of the Mediterranean sea level of 300 ft. would convert the Balearics into two islands. The edge of the northern submarine plateau is truncated abruptly by an east-west abyss more than 8,000 ft. deep. Minorca's northwest-southeast axis lies obliquely to the direction of this fault zone; and the character and extent of the Palaeozoic formations of Devonian Age comprising the island suggest that Minorca is a remnant of the continental massif which formerly united Sardinia with Catalonia. The other islands of the Balearics are aligned on the southwest-northeast trend of the submarine plateaus, and presumably are the expression of violent Alpine folding from the southeast. Rocks from Trias to Oligocene bear witness to these mountain-building movements, older formations being brought up also as inliers.

The resultant sierra of northwest Majorca, parallel to the coast, rises in the Torrellas or Puig Mayor to 4,734 ft.; a minor highland zone in the southeast reaches almost 2,000 ft.; and the core of Ibiza is crowned by La Atalaya, 1,558 ft. The rugged and precipitous cliff coastlines of both northwest Ibiza and northwest Majorca, often referred to as their Costa Brava, occur where these zones of high relief are adjacent to the sea. Elsewhere in Majorca and Ibiza there are broad belts of lowland, often of fertile Miocene soils or alluvium, surrounded or interrupted by undulating hills, boulder-strewn and scarred by the courses of torrents which in flood spread their debris on the piedmont zone. Formentera has a more monotonous relief, consisting of two tablelands (the higher, La Mola, 630 ft.) mainly of Quaternary deposits connected by a narrow isthmus of alluvium. Minorca has a more worn terrain, the highest of its small hills, Monte Toro, in the north centre, reaching an elevation of only 1,174 ft. This northern monotonous stony plateau runs to the sea in a northeast coast of much more dislocated relief which contains many bays and capes and the deep inlet of Mahón. A fairly well-marked depression separates this plateau from the low southern tableland with its gently rolling surface cut by broad ravines with fertile alluvial bottoms. Cabrera, separated by a 5-mi. wide strait from Majorca, is a semi-arid continuation of the larger island's eastern hills.

Within a general pattern of Mediterranean climate characterized by winter rain and summer drought, there are marked variations from one island to another, and within each island, dependent largely on relief and aspect. Minorca, having no protecting range of mountains, is colder and wetter in winter (25 in. annually), and feels the effects of hot summer winds more than the other islands. The average summer temperature is 75° F., and that of winter 50° F. In Majorca there are marked differences between the rainy cooler northern mountains and the protected remainder of the island, which has an average rainfall of less than 20 in. and rarely suffers gales. Ibiza, Cabrera and Formentera are even drier, with an annual precipitation of less than 15 in. In all the islands the period May–August is almost rainless, the number of rainy days being less than 80 annually. There are, therefore, no permanent streams but a great number of torrent courses and ravined gullies which are filled spasmodically. Snow rarely falls, although frosts are not uncommon in the period January–March. In the mountains of Majorca snow may lie for several weeks until the spring thaw. Daytime summer temperatures frequently reach the 90s in June, July and August, but these are moderated by sea breezes, and the evenings are usually cool and often in the 50s even in mid-summer.

Agricultural and pastoral use of the lowland areas, and the construction of hillside terraces for arable farming have limited natural vegetation to the rocky hilly lands, ravines and terrain impracticable for farming. The exposed northern areas of Minorca are either treeless or support only stunted specimens, but the sheltered southern gullies (barrancas) have some pine woods, pomegranate orchards and even semitropical vegetation on their slopes. In the other islands Aleppo and Stone pine and some holm oak occur where rainfall and soils are sufficient, but great areas are covered with Mediterranean scrub vegetation, which includes juniper, oleander, myrtle and rock roses. This *garigue* was formerly the undergrowth of a forest cover. The prevailing arboriculture of Majorca and Ibiza has resulted in a two-tier cover of the fertile parts of those islands (*huertas*), as cereals and legumes are grown in the orchards and groves of almond, olive, carob bean and fig trees. Artificial meadows of lucerne occur in the most easily irrigated areas. (G. J. B.)

Archaeology.—The earliest historical records describe the inhabitants of the Balearic Islands as cave dwellers. Natural and partly artificial caves abound in the limestone rock and have produced the few simple flint implements and incised pottery which can be assigned to the beginning of the Bronze Age and are the earliest records of human activity. Subterranean methods of living persisted, and the walled settlements of the inhabitants largely consisted of windowless rooms. Megalithic hill forts crown some of the hills.

Talayots.—The earliest and best known monuments are the talayots (towers). They are still numerous and were formerly much more so, especially in the intensively cultivated island of Majorca, where great numbers were destroyed, particularly on the plains adjoining the southeast coast of the island. They are chambered towers of stone, with either a round or a rectangular plan. They were roofed, generally with the aid of a central pillar composed of circular superimposed slabs, and faced with clay to produce a monolithic appearance.

The masonry of the round towers is very rough, the walls being composed of immense rugged blocks of hammer-dressed limestone; but the four-cornered talayots, which are presumably later, show smaller masonry. As a class the talayots are obviously akin to the nuraghi of Sardinia, and, like the nuraghi, they served as fortified dwelling places; outbuildings are normally attached and they are occasionally sited within villages enclosed by cyclopean walls, which also sometimes contain structures reminiscent in plan of those of Malta.

Taulas.—With the talayots in Minorca are associated the so-called "temples"; these halls may well have been used for ceremonial purposes, but they certainly formed a normal element of the habitations associated with the talayots. They are enclosures, usually of D-shaped plan, with the entrance in the straight side; within the area stands a taula (table), a rectangular slab of dressed stone, up to as much as 15 to 16 ft. in height, supporting a second, horizontal, slab, also carefully dressed and in one case measuring about 12 ft. 6 in. by 5 ft. 6 in. and about 2 ft. thick. These T-shaped taulas are central supports for roofing, an explanation warranted by the facts that there are often supplementary pillars between the taula and the outer wall and clay covered pilasters against the wall and in the angles, and also that the taula method of roofing is actually employed in the artificial grottoes. These halls and the adjoining rooms appear to have been built without windows.

It seems certain that these most remarkable prehistoric remains in Majorca and Minorca are not likely to be much earlier than the middle of the second millennium B.C. and represent a culture that continued with little change until Roman times.

Burial Caves.—Rock cut tombs and burial caves are found in many forms; those of the best known series, at San Vicente, on the northern extremity of Majorca, are cut into a sloping hillside. Outside the narrow doorway of the principal tomb is a forecourt, 20 ft. by 17 ft.; and within it a short antechamber from which a second doorway leads into the main chamber, 30 ft. long by 6 ft. wide; an overall length of over 60 ft. There are also small side chambers. This general type compares closely with the burial grottoes of southern France near Arles and must indicate a common origin. Carvings in Majorcan caves confirm the relationship. Many caves of the same type, when sited on level ground, are approached by steps sunk in a trench which was filled by blocking material to seal the tomb. There are many varieties of these artificial grottoes.

The *naus* or *navetas* (Catalan, "ships"), so termed from their resemblance to an upturned boat, were also graves. These are now found chiefly in Minorca, and are elongated structures built, like the talayots, of immense closely fitted blocks of stone, with a rounded end and squared or slightly concave front; in this front

face is a tiny door giving access from a forecourt through a passage to a long rectangular chamber roofed by large slabs. In the famous Nau d'Es Tudons the total length of the structure was about 60 ft., the width 24 ft. and the height about 25 ft. It is likely that the entrance to the artificial cave so formed was sealed by a structure built on the D-shaped forecourt, to match the rounded end and present a symmetrical and impenetrable artificial mound. The monument was, in fact, the equivalent of the long barrow of the west (*see* BARROW), while the plan of the passage and chamber within the *naveta* is almost the same as that of the larger burial caves, and the early date of each is indicated by the discovery in them of V-bored buttons. Structures of somewhat similar form in Majorca seem to have been used as dwellings.

Carthaginian Influence.—Ibiza was a Carthaginian stronghold and there is little evidence of any other civilization on that island. Minorca also was occupied by the Carthaginians, as the name of its principal harbour, Mahón (Portus Magonis), still bears witness; and Jama (now Ciudadela) was a Carthaginian town; but there the native civilization of the island as a whole persisted.

Roman Influence.—The islands were conquered by Q. Caecilius Metellus in 123 B.C., and thereafter remained part of the empire and supplied contingents of slingers to the Roman armies. Palma and Pollentia (now the site of the medieval town of Alcudia) were the principal cities.

Finds.—Although the Talayotic civilization seems to have continued without much modification, the position of the islands off the northern shore of the Mediterranean laid them open to continued influence from more eastern civilizations, as many finds attest. Important discoveries of bronze swords and single and double axes, antennae swords, heads and figures of bulls and other animals—doves crowning sceptres, small human figures from Sardinia or farther east, and many other objects, all bear witness to the foreign trade of the islanders over long periods of time. Local manufactures are represented by quantities of pots and shards, mostly of the native talayotic types; *i.e.*, fragments of spherical pots, often furnished with a number of small loops for suspension, and other forms, as well as the biconical cups with a hollow foot which are peculiar to the talayotic civilization. Most of the types seem to have persisted with little change until they are found mixed with Roman wares following the Roman occupation, during which period the ancient structures were extensively occupied and quantities of Roman pottery, etc., were produced. Small objects of cast lead, presumably votive, are also of native origin.

Such finds may be studied in the museums at Artá, Manacor, Alcudia, Mahón in the islands, as well as at Barcelona and Madrid, Spain; and Minorcan pottery and art in the Museum of Ethnology at Cambridge, Eng. (W. J. HE.)

History.—There is historical evidence of at least 2,600 years of settlement, for the islands passed successively under the rule of Carthaginians, Romans, Vandals, Moors and Spanish, all of whom have left their mark to some extent on the physical and cultural landscape. The islands are thus in many ways an epitome of Mediterranean insular history. Ibiza in particular was a strategic point of great importance, easily reached via the north African coast and providing a convenient base to raid the rich lands of Alicante, Valencia and Majorca. Known to the Greeks, and occupied for centuries by the Phoenicians and Carthaginians, Ibiza became a Roman colony in 123 B.C. Under all these occupations its economic resources of lead, zinc, salt, foodstuffs and purple dye (from marine molluscs) were sought by traders. Similarly Majorca and Minorca became important links in Punic War strategy, Mago, Hannibal's brother, wintering at Mahón in 206 B.C. When the archipelago was conquered by Q. Caecilius Metellus, the largest city of the Balearics, Palma (*q.v.;* the symbol of victory), was founded and olive cultivation was introduced. A five centuries' peace, during which the islands supplied their new masters with Minorcan mules and the celebrated Balearic slingers, was broken by the arrival of the Vandals, who were followed by the troops of the Byzantine emperor, Justinian. Though raided frequently both by Muslims and by Normans, the islands were not permanently conquered by the Caliphate of Cordoba until 903. The Moorish occupation led to many improvements in agriculture and irrigation, notably the introduction of windmills and water wheels turned by animals, both devices being conspicuous features of the landscape today. Majorca and Minorca became the objective of a great Pisan-Catalan crusade which in 1116 temporarily succeeded in liberating thousands of Christian slaves and in destroying the Moors' piratical bases. Although the Muslims rapidly re-established their hold, James I of Aragon (the Conqueror) annexed Majorca and Ibiza in 1230–35, Minorca falling to his descendant Alfonso III in 1286. The islands formed a semi-autonomous kingdom until 1349 and became a great base of medieval cartography and navigational science. Settlement was extended, agriculture was developed and trade prospered. In 1521 a peasant rebellion wiped out many of the nobility of Majorca, the insurrection being suppressed only with difficulty. In 1535 Barbarossa plundered Mahón, and other Barbary pirates continued their raids throughout the 16th century. In the War of the Spanish Succession the strategic value of the large landlocked harbour of Mahón attracted the attention of the participants, and its capture by the British in 1708 ushered in a century of dispute over its possession, which was not finally settled until the Spanish regained it in 1802 by the peace of Amiens. (*See* also MAHON.) In the Spanish Civil War (1936–38) points in the islands were seized by insurgent troops. Loyalist forces temporarily recaptured Ibiza, Formentera and Minorca, the latter serving as an important base for their naval operations. For a time it was expected that the islands would be ceded to Italy in return for aid extended to Gen. Francisco Franco during the hostilities.

Population.—More than 80% of the population of the Balearics live in Majorca, one-third of all the islanders residing in Palma alone. Most of the Majorcans and Minorcans are town-dwellers, but the reverse is true of Ibiza and Formentera where two-thirds of the people live in rural settlements. Cabrera and Formentera are thinly populated, the former having only 38 inhabitants. Majorca has a population density of 258 per sq.mi., Minorca, 158, and Ibiza, 6 per sq.mi. Ethnically the people reflect the rich variety of their historical antecedents. The larger towns contain a majority of folk of Catalan descent, with Jewish and Italian minorities, but the country districts show in their physical types important admixtures of Moorish, Phoenician, Greek and even Nordic characteristics, and some families can trace their ancestry to Moorish-Catalan progenitors. There are also small numbers of returned emigrants, from the mainland, from France and from Latin America, the latter known as *americanos.* Castilian is the language of the cities, but in rural areas a Catalan dialect, with many resemblances to Provençal French and with several Arabic infusions, is the common tongue spoken. Some Majorcans returned from France and residing in Sóller speak French; and some forms of speech introduced by the British still survive in Minorca.

Administration and Economy.—All the islands together form a Spanish province, with Palma as its capital. The city is also the military, judicial and ecclesiastical headquarters of the province. Minorca and Ibiza (with Formentera) are separate dioceses and judicial districts, the *audiencia* of Majorca being divided into three subdistricts. Local administration is carried on through communes, Majorca having 52, Minorca 7 and Ibiza 6 such divisions.

Arboriculture is the traditional industry of Majorca and Ibiza, cereals, legumes and animal fodder crops being grown among the almond, carob bean, fig, olive and apricot trees, either on the irrigated *huerta* lowlands or on the intensively terraced hillsides. Minorca is more important for pastoralism but also produces good crops of oranges. Stock-raising is widespread in all the islands, small groups of sheep, goats and pigs being cared for by the women and children. *Feixes* or reclaimed lands, adjacent to Ibiza city, are important sources of market-garden produce. This rural economy is essentially peasant-operated, much of the domestic furniture, foodstuffs, local customs and arts exhibiting distinct self-sufficient characteristics. Almonds, figs and apricots are exported, and there is a considerable local production of wines, olive oil, butter, cheese and poultry.

For centuries Ibiza has been an important manufacturer of sea salt, about 70,000 tons annually being sold to Britain, Scandinavia and Iceland for fish-salting. Fishing provides much food for the islanders, and some is exported to the mainland. Timber-cutting, charcoal-burning and small glass, pottery, footwear and foodstuffs factories complete the industrial fabric, but many of these occupations are complementary and secondary to agriculture, having a labour supply which fluctuates with the demands of the farmland.

The tourist industry is an important part of the economy of all the islands, many thousands of visitors, especially from Spain, France, Great Britain and Germany, being attracted by the climatic, scenic and historic merits of the Balearics. The construction of hotels, guest-houses and villas, the provision of services, and the making and sale of souvenirs, especially fine lace and embroidery, provide employment and income.

Sea communications are maintained principally through Barcelona, and air services link Majorca and Minorca with many west European cities. (G. J. B.)

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BALEN, HENDRICK VAN (1575–1632), Flemish painter, chiefly of religious subjects, was born in Antwerp in 1575 and died there on July 17, 1632. He was a pupil of Adam van Noort. After traveling for a time in Italy, he joined the Guild of St. Lucas at Antwerp in 1593. Balen was the first master of Van Dyke; he collaborated with various painters, including Jan Brueghel and Frans Snyders.

Balen's painting of the Holy Family is in the chapel of Notre Dame, Antwerp. Other pictures at Antwerp are "The Trinity" and "The Adoration of the Kings"; the Musée de Paris has two, "The Holy Family in the Desert, Attended by Angels" and "Abraham Sending Away Agar and Her Son Ismael."

BALES (Balesius), **PETER** (1547–1610?), English calligraphist, one of the inventors of shorthand writing, was born in London in 1547, and is described by Anthony à Wood as a "most dexterous person in his profession. . . ." John Evelyn speaks of him as having written, in the year 1575, "the Lord's Prayer, the Creed, Decalogue, with two short prayers in Latin, his own name, motto, day of the month, year of the Lord, and reign of the queen, to whom he presented it at Hampton Court, all of it written within the circle of a single penny, inchased in a ring and borders of gold, and covered with a crystal, so accurately wrought as to be very plainly legible; to the great admiration of her majesty, the whole privy council, and several ambassadors then at court." Bales was very dexterous in imitating handwritings, and between 1576 and 1590 was employed by Walsingham in certain political maneuvers. He was the head of a school near the Old Bailey, London, in 1590, when he published his *Writing Schoolemaster, in three Parts*. This book included an *Arte of Brachygraphie*, which is one of the earliest attempts to construct a system of shorthand. He died about the year 1610.

BALFE, MICHAEL WILLIAM (1808–1870), Irish singer and composer, best known for his opera *The Bohemian Girl*, was born in Dublin, May 15, 1808. He appeared as a violinist at the age of 9 and began composing at about the same time. In 1823 he went to London, where he played in the orchestra at Drury Lane theatre, and in 1825 was taken to Rome by Count Mazzara, a wealthy patron. He had lessons with Ferdinando Paer, and later in Milan. Between 1827 and 1833 he sang leading baritone roles in operas by Rossini, Meyerbeer and others in Paris and Italy. His own early operas were written on Italian librettos and produced at Palermo, Pavia and Milan between 1829 and 1833, when he returned to London. His first English opera, *The Siege of Rochelle*, was produced at Drury Lane in 1835. His popularity was established; in 1838 he sang Papageno in the first English performance of *The Magic Flute*, and with *Le Puits d'amour* (Paris, 1843) he began a series of French operas.

The Bohemian Girl (Drury Lane, 1843) was the most successful of all his operas and was produced in many countries, in French, German, Italian and Russian. The most popular English opera of the first half of the 19th century, it was distinguished by its melodies which, though criticized as conventional and sentimental, are spontaneous and singable. Two of the ballads from it, "When Other Lips" and "I Dreamt that I Dwelt in Marble Halls" have been published in many arrangements.

Balfe also produced several other operas in London, essayed management and conducting, but with little success, and between 1849 and 1864 traveled in France, Germany, Italy and Russia. He retired to Rowney abbey, near Ware, Hertfordshire, where he died, Oct. 20, 1870.

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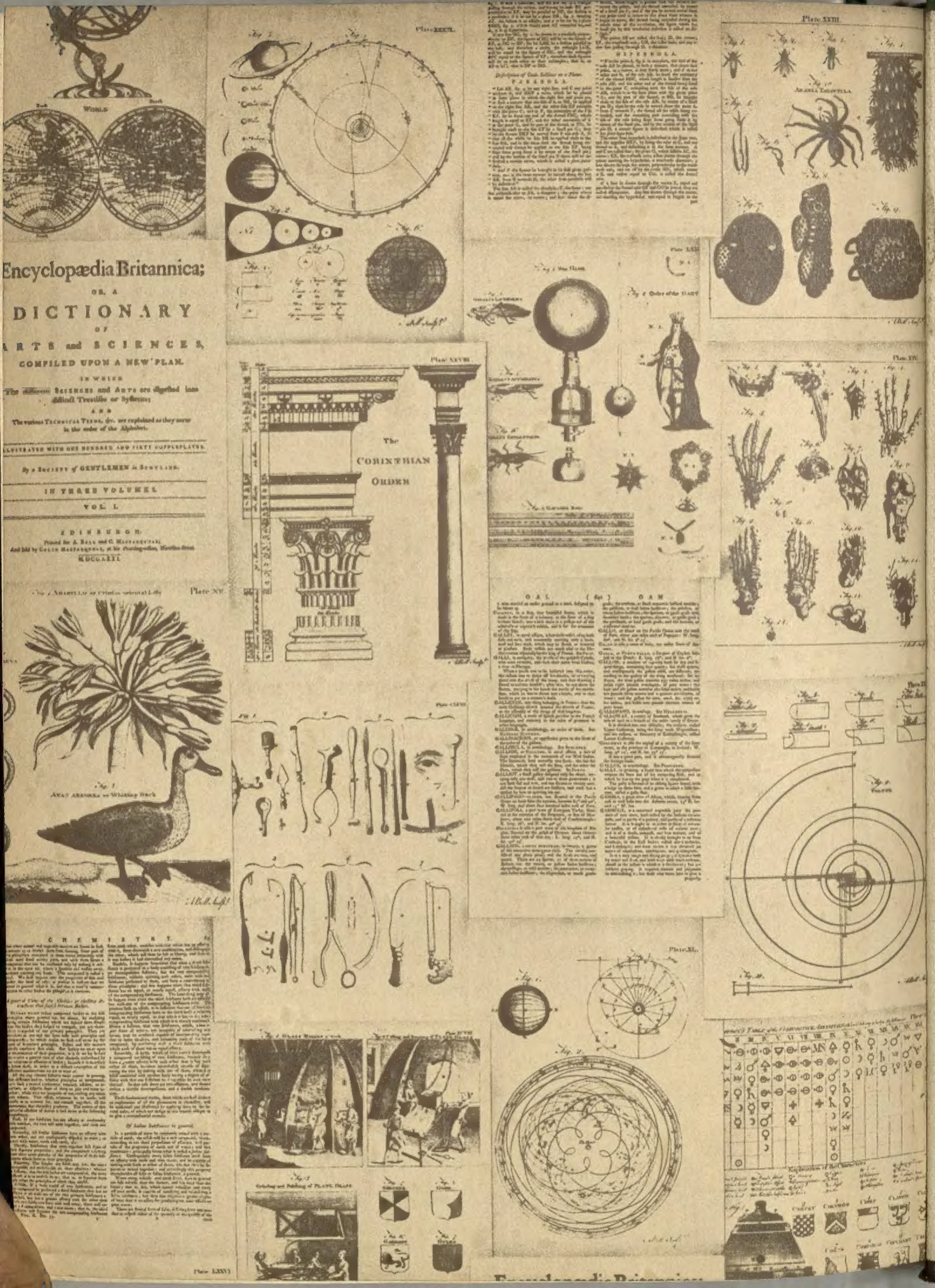

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Plate XXIII.
Plate XXVIII.
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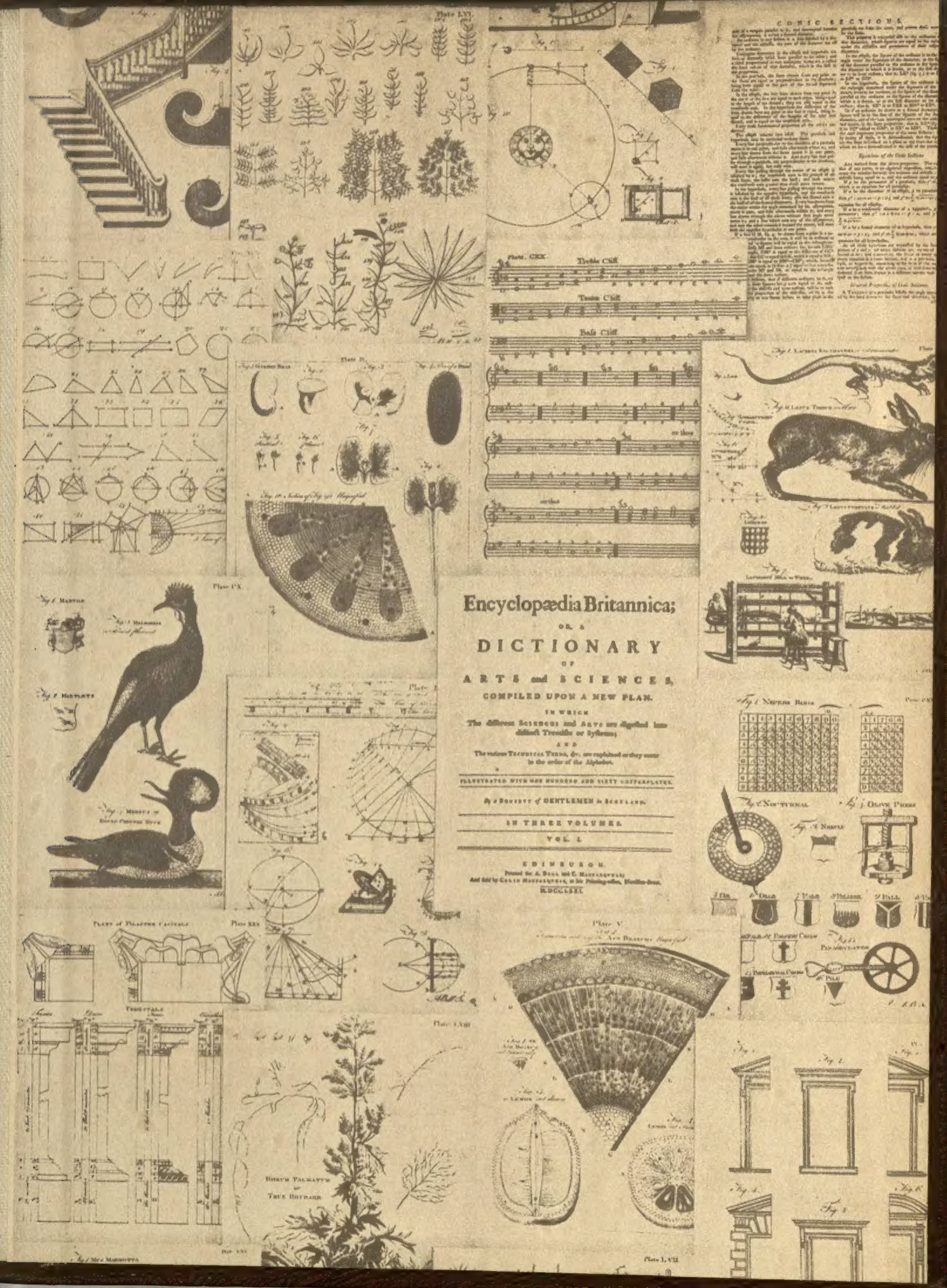
Anas Arborea or Whistling Duck
CHEMISTRY.
Plate XL.



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